IOWA GEOLOGICAL SURVEY

VOLUME XXXII

Annual Reports, 1925 and 1926

with

Accompanying Papers

GEORGE F. KAY, Ph.D., State Geologist
JAMES H. LEES, Ph.D., Assistant State Geologist

Published by
THE STATE OF IOWA
Des Moines
1927

Geology
v. 32
1925-26

Geological Survey Organization

GEOLOGICAL BOARD

His Excellency, John Hammill	Governor of Iowa
Hon. J. C. McClune	Auditor of State
Dr. Walter A. Jessup	President State University
Dr. Raymond A. Pearson	President State College
Mr. R. I. Cratty	President Iowa Academy of Science

ADMINISTRATIVE OFFICERS

George F. Kay	State Geologist
James H. Lees	Assistant State Geologist
Nellie E. Newman	Secretary

GEOLOGICAL SECTION

George F. Kay	Pleistocene Geology
James H. Lees	Areal Geology
William H. Norton	Underground Waters
B. Shimek	Areal Geology
A. O. Thomas	Stratigraphic Geology and Paleontology
John E. Smith	Economic Geology
A. C. Noe	Stratigraphic Geology, Des Moines Series
Harry S. Ladd	Stratigraphic Geology, Maquoketa Formation
Earl T. Apfel	Pleistocene Geology
G. Marshall Kay	Stratigraphic Geology, Decorah Formation
A. C. Tester	Stratigraphic Geology, Cretaceous System

TOPOGRAPHIC SECTION

E. L. McNair	Assoc. Geodetic Engineer
Herbert W. Elmore	Assoc. Cartographic Engineer
Frank L. Whaley	Assoc. Topographic Engineer
H. E. Simmons	Asst. Topographic Engineer
H. R. Kilmer	Topographer
Arthur Johnson	Junior Topographic Engineer
W. R. Broaddus	App. Eng. Field Assistant
J. D. Whitright	Rodman
Earle Fennell	Rodman
Earl Hammack	Rodman

WATER GAGING SECTION

J. B. Spiegel	District Engineer
Karl Jetter	Assistant Engineer
S. C. Fuller, Kalo	Gage Reader
B. S. Beehrle, Marshalltown	Gage Reader
John Strodthoff, Maquoketa	Gage Reader
Mrs. H. H. Sherburne, Clarksville	Gage Reader

E. J. PROLOW, GARBER	GAGE READER
JOHN A. DALE, AMES	GAGE READER
MRS. EMMA CAMERON, JANESVILLE	GAGE READER
C. L. EHRHART, BOONE	GAGE READER
CALVIN K. SMITH, VAN METER	GAGE READER
D. M. COLEMAN, TRACY	GAGE READER
FLOYD A. NAGLER, IOWA CITY	GAGE READER
R. I. COON, AMES	GAGE READER
C. W. WARREN, WAPELLO	GAGE READER
J. A. SCHROEDER, AUGUSTA	GAGE READER
J. W. RICKS, COPPOCK	GAGE READER
FRANK SCHRECKENGAST, KEOSAUQUA	GAGE READER
MRS. J. B. WILLIAMS, KEOKUK	GAGE READER

CONTENTS

LIST OF ILLUSTRATIONS

MAPS

THIRTY-FOURTH AND THIRTY-FIFTH ANNUAL REPORTS OF THE STATE GEOLOGIST

IOWA GEOLOGICAL SURVEY,
DES MOINES, DECEMBER 31, 1926.

To Governor John Hammill and Members of the Geological Board:

GENTLEMEN: I beg leave to transmit to you herewith several papers with the recommendation that they be published as Volume XXXII of the Survey. This volume will constitute the Thirty-fourth and Thirty-fifth Annual Reports of the Iowa Geological Survey. The titles of the papers submitted and the names of the authors of the papers are as follows:

Mineral Production in Iowa in 1925, by James H. Lees.
Mineral Production in Iowa in 1926, by James H. Lees.
Rock Resources of Iowa, by George F. Kay.
Iowa Coal Areas and Characteristics of Iowa Coal, by James H. Lees.
The Use of Iowa Coal for Steam Production, by T. A. Marsh.
Possible Researches in Iowa Coal, by B. P. Fleming.
Geology of Lucas County, by Alvin L. Lugn.
Geology of Crawford County, by James H. Lees.
Altitudes in Iowa, by James H. Lees.

Respectfully submitted,

GEORGE F. KAY,
State Geologist.

MINERAL PRODUCTION IN IOWA IN 1925 AND IN 1926

JAMES H. LEES

ROCK RESOURCES OF IOWA

GEORGE F. KAY

IOWA COAL AREAS AND CHARACTERISTICS OF IOWA COAL

JAMES H. LEES

USE OF IOWA COAL FOR STEAM PRODUCTION

T. A. MARSH

POSSIBLE RESEARCHES IN IOWA COAL

B. P. FLEMING

MINERAL PRODUCTION IN IOWA IN 1925

1923

Products	Unit	Quantity	Value
Cement	Bbl. of 376 lb.	5,570,675	$10,351,971
Clay products	----------	----------	7,033,924
Coal	short tons	5,710,735	20,517,000
Gypsum	short tons	566,724	5,368,532
Mineral waters	gallons	258,831	8,907
Natural gas	M cubic feet	80	172
Sand and gravel	short tons	3,597,160	2,181,881
Stone and lime	short tons	611,866	775,134
			$46,237,521

1924

Products	Unit	Quantity	Value
Cement	Bbl. of 376 lb.	4,881,613	$ 8,811,587
Clay products	----------	----------	5,719,694
Coal	short ton	5,468,450	18,097,000
Gypsum	short ton	640,953	5,657,339
Mineral waters	*no census*		
Natural gas	M. cu. ft.	575	300
Sand and gravel	short ton	2,427,626	1,473,066
Stone and lime	short ton	610,408	739,632
			$40,470,971

1925

Products	Unit	Quantity	Value
Cement	Bbl. of 376 lb.	4,856,849	$ 8,674,563
Clay products	----------	----------	5,726,239
Coal	short tons	4,714,843	14,807,000
Gypsum	short tons	702,661	6,734,271
Natural gas	M cubic feet	200	100
Sand and gravel	short tons	3,297,785	1,546,900
Stone and lime	short tons	808,288	904,669
			$38,393,742

The suggestion made in the report for 1924 that indications pointed toward a continued downward trend in mineral production during the succeeding year was in part justified by events as the total value of the output during 1925 was less than that for 1924, as were the values and quantities of cement and coal sold. However, the other major mineral products showed an increase in both quantity and value of output. Because of this the decrease for 1925 was much less than that for 1924 be-

* Figures compiled by the Iowa Geological Survey in cooperation with the United States Bureau of Mines and the Bureau of the Census. Acknowledgment is made of the use of tables and other data published by these organizations.

low the output of 1923, as the latter diminution amounted to $5,766,550, while the drop in 1925 was $2,077,229.

Preliminary figures for mineral production in the United States show that, unlike Iowa, the country as a whole experienced a revival of favorable conditions, for while production in 1924 had fallen off 11 per cent as compared with 1923, the year 1925 saw a rise of 7 per cent over the preceding year, or stated in figures of value, a change from $5,305,800,000 in 1924 to $5,696,000,000 in 1925. The total value of metallic products in 1925 was $1,380,100,000. Nonmetallic mineral products other than fuels produced in 1925 were valued at $1,293,900,000 while the output of mineral fuels—coal, petroleum, natural gas and natural-gas gasoline, in 1925 had an aggregate value of $3,016,-000,000. Final figures for 1925 were not available when this report was written, but the summary statement shows that in 1924 Iowa ranked as twenty-fourth state and produced 0.87 per cent of the total value of mineral production in that year.

CEMENT

Shipments of portland cement were somewhat less in 1925 than in the preceding year and the value was slightly lower also. Evidently the manufacturers cut their production sharply during 1925 to dispose of some of the large surplus remaining on hand at the close of 1924. Figures for the United States show that Iowa was the only state in which production was less in 1925 than in 1924. In Iowa the decrease was 17 per cent while in other states the increase ranged from 2 per cent in Illinois to 35 per cent in Washington. In the matter of shipments also Iowa dropped 1 per cent below the figures for 1924, while Illinois dropped 3 per cent. Other states increased their shipments from 4 per cent for Pennsylvania to 39 per cent for Washington. Twelve states have four or more factories each while seventeen others have two or less each. Wisconsin began producing and shipping in June, 1924, while South Dakota began producing in December, 1924, and shipping January, 1925. The commercial district which includes eastern Missouri, Iowa, Minnesota and South Dakota has eleven plants. In 1924 the production was 14,822,738 barrels and in 1925 it was 14,571,751 or 2 per cent less, while the shipments in 1924 were 13,984,167 barrels, valued at $24,757,538 and in 1925 they were 14,477,932 barrels, with a value of $25,317,292, an increase in quantity of 4 per cent. The average factory value per barrel was $1.77 in 1924 and $1.75 in 1925.

The appended table shows the production of cement in Iowa during the past three years.

Production of Cement in Iowa, 1923 to 1925

	1923	1924	1925
Production, bbls.	5,732,470	5,624,466	4,648,145
Stock, Dec. 31, bbls.	952,242	1,695,093	1,479.670
Shipments, bbls.	5,570,675	4,881,613	4,856,849
Shipments, value	$10,351,971	$8,811,587	$8,674,563
Average factory price per bbl.	$1.86	$1.81	$1.79
Consumption, bbls.	3,624,857	3,144,001	2,704,872
Consumption per capita, bbl.	1.46	1.26	1.08
Surplus production	1,945,818	1,737,612	2,151,977
Annual finished cement capacity of plants, bbls.	6,875,000	6,685,000	6,935,000
Daily clinker capacity, bbls.	19,308	20,300	20,603
Number rotary kilns	28	28	28

The producing companies remained the same as in previous years except that the Gilmore factory was sold on October 7 to the Northwestern States Company. The list of producers in 1925 and 1926 was as follows:

Hawkeye Portland Cement Co., Des Moines; office 806 Hubbell Building, Des Moines
Lehigh Portland Cement Co., Mason City; office Young Bldg., Allentown, Pa.
Northwestern States Portland Cement Co., Gilmore City and Mason City; office First National Bank Bldg., Mason City
Pyramid Portland Cement Co., Valley Junction; office 508 Insurance Exchange, Des Moines.

CLAY WARES

The value of clay wares produced in 1925 was somewhat greater than the output of the preceding year, although it fell considerably short of the value for 1923. The increase in 1925 was due chiefly to the larger volume of brick and sewer pipe which was sold. The sales of most other classes of ware were somewhat below those for the preceding year. Hollow building tile of various kinds was the leading product and sewer pipe was second with drain tile a close third. Thirty-seven counties have clay wares plants and among these Cerro Gordo maintains the lead it has held for many years, Webster is second, Polk third, Dallas fourth and Woodbury fifth. The production of various wares in recent years was as follows:

Class	Plants			Quantity			Value		
	1923	1924	1925	1923	1924	1925	1923	1924	1925
				thous.	*thous.*	*thous.*			
Common brick	52	51	42	72,558	62,070	73,004	$ 921,853	$ 737,898	$ 855,305
Vitrified brick	4	4	1	31,523	6,507	d7,361	513,684	129,314	d184,939
Face brick	22	19	19	29,426	23,785	30,654	593,791	451,136	536,545
				tons	*tons*	*tons*			
Hollow bld. tile[a]	44	37	44	297,253	243,712	275,781	2,197,515	1,740,296	1,802,145
Hollow bld. tile[b]	8	16	8	26,073	53,412	43,227	195,006	446,246	316,116
Drain tile	54	54	48	173,678	147,499	119,993	1,508,836	1,266,586	925,958
Sewer pipe	5	5	15	54,828	52,998	67,035	865,676	793,840	929,294
Other products[c]							237,563	154,379	175,937
	64	69	67				7,033,924	5,719,694	5,726,239

a Includes partition, load-bearing, etc.
b Includes floor, arch, silo, etc.
c Includes flue lining, pottery, raw clay, miscellaneous wares.
d Includes wall coping and roofing tile.

Iowa ranks as the twenty-third state in value of common brick sold, fifteenth in value of face brick, fifth in value of hollow building ware, second in value of drain tile and eighth in value of sewer pipe. For many years Iowa led in the making of drain tile, but drain tile is distinctly an agricultural material, much of Iowa's farm land has been drained and agricultural conditions of late have not been conducive to the purchase of tile. Hence Ohio now stands first in making of this ware with an output valued at $1,344,847 compared with Iowa's output of $925,958. Indiana is third with a production valued at $827,518 and Illinois ranks fourth with an output of $707,859. The other states are all considerably behind these four.

The output of various classes of clay wares in the United States in 1925 was as follows:

Class	Quantity	Value
Common brick, M	7,565,819	$88,607,199
Vitrified brick for paving, M	448,492	10,350,093
other uses, M	90,609	1,525,604
Face brick, M	2,474,690	45,427,625
Fancy brick, M	1,701	50,279
Enameled brick, M	16,931	1,507,659
Terra cotta, tons	152,441	19,138,690
Hollow building tile, tons	4,228,286	29,274,545
Roofing tiles, squares	289,956	5,155,301
Other tile, square feet	74,656,401	21,968,508
Drain tile, tons	660,673	4,960,423
Sewer pipe, tons	2,138,672	30,420,828
Stove lining, tons	25,852	656,139
Flue lining, tons	182,267	2,480,327
Wall coping, tons	37,124	381,367
Fire brick, M	998,889	41,163,701
Clay sold, tons	656,918	3,482,236
Other clay products		8,426,249
Total except pottery		314,976,773
Pottery		112,018,500

The following list gives the output of different wares by counties or by groups of counties which have less than three producers each. Statistics are given in as much detail as possible without revealing the production of individual operators. Counties are grouped according to geographic proximity as much as possible.

Production of Clay Wares in Iowa in 1925

Counties	No. Producers	Face brick and Common brick (1)		Hollow ware		Drain tile		Other products (2)	
		thous.	*value*	*tons*	*value*	*tons*	*value*	*value*	*value*
Allamakee (1), Fayette (1), Floyd (1), Grundy (1)	4	6,759	$ 90,354	18,059	$132,152	(a)			$ 222,506
Appanoose (1), Marion (1), Wapello (2)	4	12,467	142,959	12,488	72,919	4,557	$ 25,593		241,471
Audubon (2), Guthrie (1)	3	198	2,807	1,212	9,703	1,544	9,578		22,088
Benton (1), Tama (3)	4	2,709	39,408	152	1,395	1,516	13,779		54,582
Boone (1), Hamilton (1), Hardin (1), Story (2), Wright (1)	6	5,301	70,647	1,786	11,000	2,727	26,834	$ 23,307(5) (10)	131,788
Cerro Gordo	3	4,975	72,833	160,124	1,011,398	42,839	341,999	(8)(b)	1,426,230
Dallas	3	4,272	74,138	51,762	378,790	10,956	73,940		526,868
Dubuque (1), Jackson (1), Johnson (2), Jones (1), Scott (1)	6	785	12,165		(c)	1,561	11,182	26,477(3)(8)(9)	49,824
Henry (1), Lee (1), Washington (2)	4	148	2,380	276	1,997	2,619	17,587		21,964
Jasper (2), Poweshiek (1)	3	110	1,614	1,741	13,042	1,312	13,261	(8)(d)	27,917
Jefferson (1), Keokuk (3), Mahaska (2)	6	3,168	49,921	5,232	31,874	9,334	74,757	198,618(5)(7)(8)	355,170
Polk	6	25,613	378,810	18,911	121,242	5,399	47,802	360,853(5)(6)	908,707
Sac (1), Union (1), Warren (1), Woodbury (2)	5	32,541	403,507	21,779	135,389	2,975	24,045		562,941
Webster	8	4,595	50,561	31,479	245,986	25,920	188,016	684,840(5)(7)(8)(10)	1,169,403
Totals	67	103,658	$1,391,850	319,011	$2,118,261	119,993	$925,958	$1,290,170	$5,726,239

(a) Included with hollow ware. (b) Included with brick. (c) Included with other products. (d) Included with drain tile. Amounts and values of these items are included with state totals for classes to which they belong.

(1) Includes: Common brick, 73,004,000, value, $855,305; Face brick, 30,654,000, value, $536,545.

(2) Includes: (5) Sewer pipe, 5 producers, 67,035 tons, value, $929,294; (6) Vitrified brick and (8) roofing tile and other, unspecified, products, 7 producers, $264,398; (7) Flue lining, 3 producers, 5,306 tons, value, $57,830; Wall coping, 3 producers, 1,087 tons, $15,946; (9 and 10) Earthenware and raw clay sold, 4 producers, value, $22,602.

The list given herewith shows the operators who reported production in 1925 to the Bureau of the Census, together with the kinds of clay ware which they produced, according to the following schedule: 1, common brick; 2, face brick; 3, fancy brick; 4, building tile; 5, vitrified brick; 6, drain tile; 7, sewerpipe; 8, other products; 9, pottery; 10, raw clay sold.

Allamakee County
Postville Mfg. Co., Postville, office Minneapolis, Minn.
Appanoose County
Centerville, Centerville Brick Co., 1
Audubon County
Audubon, Audubon Brick & Tile Works, 1, 4, 6
Kimballton, Crystal Springs Clay Works, 1, 3, 6
Benton County
*Atkins, Rinderknecht Bros.
Belle Plaine, Buckeye Clay Products Co., 4, 5
Garrison, Garrison Brick & Tile Works, 1, 4, 6
Black Hawk County
*Waterloo, Art Novelty Pottery (William Raab), 9
*Waterloo, Waterloo Granite Brick Co., 1
Boone County
Boone, Boone Brick, Tile & Paving Co., office Des Moines, 1, 2, 5
Buena Vista County
Linn Grove, Linn Grove Brick & Tile Co., 1, 4, 6
*Sioux Rapids, Sioux Rapids Drain Tile Works, 1, 4, 6
Cedar County
*Tipton, Tipton Brick & Tile Works, 1, 4, 6
Cerro Gordo County
Mason City, Mason City Brick & Tile Company, 1, 2, 4, 6
Mason City, National Clay Works, 1, 2, 4, 6
Mason City, North Iowa Brick & Tile Co., 4, 6
Clayton County
Clayton, Clayton Brick and Tile Co., 1, 4
Dallas County
Adel, Adel Clay Products Co., 1, 2, 4, 6
Redfield, Redfield Brick & Tile Company, 1, 4, 6
Van Meter, Platt Company, Inc., 1, 4, 6
Dubuque County
*Dubuque, Frank Beutin, 1
*Dubuque, Clayton Brick & Tile Co., 1, 4, 6
Dubuque, John L. Heim & Son, 1
Fayette County
Clermont, Clermont Brick & Sand Co., 1, 2, 4
Floyd County
Rockford, Rockford Brick & Tile Company, 1, 2, 4, 6
Franklin County
*Sheffield, Sheffield Brick & Tile Co., 1, 4, 6
*Sheffield, Smith Brick & Tile Co., 1, 4, 6
Grundy County
*Reinbeck, Gethmann Brick Co., office Gladbrook, 2
Guthrie County
Glendon, Glendon Brick & Tile Co. (Robert Goodwin, Jr.) office Menlo, 1, 4, 6
Hamilton County
Webster City, National Sewer Pipe Co., 6, 7, 8
Also has clay pit at Nevada, Story Co., 10
*Webster City, Therm-A-Jug Co., 9
Hardin County
Eldora, Eldora Sand Co., 10
*Eldora, Estate of Henry L. Huff, 10
Henry County
Winfield, Winfield Brick & Tile Works (J. E. Pierce), 1, 4, 6
Howard County
*Cresco, (Cresco Brick & Tile Works) C. A. Marshall, 1, 4, 6
Jackson County
Bellevue, Bellevue Clay Products Company, 1, 4, 6, 9
Jasper County
Lynnville, Lynnville Brick & Tile Works (C. H. Newby), 4, 6
Newton, Newton Clay Products Co., 1, 4, 6
Jefferson County
*Batavia, Batavia Brick and Tile Co., 1, 4, 6
Packwood, S. F. Steigleder & Son, 6
Johnson County
Iowa City, Ferd. Goss Brick Yard, 1
Tiffin, Tiffin Tile Company, 1, 6
Jones County
Monticello, Monticello Clay Works (Frank D'Autremont), 6

Keokuk County
- Hedrick, Hedrick Tile Works, 1, 4, 6
- Keota, Iowa Clay Products Co., office Washington, 1, 4, 6
- *Richland, Iowa Clay Products Co., office Washington, 1, 4, 6
- *What Cheer, Nelson Bros. & Sundberg, 1, 9
- What Cheer, What Cheer Clay Products Co., 4, 6, 7, 8

Lee County
- Fort Madison, Julius Reichelt, 1

Mahaska County
- New Sharon, Peter Meyer, 1, 6, 8
- *New Sharon, Cecil Bros., 1, 4, 6
- Oskaloosa, Standard Clay Products Co., 1, 2

Marion County
- Harvey, Standard Clay Products Co., office Oskaloosa, 4, 6
- Knoxville, Knox Clay Products Co., Inc., 1, 4, 6

Muscatine County
- *Muscatine, Charles Stark, clay pipes

Palo Alto County
- *Graettinger, Graettinger Tile Works, 6

Polk County
- Des Moines, The Capital Clay Company, 1, 2
- Des Moines, Des Moines Clay Company, (2 plants), 1, 2, 4
- Des Moines, Des Moines Brick & Tile Co., 4, 6, 10
- Des Moines, Flint Brick Company, 1, 5
- Des Moines, Goodwin Tile & Brick Co., 4, 6
- Des Moines, Iowa Pipe & Tile Co., 6, 7, 8

Poweshiek County
- Grinnell, Grinnell Clay Products Co., 1, 4, 6

Sac County
- Auburn, Auburn Brick & Tile Company, 4, 6

Scott County
- LeClaire, W. E. Martin & Sons, Inc., 1, 4, 6
- *Pleasant Valley, Martin & Sons, 1, 4, 6

Story County
- Maxwell, Maxwell Brick and Tile Co., 1, 2, 4, 6
- Nevada, Nevada Brick & Tile Works, 1, 4, 6
- Nevada, National Sewer Pipe Co. (T. J. Lyman), 10

Tama County
- Dysart, Dysart Brick & Tile Company, 1, 6
- Gladbrook, The Gethmann Brick Co., 2
  Also has plant at Reinbeck, Grundy Co., 2
- Gladbrook, Gladbrook Press Brick & Tile Co., 1, 2, 6
- *Tama, Tama Brick & Tile Co., 1, 4, 6

Union County
- Creston, Creston Brick & Tile Works, 1, 2, 4, 6

Wapello County
- Eldon, Iowa Clay Products Co., office Washington, 1, 4, 6
- Ottumwa, Morey Clay Products Co., 1, 2, 4, 6
- *Ottumwa, Ostdeik Brick Works, 1, 4, 6

Warren County
- Carlisle, Carlisle Clay Products Co., Inc., 4, 6

Washington County
- Kalona, Kalona Clay Co., Inc., 1, 4, 6
- Washington, Washington Brick & Tile Works, 1, 4, 6

Webster County
- Clayworks, Johnson Clay Works, Inc., 1, 2, 4
- Fort Dodge, Bradshaw & Company, 1, 2, 4, 6
- *Fort Dodge, Coats Mfg. Co., 4
- Fort Dodge, Fort Dodge Brick & Tile Co., 1, 4
- Fort Dodge, Plymouth Clay Products Co., 6, 7, 8
- Fort Dodge, Vincent Clay Products Co., 4, 6
- Lehigh, Lehigh Sewer Pipe & Tile Co., office Fort Dodge, 6, 7, 8
- Lehigh, George F. Drain, 10
- Otho, Kalo Brick & Tile Company, office Ft. Dodge, 1, 2, 4, 5, 6

Woodbury County
- *Correctionville, Woodbury County Tile Plant, 6
- Sergeant Bluff, Ballou Brick Company, office Kansas City, Mo., 1, 2
- *Sioux City, Lehigh Sewer Pipe & Tile Co., 6, 7
- Sioux City, Sioux City Brick & Tile Co., 1, 2, 8
- *Sioux City, Sioux City Crockery Co., 9

Wright County
- Goldfield, Goldfield Brick & Tile Works, 1, 4, 6

COAL

Coal production in Iowa continued the downward trend which was noticeable in the industry in the two preceding years. While

* Added from Bulletin 16 of the Iowa Bureau of Labor, 1925.

the tonnage raised in 1925 was larger than that of 1921 or of 1922, still it was smaller than that of 1923 or of 1924. The value at the mines of the 1925 output was smaller than that of any year since 1916. One reason for the prevailing condition seems to be the increasing use of the higher priced but cleaner coals from states farther east, some of which are operating on a non-union basis.

Conditions somewhat similar to those affecting Iowa in recent years seem to have been prevalent over the country as a whole, if one may judge from the figures given below.

Production of Coal in Iowa and the United States

Iowa			United States*		
Year	tons	value	Year	tons	value
1916	7,260,800	$13,530,383	1916	502,519,682	$ 665,116,077
1917	8,965,830	21,096,408	1917	551,790,563	1,249,272,837
1918	8,192,195	24,703,237	1918	579,385,820	1,491,809,940
1919	5,624,692	17,352,620	1919	465,860,058	1,160,616,013
1920	7,813,916	30,793,847	1920	568,666,683	2,129,933,000
1921	4,531,392	17,256,800	1921	415,921,950	1,199,938,000
1922	4,335,161	16,119,000	1922	422,268,099	1,274,820,000
1923	5,710,735	20,517,000	1923	564,564,662	1,514,621,000
1924	5,468,450	18,097,000	1924	483,686,538	1,062,626,000
1925	4,714,843.	14,807,000	1925	522,967,000	1,046,000,000

As an indication of the methods used in recovering Iowa coal the following tables will be of interest.

Coal mined in Iowa in 1925 was produced as follows:

	tons	*per cent*
Mined by hand	901,839	19.1
Shot off solid	2,780,633	59.0
Machine cut	922,405	19.6
Strip pits	229	
Not specified	109,737	2.3
	4,714,843	

An article in the August, 1927, Coal Age by H. O. Rogers of the U. S. Bureau of Mines gave the results of a study of underground haulage as practiced over the United States in 1924. During that year 7,361 soft coal deep mines used 36,352 animals and 14,723 locomotives in addition to 649 rope haulage units. These latter included only haulage on the bottom and not hoists. A total of 3,585 mines reported the use of some type of underground locomotive and these mines produced 88 per cent of the

* Bituminous coal only. Figures for 1925 are estimates.

coal mined. The other 3,776 mines produced 12 per cent of the total output. The following data refer to Iowa.

Mines using animals only	228	Per cent total production	48.4
Animals used	614	Mines using locomotives only	2
Rope haulage units	31	Locomotives used	4
Tons produced	2,715,190	Tons produced	105,842
Per cent total production	49.7	Per cent total production	1.9
Mines using locomotives and animals	26	Total mines	256
Animals used	365	Animals used	979
Locomotives used	62	Rope haulage units	31
Tons produced	2,647,418	Locomotives used	66
		Tons produced	5,468,450

The 66 locomotives are classified as follows:

Storage battery, with trolley	4	Electric trolley	58
Storage battery without trolley	2	Gasoline	2

Production methods are shown also by the following table:

Mines using electric locomotives	28	Mines using no electric locomotives	228
Locomotives used	64	Tons produced	2,637,538
Tons produced	2,830,912	Per cent of production	48.2
Per cent of production	51.8		

The accompanying table giving detailed figures of production in the different counties shows that twenty-three counties produced coal in 1925 and that among these Marion was the leader, Monroe was second, losing the position held for so many years, Polk was third, Appanoose fourth and Lucas fifth. The number of mines reporting was 208, although it may be noted that the State Mine Inspectors' report, which may be somewhat more complete, as the inspectors are on the ground, lists 354 mines as being active in 1925. The same document reports 4,833,631 tons as being the production during this year, or 118,788 tons more than the figures compiled by the Bureau of Mines. The state inspectors also report a total of 11,241 men employed as against the number 10,167 reported to the federal bureau.

Statistics of coal production in Iowa in 1925

Counties	No. producers	Loaded at mines for shipment	Sold to local trade	Used at mine	Total production		Average value per ton at mine	Number of employees			Average number of days worked
		tons	*tons*	*tons*	*tons*	*value*		Underground	Surface	Total	
Adams	4		4,881		4,881	$ 19,000	$3.89	21	4	25	155
Appanoose	54	466,491	74,022	4,507	545,020	1,860,000	3.41	2,491	198	2,689	96
Boone	7	325,836	43,097	5,023	373,956	1,481,000	3.96	785	63	848	171
Dallas	5	363,810	9,826	1,527	375,163	1,178,000	3.14	758	65	823	154
Davis (1), Lucas (2)	3	503,289	10,953	(a)	514,242	1,545,500	4.15,3.00	547	60	607	70, 216
Greene (1), Story (1), Webster (1)	3		12,122	(b)	12,122	36,000	1.89, 3.21, 3.65	43	4	47	120, 150, 192
Guthrie	4		4,053		4,053	16,000	3.95	22	4	26	131
Jasper	8	(b)	37,795	3,539	41,334	140,000	3.39	203	34	237	70(c)
Jefferson (1), Van Buren (2)	3	(b)	6,743	(b)	6,743	16,000	2.84,2.21	19	2	21	179, 123
Keokuk	5		6,882		6,882	21,000	3.05	21	2	23	145
Mahaska	22	(b)	43,430	513	43,943	131,000	2.98	106	12	118	152
Marion	15	898,191	30,126	19,632	947,949	2,811,000	2.97	914	86	1,000	233
Monroe	11	765,105	24,393	24,869	814,367	2,393,000	2.94	1,293	100	1,393	188
Page (2), Taylor (3)	5	(b)	33,611	(b)	33,611	146,000	4.26, 4.57	99	11	110	245, 160
Polk	19	322,586	336,266	12,020	670,872	2,179,000	3.25	1,511	120	1,631	139
Wapello	18	(b)	60,580	(b)	60,580	193,000	3.19	123	21	144	146
Warren	3	64,540	159,656	5,728	229,924	566,000	2.46	279	34	313	204
Wayne	4	(b)	29,201	(b)	29,201	75,000	2.57	100	10	110	128
Totals	193	3,711,654	905,840	97,349	4,714,843	$14,807,000		9,337	830	10,167	153

(a) Included in Loaded at mines; (b) Included in Local trade; (c) This low figure was due to the very short time of operation of the Colfax Consolidated mines. Other mines operated from 150 to 225 days.

The list of operators was as given below.

Adams County
Joe Aukeny, Villisca
John G. Henton, Carbon, R.F.D. 1
Jones Coal Co., Carbon
Lockwood Coal Co., Corning
Pleasant Valley Coal Co., Nodaway
Smith & Robinson, Carbon
Appanoose County
Acken Coal Co., Mystic
Anchor Coal Mining Co., Ridgeway
Appanoose Coal & Fuel Co., Mystic
Appanoose County Coal Co., Centerville
Armstrong Coal Co., Commerce Bldg., Kansas City, Mo.
Barrett Coal Co., Mystic
Beggs Coal Co., Mystic
Bradshaw Coal Co., Dean
Brand Coal Co., Plano
Brazil Coal Co., Brazil
Caldwell Coal Co., Exline
Frank Casale, Centerville
Center Coal Co., Centerville
Centerville Block Coal Co., Centerville
Citizens Coal Co., Centerville
Clarke Coal Co., Centerville
Diamond Block Coal Co., Mystic
Domestic Coal Co., Cincinnati
Duff Coal Co., Mystic
Egypt Coal Co., Mystic
Empire Coal Co., Centerville
Fairlawn Coal Co., Centerville
Fenton Coal Co., Plano, R.R. 1
Fowler & Wilson Coal Co., Centerville
Friendship Coal Co., Cincinnati
Garfield Coal Co., Mystic
Helman Bros. Coal Co., Plano
High Test Coal Co., Centerville
C. P. Houser, Seymour
Hunt Bros. Coal Co., Mystic
Iowa Block Coal Co., Exline
Johnson Kelly, Centerville
O. A. Koontz, Centerville
Liberty Coal Co., Mystic
Little Walnut Coal Co., Mystic
Allen Long Coal Co., Centerville
W. W. Lowe, Brazil
Maddalozzi Coal Co., Mystic
McConville Coal Co., Centerville
Monitor Coal Co., Centerville
Mystic Coal Co., Mystic
New Oriental Coal & Mining Co., Centerville
New Phoenix Coal Co., Brazil
North Hill Coal Co., Centerville
Numa Coal Co., Numa
Peacock Coal Co., Brazil
Prospect Coal Co., Exline
Raney Coal Co., R.R. 2, Centerville
Rathbun Coal Co., Rathbun
Rock Valley Coal Co., Centerville
Rosebrook Coal Co., Centerville
Ryals-Yagzy Coal Co., Des Moines
E. Scritchfield, Cincinnati
Service Coal Co., Mystic
Sleeth Coal Co., Coal City
South Side Coal Co., Centerville
Sunshine Coal Co., Mystic
Star Coal Co., Centerville
Swanson Coal Co., Centerville, R.R. 2
Thistle Coal Co., Centerville
J. A. Truby, Mystic
Wakefield Coal Co., Brazil
White Oak Coal Co., Exline
Winifred Coal Co., Mystic
Boone County
Boone Coal Co., Boone
S. O. Currier Coal Co., Pilot Mound
W. D. Johnson Coal Co., Boone
Madrid Coal Co., Equitable Bldg., Des Moines
Richard May Coal Co., Lehigh
Ogden Coal Co., Boone
Chas. Otis Coal Co., Boone
Scandia Coal Co., 606 Grand Ave., Des Moines
Dallas County
Dallas Coal Co., Liberty Bldg., Des Moines
Dallas Products Co., Madrid
Norwood-White Coal Co., 408 6th Ave., Des Moines
Radiant Coal Mining Co., 907 So. Surety Bldg., Des Moines
Scandia Coal Co., 606 Grand Ave., Des Moines
Shuler Coal Co., 802 So. Surety Bldg., Des Moines
Davis County
Henderson and Goodwin Coal Co., Floris
Lunsford Bros. Coal Co., Bloomfield
Greene County
Buckeye Coal Co., Rippey
Keystone Coal Co., Rippey
Riverside Coal Co., Rippey
Guthrie County
J. E. Lewis Coal Co., Yale
Love Coal Co., Panora
Mallon Coal Co., Guthrie Center
John Mansell Coal Co., Guthrie Center
W. H. Scott, Guthrie Center, R. R. 5
H. M. Sipe Coal Co., Guthrie Center
Jasper County
Colfax Consolidated Coal Co., Colfax
Jeffreys & Binder Coal Co., Newton
McKeevers Coal Co., Colfax
T. J. Morris Coal Co., Colfax
D. E. Norris Coal Co., Prairie City
Prairie City Coal Co., Prairie City
Howard Sheeter Coal Co., Monroe

Sunny Brook Coal Co., Colfax
William White Coal Co., Prairie City

Jefferson County
R. B. Cross, Birmingham, R.R. 2
C. S. Henness, Fairfield

Keokuk County
Big Four Coal Co., What Cheer
Carson Bros., What Cheer
Newcomb Bros. Coal Co., What Cheer
O. W. Olive Coal Co., Delta

Lucas County
Central Iowa Fuel Co., 1219 So. Surety Bldg., Des Moines
Lucas Coal Co., Lucas

Mahaska County
Adams Coal Co., Oskaloosa
Adey & Leibris, Givin
Chas. Ahrweiler, Oskaloosa
Rosser Davis Coal Co., Beacon
Dixon Coal Co., Oskaloosa
Edwards Bros. Coal Co., Beacon
A. M. Ellis Coal Co., Givin
Evans & Hasselman Coal Co., Eddyville
Equality Coal Co., Albia
Frehn and Cons Coal Co., Oskaloosa
R. H. Furnald Coal Co., Oskaloosa
Steve Gasper & Steve Gergley, Lakonta
Givin Coal Co., Givin
Hynick Coal Co., Givin, R.R. 1
Jones & Mathis Coal Co., Givin
Lanning Coal Co., Oskaloosa
Lee Coal Co., What Cheer
Thomas Lewis, Givin
Matrison & Morris, Oskaloosa
Nelson Bros., Oskaloosa
O'Brien & Allen, Beacon
Roberts Bros. Coal Co., Oskaloosa
Snook & Sons Coal Co., Oskaloosa
Swanson & Hohn Coal Co., Oskaloosa
Sweitzer Coal Co., Eddyville
O. R. Thompson Coal Co., Givin, R.F.D.
White Bros., Rose Hill
Williams Coal Co., New Sharon
Woodward & Boggs Coal Co., Oskaloosa

Marion County
Perry Brown Coal Co., Knoxville
Geo. L. Burt Coal Co., Knoxville
Consolidated Ind. Coal Co., 139 West Van Buren St., Chicago, Illinois
Dunreath Coal Co., Des Moines
Chas. Fortner Coal Co., Flagler
Gold Goose Coal & Mining Co., Albia
Hayes Bros. Coal Co., Knoxville
Holland Coal Co., Des Moines
Horse Shoe Coal Co., Bussey
C. C. Kendall Coal Co., Marysville
Knox Coal Co., Knoxville
Walter McElrea, Dallas
McKenzie Bros. & Cook Coal Co., Harvey
Miller Coal Co., Knoxville
Mulkey & Thomas, Knoxville
Pershing Coal Co., 6th Fl. Ins. Exch. Bldg., Des Moines
Red Rock Coal Co., Des Moines
Success Coal Co., Otley
Vanceunebrak Bros. Coal Co., Knoxville
Vernon Coal Co., Dallas

Monroe County
Air Line Coal Co., Albia
Albia Coal Co., Ottumwa
Central Coal Co., Oskaloosa
Lockman Coal & Mining Co., Lockman
DeRoss Coal & Mining Co., Albia
Graham Coal Co., Avery
Hocking Coal Co., Hocking
Lovilia Coal Co., Lovilia
Maple Coal Co., 803 So. Surety Bldg., Des Moines
Smoky Hollow Coal Co., Albia
Superior Coal Co., Gillespie, Ill.

Page County
Evans Coal Co., Clarinda
Pearson Coal Co., Clarinda

Polk County
Acme Coal Mining Co., Des Moines
Adelphi Coal & Mining Co., 2300 East 24th St., Des Moines, Iowa
Beck Coal & Mining Co., 507 6th Ave., Des Moines
Bennett Bros. Coal Co., 427 Grand Ave., Des Moines
Bloomfield Coal & Mining Co., 513 E. Grand Ave., Des Moines
Clover Leaf Coal Co., Des Moines
Commerce Coal Co., Commerce
Des Moines Coal Co., 910 Grand Ave., Des Moines
Des Moines Ice & Fuel Co., 100 Maple St., Des Moines
Diamond Joe Coal Co., Runnells
Eagle Fuel Co., 716 Grand Ave., Des Moines
Economy Coal Co., 418 Hubbell Bldg., Des Moines
Flint Brick & Coal Co., 411 8th St., Des Moines
Independent Coal Co., Des Moines
Moore Coal Co., Des Moines
Norwood-White Coal Co., 408 6th Ave., Des Moines
Saylor Coal Co., 606 Grand Ave., Des Moines, Iowa
Urbandale Coal Co., 804 11th St., Des Moines

Story County
Summit Coal Co., Ames, Iowa

Taylor County
Bean Coal Co., New Market
New Market Coal Co., New Market
Richardson Coal Co., Gravity

Van Buren County
J. Daniels & Sons, Douds
Hugh Findlay Coal Co., Douds

James Tweedy Coal Co., Mount Zion
J. H. Logan, Mount Zion

Wapello County
Charles Akers Coal Co., Ottumwa
Best Coal Co., Ottumwa, R.F.D.
Brooke Coal Co., Ottumwa, R.F.D.
R. E. Cooper, Ottumwa
J. W. Dawson Coal Co., Kirksville
W. O. Donaldson Coal Co., Ottumwa
Arthur Gardner Coal Co., Ottumwa
Genochio & Peterson Coal Co., Ottumwa
Gibbs Bros. Coal Co., R.F.D., Ottumwa
Glendale Coal Co., 1317 Castle St., Ottumwa
Glenn Bros. Coal Co., R.F.D., Ottumwa
Hartwig Bros. Coal Co., Eldon
Haseltine Coal Co., Ottumwa
Jones & Rowley, Blakesburg, R.R. 3.
Louis Kellar Coal Co., Eldon
Lone Star Coal Co., Eldon
Mat Mier Coal Co., 914 E. 4th St., Ottumwa
Mier Coal Co., R.R. 8, Ottumwa
Mohohan Coal Co., Ottumwa
Richard Reese Coal Co., Ottumwa
Rutledge Coal Co., R.R. 3, Ottumwa
George Simmer Coal Co., Ottumwa
Simpson Bros. & Howard, Ottumwa
Union Coal Co., Ottumwa

Warren County
Des Moines Ice & Fuel Co., 100 Maple St., Des Moines
Great Western Coal Co., 201 Equitable Bldg., Des Moines
Indian Valley Gloss Coal Co., 606 Observatory Bldg., Des Moines

Wayne County
L. E. Bennett, R.R. 2, Promise City
Peter Ripper, Harvard
Rissler & Yocum, Promise City
Seymour Coal Co., Seymour
Violet Valley Coal Co., Seymour

Webster County
Geo. Marcy Coal Co., Lehigh

GYPSUM

The gypsum industry in Iowa showed a gratifying advance during 1925 and maintained the record it has held for several years—of increasing its production over that of each preceding year. This increased production was shared by all but one of the operating concerns and it was spread over practically every phase of the industry, from the quantity mined to the quantities and values of the various finished products. The following table gives data for the past two years and shows the growing output from Iowa mills.

Production of Gypsum in 1924 and 1925

	1924		1925	
	tons	*value*	*tons*	*value*
Crude gypsum mined	727,385		800,167	
Sold crude—to cement mills	149,972	$ 371,331	134,200	$ 330,001
For agricultural and other uses	1,236	8,098	6,251	51,585
Total sold crude	151,208	379,429	140,451	381,584
Sold calcined—as stucco	68,280	459,044	21,329	137,903
as neat plaster	313,521	2,451,273	380,124	2,918,414
as sanded plaster, etc.	1,230	11,031	25,837	185,313
as plaster of Paris	5,503	55,626	3,192	37,503
as dental plaster, Keene's cement, plate glass works	3,660	31,770	4,031	33,221
as plaster board, wall board	55,486	1,719,322	71,754	2,332,141
as partition and other tile	42,065	549,844	50,835	529,581
for insulating, fire proofing, other purposes			5,108	178,611
Total sold calcined	489,745	5,277,910	562,210	6,352,687
Total sold	640,953	$5,657,339	702,661	6,734,271

The table shows that there was an increase of 72,782 tons in the crude gypsum raised and that while the amount sold as cement retarder was less in 1925 the amount used as land plaster was larger as was that used raw for other purposes, so that the value of the raw material sold was $2,155 more in 1925 than in 1924. The total amount of wall plaster sold in 1925 was 427,280 tons, valued at $3,241,630. This exceeded the sales of the previous year by 44,249 tons and $320,288. The total output in 1925 was larger than that of 1924 by 61,608 tons and the increased value amounted to $1,076,932.

One item of interest in the industry was the sale by the Centerville Gypsum Company of anhydrite, the form of gypsum which has no water of crystallization, for poultry grits. Some parts of the Centerville deposit contain a good deal of anhydrite and as this can not be used in making plasters its use as grits and for similar purposes represents a distinct saving.

Iowa continued to hold second rank in the gypsum industry in 1925, New York having a long lead and Ohio coming in a close third. In 1924 Michigan's total output exceeded that of Iowa by $293,483, but in the next year Iowa outstripped Michigan by $1,286,977. The following table shows the production of the leading states.

Production of Gypsum in the United States in 1925

	Plants	Mined	Sold crude		Sold calcined		Total value
		Tons	*Tons*	*Value*	*Tons*	*Value*	
Iowa	7	800,167	140,451	$381,584	562,210	$6,352,687	$6,734,271
Kansas	3	166,952	52,869	126,886	87,656	882,624	1,009,510
Michigan	5	649,053	155,961	391,093	477,076	5,056,201	5,447,294
Nevada	6	350,130	31,471	57,073	259,693	1,664,736	1,721,809
New York	10	1,730,254	354,394	1,017,403	1,193,520	15,518,836	16,536,239
Ohio	3	551,479	11,423	32,818	540,504	6,361,314	6,394,132
Oklahoma	4	320,931	*	*	*	*	2,599,463
Texas	6	558,132	*	*	*	*	3,721,954
Others(1)	18	551,204	267,566	816,372	984,076	9,233,946	3,728,901
	62	5,678,302	1,014,135	2,823,229	4,104,735	45,070,344	47,893,573

The Hawkeye Gypsum Products Company of Fort Dodge began mining and shipping crude gypsum during 1925. Otherwise the list of producers remained as it has been for some years.

* Included with others.
(1) Includes also Arizona, California, Colorado, Montana, New Mexico, Oregon, South Dakota, Utah, Virginia, Washington and Wyoming.

Centerville Gypsum Co., Centerville
Beaver Products Co., Fort Dodge; office Buffalo, N. Y.
Universal Gypsum Co., Fort Dodge, two plants; office 1153 Conway Bldg., Chicago
Hawkeye Gypsum Products Co., Fort Dodge
Wasem Plaster Co., Warden Apts., Fort Dodge
Cardiff Gypsum Plaster Co., 903 Central Ave., Fort Dodge
United States Gypsum Co., Fort Dodge; office 205 West Monroe St., Chicago

LIMESTONE AND LIME

The limestone industry not only recovered from the decline of the past few years but exceeded in its output that of any year since 1912. The output of stone and lime for that year had the highest value of that for any year of which the Survey has any record, $998,236. The amount and value of production during the past ten years are shown in the following table.

Stone and lime production in Iowa, 1916 to 1925

Year	*tons*	*value*	Year	*tons*	*value*
1916		$610,534	1921	423,279	$563,427
1917	709,956	580,750	1922	627,443	719,203
1918	451,840	444,800	1923	611,876	775,134
1919	519,030	567,356	1924	610,408	739,632
1920	620,665	840,544	1925	808,288	904,669

The lime burning industry shared in the growth shown by the quarrying trade, as its output was larger in both tonnage and value than that of the year before.

The table given below shows the production of the various counties during 1925 and a comparison of the totals for 1924. Scott county was well in the lead, Marshall was second, Dubuque held third place and Black Hawk ranked fourth. As the table shows much the greater part of the output was crushed for road and concrete work.

Limestone and lime production in 1925

Counties	Producers	Building, Rubble, riprap[a]		Concrete, road metal		Other uses[b]		Total	
		tons	*value*	*tons*	*value*	*tons*	*value*	*tons*	*value*
Allamakee (1), Clayton (1), Mitchell (1)	3	17,180	$26,100	with "Building, etc."		with "Building, etc."		17,015	$26,100
Black Hawk (2), Cerro Gordo (1)	3	....		73,891	$87,552	with "Concrete, etc."		73,891	87,552
Dubuque	5	37,710	41,222	41,625	86,259	with "Concrete, etc."		79,335	127,481
Hardin (1), Marshall (2)	3	with "Concrete, etc."		182,279	194,177	36,669	$23,367	218,948	217,544
Clinton (1), Jackson (1), Johnson (1), Linn (1)	4	with "Concrete, etc."		40,789	58,168	14,012	21,218	54,801	79,386
Jones	3	8,789	9,838	4,042	3,944	1,925	1,472	14,756	15,254
Lee	3	with "Concrete, etc."		35,559	47,191	with "Concrete, etc."		35,559	47,191
Scott	3	4,193	5,028	265,190	254,619	44,601	44,512	313,984	304,161
Totals	27	57,923	68,176	547,674	674,903	152,692	161,590	808,288	904,669
Production in 1924	33	49,820	63,938	434,460	533,500	126,128	142,194	610,408	739,632

a Includes: building, etc., 5,933 tons, value $7,983; rubble, 2,862 tons, value $4,166; riprap, 49,128 tons, value $56,027.
b Includes: railroad ballast and other uses, 38,020 tons, value $30,094; flux, 12,517 tons, value $16,335; sugar factories and lime, 9,148 tons, value $43,439; agriculture, 93,007 tons, value $71,722.

Figures for the United States show that the quantity of limestone sold or used by producers in 1925 was 13 per cent more than in 1924. The amount used for liming land was 44 per cent greater than the year before. Sales of lime were 12 per cent greater in quantity and 8 per cent greater in value in 1925 over 1924. Iowa ranked nineteenth in production of limestone. The following table shows the production for 1924 and 1925.

Use	1924		1925	
	tons	*value*	*tons*	*value*
Building	1,097,530	$15,805,680	1,204,550	$16,092,079
Curbing, etc.	5,560	78,264	11,730	98,587
Rubble	392,180	623,844	324,630	513,387
Riprap	1,695,280	1,513,443	1,847,330	1,406,714
Crushed	46,446,680	47,594,437	51,337,840	52,446,110
Flux	19,683,150	15,827,464	22,840,500	17,318,366
Sugar factories	618,230	1,055,505	471,580	796,974
Glass factories	177,260	286,164	324,160	412,832
Paper mills	138,280	236,834	109,730	198,691
Agriculture	1,352,600	2,046,860	1,954,480	2,880,589
Other	4,287,680	4,800,461	5,222,910	5,843,699
	75,895,430	89,868,956	85,649,440	98,008,028
Portland cement	37,727,000		40,720,100	
Natural cement	236,000		292,000	
Lime	8,144,000		9,100,000	
	122,001,430		135,761,440	

The following list gives the Iowa operators of limestone quarries. Lime producers are indicated in the list.

Allamakee County
- John Sampson, Postville
- Wilkes Williams, R.F.D. No. 1, Postville

Black Hawk County
- Hawkeye Quarries Co., La Porte City; office at Cedar Rapids
- A. Bartlett, 1165 E. Fourth St., Waterloo

Bremer County
- Waverly Stone & Gravel Co., office at Fowler Bldg., Waterloo

Cerro Gordo County
- Henry Kuppinger, Mason City
- Ideal Sand & Gravel Co., Mason City
- Quinby Stone Co., 24 13th St. N. E., Mason City

Clayton County
- Marquette Stone Products Co., McGregor

Clinton County
- Alden Lime Co., Clinton
- C. T. Hanrahan, Charlotte
- Carl Jensen, Charlotte

Dubuque County
- Wm. Becker, 1333 Kaufman Ave., Dubuque
- H. L. Dehner, Cascade
- Fred W. Faldorf, 1155 Grand View Ave., Dubuque
- Dubuque Stone Products Co., Dubuque, also lime
- Grassel & Sons, Dubuque
- Mulgrew & Sons Co., Dubuque
- Ulrich-Paley Co., Dubuque
- Thos. R. Welsh, 202 W. Locust St., Dubuque
- B. N. Arquitt, Farley

Hardin County
- Iowa Limestone Co., Alden; office 907 Bankers Trust Bldg., Des Moines

Howard County
Cresco Stone & Concrete Co., Cresco
Jackson County
A. A. Hurst, Hurstville; office at Maquoketa; also lime
Johnson County
River Products Co., Coralville; office at 218 Johnson County Bank Bldg., Iowa City
Jones County
The Reformatory, Anamosa
Geo. B. Shaler, Stone City
H. Dearborn's Sons, Stone City
Keokuk County
Russell B. Royce, Sigourney
Lee County
McManus Quarries Co., Inc., Ballinger Sta.; office at Box 93, Keokuk
Keokuk Quarry & Construction Co., 1325 Main St., Keokuk
Burlington Quarry Co., Montrose; office at 17 S. Seventh St., Keokuk
Linn County
Ellis Park Stone Co., Cedar Rapids
J. E. Colton, Mount Vernon
Madison County
Perú Stone & Cement Co., Perú; office at 308 West 5th Street, Des Moines
Marshall County
Le Grand Stone Co., Le Grand
County Engineer, Marshalltown
Mitchell County
Belzer & Brenden, Osage
Osage Stone Co. (H. L. Wilson), Osage
Pocahontas County
Gilmore Portland Cement Corp., Gilmore City. Sold to N. W. States Portland Cement Co., Mason City
Scott County
Otto Thompson, Bettendorf Stone Co., Bettendorf; office at 820 Kirkwood Blvd., Davenport
Dolese Bros. Co., Buffalo; office at 337 W. Madison St., Chicago, Ill.
Linwood Cement Co., 713 Kahl Bldg., Davenport

SAND AND GRAVEL

The sand and gravel trade improved somewhat from the conditions prevailing in 1924 although it was not up to the state of the industry in 1923. The output for that year was 3,597,100 tons with value of $2,181,881, probably the largest, in both tonnage and value, in the history of the state. The following table shows the various purposes for which sand and gravel were used in 1924 and 1925.

Summary of sand and gravel production

Kind of material	1924		1925	
	tons	*value*	*tons*	*value*
Sand:				
Molding	22,397	$ 24,209	33,418	$ 36,134
Building	653,031	317,068	636,534	321,190
Paving	575,835	234,966	882,368	245,900
Grinding and polishing	with	filter sand	19,324	28,223
Engine	47,607	24,661	40,350	24,715
Filter	15,681	32,922	6,249	7,127
Other	10,879	3,954	51,255	24,970
Total sand	1,325,430	637,780	1,669,498	688,259
Gravel:				
Building	311,558	289,584	381,496	342,653
Paving	563,776	483,003	939,102	426,781
Railroad	226,862	62,699	307,689	89,207
Total gravel	1,102,196	835,286	1,628,287	858,641
Total production	2,427,626	1,473,066	3,297,785	1,546,900

An inspection of data of past production shows that there has not been a great change in the amount of sand and gravel sold during each year of the past decade although previous to that time the output was much less than at present. The sales during 1916 were greater than during any other year except 1923, but the amount received was less than that of any year since except 1918. Current prices at the pits seem to have fluctuated more than tonnages. The following table gives the output of each year since 1916.

Output of sand and gravel 1916 to 1925

Year	tons	value	Year	tons	value
1916	3,321,691	$980,272	1921	2,641,982	$1,726,958
1917	2,909,441	1,060,586	1922	2,690,798	1,752,233
1918	2,004,444	904,307	1923	3,597,160	2,181,881
1919	2,093,471	1,383,764	1924	2,427,626	1,473,066
1920	2,467,644	1,993,441	1925	3,297,785	1,546,900

Polk county was the leader in production, as regards both tonnage and value, Muscatine ranked second and Cerro Gordo, Cherokee, Linn, Sac, Clayton, Wapello, Hardin and Clinton followed in order. Each of these produced material worth more than $35,000 and their combined output was 1,565,269 tons with a value of $971,658. Clayton county had the unique distinction of getting over a dollar a ton for her product as it was all sold for the finer uses—molding, polishing, etc. The other extreme was held by Palo Alto county, whose product was valued at only eighteen cents a ton. It was all railroad ballast, produced by the railway company for its own use.

The following table gives, so far as may be shown, the production of the different counties. When studied with the list of producers it will show the various kinds of material derived from each county.

Counties	No. Producers	Building sand		Paving sand		Other sand		Gravel		Total	
		tons	*value*	*tons*	*value*	*tons*	*value*	*tons*	*value*	*tons*	*value*
Black Hawk	3	32,515	$20,930			*a*		*a*		32,515	$20,930
Boone (1), Story (2)	3	*b*				*b*		51,484	$14,166	51,484	14,166
Butler (2), Cerro Gordo (2)	4	105,100	37,850	*a*		*a*		88,700	71,895	193,800	109,745
Cherokee	3		*b*					209,799	82,465	209,799	82,465
Clay (2), Dickinson (1), Palo Alto (1)	4	6,117	2,441			*a*		64,747	12,178	70,864	14,619
Clayton (2), Dubuque (2), Fayette (1)	5	35,255	11,916	*c*		63,707	$49,429	39,050	21,403	138,012	37,053
Clinton	5	12,250	10,265					28,978	26,788	41,228	82,748
Dallas (2), Fremont (1)	3	20,990	12,280	*a*		*a*		*a*		20,990	12,280
Des Moines (1), Lee (2)	3	15,563	8,041	*b*		*b*		21,000	20,300	36,563	28,341
Floyd (1), Franklin (1), Tama (1)	3	14,469	12,925					*a*		14,469	12,925
Hardin (2), Marshall (2)	4	*d*		76,912	$33,139	*d*		66,773	35,757	143,685	68,896
Humboldt (1), Kossuth (1), Webster (1), Wright (2)	5	28,309	12,644			*a*		53,508	25,770	81,817	38,384
Ida (1), Sac (3)	4	20,713	10,469	*a*				86,863	51,403	107,576	61,872
Jackson (1), Scott (2)	3	23,348	15,530	*b*				53,813	32,066	77,161	47,596
Johnson	3	23,510	14,120					*a*		23,510	14,120
Linn	4	125,553	74,312					*a*		125,553	74,312
Lyon (1), Plymouth (2)	3	40,078	17,235	*a*				27,727	16,651	67,805	33,886
Mahaska (1), Marion (1), Wapello (1)	3	*d*		68,129	38,383	*d*		27,591	25,485	95,720	63,868
Muscatine	5	43,421	31,533	52,386	11,046	34,606	46,514	104,265	86,179	234,678	175,272
Polk	9	142,082	55,769	105,930	36,653	8,195	3,638	208,399	201,670	464,606	307,730
Sioux	6	15,703	4,508					14,030	9,154	29,733	13,662
Winneshiek	3	*d*		6,143	3,666			*d*		6,143	3,666
Pits operated by Hwy. Comm.				500,000	100,000			500,000	100,000	1,000,000	200,000
Totals	88	636,534	321,190	882,368	245,900	150,596	101,169	1,628,287	858,641	3,297,785	1,546,900

a Included with Building sand. *b* Included with Gravel. *c* Included with Other sand. *d* Included with Paving sand.

The list given below shows the active producers of sand and gravel in the state and the kinds of material each produced in 1925 according to the following schedule: 1, molding; 2, building; 3, grinding and polishing; 4, fire or furnace; 5, engine; 6, paving; 7, filter; 8, other sands; 9, building gravel; 10, paving gravel; 11, railroad ballast.

Black Hawk County
- Iowa Sand & Gravel Corp., 908 L. & J. Bldg., Waterloo. 2, 3, 5, 9
- Iowa Foundry Sand Co., Waterloo. 1
- Waterloo Dredging Co., Waterloo. 2

Boone County
- McHose Sand & Tile Co., Frazer; office at Boone. 2, 5, 9
- Northwestern Gravel Co., office at Des Moines

Bremer County
- H. S. Bunth, Waverly

Buena Vista County
- Chicago & North Western Ry. Co., Sioux Rapids

Butler County
- Aplington Cement Tile & Block Works, Chas. Willeke, Aplington. 2
- Waverly Gravel & Tile Co., Shellrock; office at Waverly. 2, 6, 9, 10

Carroll County
- Chicago Great Western R. R. Co., Lanesboro

Cerro Gordo County
- Clear Lake Sand & Gravel Co., Clear Lake. 2, 9
- Ideal Sand & Gravel Co., Mason City. 2, 5, 6, 8, 9, 10, 11
- Chicago, Milwaukee & St. Paul Ry. Co., Plymouth; office at Chicago, Ill.

Cherokee County
- M. J. Gillease Co., Cherokee
- E. L. Halford & Son, Cherokee. 9
- Illinois Central Ry. Co., Cherokee. 11
- Northwestern Gravel Co., Quimby, office Royal Union Life Bldg., Des Moines. 2, 9

Clay County
- John Stolley, Spencer. 2, 9, 10
- Spencer Washed Sand & Gravel Co., Spencer. 2, 7, 9

Clayton County
- Clayton White Sand Co., Clayton. 4
- Langworthy Silica Co., Clayton; office at 902 Federal Bank Bldg., Dubuque. 1, 3, 4, 5

Clinton County
- Clinton Sand & Gravel Co., 604 Wilson Bldg., Clinton. 2, 9
- Schneider Sand & Gravel Co., Clinton. 2, 9
- Jenner Bros., DeWitt; office at 320 First Nat. Bank Bldg., Davenport. 10
- A. F. Barber, R. D. No. 2, Grand Mound. 9, 10
- Hopkins & Chaffee, Clinton. 2

Dallas County
- Portland Cement Sand & Gravel Co., Booneville, office at 513 Youngerman Bldg., Des Moines. 2, 5, 6, 7, 9, 10
- Coon River Sand Co., office at 501 Hubbell Bldg., Des Moines. 8, 10

Des Moines County
- Kelley Sand & Fuel Co., Burlington (R. J. Dietlein). 2, 6, 9, 10

Dickinson County
- Chicago, Milwaukee & St. Paul Ry. Co., Milford. 8

Dubuque County
- Frank Beutin, Garfield-Kniest Sts., Dubuque. 2, 5, 6, 9, 10
- Chicago, Milwaukee & St. Paul Ry. Co., Dubuque
- Molo Sand & Gravel Co., Dubuque. 2, 6, 9, 10

Fayette County
- Clermont Brick & Sand Co., Clermont. 2, 10

Floyd County
- Iowa Foundry Sand Co., Floyd. 1
- Chicago, Rock Island & Pacific Ry. Co., Marble Rock

Franklin County
- W. C. Nolte, Sheffield. 2

Fremont County
- Nebraska-Iowa Sand & Gravel Co., Crosby; office at Nebraska City, Nebr. 2

Hardin County
- Chicago & North Western Ry. Co., Gifford
- Northwestern Gravel Co., Gifford, office at Des Moines. 2, 6, 9, 10
- Eldora Sand Co., Steamboat Rock; office at Eldora. 8

Humboldt County
- Humboldt Gravel & Tile Co., Humboldt. 2, 7, 8, 9, 11

Ida County
- Smith Bros., Ida Grove. 2

Jackson County
- F. H. C. Habich, Bellevue; office at Galena, Ill.

Bellevue Sand & Gravel Co., Bellevue; office at Koss Construction Co., 5th & I. U. Ry. Tracks, Des Moines. 2, 6, 9, 10
Chicago, Milwaukee & St. Paul Ry. Co., Smiths

Johnson County
Hills Sand & Gravel Co., Hills. 2, 9
City Sand Co., N. Madison St., Iowa City. 2, 9
E. D. Porter, River Junction. 2

Jones County
Chicago, Milwaukee & St. Paul Ry. Co., Monticello

Kossuth County
C. J. Lenander, Bancroft, office at 918 Andrews Bldg., Minneapolis. 10

Lee County
Jos. Jaeger, Fort Madison; office at Montrose. 2, 5
Keokuk Sand Co., foot of Bank St., Keokuk. 2

Linn County
Kings Crown Plaster Co., 98 First Ave. W., Cedar Rapids. 2
Larimer & Shaffer, 931 North 1st St. W., Cedar Rapids. 2
John Hoge, Springville. 2, 10
Mrs. Rozella Corbett, Viola. 10

Lyon County
Miller Sand & Gravel Co., Box 101, Doon. 2, 9
Chicago, Rock Island & Pacific Ry. Co., Granite

Mahaska County
Iowa Sand & Gravel Co., Tracey; office at Oskaloosa. 2, 6, 9, 10

Marion County
Harvey Sand & Gravel Co., Harvey. 9, 10

Marshall County
Empire Sand & Material Co., Marietta; office at Lock Box 467, Marshalltown. 2, 6, 9
Hawkins Sand Co., 1110 N. 3rd Ave., Marshalltown. 6, 10

Muscatine County
Chicago, Rock Island & Pacific Ry. Co., Fruitland
Automatic Gravel Products Co., Box 34, Muscatine. 2, 3, 5, 6, 7, 8, 9, 10, 11
The Hahn Muscatine Co., 301-302 Amer. Bank Bldg., Muscatine. 2, 6, 9, 10
Sand & Gravel Products Co., Muscatine. 2, 9
Northern Gravel Co., Muscatine. 2, 3, 5, 7, 8, 9
Pearl City Gravel Co., Ed. L. Hahn, Muscatine. 2, 6, 9, 10

Palo Alto County
Chicago, Rock Island & Pacific Ry. Co., Graettinger. 11

Plymouth County
Big Sioux Gravel Co., Akron. 2, 6, 9, 10
Albert A. Wenzel, Pierson; office at Kingsley. 9
J. J. Kemp, Oyens

Polk County
Chicago, Rock Island & Pacific Ry. Co., Avon and Commerce
Commerce Sand & Gravel Co., G. N. Doty, Pres., Commerce. 2, 9
Capital City Sand Co., Lovington; office at 308 W. Fifth St., Des Moines. 2, 5, 6
Consumers Ice Co., 8th & N. Y. Ave., Des Moines. 6, 8
Coon River Sand Co., 308 9th St., Des Moines. 2, 9
The Des Moines Sand & Fuel Co., 510 Grand Ave., Des Moines. 2, 5, 6, 9, 10
Independent Sand & Gravel Co., S. W. 7th & Tuttle Sts., Des Moines. 2, 6, 9, 10
Flint Crushed Gravel Co., Herrold; office at Des Moines. 6, 10, 11
Commercial Sand Co., 513 Youngerman Bldg., Des Moines. 2, 5, 6, 7, 9, 10
Hawkeye Sand & Gravel Co., 906 Walnut St., Des Moines. 2

Sac County
Chicago & North Western Ry. Co., Lake View
Northwestern Gravel Co., Lake View. 2, 6, 9, 10
Sac County, Office of Engr., Sac City. 10

Scott County
W. G. Block Co., Box 528, Davenport. 2
Builders Sand & Gravel Co., Nahant. 2, 6

Sioux County
D. A. Sorgdrager, R. D. No. 1, Alton. 2.
Alton Cement Works, Alton. 9
French & Briggs, Hawarden. 9
C. A. Oehlerking, Hawarden. 10
Schemmer Sand & Gravel Co., Rock Valley. 2, 10
Rock Valley Sand & Gravel Co., Rock Valley. 2, 9

Story County
Ames Sand & Gravel Co., Ames. 9, 10
Bates & Sarsfield, Nevada. 10

Tama County
Tama Sand Co., Tama. 10

Wapello County
Ottumwa Sand Co., Ottumwa. 1, 2, 5, 6, 9, 10

Webster County
Johnston Bros., Clay Works. 2, 9

Winneshiek County
Bernatz Bros., Decorah
Decorah Stone Products Co., R. Bucknell, Secy., Decorah. 6
Geo. Wm. Higgins, Decorah. 2
Wm. McNamara, Decorah. 2, 9
John T. Nolan, Decorah
J. H. Rosenthal, Decorah

Wright County
Belmond Cement Mfg. Co., Belmond
Luick Gravel Co., Belmond. 10
Chicago, Rock Island & Pacific Ry. Co., Belmond. 11
Chicago Great Western R. R. Co., Belmond

NATURAL GAS

Natural gas was recovered from a number of small shallow wells, most of which are in the northcentral part of the state. No accurate census of these wells has ever been made as all of them have been drilled by private persons and are used to supply individual families. The amount for which reports were made was 200,000 cubic feet with a value of $100, although doubtless several times this amount was actually consumed.

MINERAL PRODUCTION IN IOWA IN 1926

Products	Unit	Quantity	Value
Cement shipped	Bbl. of 376 lb.	4,788,639	$ 8,167,341
Clay ware			4,495,088
Coal	Ton	4,625,487	14,214,000
Gypsum	Ton	683,201	6,588,203
Limestone and lime	Ton	944,371	952,141
Sand and gravel	Ton	2,701,982	1,569,006
			$35,985,779

Mineral production in 1926 continued the decline which has been evident for several years. The decrease from production in 1925 amounted to $2,407,963 and put the total output lower than that of any year, with one exception, since 1916, when it rose for the first time to the sum of $30,210,284. The excepted year was 1921, when the value was $360,609 less than that for 1926. The diminished value in 1926 was chiefly on account of the marked decrease in value of clay wares manufactured although cement, coal and gypsum also failed to reach the levels of the preceding year. Stone and lime and sand and gravel values were somewhat higher in 1926 and the tonnages of stone and lime were considerably above those of 1925 although those of sand and gravel were somewhat less.

The total values of minerals produced in Iowa and in the United States during the past decade are shown in the following table.

Production of minerals from 1917 to 1926

Year	Iowa	United States
1917	$39,336,372	$4,992,496,000
1918	38,742,009	5,540,708,000
1919	37,882,183	4,595,770,000
1920	57,250,317	6,981,340,000
1921	35,625,170	4,138,500,000
1922	36,189,398	4,647,290,000
1923	46,237,521	5,986,500,000
1924	40,470,971	5,305,800,000
1925	38,393,742	5,677,630,000
1926	35,985,779	6,262,000,000

Pennsylvania always heads the list of states, on account of its immense production of anthracite and bituminous coal. In 1925 Oklahoma, California, Texas, West Virginia, Ohio and

Illinois were next, in the order given. Iowa had twenty-sixth place in the list. The chief minerals hold rank in the order of coal, petroleum, pig iron, clay products, cement, natural gas, coke, copper, stone, iron ore. It is noteworthy that iron and copper are the only metals to be included among the first ten minerals. Gold is sixteenth and silver eighteenth. Sand and gravel rank thirteenth.

CEMENT

Only four cement plants were active in 1926 as the Gilmore City factory of the Northwestern States Portland Cement Company was not in operation. Production of cement in 1926 exceeded that of 1925 by 277,666 barrels or 6 per cent but shipments were less in 1926 by 68,210 barrels, a decrease of 1 per cent. The value of shipments was $507,222 less in 1926 than during the previous year. This was in part due to the decline of eight cents per barrel in average factory prices.

Iowa ranks eleventh in amount of production and amount and value of shipments and fifth in average factory price received. The following table gives summarized data for Iowa and the United States.

Production of cement in Iowa and the United States, 1924 to 1926

	1924	1925	1926
	Iowa		
Production, bbls.	5,624,466	4,648,145	4,925,811
Stock, Dec. 31, bbls.	1,695,093	1,479,670	1,616,842
Shipments, bbls.	4,881,613	4,856,849	4,788,639
Shipments, value	$8,811,587	$8,674.563	$8,167,341
Aver. fact. price per bbl.	$1.81	$1.79	$1.71
Consumption, bbls.	3,144,001	2,704,872	2,826,839
Consumption per capita, bbl.	1.26	1.08	1.17
Surplus production, bbls.	1,737,612	2,151,977	2,151,977
Annual capacity, bbls.	6,685,000	6,935,000	6,575,000
Daily clinker capacity, bbls.	20,300	20,603	19,103
Number rotary kilns	28	28	26
	United States		
Production, bbls.	149,358,109	161,685,901	164,530,170
Shipments, bbls.	146,047,549	157,295,212	162,187,090
Shipments, value	$264,046,708	278,524,108	277,965,473
Average factory price, bbl.	$1.81	$1.77	$1.71
Consumption per capita, bbl.	1.29	1.38	1.37
Number plants active	132	138	140

Pennsylvania has a long lead in the cement industry, as her shipments in 1926 were over 41,000,000 barrels, while California, the next in rank, shipped over 13,600,000. Michigan was third with nearly 12,000,000 barrels to her credit and New York stood fourth with 8,500,000 barrels shipped.

CLAY WARES

The production of clay wares in 1926 fell below that in 1925 in every department except the making of sewer pipe, which gained nearly one hundred thousand dollars in 1926, and the manufacture of pottery, in which an advance of over two thousand dollars was reported. The production of brick of various classes, of hollow building tile and drain tile was notably less than during the preceding year. Indeed the output of drain tile was the lowest it had been since 1901. Coupled with the parallel increase in the making of hollow building ware this is the striking feature of clay manufacture in Iowa. Perhaps a condensed table showing the production of various clay wares will be of interest.

Year	Plants	Common brick	Face brick	Vitrified brick	Hollow ware	Drain tile	Sewer pipe	Other ware	Total value
1894	437	$1,317,473	$ 2,950	$ 376,951	$ 8,545	$ 557,312	$ 58,000	$ 58,275	$2,379,506
1895	412	1,095,074	89,430	243,928	19,294	290,515	55,131	76,920	1,870,292
1896	339	1,003,624	47,386	112,985	8,485	225,650	73,039	220,908	1,694,402
1897	330	850,834	60,030	426,056	14,740	372,070	44,300	52,841	1,821,247
1898	349	1,069,947	55,745	290,463	21,013	343,265	33,000	39,050	2,057,022
1899	372	1,328,050	165,590	225,044		359,568		113,946	2,240,217
1900	381	1,462,395	93,632	129,677	32,150	379,140	52,452	246,042	2,395,488
1901	349	1,651,926	87,559	227,378	59,270	516,714	53,500	145,656	2,774,200
1902	329	1,624,673	82,901	212,537	104,324	673,122	76,000	70,034	2,843,591
1903	296	1,396,088	84,506	221,481	131,191	1,009,933	88,000	102,384	3,033,583
1904	331	1,430,581	102,330	199,528	164,658	1,321,745	94,800	173,534	3,507,576
1905	311	1,367,742	63,137	130,003	134,418	1,531,376	90,000	90,994	3,408,547
1906	304	1,125,009	101,795	185,990	162,664	1,721,614	114,241	6,014	3,417,327
1907	277	1,085,383	96,316	223,193	176,854	2,011,793	103,369	30,877	3,728,785
1908	301	896,890	86,232	185,112	129,003	2,522,363	211,044	47,983	4,078,627
1909	241	1,072,340	138,218	198,780	304,398	2,830,910	282,637	89,230	4,916,513
1910	237	1,088,266	109,911	223,273	94,366	3,457,455	313,430	48,335	5,335,036
1911	217	1,025,011	114,178	103,384	374,628	2,468,962	284,817	65,859	4,436,839
1912	207	1,017,097	142,637	197,035	535,254	2,293,084	291,672	47,713	4,524,492
1913	183	1,052,036	181,911	222,105	762,563	2,798,816	503,360	54,790	5,575,581
1914	183	1,067,746	148,394	211,905	1,083,397	3,180,836	558,751	154,966	6,405,995
1915	161	898,851	153,324	300,785	1,008,457	3,802,599	448,721	136,351	6,749,088
1916	162	947,247	283,559	393,038	1,141,291	3,986,163	494,428	129,990	7,375,716
1917	142	1,045,790	282,840	83,310	1,542,884	4,004,989	455,561	80,507	7,543,225
1918	127	749,325	188,041	116,522	1,550,076	2,256,200	398,848	38,660	5,318,848
1919	115	941,489	449,491	179,969	2,475,291	3,127,378	902,008	49,698	8,125,324
1920	109	1,146,182	346,164	176,430	3,048,776	4,760,115	918,669	92,896	10,489,232
1921	103	680,689	189,568		1,209,180	2,412,849	783,429	435,868	5,711,583
1922	69	728,508	354,041		2,170,368	1,495,116	681,233	310,183	5,739,449
1923	64	921,853	593,791	513,684	2,392,521	1,508,836	865,676	237,563	7,033,924
1924	69	737,898	451,136	129,314	2,186,542	1,266,586	793,840	154,379	5,719,694
1925	67	855,305	536,545	184,939	2,118,261	925,958	929,294	175,937	5,726,239
1926	53	652,025	511,772		1,539,257	482,794	1,024,763	284,477	4,495,088

One of the notable features shown by this table is the great decrease in number of plants in operation. There are several possible causes for this mortality, among them being exhaustion or unsuitability of available material, the tendency to concentrate production into fewer and larger plants, the lack of markets as farm drainage became more complete and as the local markets supplied by these numerous smaller operations were invaded by wares, both cheaper and better, perhaps, produced by larger plants. Of course general financial conditions have also been an important factor.

Naturally unit prices have risen markedly and are as important as total production in accounting for the increased values above earlier years. The following short table will give a general idea of these two factors.

Quantities and prices of clay wares

	1897		1905		1915	
	Quan.	Price	Quan.	Price	Quan.	Price
Common brick, M	140,032	$ 4.80	170,067	$ 8.03	125,752	$ 7.15
Face brick, M	10,669	6.10	5,937	10.63	11,916	12.87
Vitrified brick, M	56,315	7.14	12,963	10.03	20.573	14.62
	1920		1923		1926	
Common brick, M	60,470	$ 18.95	72,558	$ 12.71	57,381	$ 11.36
Face brick, M	13,678	25.31	29,346	20.11	30,963	16.50
Vitrified brick, M	6,116	28.85	6,500	19.00	7,600	20.00
Hollow ware, tons	293,081	10.40	323,326	7.40	260,194	5.91
Drain tile, tons	453,122	10.51	173,678	8.69	74,445	6.62
Sewer pipe, tons	41,634	22.07	54,828	15.79	71,883	14.26

Figures are not available for quantities of hollow ware, drain tile or sewer pipe previous to 1919. The figures for vitrified brick in 1923 and 1926 are only approximate.

The table which follows shows as fully as is possible the production of different wares in 1926. The decrease in the number of operators in different counties makes the showing of county productions impossible in most cases. Thus fifty-three operators from thirty-two counties reported production in 1926 and Dallas, Polk and Webster were the only counties in which three or more plants were working. In 1897, by contrast, 330 operators reported from 81 counties. Data from fifty counties could be given in detail. The figures for 1926 show that forty-one plants made common brick, twenty-four made face brick, thirty-six made hollow building tile, thirty-four made drain tile, five made sewer pipe, five flue lining and four wall coping.

Production of Clay Wares in Iowa in 1926

Counties	No. Producers	Common brick, face brick, vitrified brick		Hollow ware		Drain tile		Other products (a)	Total value
		Thous.	*Value*	*Tons*	*Value*	*Tons*	*Value*	*Value*	
Appanoose(1), Henry(1), Lee(1), Washington(1)	4	3,120	$ 34,643	4,130	$ 24,590	b			$ 59,233
Audubon(2), Pottawattamie(1), Union(1)	4	1,667	17,572	1,961	12,430	3,880	$ 25,684		55,686
Benton(1), Grundy(1), Hardin(1), Tama(2)	5	3,428	47,095			731	5,915	(9)c	53,010
Cerro Gordo (1), Dubuque(1), Fayette(1), Floyd(1), Wright(1)	5	9,708	129,717	109,823	609,335	32,461	174,731		913,783
Dallas(3), Guthrie(1)	4	2,852	37,609	33,364	194,566	8,341	52,979		285,154
Jackson(1), Johnson(1), Jones(1), Scott(1)	4	342	5,208	1,077	4,712	d		$28,367(8)	38,287
Jasper(2), Keokuk(1), Poweshiek(2)	5	d		1,302	10,153	1,997	18,071	230,182(5)(6)(7)(8)	258,406
Mahaska(2), Wapello (1)	3	7,911	88,828	18,034	113,048	5,152	30,862		232,738
Polk(5), Warren (1)	6	29,281	467,090	29,450	172,122	6,805	59,974	209,795	908,981
Story(2,) Woodbury(2)	4	29,070	367,118	5,325	39,763	b			406,881
Webster	8	8,409	115,722	57,503	373,628	12,687	95,105	698,474(5)(6)(7)(9)	1,282,929
	53	95,942	1,314,244	260,194	1,539,257	74,445	482,794	1,158,793	4,495,088

(a) Includes: (5) Sewer pipe, 71,883 tons, value $1,024,763; (6) Flue lining and (7) wall coping, 5,732 tons, value $66,193; (8) Other ware and pottery and (9) raw clay sold, value $67,805.
(b) Included with Hollow ware; (c) Included with Drain tile; (d) Included with Other products.

The following summary table gives data of production for the nation in 1926.

Class	No Est.	Quantity	Value
Common brick, M	1,220	7,520,411	$ 88,249,925
Vitrified brick, for paving, M	80	381,684	8,918,947
other uses, M	51	85,896	1,365,794
Face brick, M	456	2,439,820	44,516,236
Fancy and enameled brick, M	9	15,556	1,279,284
Hollow brick, M	39	63,359	692,258
Terra cotta, tons	34	155,564	19,666,880
Hollow bld. tile, partition, etc., tons	396	3,698,778	23,560,571
Hollow Bld. tile, floor arch, etc. tons	66	397,639	4,257,857
Roofing tile, squares	44	408,724	7,015,775
Floor tile, sq. ft.	65	24,920,354	5,521,965
Mosaic tile, sq. ft.	19	22,573,178	4,865,967
Faience tile, sq. ft.	33	7,702,558	4,794,128
Wall tile, sq. ft.	26	39,009,986	12,787,359
Drain tile, tons	301	519,483	3,858,408
Sewer pipe, tons	111	1,994,333	29,303,094
Stove lining, tons	20	11,573	472,904
Flue lining, tons	89	241,465	2,857,309
Wall coping, tons	54	56,345	685,303
Fire brick, M	230	1,048,694	42,706,932
Clay, tons	292	107,836	3,995,059
Other ware	94		6,581,590
	2,008		$317,953,545
Pottery	351		116,488,308
Totals	2,359		434,441,853

COAL

A study of the data on coal production in 1926 and comparison with similar data for previous years brings out several interesting facts. While the list of producing counties remains about the same there are some important shifts in relative rank. In 1916 three counties mined over a million tons each, namely, in order, Monroe, Polk and Appanoose, and in fact Monroe county usually has been the leader. In 1926 the three leaders were Marion, Monroe and Polk, although neither county reached the million ton mark. Marion has attained the supremacy in recent years through the output of three large mines—the Consolidated Indiana, Pershing and Red Rock. Appanoose, on the other hand, produced less than half as much coal in 1926 as in 1916. Another noteworthy fact is that Appanoose county mines always require more men per ton of coal raised than any of the other large producers. Probably this is due to the combination of low coal and numerous small mines—fifty-seven in 1926—which renders large output per man difficult or impossible. It would be an interesting study to determine the number of tons of coal produced per man in different fields and under different working conditions. It may be stated here that the output per man in Appanoose in 1926 was 233 tons and in Marion, with fourteen mines, the output was 778 tons per man. Adams county miners recovered only 141 tons per man.

It may be noted again that while the number of men employed in mining increased up to 1909, when 17,286 were engaged, the number has declined since then until in 1926 only 8,869 men were reported. In comparing figures for 1925 and 1926 it may be noted that while the production in 1926 was only 89,356 tons less than in 1925, yet 1,298 fewer men were required to produce the tonnage of the later year and that on the average the men worked thirty days more than in 1925.

The small field in the Nodaway bed in Adams, Page and Taylor counties continues operation on about the same small but steady scale and it is noteworthy that its average value and average days worked are among the highest in the state.

As a rule the larger mines and more important counties are well served by railroads. Every mine in Monroe county except one has railroad connections and thirty-nine Appanoose mines are served by railroads. However, only six Polk county mines are on railways, Wapello has only one railroad mine and Mahaska has none.

The number of operators decreased from 193 in 1925 to 184 in 1926 while the number of active mines dropped from 208 to 193. The table given below shows the data regarding production in the different counties and for the sake of comparison gives totals for 1925.

Coal production in Iowa in 1926

Counties	No. Producers	Loaded at mines for shipment	Sold to local trade	Used at mines	Total production		Average value per ton at mine	Number of employees			Average number of days worked
		tons	tons	tons	tons	value		Underground	Surface	Total	
Adams	4		6,088		6,088	$ 23,000	$3.78	41	2	43	125(a)
Appanoose	52	425,708	52,653	2,136	480,497	1,592,000	3.31	1925	144	2,069	114
Boone	6	354,434	65,882	7,066	427,382	1,402,000	3.28	751	51	802	219
Dallas	5	348,023	9,972	1,416	359,411	1,064,000	2.96	676	62	738	148
Davis(1), Lucas(2)	3	411,246	5,009	18,596	434,851	1,307,000	3.53, 3.00	505	51	556	149, 249
Greene(2), Story(1)	3		4,899		4,899	12,400	2.44, 2.51	17	4	21	129, 40
Guthrie	4		5,591		5,591	15,000	2.68	26	1	27	125
Jasper	6	(b)	21,344	2,750	24,094	94,000	3.90	67	14	81	132
Jefferson(2), Keokuk(2)	4		2,369		2,369	7,000	2.89, 3.05	16	3	19	81, 65
Mahaska	24		55,133	(b)	55,133	147,000	2.67	118	9	127	161
Marion	14	878,474	33,120	14,494	926,088	2,588,000	2.79	1,104	86	1,190	238
Monroe	11	826,000	24,226	24,746	874,972	2,690,000	3.07	1,231	100	1,331	210
Page(2), Webster(1)	3	(b)	25,258		25,258	96,000	4.11, 2.50	58	7	65	225, 180
Polk	17	318,722	345,184	10,549	674,455	2,163,000	3.21	1,102	88	1,190	190
Taylor	4	(b)	13,424	(b)	13,424	58,000	4.32	48	4	52	208
Van Buren	3	(b)	6,643	(b)	6,643	18,000	2.71	16	2	18	145
Wapello	14	(c)	50,743	1,765	52,508	153,000	2.92	115	8	123	161
Warren	3	214,104	9,381	9,134	232,619	725,000	3.12	313	33	346	223
Wayne	4		19,205	(b)	19,205	60,000	3.13	63	8	71	134
Totals	184	3,791,893	740,136	93,458	4,625,487	14,214,000	3.07	8,192	677	8,869	183
Totals for 1925	193	3,711,654	905,840	97,349	4,714,843	$14,807,000		9,337	830	10,167	153

(a) Low figure due to short operation of one mine. (b) Included with Sold to local trade. (c) Included with Used at mines.

GYPSUM

The gypsum industry was unable to live up to its record for several years of increasing output each year. The quantity mined in 1926 was 1,743 tons larger than that mined in 1925 and the amounts of neat plaster and wall board were larger also, but several other items were somewhat smaller, so that the total value of the output was $146,068 less than the value of the product for 1925. The amount of raw gypsum used in agriculture does not increase much although it fluctuates a good deal. The value of gypsum as a soil amendment has been fairly well demonstrated and probably its cost and the lack of knowledge as to its qualities are the only deterrents to wider use. The Iowa Geological Survey has issued a pamphlet entitled Gypsum in Agriculture and the Iowa Agricultural Experiment Station's Bulletin 232 gives results of tests on uses of gypsum on various soils.

The following table gives the output of different products in 1925 and 1926.

Gypsum production in 1925 and 1926

	1925		1926	
	tons	*value*	*tons*	*value*
Crude gypsum mined	800,167		802,910	
Sold crude—to cement mills	134,200	$ 330,000	125.956	$ 268,507
for agriculture and other uses	6,251	51,585	3,847	28,347
Total sold crude	140,451	381,585	129,803	296,854
Sold calcined—as stucco	21,329	137,903	30,355	236,804
as neat plaster	380,124	2,918,414	402,005	3,005,877
as sanded plaster	25,837	185,313	164	1,751
as plaster of paris	3,192	37,503	2,455	23,266
as dental plaster	4,031	33,221	1,823	17,781
as wall or plaster board	71,754	2,332,141	87,395	2,605,745
as partition tile	50,835	529,581	18,481	171,621
for insulating, fire-proofing, other uses	5,108	178,611	10,820	228,504
Total sold calcined	562,210	6,352,687	553,498	6,291,349
Total sold	702,661	6,734,271	683,201	6,588,203

The list of producers remained the same as in 1925 except that the Centerville Gypsum Company was reorganized as the Federal Gypsum Company with headquarters at Des Moines. This company increased its sales of anhydrite for poultry grits very notably over those for 1925. The Hawkeye Gypsum Products Company marketed its entire output to the cement trade for retarder. The table given above shows that three items account for much the greater part of the amount and value of gypsum products sold, namely raw gypsum for cement retarder and calcined gypsum used as neat plaster and as wall and plaster board. These amount to 619,203 tons, valued at $5,908,476 out of total sales of 683,201 tons with a value of $6,588,203.

LIMESTONE AND LIME

The production of limestone and lime in 1926 was one of the bright spots in the mineral industry in Iowa and one of the few in which marked gains were made over production in 1925. In fact the output of limestone was next to the largest recorded in the history of the industry. The peak of production was reached in 1912 when the limestone produced was valued at $944,885 and the sandstone and lime marketed were worth $53,351, which was somewhat more than the value of the lime burned in 1926. Hence the total output of stone and lime in 1912 was valued at $998,236 or $46,095 more than the value of the 1926 production. As compared with conditions in 1925 the industry shows a gain of 136,083 tons, and $47,472. Substantial increases were made in amounts and values of lime burned, of rough stone used for rubble and for riprapping and of crushed stone used as railroad ballast, flux, sugar clarifier and notably as agricultural stone, which reached the highest production in the history of its use in Iowa. As is natural in these days of road building and concrete construction the production of crushed rock for these purposes occupied much the largest part of the attention of quarrymen and the output was larger by 79,616 tons than that of 1925. However, owing to somewhat lower prices the total value was $75,413 less than that of the product during 1925. For the first time in many years no production of building stone was reported. Mr. Wilkes Williams of Postville, who conducted the one establishment in Iowa for dressing native limestone, has recently died and hence it is probable that this industry will not be revived. Sixteen counties reported production in 1926 as against fifteen in 1925. The Iowa Limestone Company of Des Moines has recently taken over the Alden quarries in Hardin county and is already becoming an important factor in the production of crushed stone for various uses.

The table given below will explain the statements made above and will show the details of production by counties so far as possible.

Production of Limestone and Lime in 1926

Counties	Producers	Rubble, riprap[a] tons	Rubble, riprap[a] value	Concrete, road metal tons	Concrete, road metal value	Other uses[b] tons	Other uses[b] value	Total tons	Total value
Black Hawk(2), Cerro Gordo(1)	3			58,498	$ 67,871	9,802	$ 6,446	68,200	$ 74,297
Clayton(1), Clinton(1), Marshall(1), Winneshiek(1)	4	50,270	$42,270	52,755	55,004	77,784	78,057	190,809	175,531
Dubuque	5	27,241	27,859	54,121	72,003	4,635	43,911	85,997	143,770
Hardin(1), Jackson(1), Johnson(1)	3			115,092	132,700	49,353	55,207	164,445	187,907
Jones	3	9,305	9,640	12,202	11,462	4,174	3,110	25,681	24,212
Lee	3	c		27,883	38,352	14,400	21,216	42,283	59,568
Linn(1), Lousia(1), Mitchell(1)	3			c		14,483	21,229	14,483	21,229
Scott	3	6,670	7,789	201,070	214,347	44,640	43,691	368,580	265,827
Totals	27	97,300	94,917	627,290	599,490	219,781	257,734	944,371	952,141
Totals for 1925	27	57,923	68,176	547,674	674,903	152,692	161,590	808,288	904,669

a Includes: Rubble, 5 producers, 6,150 tons, value $7,161; Riprap, 10 producers, 91,150 tons, value $87,756.
b Includes: Railroad ballast, 3 producers, 75,190 tons, value $69,670; Flux, 5 producers, 14,280 tons, value $17,677; Sugar factories and lime, 5 producers, 15,711 tons, value $68,767; Agriculture, 16 producers, 114,700 tons, value $101,620.
c Included in Other uses.

SAND AND GRAVEL

The total quantity of sand and gravel produced in 1926 was considerably less than the output of the previous year, but as prices averaged somewhat better the combined values were a little higher in the later year. Individual grades differed both in amounts and in values. For the first time, figures of washed material were collected and these show that a large share of the production goes through some process of preparation for use. The following summary shows the kinds and amounts of material produced in 1925 and 1926 and will permit comparison of outputs.

Summary of sand and gravel production

Kind of material	1925			1926		
	No. pits	*tons*	*value*	No. pits	*tons*	*value*
Sand						
Molding	4	33,418	$ 36,134	5	27,843	$ 23,259
Structural	58	636,534	321,190	50	664,062	354,341
Paving	27	882,368	245,900	30	524,761	235,285
Cutting and grinding	5	19,324	28,223	3	13,688b	14,555
Engine	13	40,350	24,715	11	43,091	30,225
Filter	6	6,249	7,127	4	10,773	2,882
R.R. ballast				5	47,438	16,616
Other	10	51,255a	24,970	7	17,551c	8,988
Total sand		1,669,498	688,259		1,349,207	686,151
Gravel						
Structural	47	381,496	342,653	39	307,610	282,125
Paving	38	939,102	426,781	34	661,782	430,777
R.R. ballast	8	307,689	89,207	13	377,472	162,983
Other				4	5,911	6,970
Total gravel		1,628,287	858,641		1,352,775	882,855
Total production		3,297,785	1,546,900		2,701,982	1,569,006

a Includes Ballast sand and Fire or furnace sand.
b Includes Blast sand.
c Includes Fire or furnace sand.

An attempt has been made this year to show the production of gravel in a little more detail than formerly and in the table by counties the output of different kinds is shown so far as possible. Structural sand includes that used in concrete and mortar and structural gravel is used in concrete for building. That used in paving and roadmaking is included in the column headed Paving and other gravel. The table shows also that Polk county maintained rather a long lead in production of both sand and gravel, Muscatine was second and Cherokee had third place. Mahaska, Marion and Wapello are worthy of note for such large production from southern Iowa, where sand and gravel are relatively scarce. It is unfortunate that so few counties have three or more producers—from the standpoint of the statistician as well as that of producers and consumers, because the small number prohibits revelation of data regarding most counties. In 1926 eighty-five producers were distributed over forty-two counties and only six counties had three or more operators.

Production of sand in the United States in 1926 amounted to 92,114,279 tons, valued at $55,675,988, while gravel production was 90,986,539 tons, valued at $55,662,713, making a total production of 183,100,818 tons, with a value of $111,338,701. The Bureau of Mines estimates that this material represents the volume of a ditch a yard wide and a yard deep extending three times around the world.

New York ranked first with a production of 19,334,000 tons, Illinois was second with 17,777,000 tons and Iowa ranked eighteenth.

Production of sand and gravel in 1926

Counties	Producers	Structural sand		Paving and other sand[a]		Total sand	
		tons	*value*	*tons*	*value*	*tons*	*value*
Black Hawk(1), Butler(2)	3	28,301	$ 13,918	b		28,301	$ 13,918
Boone(1), Marshall(2), Story(1)	4	21,640	10,912	19,664	$ 8,765	41,304	19,677
Buena Vista(0), Clay(1), Dickinson(1), Lyon(1), Osceola(1)	4	9,705	3,095	9,047	678	18,752	3,773
Cerro Gordo(1), Floyd(1), Franklin(1), Wright(0)	3	84,568	34,000	b		84,568	34,000
Cherokee(3), Plymouth(2)	5	72,560	21,036	b		72,560	21,036
Clayton(2), Dubuque(2), Fayette(1), Winneshiek(1)	6	13,458	8,075	62,296	26,732	75,754	34,807
Clinton(2), Jackson(2)	4	5,586	4,102	18,389	11,759	23,975	15,861
Dallas(0), Des Moines(2), Lee(2), Scott(2)	6	43,761	30,631	46,018	33,584	89,779	64,215
Hardin(2), Humboldt(1), Kossuth(0), Palo Alto(1)	4	23,341	17,317	b		23,341	17,317
Ida(1), Sac(1), Webster(1)	3	21,409	10,570	b		21,409	10,570
Johnson(2), Tama(1)	3	38,050	17,500	b		38,050	17,500
Linn	3	89,917	64,783	43,609	23,830	133,526	88,613
Mahaska(1), Marion (1), Wapello(1)	3	179,199	100,757	b		179,199	100,757
Muscatine	5	38,131	34,720	116,536	59,241	154,667	93,961
Polk	9	152,535	55,062	132,919	54,807	285,454	109,869
Sioux	5	79,535	45,885	24,591	10,102	104,126	55,987
Totals	70	664,062	354,341	685,145	331,810	1,349,207	686,151
Totals for 1925		632,695	318,587	1,023,231	360,859	1,669,498	688,259

a Includes: Molding, paving and roadmaking, cutting and grinding, blast, fire or furnace, engine, filter, railroad ballast, and other sands.
b Included with structural sand.

Production of sand and gravel in 1926

Counties	Producers	Structural gravel		Paving and other gravel c		Total sand and gravel		Total quantity washed	
		tons	*value*	*tons*	*value*	*tons*	*value*	*tons*	*value*
Black Hawk (2), Butler (1)	3	26,228	$ 21,559			54,529	$ 35,477	53,219	$ 34,947
Boone (1), Marshall (2), Story (2)	5	6,447	8,642	95,306	$ 11,000	137,051	37,219	47,751	28,319
Buena Vista (1), Clay (1), Dickinson (1), Lyon (2) Osceola (1)	6	7,992	3,256	15,779	2,175	42,603	9,204	14,009	2,821
Cerro Gordo (1), Floyd (0), Franklin (0), Wright (2)	3	*d*		84,352	83,787	168,918	117,787		
Cherokee (3), Plymouth (2)	5	31,934	20,543	187,942	77,860	292,436	118,439	141,861	65,681
Clayton (0), Dubuque (2), Fayette (1), Winneshiek (0)	3	*d*		30,550	19,338	106,304	54,145	85,230	45,911
Clinton (3), Jackson (2)	5	19,537	15,225	62,890	44,908	106,402	75,994	106,402	75,994
Dallas (1), Des Moines (2), Lee (0), Scott (0)	3	*d*		36,156	34,637	126,035	98,852	102,745	76,175
Hardin (1), Humboldt (1), Kossuth (1), Palo Alto (1)	4	27,253	17,228	76,366	15,732	126,959	50,277	61,378	40,677
Ida (0), Sac (2), Webster (2)	4	31,623	29,643	106,208	23,150	159,240	63,363	156,663	62,700
Johnson (2), Tama (1)	3	*d*		6,100	4,600	44,150	22,100		
Linn	2	*b*				132,833	88,613	132,747	88,599
Mahaska (1), Marion (1), Wapello (1)	3	*b*		59,019	74,566	238,218	175,323	237,935	174,746
Muscatine	4	21,882	19,600	109,159	100,230	285,708	213,801	285,708	213,801
Polk	7	58,146	74,589	197,583	145,053	541,183	329,475	538,197	323,999
Sioux	3	35,386	22,950	*e*		139,512	78,937	133,135	76,825
Totals	63	307,610	282,125	1,045,165	600,730	2,701,982	1,569,006	2,294,289	1,444,995
Totals for 1925		381,496	342,653	1,246,791	515,988	3,297,785	1,546,900		

b Included with structural sand.
c Includes: Paving and roadmaking, railroad ballast, and other gravel.
d Included with paving gravel.
e Included with structural gravel.

ROCK RESOURCES OF IOWA

GEORGE F. KAY

Introduction

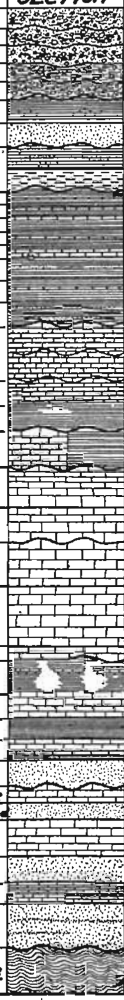
Rocks in the wide, scientific use of the term include all classes of earthy or stony material, whether consolidated or not. Soft chalk, softer clay, or the loose bed of sand or gravel—if produced by natural physical agents—is to the geologist as truly rock as the hard granite bowlder found in places in our prairies. In accordance, however, with a somewhat prevalent notion, the rocks of Iowa may be divided into hard and soft, into indurated and non-indurated rocks, into the regularly-bedded deposits that are recognized as rocks by even the non-geological observer, and the loose, superficial materials that almost everywhere conceal the beds of the indurated series.

The hard or indurated rocks of Iowa consist chiefly of limestones, sandstones, quartzites, various forms of shale, coal, and gypsum. All of these rocks except coal are of marine origin. Over the hard or indurated rocks there is spread a covering of unconsolidated materials—mantle rock—ranging from a few inches to more than five hundred feet in thickness, and forming the soils and subsoils which are so important an element among the many causes of Iowa's prosperity. These unconsolidated materials include the drift, of glacial origin, loess, the result of wind action, geest, a residual product of weathering, and alluvium, which is a flood-plain deposit.

The indurated and the mantle rocks are the geological formations of the state. Detailed studies have been made by the staff of the Iowa Geological Survey and by other persons of the different geological formations, their extent and thickness, the character of the different kinds of rock included, something of the contained fossils, and the economic features of the formations. Careful examinations have been made of the various economic minerals and their distribu-

This paper and the three which follow were presented at the Iowa Power Conference, held March 30 and 31, 1927, at the State University of Iowa under the auspices of the College of Engineering and the Extension Division. Reprinted by permission from Extension Bulletin no. 170, April 15, 1927.

tion, geology, properties, and uses. More than thirty volumes have been published by the Iowa Geological Survey alone on the many phases of the rocks and minerals of the state.



SYSTEM	SERIES	FORMATION	COLUMNAR SECTION	Thickness Feet	Character of Rocks
Pleistocene	Wisconsin				
	Iowan				
	Illinoian				
	Kansan				
	Nebraskan				
Cretaceous	Upper Cretaceous	Colorado		150	Shales, with soft chalky limestones
		Dakota		100	Sandstone
Permian		Fort Dodge		50	Sandy shale and sandstone
				30	Gypsum
Pennsylvanian	Missouri	Wabaunsee		108	Shale and limestone
		Shawnee		233	Limestone and shale
		Douglas		26	Limestone and shale
		Lansing		34	Limestone and shale
		Kansas City		131	Limestone and shale
	Des Moines	Pleasanton			Shale and sandstone
		Henrietta		750	Shale and sandstone
		Cherokee			Shale, sandstone, coal.
Mississippian	Meramec	Ste. Genevieve St. Louis		0–40	Limestone
		Spergen Warsaw		35–105	Limestone
	Osage	Keokuk Burlington		150–215	Limestone
	Kinderhook			150	Shale and sandstone
Devonian	Upper Devonian	State Quarry – Lime Creek		40–120	Limestone Shale
		Cedar Valley		100	Limestone, shaly limestone. Some dolomite in the northern counties.
		Wapsipinicon		60–75	Limestones, shales and shaly limestones.
Silurian	Niagaran	Gower		120	Dolomite
		Hopkinton		220	Dolomite Very fossiliferous in places.
	Alexandrian			0–40	Limestone and dolomite.
Ordovician	Cincinnatian	Maquoketa		200	Dark shales, shaly limestones, and locally, beds of dolomite.
	Mohawkian	Galena		340	Dolomite chiefly. In places unaltered limestone.
		Decorah		0–40	Shales with thin beds of limestone
		Platteville		90	Marly limestones and shales.
	Canadian	St. Peter		80–160	Sandstone
		Prairie du Chien: Shakopee		20–80	Dolomite
		Prairie du Chien: New Richmond		20	Quartzitic sandstone
		Prairie du Chien: Oneota		150	Dolomite
Cambrian	Croixan	Jordan		100	Coarse sandstone
		St Lawrence		50	Dolomite, sandy
		Dresbach			Sandstone, with bands of glauconite
Algonkian	Huronian	Sioux Quartzite			Quartzite

Figure 1

In this paper discussion will be limited largely to the consideration of the rocks of the state which are of economic value, and hence are related closely to our industrial development. These rocks be-

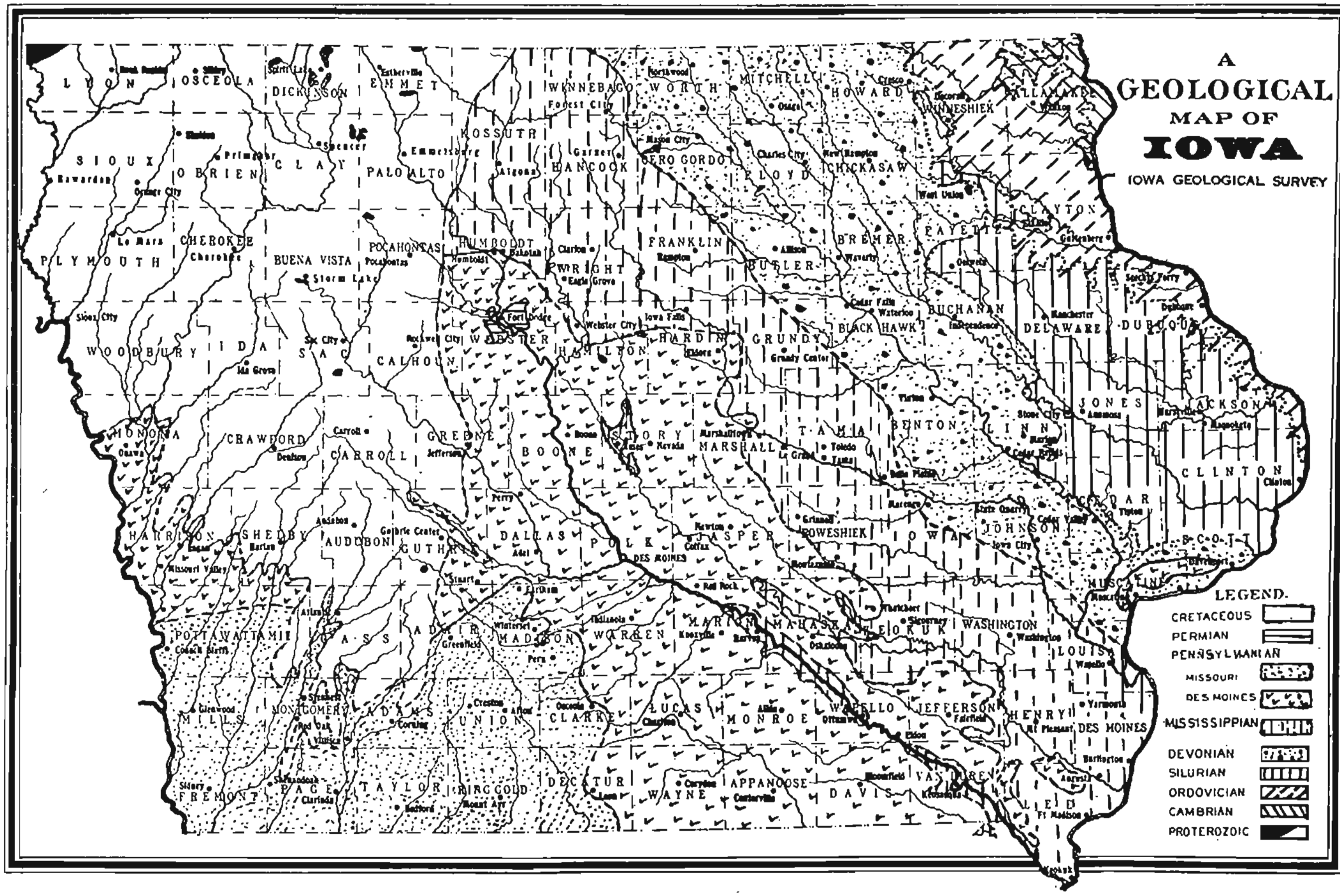

A
GEOLOGICAL
MAP OF
IOWA
IOWA GEOLOGICAL SURVEY
LEGEND.
CRETACEOUS
PERMIAN
PENNSYLVANIAN
MISSOURI
DES MOINES
MISSISSIPPIAN
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
PROTEROZOIC

Figure 2

long in age to several of the well established geological systems. From oldest to youngest, the systems represented by rocks in Iowa are Algonkian, Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, Permian, Upper Cretaceous, and Pleistocene. The subdivisions of each of these systems in Iowa are given in Figure 1; also the thickness and character of the rocks of each of the formations. It will be noted that many of the formations bear geographic names. These names are derived from localities where the beds are well exposed or typically developed. Thus, the Des Moines series is named from the river along which the beds of this age are found as surface rocks; the St. Louis, from the city where the formation was first studied; and other geographic names have similar reasons for their application.

The areal distribution in Iowa of each of the systems of rocks is shown on the geological map of Iowa, Figure 2.

Rocks of Economic Importance

The rocks of economic importance have a wide range in use, in origin, in age, and in distribution. The Sioux quartzite, although not quarried in Iowa, is used in adjacent states as a building stone, for paving blocks, and other purposes. The Croixan is the best water-bearing horizon in Iowa, owing to its wide outcrop in Wisconsin and Minnesota, and the St. Peter forms the next most reliable aquifer. The lead and zinc of Dubuque county are found in the Galena limestone. The different limestones of the state yield abundant supplies of crushed and dressed stone, notably the Ordovician and Silurian. The cement plants at Mason City get their limestone and shale from the Devonian. The plant at Gilmore uses limestone from the local beds of Mississippian age, which also supply the Pyramid plant at Valley Junction, while the Hawkeye plant, near Des Moines, gets shale from the Des Moines series and limestone from the Missouri. On account of its stores of coal and shale the Des Moines series comprises probably the most important rock strata of Iowa. The rocks of St. Louis age at Centerville contain a bed of gypsum which is being used for making wall plaster, and the extensive bed of gypsum in the Permian system at Fort Dodge supplies several large mills which manufacture various kinds of building materials. The great shale formations of the state, such as the Maquoketa, the Kinderhook, the Des Moines, and the Colorado, also the glacial drift sheets and the loess, supply numerous clay works with raw materials for brick, tile, pottery, and other wares. Sand and gravel beds in the drift or in stream valleys, and to a less extent beds of sandstone, supply the demands for these materials for building, road construction, and other uses.

The extent to which the rock resources of Iowa are being developed may be indicated best by referring to the annual production of various minerals. Although it would be of great interest to trace the history of development of each of our mineral resources the discussion in this paper will be limited to a consideration of the output of the last few years. Figures of yearly production will be given for the year 1920 and each succeeding year including 1925; figures for 1926 are not yet available.

Chief Mineral Products

The chief mineral products being produced commercially in Iowa are coal, cement, gypsum, clay products, sand and gravel, and stone and lime. The total annual mineral production in recent years is shown in Figure 3.

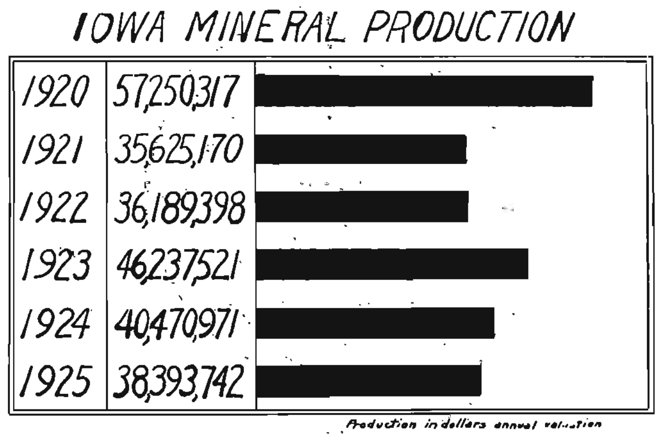


Figure 3

It will be seen that in this six-year period the greatest production was in 1920, the smallest in 1921. Without attempting to discuss the many factors which contributed to the marked differences in yearly production it may be stated that 1920 was the inflation year; in this year the production was $20,000,000 higher than in the previous year; prices were at their peak and the demand for products was above normal. In 1921 and 1922 the production dropped back more than $20,000,000 each year. Then in 1923 there was an increase of more than $10,000,000 above the production of the preceding year. It is noteworthy that in this year the increase was not limited to one product but was shared by all the major branches of the mineral industry. The decline of 1925 below 1924 was due almost entirely to the reduction in tonnage and value of the coal produced in the latter year as compared with that of the year before. The following table shows the value of the chief products for each of the years from 1920 to 1925.

	Coal	Cement	Gypsum	Clay Products	Sand and Gravel	Stone and Lime
1920	$30,793,847	$ 8,742,854	$4,422,965	$10,489,232	$1,993,441	$840,544
1921	17,256,800	7,439,983	2,922,700	5,711,583	1,726,958	563,427
1922	16,119,000	7,709,313	4,146,182	5,739,449	1,752,233	719,203
1923	20,517,000	10,351,971	5,368,532	7,039,924	2,181,881	775,134
1924	18,097,000	8,811,587	5,657,339	5,692,147	1,473,065	739,632
1925	14,807,000	8,674,563	6,734,271	5,726,239	1,546,900	904,669

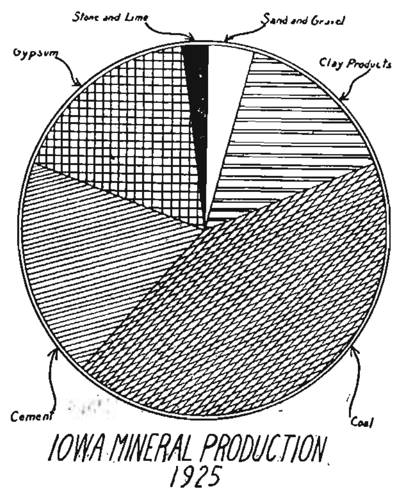


Figure 4

In 1925 the order of values of the chief products from the highest to the lowest was coal, cement, gypsum, clay products, sand and gravel, and stone and lime. The relative values of these materials are shown graphically in Figure 4.

Coal

The value of coal each year greatly exceeds the value of any other mineral product in Iowa. The values for 1920 and each succeeding year including 1925 are shown graphically in Figure 5; and the tonnage production and value in Figure 6. In 1920 the value reached $30,793,847, which is the highest figure in the history of coal mining in the state. In that year the total output was 7,813,916

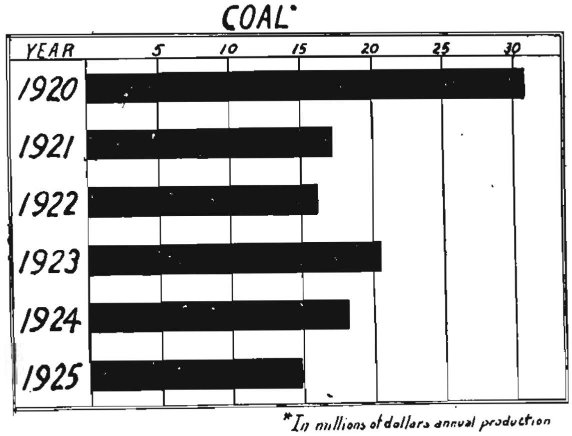


Figure 5

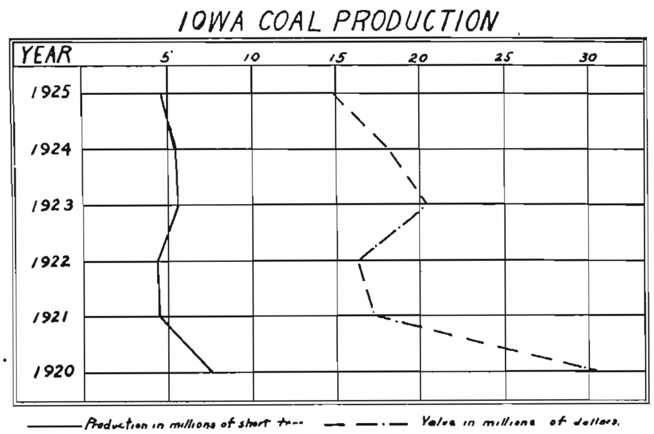


Figure 6

tons with a value of $3.94 a ton at the mine. The number of employes was 11,905 men. The average number of days worked in the coal mining counties was 250. In 1921 the value of the output was $17,256,800; in 1922, $16,119,000; in 1923, $20,517,000; in 1924, $18,097,000, and in 1925, $14,807,000. The value for 1925 was the lowest of any year since 1916.

The chief coal is mined from the Des Moines series in the Des Moines valley, but some coal is mined in Adams, Page, and Taylor counties from the Nodaway coal seam, which averages only about 18 inches in thickness. In 1925, Marion county ranked first in value of coal produced; Monroe county ranked second, Polk county third, Appanoose county fourth, Lucas county fifth, Boone county sixth, and Dallas county seventh. Figure 7 shows the coal pro-

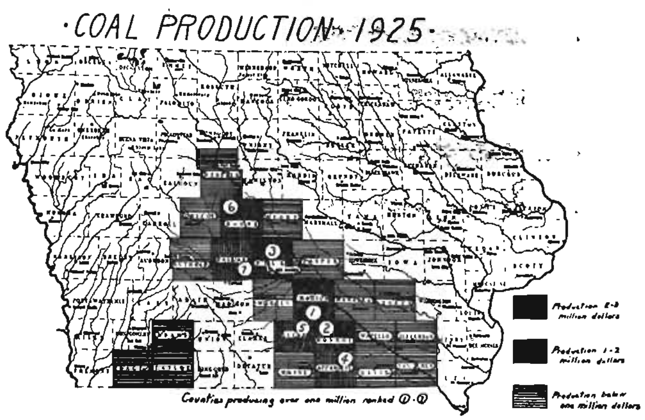


Figure 7

ducing counties in Iowa in 1925; the numbers indicate the rankings of the most important counties. It has been estimated that at the present rate of production there is sufficient coal in Iowa to last for more than twenty-five hundred years.

Cement

Only a comparatively few years ago Iowa entered the field as a producer of Portland cement, yet to-day she ranks high among states in this regard. In 1920, the value of the output was $8,742,854; in 1921, $7,439,983; in 1922, $7,709,313; in 1923, $10,351,971; in 1924, $8,811,587; and in 1925, $8,674,563. These values are shown graphically in Figure 8. The banner year was 1923, when 5,732,470 barrels were produced, and 5,570,675 barrels were shipped. The shipments were made by the following five plants: the Gilmore Portland Cement Company, Gilmore City; Hawkeye Portland Cement Company, Des Moines; Lehigh Portland Cement Company, Mason City; Northwestern States Portland Cement Company, Mason City, and the Pyramid Portland Cement Company, Valley Junction. The

Pyramid and Hawkeye plants use the wet process; the others use the dry process. All the plants use limestone and shale and burn the clinker with coal. In this year there were twenty-seven producing states in the United States, and Iowa occupied eighth place in both production and shipment. The Portland cement factories of Iowa manufactured 4,648,145 barrels of cement in 1925, and during the same year they shipped 4,856,849 barrels, which at an average price of $1.79 per barrel were worth $8,674,563. In this year Iowa

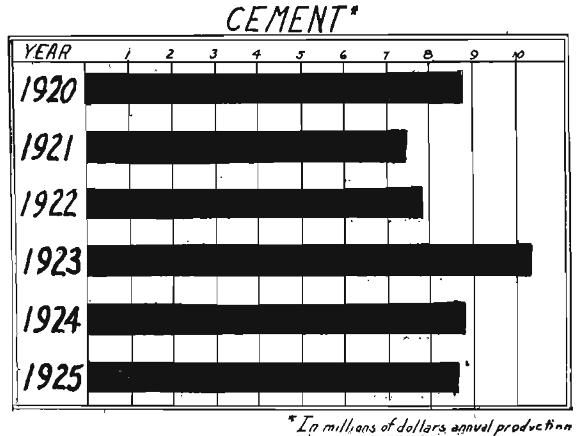


Figure 8

was the only state in the Union which suffered a decline in production, and was one of the two states where shipments declined in amount and value, the other being Illinois. The raw products, limestone and shale, from which Portland cement is being made in Iowa are widely distributed in the state, and at several places the rocks are of unusually good quality and occur in such quantity that they are available for extensive future development.

Gypsum

For many years Iowa has been one of the important producers of gypsum and its products—wall plaster, fireproofing, tile, blocks, boards, etc., plaster of Paris, and other materials. For many years New York has ranked first of all the states in the Union in value of gypsum, and Iowa with few exceptions has been second. Volume XXVIII of the reports of the Iowa Geological Survey deals with the subject of gypsum in a most comprehensive manner. The geologic, chemical, economic, and technologic aspects of gypsum are described.

The value of the gypsum in 1920 was $4,422,965; in 1921, $2,922,-700; in 1922, $4,146,182; in 1923, $5,368,532; in 1924, $5,657,339; and in 1925, $6,734,271. These values are represented graphically in Figure 9. The value in 1921 was less than in 1920, but since 1921 the value has increased consistently until in 1925 the value was the highest in the history of the gypsum industry in Iowa. The gypsum products industry in Iowa is one of the few branches of the mineral business which shows constant gains from year to year, even during the adverse conditions that have prevailed during most of

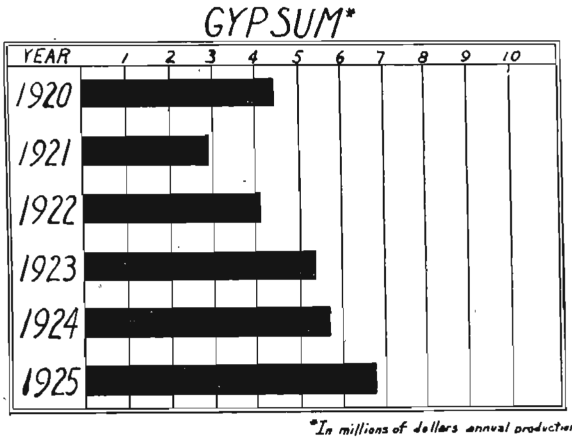


Figure 9

the past few years. The tonnage of crude gypsum raised in 1925 was 800,167. Of this total 140,451 tons was sold crude to Portland cement mills as retarder, for agricultural gypsum—"land plaster"—and for various other purposes. Most of the gypsum mined is calcined to make plaster of various sorts, wall board, partition and roof tile, and other materials. Five plants are operating at Fort Dodge and one plant at Centerville.

Clay Products

The value of clay products in 1920 was $10,489,232, the highest figure in the history of the industry; in 1921 the value dropped to $5,011,583; in 1923 it rose to $7,039,924; in 1924 it again dropped to $5,692,147, and in 1925 it rose somewhat, the value being $5,-726,239. The values during these years are shown graphically in

Figure 10. The kinds of clay products marketed are hollow building tile of various kinds, sewer pipe, drain tile, common brick, face brick, flue lining, paving brick, and pottery. In Iowa there were sixty-seven establishments in 1925. The chief producing counties in recent years have been Cerro Gordo, Webster, and Polk. Our state ranks twenty-third in the United States in value of common brick sold, fifteenth in value of face brick, fifth in value of hollow tile, second in value of drain tile, and eighth in value of sewer pipe. Slowing down in building operations and in other civic improve-

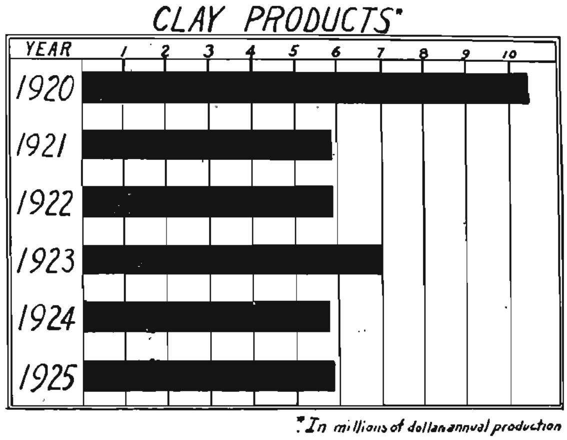


Figure 10

ments wherein clay products are used, as well as in land improvement represented by drainage and similar work, have a marked effect upon the clay working industries. Although Iowa has abundant clay for all ordinary uses the state does not possess, so far as is now known, any strictly first-class refractory clays in commercial quantities.

Sand and Gravel

The value of the sand and gravel produced in Iowa in 1920 was $1,993,441; in 1921, $1,726,958; in 1922, $1,752,233; in 1923, $2,181,881; in 1924, $1,473,065, and in 1925, $1,546,900. The values during these years are shown graphically in Figure 11. The sand was used mainly as building sand, paving and road making sand; some was used for molding, cutting and grinding, fire or furnace purposes, engines, filters, and various other purposes. The gravel was used in the building trade, for railroad ballast and for paving and road making.

More than forty counties are producing sand and gravel; the chief producers are Polk, Muscatine, Cerro Gordo, Cherokee, Sac, Linn, Hardin, Boone, Black Hawk, and Wapello. It may be noted that several of these counties—namely, Cerro Gordo, Cherokee, Polk, Sac, Hardin, and Boone—in the central part of the state are

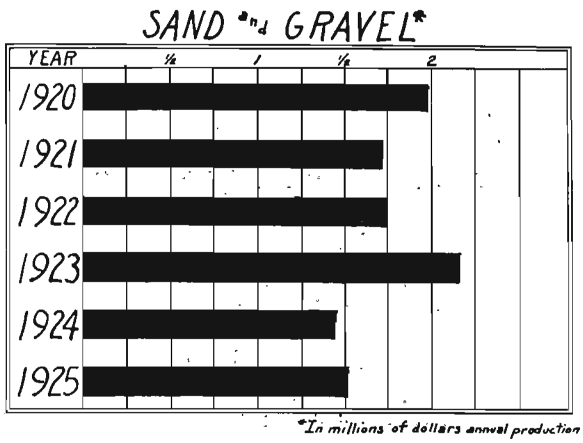


Figure 11

in the area covered by what is known as the Wisconsin glacial drift. This drift sheet contains great amounts of sand and gravel, both incorporated in the body of the drift and as masses of nearly clean material. These latter are all ready for the shovel of the excavator, as in Cherokee, Cerro Gordo, and Sac counties, and the former yields its store to the streams, from which it may readily be dredged, as is the case in Polk county. The other important counties are located on large streams—the Mississippi, the Cedar, and the Des Moines—which have gathered their stores from the glacial drift across which they flow.

The sands and gravels of Iowa are by nature better fitted for the coarser uses rather than for finer ones such as glass making, molding, polishing, and filter sands. However, some of these latter purposes are served by carefully selecting and preparing some of the finer and better grades of sand.

Limestone and Lime

The value of limestones and lime produced in Iowa in 1920 was $840,544; in 1921, $563,427; in 1922, $719,203; in 1923, $775,134; in 1924, $739,632; and in 1925, $904,669. These values are represented graphically in Figure 12. The value in 1925 was the largest reached by the industry since 1912. The limestone is used in con-

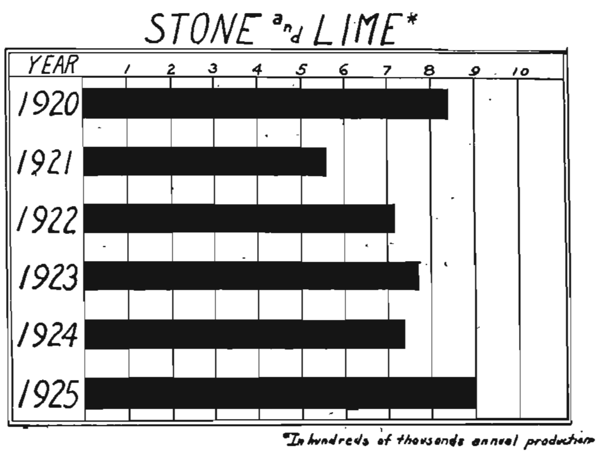


Figure 12

crete and road work, in agriculture, for railroad ballast, flux, in sugar factories and for building. The chief producing counties are Scott, Dubuque, and Black Hawk.

Lime is burned at Dubuque and at Hurstville near Maquoketa.

Oil and Gas

Oil in commercial quantities has never been found in Iowa. Gas has been found and no doubt will continue to be found in various parts of the state in small quantities in sands and gravels of Pleistocene age. One is not justified in making the statement that oil and gas will never be found in commercial quantities in the indurated rocks of Iowa, but it is proper to assert as has been asserted frequently in reports of the Iowa Geological Survey and elsewhere that all the evidence that has been gained from a study of the geology of the state, especially in connection with the many deep wells that have been drilled in efforts to get supplies of water, points consistently to the conclusion that in nearly all parts of Iowa it would be a waste of money and effort to drill deep wells with the sole expectation of obtaining commercial quantities of either oil or gas. In volume XXIX of the reports of the Iowa Geological Survey there is a thorough discussion of the possibilities of finding oil and gas in Iowa. The geologic formations are discussed in detail, and the probabilities of oil being found in such well known horizons as the Platteville (Trenton), Silurian, Devonian, and the Cherokee shales are considered. The prospect is stated to be distinctly dis-

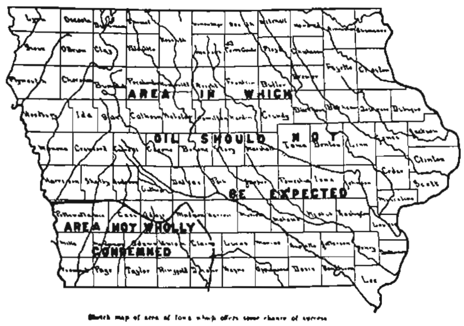


Figure 13

couraging. The only part of the state for which any hope is held out is the southwestern, including most of the three southern tiers of counties as far east as Winterset, Osceola, and Leon. There is no use in drilling, either here or elsewhere, below the upper part of the St. Peter sandstone. The chance of failure, even in southwestern Iowa, is very high.

Natural Fertilizers

A few years ago it was reported that potash was present in Iowa lakes, but investigation showed that there was no foundation for such rumors. Gypsum has been found useful as a soil amendment, and Iowa has abundant supplies. Peat, which is found in the many bogs which lie on the Wisconsin glacial drift of north central Iowa, can be used for chemical fertilizers and is inoculated with nitrifying bacteria. No extensive deposits of phosphates have been found in Iowa, but some limestone beds contain traces of this material, although not enough to make them very valuable on that account. Iowa has large deposits of limestone which is suitable for agricultural purposes. The best and most extensive beds are near those localities where the need for limestone is greatest. A recent report on the fertilizers of Iowa, prepared by Professor John E. Smith, was published in volume XXXI of the reports of the Iowa Geological Survey. Professor Smith states that nearly ninety per cent of Iowa soil could be made more productive by the addition of limestone.

Iowa with her rich soil is one of the foremost agricultural states of the Union. Perhaps our pride in our soil resources causes us to underestimate the importance of our other natural resources. The rocks of the state are a great asset. Their value will be realized more and more as we assume to a greater extent than we have in the past our obligation to use in connection with the development of our industries and in other ways our own natural resources rather than ship into the state from other states similar materials of no better quality than are to be found within our own borders.

IOWA COAL AREAS AND CHARACTERISTICS OF IOWA COAL

JAMES H. LEES

I feel that the subject assigned to me for discussion is of very serious importance to the interests represented here, for no matter how we may designate the present stage of civilization—whether the age of steel or electricity or radio or even jazz—it still remains true that fuel is the basic resource of industry, and of the great primary sources of power and heat—coal, water-power, oil, natural gas—coal is now and probably in our generation will remain well in the lead. If this is true it is well that every citizen should have an intelligent interest in this resource—its occurrence, its extent, its character and the best methods for its recovery and use.

A generalized time-scale to show those periods which are of special interest in this study may well be given here and is as follows:

Cenozoic	Present Pleistocene—Glacial period Pliocene Miocene—Some coal in California Oligocene Eocene—Coal and lignite
Mesozoic	Cretaceous—Coal Jurassic Triassic—Some coal in Virginia and North Carolina

Professor E. C. Jeffrey of Harvard University in summarizing a recent paper on Conifers and the Coal Question says: "It is clear from the structural study of Tertiary coals and their contained woods that these coals can not have been formed *in situ* as is generally assumed, since the woods are those of land and even desert trees." "Tertiary coals in general - - - are to be regarded as the result of water transportation and aqueous sedimentation." Science, N. S., vol. LXV, p. 357, April 8, 1927.

was published in volume XXXI of the reports of the Iowa Geological Survey. Professor Smith states that nearly ninety per cent of Iowa soil could be made more productive by the addition of limestone.

Iowa with her rich soil is one of the foremost agricultural states of the Union. Perhaps our pride in our soil resources causes us to underestimate the importance of our other natural resources. The rocks of the state are a great asset. Their value will be realized more and more as we assume to a greater extent than we have in the past our obligation to use in connection with the development of our industries and in other ways our own natural resources rather than ship into the state from other states similar materials of no better quality than are to be found within our own borders.

IOWA COAL AREAS AND CHARACTERISTICS OF IOWA COAL

JAMES H. LEES

I feel that the subject assigned to me for discussion is of very serious importance to the interests represented here, for no matter how we may designate the present stage of civilization—whether the age of steel or electricity or radio or even jazz—it still remains true that fuel is the basic resource of industry, and of the great primary sources of power and heat—coal, water-power, oil, natural gas—coal is now and probably in our generation will remain well in the lead. If this is true it is well that every citizen should have an intelligent interest in this resource—its occurrence, its extent, its character and the best methods for its recovery and use.

A generalized time-scale to show those periods which are of special interest in this study may well be given here and is as follows:

Cenozoic	Present Pleistocene—Glacial period Pliocene Miocene—Some coal in California Oligocene Eocene—Coal and lignite
Mesozoic	Cretaceous—Coal Jurassic Triassic—Some coal in Virginia and North Carolina

Professor E. C. Jeffrey of Harvard University in summarizing a recent paper on Conifers and the Coal Question says: "It is clear from the structural study of Tertiary coals and their contained woods that these coals can not have been formed *in situ* as is generally assumed, since the woods are those of land and even desert trees." "Tertiary coals in general - - - are to be regarded as the result of water transportation and aqueous sedimentation." Science, N. S., vol. LXV, p. 357, April 8, 1927.

Paleozoic	Permian Pennsylvanian—Coal Mississippian—Some coal Devonian Silurian Ordovician Cambrian
Proterozoic	
Archeozoic	

The Iowa coal fields, in common with those of the Interior and Appalachian districts, belong to the Carboniferous, or as it is now coming to be known, the Pennsylvanian system of strata. Much of the coal of the Rocky Mountain province, on the other hand, is of Cretaceous age, while the lignites of the Gulf region and the Great Plains province and the coals of the Pacific coast are nearly all found in strata of Eocene age. Theoretically there is no direct relation between the geologic age of a coal bed and the character of the coal therein, but practically it is true that under normal conditions of deposition and preservation the older coals are of higher grade than are those of more recent age. This is illustrated in the gradation from the high grade bituminous coals of Pennsylvanian age in the eastern and central interior states through the softer bituminous and sub-bituminous coals of the Rocky Mountain Cretaceous to the Eocene lignites of the southern states and the northern Great Plains.

Then too the thickness of cover is an important factor in the hardness and general character of coals. For example the Pennsylvanian system of western Pennsylvania—the bituminous field—has a maximum thickness in the southwestern counties of 2600 feet and the upper division, which is the least productive but which furnishes the heaviest cover, is 800 feet thick above its one merchantable coal bed. The Pennsylvanian strata of the Illinois fields have a maximum thickness of 2000 feet, although the basal barren sandstones are in places 700 feet thick. Coal No. 6, the Herrin bed, the famous Franklin county coal, is reached in Franklin county at depths ranging from 200 to 700 feet. The Des Moines series, the productive coal measures of central and southeastern Iowa, are usually assigned a maximum thickness of 750 feet, but in most places the depth to the coal beds is much less than this, and few mines exceed 300 feet in depth. These figures naturally take no account of the thickness of strata which may have been removed by erosion in the immense interval which elapsed between the uplifting of the Pennsylvanian beds and the oncoming of the glaciers of the Ice Age, which covered these beds with a protective mantle of glacial drift. Then too the presence or absence of crustal movements and of volcanic activity involving coal beds is an important and in many cases a decisive factor in determining whether a given coal will eventually be anthracitic, bituminous or even sub-bituminous. The best known illustration of the effect of crustal, or dynamic, activity is the anthracite region of eastern Pennsylvania and the semi-bituminous fields of the Appalachian region. Several small fields of anthracite in the Rocky Mountain province and the Cascade Mountain region are due to igneous intrusions coupled in some measure with regional metamorphism. If it were not for these disturbances the coals now affected by them probably would be no better than those in neighboring regions—bituminous in eastern Pennsylvania, sub-bituminous in the Rocky Mountain province, and sub-bituminous or lignite in the Cascade region of Washington. The combination of a progressively thinning cover and of gradually diminished metamorphism from the Appalachian mountain region toward the Mississippi valley and the Great Plains forms an important if not a dominating factor in the progressive softening of the coals from the anthracites of eastern Pennsylvania to the bituminous coals of Iowa and Texas. There is no basic difference between the coals of different provinces. They were formed from similar materials and under approximately similar conditions. The Eastern province owes the thick strata of its Pennsylvanian system to the presence of a large and probably high land mass to east and northeast, from which large quantities of mud and sand were transported to the lagoons and marshes of the coastal regions. On the other hand the land area which drained into the inland sea covering the present Mississippi Valley—Isle Wisconsin and, probably, the Canadian Shield—furnished less wastage. perhaps because of lower elevation, and hence thinner layers of rock material to enclose the newly formed coal beds. It seems likely too that conditions during coal formation were more stable in the Eastern province than farther west, in that the oscillations of sea and land were less frequent but of longer duration, judging from the thickness of the coal beds, and probably of the sediments also.

The coincidence of heavy sedimentation and strong diastrophism in the East on the one hand and lighter sedimentation with practically no diastrophism in the Mississippi Valley on the other hand is no mere accident but follows as the resultant of well established causes. The thick deposits were near the continental margin, and such a combination was bound to result in crustal movement with crumpling, faulting, heating and all the changes that go on under the general process of metamorphism, with consequent compression and hardening of the coal and expulsion of much of the volatile substances. The Mississippi valley has, throughout its known geologic history, been more stable than the east and west coasts and less subjected to igneous or dynamic disturbances. Hence the strata here are more nearly in the condition and position they assumed when they consolidated.

I have dwelt at some length on these differing conditions of sedimentation, igneous intrusions and dynamic activity or diastrophism because they are fundamental in the formation and character of coal deposits and of the strata in which these coal beds are contained and because a knowledge of these conditions is invaluable in a geologic or economic study of the coals and their utilization. I should like now to consider in some detail the local conditions under which our Iowa coals were formed.

At the opening of Pennsylvanian time the land surface of the east-central part of the United States, say from Nova Scotia and southern New England westward to eastern Kansas, was low-lying but very irregular. In the Rocky Mountain and Pacific coast regions deep-sea conditions prevailed, so those areas are of no further concern to us. Some interesting evidence of the irregularity of the surface of the Mississippian strata has been revealed by drillings in Polk county. At Mitchellville the Mississippian limestones were reached about 760 feet above sea level, on the southeast edge of Des Moines 600 feet, in the western part of Des Moines 374 feet and at Commerce, west of the city, 300 feet above sea level. Another instance which recently came to my attention is shown in the new Chicago, Burlington and Quincy railroad well at Tracy, southeast of Des Moines. On the east bank of Des Moines river, opposite the village, the sandy limestones of St. Louis (upper Mississippian) age rise several feet above water level. In the well, which was drilled in the bottoms, only a few feet above river level, the Pennsylvanian shales were penetrated ninety-two feet before the St. Louis limestones were reached. There is here a difference in elevation of a hundred feet within two miles. Very similar conditions prevailed throughout the general region in which the coal beds were later to be formed.

The movements which had brought Mississippian deposition to a close and had raised above sea level large areas of land across the central-eastern part of the United States had developed a great geosyncline which extended from north-central Iowa southwestward as far as central Texas and perhaps farther in each direction. Probably similar synclines existed in the eastern part of the Mississippi valley and in the Appalachian region, where the eastern coal fields now exist.

Climatic conditions at the beginning of Pennsylvanian time became more favorable than ever before for the development of a very extensive and abundant vegetation. This was not a sudden development, for coal beds in Mississippian strata of the eastern states show the presence of similar conditions, although these were but the precursors of the exceptionally favorable situation of the Pennsylvanian. It does not seem necessary to assume, as was formerly done, the presence of a hot dense moist atmosphere through which the sun's rays had never penetrated and whose heavy gases were absorbed by the vegetation of the period. On the contrary the evidence points rather to possible aridity as well as to lower temperatures than were formerly assumed.

Under these general conditions then, the Pennsylvanian period began with the continental sea advancing up the Western Interior geosyncline from the southwest, just as it was advancing over other land areas farther east. On the low-lying marginal reaches between uplands and ocean a series of great coastal swamps was forming, similar to the Great Dismal swamp and the coastal marshes of Virginia and the Carolinas. Similar bogs or marshes no doubt developed over poorly drained areas remote from the sea, just as is true to-day, and so fresh water, brackish water, and salt water swamps existed simultaneously, each with its appropriate vegetation. This vegetation consisted of giant tree-ferns and horsetails, Lycopods such as Lepidodendron and Sigillaria, whose stems are now so often seen in coal and the associated rocks, and of an undergrowth containing smaller ferns and other lowly phases of plant life. The flowering plants and the modern types of trees had not yet appeared on the earth. Probably there was a growth of vegetation over the drier land areas, but as is the case with similar growths to-day such vegetation would normally leave no record of its existence. The elements of this marvelously developed flora, however, which lived in the swamps, as they died fell into the waters from which they had sprung and were there partly preserved. During the process of decay in the open air the carbon and hydrogen of wood unite with the oxygen of the air or of the wood and so form carbon dioxide and water and pass from our notice. But under water atmospheric oxygen is largely excluded, and the reactions are chiefly among the elements of the wood itself. Under these conditions marsh gas ($C\ H_4$) is formed, with some carbon dioxide ($C\ O_2$) and water (H_2O). All of these processes would use up the carbon less rapidly than the other elements and so would result in the proportionate increase of carbon in the residue.

As generation after generation of the ancient plants lived, died, and fell to the floor of the swamp there was gradually accumulated an increasing layer of vegetable material which was constantly undergoing progressive changes which carried it further and further from its original state and into peaty and possibly lignitic stages. How fast this vegetal material accumulated is very difficult and perhaps impossible to estimate with any degree of accuracy. The abundance of vegetation and its rate of growth, the percentage which would be preserved, the prevailing climatic conditions and doubtless other factors would affect the problem. The estimate has been made that under conditions as we know them nearly 10,000 years would be required for the formation and preservation of a foot of vegetal material having a specific gravity of 1.4, about that of average coal.

In the course of time the interior sea reached Iowa. The marsh and bog types of vegetation grew and accumulated here as we have described the processes above and Iowa's coal resources began their formation. The statement has already been made that the surface over which the Pennsylvanian sea advanced was very irregular. Because of this fact the earliest deposits on a slowly sinking land area would be in the valleys and depressions and the burial of the hills and uplands would come later, perhaps much later. Some of the coal swamps which were formed in these depressions were limited by walls of limestone, and miners of the present day find these walls barring their further advance and marking the limits of the coal bed they are working.

Most of the basins and depressions in which the Iowa coal swamps formed were rather limited in extent, and so the accumulations of vegetable matter which later became consolidated into coal are not very large, most of them being only a few hundred or at most a few thousand acres in size. These beds are mostly lenticular in vertical section, being much thicker near the center than on the margins, where they usually feather out and finally disappear. One noteworthy exception to this rule, however, is the bed known as the Centerville or Mystic seam. This bed, although it has an average thickness of only about two and a half feet, and has a rather wide vertical range, still is very uniform in its character and appearance, as well as in its thickness, and is estimated to underlie in workable condition about 1500 square miles in Appanoose and Wayne counties in Iowa and several neighboring counties of Missouri.

It must not be supposed that the interior sea progressed uniformly and uninterruptedly from southwest to northeast, or that conditions remained the same throughout Pennsylvanian time. On the contrary there were many oscillations of the land and since much of the area under discussion was near the critical level of crustal movement, the sea level, it was inevitable that because of these movements the coast line should frequently swing back and forth over the marginal areas on either side the strand. These oscillations resulted in equivalent alternations of deposits—when a given area was at the proper position above sea level vegetation was accumulating, but when this area was under the sea it and its contained bed of vegetal matter became covered by a layer of sand or mud or perhaps limy ooze, depending on local conditions. These materials in due time were consolidated into sandstone or shale or limestone and also by their weight compressed the underlying bed of vegetal matter until it assumed the characters of lignite or the various grades of bitumous coal. The thickness of each deposit depended, of course, on the length of time it was accumulating, in other words the interval between successive effective oscillations, the rate at which material was contributed, the amount of condensation caused by compression or drying or chemical changes and doubtless by other factors. The estimate has been made that a vigorous growth of vegetation would yield annually about a ton of dried matter per acre. If the annual yield for a thousand years were all preserved, except for the natural loss by escaping gases, and were duly compressed it would yield less than an inch and a half of coal. In spite of this slow growth some Iowa coal beds are known to have thicknesses of eight to ten feet, and one bed with a measured thickness of thirteen and one-half feet and a reported thickness at another point of sixteen feet has been found in Marion county. Most of the beds which are worked, however, are four to five feet thick on an average. From these thicknesses they range down to mere films between layers of shale or other rock. I know of no estimate of the total thickness of coal in the Iowa measures, and indeed such an estimate would be difficult to make and of little value when it was made owing to the limited extent of the beds, their differing thickness, and the fact that the beds of a given locality are not all actually superimposed, but may be widely scattered. It may be said with assurance, however, that the coal beds form only a small percentage of the total thickness of the Iowa coal measures, as is true in other states. The purity of the accumulating material—viewed from the standpoint of the vegetation—would depend on the amount of waste matter—mud and sand—which was washed in from surrounding uplands or brought in by streams. If such material were nearly or entirely absent the deposit might, after the necessary processes, become a high grade coal while conversely a large amount of this detrital material would cause the deposit to be bony coal or perhaps only a carbonaceous shale. It must be kept in mind that this feature is quite apart from the presence of that mineral matter which is an original and essential constituent of the plant and which on combustion would become ash and sulphur. This will be discussed somewhat in connection with the character of Iowa coals.

The rock makers of the Pennsylvanian—conglomerates, sandstones, shales and limestones—form much the greater bulk of the strata, even though they are not quite so important economically. The source of these materials has been mentioned above, and it may be said in addition that the conglomerates would accumulate close to the land, where the streams and the currents would first begin to drop their loads, while the sands and clays would be carried and dropped progressively farther off shore, where the waters were quieter and the currents had less and less carrying power. The limestones would form in still, clear, though not necessarily very deep waters, but nevertheless under more typically marine conditions. With a knowledge of these varying conditions under which different strata form we are able to recreate to some extent a picture of the circumstances under which the earlier beds of the Pennsylvanian system of Iowa were laid down. These beds are known as the Des Moines series, and at present they cover southwestern Iowa and extend as far north as Onawa and Humboldt while their eastern margin may be defined roughly as along a line drawn between Iowa Falls and Keokuk. Undoubtedly the Des Moines seas had a much wider extent as outliers of their deposits are known at many places as far north and east as Iowa City and Maquoketa, and a large mass with workable coal beds is present between Muscatine and Davenport. Probably at their widest extent the Iowa and Illinois arms of the epi-continental sea were united over eastern Iowa and western Illinois. Most of these outliers, however, contain no coal beds or only very thin ones, indicating that conditions in those localities or at those times were not favorable to the accumulation of vegetal material as coal. Formerly the strata exposed or otherwise known to exist at a number of places in western Iowa, such as Logan and Atlantic, were thought to belong to a higher series than the Des Moines, but more recent study points to their Des Moines age. It is a peculiar fact and one of large economic interest that very little coal has been found in these strata west of Guthrie Center and Jefferson—or in other words, west of the eastern margin of the overlying strata. A few evidences of the presence of coal have been found, as at Missouri Valley and Denison, but here again conditions for extensive and recurrent coal formation do not seem to have been present.

In southwestern Iowa the Des Moines series is overlain by a group of beds known as the Missouri series. This consists of many alternating beds of limestones and shales of marine origin together with two beds of coal, which resemble the Mystic bed in their uniformity of thickness and character and their rather wide distribution. The upper or Nyman coal is too thin to be of economic importance, as it is not more than a foot thick. The lower bed, the Nodaway coal, is about sixteen inches thick and has been mined in Montgomery and Page and western Adams and Taylor counties. It comes to the surface in the latter two counties but is known from borings as far west as Nebraska City.

Overlying all the older formations of northwestern and west-central Iowa are the sandstones of the Dakota stage and the limestones and shales of the Colorado stage, both belonging to the Cretaceous system. The Cretaceous of northwestern Iowa carries some lignite, but the beds are too thin and of too poor quality to be of economic value. The sandstones extend as far east as Jefferson and Guthrie Center and as far south as Cass and Adams counties, with outliers beyond, but their chief importance lies in the fact that they cover up the Missouri and Des Moines beds and so render these formations more difficult of access.

Mr. M. R. Campbell in 1913 estimated the original area of the known productive coal field of Iowa as 12,560 square miles, with an estimated tonnage of 29,168,000,000 short tons. Similar estimates had been made previously by the United States Geological Survey in which the total area of the coal-bearing formations of Iowa was usually given as about 20,000 square miles of which about 13,000 might be considered potentially productive. I do not know on just what basis of extent and thickness of coal beds these estimates have been made except that Mr. Campbell states that 14 inches is taken as the minimum thickness. That would just take in the Nodaway field, and Mr. Campbell's map indicates that as one of the workable fields.

In connection with this study I have made the following computations. The area of Iowa underlain by beds of Des Moines age is 24,250 square miles. I suppose that all of this area may be considered as legitimate prey for the promoter if not for the prospector. The area of Des Moines beds which are not covered by Missouri or Cretaceous strata is about 11,250 square miles, or 7,200,000 acres, and it is a rather remarkable coincidence, as I have suggested, that the region which is overlain by these later beds is the least productive part of the Des Moines series. If now we consider all of this area to be coal-bearing, which probably is an exaggeration, and if we assume an average thickness of workable coal of four feet, which probably is a sufficiently liberal allowance and which will give a content of 4000 tons per acre, we shall have a total original volume of 28,800,000,000 tons. The total possible area underlain by the Nodaway coal of southwestern Iowa is about 1500 square miles or 960,000 acres, according to recent studies of that region. The maximum thickness which we may assign to this coal is 1.2 foot, which would give a yield of 1,150,000,000 tons. The total coal supplies from the two series of strata, then, would be 29,950,000,000 tons. Now on the one hand future explorations may extend the known areas of workable coal beyond the western limits which I have suggested, and further requirements may necessitate the use of thinner and deeper beds than those now being mined. These factors if realized will increase the available supply. On the other hand it is practically certain that hundreds of square miles within the productive territory are absolutely barren and that other hundreds contain only beds that are too thin to be of great service under any economic conditions. Then too there are bodies of coal of workable extent and thickness which have too poor roof or too much water to be available under present or reasonably calculable future mining possibilities. These factors will decrease the available supply by an unknown amount, but by one which will, I fear, at least counterbalance the favorable factors.

With regard to the possible depth of mining in Iowa it may safely be said that there is no danger of the economical limit being reached for the simple reason that coal absolutely does not exist in Iowa at the great depths which are entirely feasible with modern mining and hoisting machinery. The deepest mines in the state are in Dallas county near Waukee and are 373 feet and 417 feet deep. The Des Moines and Missouri strata are thickest in the southwestern part of the state, and here the records of the wells at Glenwood and Bedford place the base of the Des Moines series—the lowest possible horizon for finding coal—at 1235 feet and 1340 feet respectively below curb, probably as great depths as these strata reach anywhere in the state. In 1913 the Assumption Coal Co. was hoisting coal in Christian county, Illinois, from a depth of 1004 feet. A good many shafts in the anthracite field of Pennsylvania are more than 1000 feet deep. An English colliery is hoisting coal from a two- to six-foot bed at a depth of 3900 feet, and another is mining a two-foot bed 2460 feet below the surface. These figures indicate the possibilities in future Iowa mines if necessity arises.

Up to the end of 1925 Iowa coal mines had produced 264,300,000 tons, of which practically 100,000,000 tons had been mined since 1910. If we assume, as is usually done, that half a ton was left in the mine for each ton that was removed, that means a total exhaustion of 396,450,000 tons or a little less than 1.4 per cent of the total supply. If we estimate the annual exhaustion as 10,000,000 tons, the average for the past fifteen years, we shall see that the supply is still good for 2950 years. Even if it seems best to reduce the estimate by fifty per cent, the supply is sufficient to remove worry to the distant future—as human life goes. The Nodaway field, at the present rate of exhaustion, about 35,000 tons a year, should last for 35,000 years.

The earliest recorded production of coal in Iowa was given in the U. S. Census for 1840 as 400 tons. In 1848 the production reached

10,000 tons; In 1867 it was 150,000 tons; in 1876 the output was 1,250,000, and by 1899 it had reached 5,000,000. The largest production was 8,965,000 tons in 1918, although the greatest spot value was reached in 1920, when the output was valued at $30,800,000. Since 1920 the production has been less than during most of the earlier years of the present century. This decline in production probably is to be assigned in part to adverse financial conditions in the state, in part, to increasing use of outside coals by Iowa people and in part to the mine labor situation. Approximately 15,000,000 tons of coal are used in Iowa every year, and of this amount nearly two-thirds is shipped in from other states. The reasons for this condition can be best discussed in connection with the character of Iowa coal. Discussions of the financial and labor situations really have no place in this paper.

The Nodaway coal is mined by the longwall system, by which the coal is undercut and breaks down by its own weight and that of the superincumbent strata. Powder is not used to a great extent, and hence the coal is not shot to pieces so badly as by other methods. A few machines have been used for undercutting, but most of the work is done with picks. Similar methods are used in the Centerville bed of Appanoose and Wayne counties, the former of which divides with Polk county the distinction of using more than half of the mining machines in operation in Iowa. In most of the other Iowa mines, the shortwall or room and pillar method is used, and the coal is "shot from the solid." That is, it is drilled and blasted with powder or other explosive, after a cut has been made along the side of the room. This method produces a great deal of small coal which must be sold as steam coal, but it seems to be preferred by the miners. However, machine mining and the longwall system are used in some mines. About eighty mining machines are in use in the state. Shortwall mining necessitates leaving about one-third of the coal in the ground, while longwall methods permit nearly complete extraction.

Now what are the outstanding characteristics of Iowa coals? All of them are relatively soft, some of them more than relatively. All are high-ash-and-sulphur coals, with the percentage of volatile matter nearly as high as that of the fixed carbon—within about 6 per cent on the average. They do not stand air storage very well as the sulphur oxidizes and the coal breaks down. On the other hand a casual inspection of a large number of analyses of Illinois coals, for example, will show that those coals do not contain many more heat units on the average than do Iowa coals. Neither do the analyses show a vast difference in chemical composition. Why then are Illinois and eastern coals supplanting Iowa coals in Iowa markets? I believe that the answer to this question lies as much in the physical character of the coals as in their chemical analysis and their B.t.u.s. Because of their cover and the other conditions mentioned earlier in this paper the Iowa coals have not been compressed into so hard layers as have the eastern coals. All coals show more or less alternating bright and dull laminae, of which the latter are somewhat softer than the former and contain more mother coal or mineral charcoal. This mother coal is softer than the brighter coal, and a coal which contains much of it will not have the hardness and the ability to stand up under rough handling and other treatment that brighter more solid and uniform coals possess. Doctor Savage of the Illinois Geological Survey has suggested that the mother coal and the dull laminae were formed when the water level of the swamp was a little lower than usual and decay of the vegetation went on for a time in the air. When the water level rose the layers formed under water would make the bright bands. Iowa coals contain a good deal of mother coal and dull laminae. So do Illinois coals, but the eastern coals are more uniformly bright.

Owing to these physical characters, and perhaps to others, when Iowa coal is fed into the ordinary house furnace it is decomposed rather quickly and easily. Much of the volatile matter and some of the carbon are driven off before they can be heated to the ignition point. Hence a large amount of smoke and soot and gas goes into the chimney, where it is valueless for heating purposes. Hence the hue and cry about dirty Iowa coal. Hence the swing over to harder coals with less ash and sulphur and the use of ten million tons of foreign coal in Iowa and only five million tons of domestic coal.

As between the different Iowa fields it may be said that the Centerville bed is somewhat softer than the other coals but that it stores well if it is kept from undue moisture. In such conditions it loses weight somewhat, showing that it is giving up its own moisture. On account of its softness and of its block structure it requires careful handling and shielding from moisture to avoid excessive breakage and slacking. Therefore it should be shipped in closed cars. The Nodaway coal is in general similar to the Centerville, and as it is mined by similar methods it needs similar treatment. The coals of the other parts of the Des Moines series, in what may be called the shortwall or shooting fields, do not differ greatly in physical characters. Some are harder and some are softer; some contain less ash and sulphur, and some contain more. In a few cases the volatiles exceed the fixed carbon, as in one analysis which follows. But one can not draw any areal limits and put the coals of different qualities therein. The good coals are where you find them; the poorer ones hold the rest of the field.

In 1917 I made a statement in the *Iowa Magazine* which I may summarize as follows:

	Ash, per cent	B. t. u.	Cost
Average Iowa coal	11.63	10,657	
Average Illinois coal	8.80	11,148	
Difference, favor Illinois	2.83	491	
Four Des Moines coals	10.	11,400	$4.50
Franklin Co., Ill., coal	9.04	12,276	7.00
Difference, favor Illinois	1.	876 or 7%	2.50

We may let these statements stand as representing, with changed cost values, the present situation for domestic fuels. However, I should like to give here a few analyses of Iowa coals and of foreign coals that are competing in our markets for the domestic trade. The prices given are for retail delivery in Des Moines. The analyses are of coal "as received," and most of them are from car samples. The last one is not strictly comparable as it is a computed average of analyses of sixteen coals which were collected from mine faces by the writer. Still it will serve in a general comparison.

Analyses of Lump Coals

	A	B	C	D	E
Moisture	1.72	1.32	3.75	4.65	6.80
Volatile matter	10.46	38.31	36.75	36.85	39.06
Fixed carbon	79.50	56.67	55.30	52.65	50.28
Ash	8.32	3.70	4.20	10.85	10.66
Sulphur	2.49	0.62	0.70	1.58	3.22
B. t. u.	13,876	14,270	14,110	12,500	12,880
Cost per ton	$13.00	$13.00	$12.00	$10.00	$10.00

	F	G	H	I	J
Moisture	12.19	17.13	10.78	19.11	15.07
Volatile matter	39.48	35.44	41.56	30.45	34.09
Fixed carbon	37.28	40.36	36.75	38.86	39.21
Ash	10.71	7.07	10.91	11.58	11.63
Sulphur	4.56	4.00	4.43	4.26	4.52
B. t. u.	10,446	10,932	11,253	10,233	10.657
Cost per ton	$7.00	$7.50	$7.00		

A. Arkansas semianthracite, Hartshorn seam, Johnson county.
B. West Virginia semianthracite.
C. Eastern Kentucky "Hot Spot," Perry county.

D. Western Kentucky, bed No. 12, Muhlenberg county.
E. Franklin county, Illinois, John A. Logan Coal Co., bed No. 6.
F. Great Western Coal Co., Des Moines, Orillia mine. Average of several face samples. Data from Mr. J. H. Durrell, Mgr.
G. Centerville, Iowa, Mystic mine No. 3.
H. Norwood—White Coal Co., Mine No. 8, Herrold, Polk county, Iowa. Face sample. This analysis is rather unusual in that the volatile matter is greater in amount than the fixed carbon.
I. Nodaway coal, Campbell Coal Co., New Market, Taylor county, Iowa.
J. ''Average coal.'' Average of sixteen selected samples.

The facts and conditions outlined above apply with even more force to the power users of the state. On the one hand much more attention has been paid to scientific and efficient combustion under power boilers than in domestic furnaces, but on the other hand steam sizes of Iowa coals are of much poorer quality than domestic sizes. Mr. Marsh in his recent book on combustion in the power plant says that Iowa coals have proved the undoing of more stokers, probably, than any other fuels. However, it seems to me that he gives us rather the worst of it when he says that ''in this state coal containing 16 per cent of ash is really choice fuel and even 26 per cent ash coal is only 'poor.' Bad Iowa coal contains 35 to 40 per cent of ash.'' I believe that the analyses of lump coal given above and those of steam sizes given below will bear out this contention.

Analyses of Steam Coals

	A	B	C	D	E	F
Moisture	Dry	16.99	16.64	10.12	11.09	13.66
Volatile matter	37.7	30.45	29.38	31.60	29.65	30.35
Fixed carbon	48.6	35.93	31.80	34.58	34.29	38.00
Ash	13.7	16.63	22.18	23.70	24.97	17.99
Sulphur	4.0	4.11	4.38	5.39	6.72	4.24
B. t. u.	12,510	9,082	8,478	8,884	8,167	9,266
Cost per ton	$3.75	$3.97	$2.97	$2.63	$2.48	$2.74

	G	H	I	J	K
Moisture	13.66	6.53	5.98	6.58	9.30
Volatile matter	27.52	37.47	38.71	37.51	33.20
Fixed carbon	30.44	46.12	46.14	45.03	51.30
Ash	28.38	9.88	9.17	10.88	6.20
Sulphur	6.20	3.06	3.17	3.31	2.80
B. t. u.	7,333	11,962	12,143	11,823	12,995
Cost per ton	$2.65	$6.52	$5.74	$5.09	$6.00

A. Scandia Coal Co., mines in Dallas county, Iowa. Analysis by U. S. Bureau of Mines. Based on 20 cars 6 by 2 inch egg delivered to Fort Des Moines. Moisture as received was 13.2 per cent. B. t. u. 10,860. Data from Mr. K. G. Carney.
B. and C. Scandia Coal Co. B, crushed mine run; C, steam coal. Analyses are ''as fired'' and moisture is about 2 per cent higher than as received.
D. Flint Coal Co., Des Moines. Nut mixed as delivered to Roosevelt High School.
E. Des Moines Coal Co., Des Moines. Nut mixed as delivered to North High School.

F. Economy Coal Co., Des Moines. Nut mixed as delivered to East High School.

G. Des Moines Coal Co., Des Moines. Nut mixed as delivered to Lincoln High School.

Analyses B to G are by Mr. J. A. Lysaght, chemist for Des Moines City Railway. B and C, courtesy Mr. Carney; D to G, courtesy Mr. W. R. Spry, custodian of school buildings.

H. I. J. John A. Logan Coal Co., Chicago. Mines in Franklin county, Illinois. H is egg coal, I is No. 2 nut, J is 1½ inch screenings. All analyses as received. Furnished by Mr. K. G. Carney.

K. Western Kentucky steam coal. Car load lot, three-fourths inch screenings.

I am not going to discuss the burning of steam coal, as Mr. Marsh can do that more practically than I can. I should like to suggest, however, the desirability of continued study of the questions related to that problem, by both coal users and coal producers. The question of reducing the ash content of steam coals, for example, by dry cleaning and by washing merits most careful consideration. A recent paper in the *Proceedings of the Australasian Institute of Mining and Metallurgy* on "The Burden of High-Ash Coal" classifies ash as inherent, which cannot be reduced, and extraneous, which may be removed by careful mining and cleaning. Both forms impose a burden which mounts to immense figures, as for instance in steel making in the United States where each per cent of increase in ash content adds 33 cents to the cost of producing a ton of pig iron, a total added cost of $13,000,000 annually. A brief paper by Doctor Olin and Mr. Troeltzsch, published recently by the Iowa Geological Survey, gives the results of crushing and flotation tests on several Iowa coals and offers encouragement for further study and experimentation in this direction. In this paper the authors classify sulphur in coal as organic, which cannot be removed, and inorganic, mainly pyrite, a good deal of which is removable and which it should be the object of all concerned to remove to the greatest possible extent.

In summary we may state that: Coal was formed in swamps, many of which were of great extent. The thicker the cover the harder the coal.

Crustal movements and metamorphism help to make harder coal. Iowa coal is of Pennsylvanian age, as are the eastern coals.

The coal beds alternate with other strata owing to changes in level of sea and land and changes in deposition.

The known productive coal areas of Iowa amount to about 12,750 square miles, of which 11,250 square miles are in the Des Moines series and 1500 miles in the Missouri series. The possible tonnage of this area is 29,950,000,000.

No coals exist in Iowa beyond the economical limit of mining.

Only a little more than one per cent of the possible supply has been used so far. At this rate there is coal enough to last nearly 3000 years.

The Centerville and Nodaway coals are mined longwall, without shooting. Most other coal is shot and is mined shortwall.

Because of thinner cover and less metamorphism Iowa coals are softer than eastern coals. Also they contain more alternations of softer dull laminae and harder bright laminae, which adds to their softness.

Iowa coals are dirtier and make more smoke than most other coals used in this state but with careful use will yield good results.

The following references were consulted:

Coal Deposits of Iowa, Henry Hinds. Fuel Values of Iowa Coals, F. A. Wilder. Analyses of Iowa Coals, A. W. Hixson and James H. Lees: Iowa Geological Survey, vol. XIX.

Analyses of Iowa Coals, A. W. Hixson: Iowa Geological Survey, vol. XXIV.

Distribution of Ash and Sulfur in Iowa Coals, H. L. Olin and J. R. Troeltzsch: Iowa Geological Survey, vol. XXXI.

Missouri Séries of Pennsylvanian System in Southwestern Iowa, J. L. Tilton: Iowa Geological Survey, vol. XXIX.

Report of Iowa Mine Inspectors, 1924 and 1925.

Purchase and Sale of Illinois Coal on Specification, S. W. Parr: Illinois Geological Survey, Bull. No. 29.

Coal Resources of District VII, F. H. Kay: Illinois Geological Survey, Coal Mining Investigations, Bull. 11.

Twenty-second Annual Report, Part III, Coal: U. S. Geological Survey, 1900-1901.

Mineral Resources of the United States, 1910: U. S. Geological Survey.

Analyses of Coals in the United States: U. S. Bureau of Mines, Bull. 22.

Analyses of Iowa Coals: U. S. Bureau of Mines, Technical Paper 269.

Coal Resources of the World, vol. II: XII International Geological Congress, 1913.

Geology, vol. II, Chamberlin and Salisbury.

The Burden of High-Ash Coal, K. Butler: Australasian Institute of Mining and Metallurgy, No. 63.

Combustion in the Power Plant, T. A. Marsh.

Conditions Under which Vegetable Matter in Illinois Coal Beds Accumulated, T. E. Savage: Journal of Geology, vol. XXII, p. 754.

They Weren't Pyramids After All, James H. Lees: Iowa Magazine, April-May, 1917.

Random Notes on Coal and its Mining. George H. Ashley: Coal Age, vol. 31, p. 805.

Text-Book of Geology, Pirsson and Schuchert, 2d ed., pt. II, chaps. xxvii-xxix.

THE USE OF IOWA COAL FOR STEAM PRODUCTION

T. A. Marsh.
Engineer, Combustion Engineering Co., Chicago

The coals of Iowa aré among the most easily burned fuels found anywhere. This statement may sound somewhat startling, nevertheless it is a fact. Iowa coals give less difficulties than the anthracites or some of the eastern coking coals.

I do not wish to give the impression that few difficulties have been encountered in the past with Iowa coal. Quite the contrary. However, when in the light of to-day's knowledge we take a retrospect of the past 25 years' practice, experiments and development in the art of burning Iowa coals, we can find little or no logic or engineering reason for much of the work.

Most of the early designs of grates and furnaces were as evidently in error as would be a bridge not strong enough to carry the load of a train or a cylinder not strong enough to resist steam pressure without bursting.

The many faulty engineering designs and failures to properly burn the coals of Iowa were due largely to the following causes: lack of thorough information regarding the fuel characteristics; lack of knowledge in the art of combustion; the fact that in many instances if Iowa coal gave difficulties, Illinois or other coal could be substituted.

To-day, with the elements of the problem well understood and with many plants burning Iowa coal with marked success and high efficiency, it is interesting to look back and note the various steps leading to the development of present day successes.

The coals of Iowa are now well known chemically. Their physical and combustion characteristics are well established. In general, Iowa coals classify as free burning bituminous coals of high ash content. The ash fuses at a temperature usually below 2200° F.

The high ash content of the coal makes it difficult to ignite and rather slow to burn in fuel beds. The low fusion temperature of the ash renders the coal very susceptible to clinker formation at ordinary furnace temperatures. Clinker formation on grates retards combustion and therefore further reduces the amount of coal that can be burned.

The above general remarks state broadly the problems to be met in the burning of Iowa coals. During the last twenty years practically all known types of stokers have been tried with Iowa coal. The earlier installations at the beginning of this century were largely of the inclined overfeed type of stoker. With this type of stoker the fuel bed was agitated, and the ash from the lower part of the fuel bed was frequently brought up to the hotter zone near the top of the fuel bed. The temperature near the top of the fuel bed being above that of the fusion temperature of the ash, fusion resulted and clinker was formed.

These early types of stokers were provided with clinker dumping devices. The high percentage of ash found in Iowa coal naturally increased considerably the amount of ash and clinker to be removed from the furnace and made the performance of stokers using dumping plates quite limited.

It was very evident that such fuel bed action could not be at all successful with Iowa coal. The formation of clinker in large quantity clogged the grate and disrupted the fuel bed. Combustion rates were low, ash pit losses were high, operation was most difficult and maintenance excessive.

At about the same time, a number of early designs of underfeed stokers were installed throughout Iowa. These stokers used forced blast and built up high temperatures in and just above the fuel bed. The limitation of this type of stoker was again due to the formation of clinker, and while good combustion rates were obtained for short periods clinkers formed so rapidly and were removed with such difficulty that the operation was very strenuous and the service of the stokers short-lived.

A thorough knowledge of the fuel and its characteristics would no doubt have saved expense and prevented numerous failures of stokers of these types for burning Iowa coal.

Following the era of overfeed and underfeed stokers in Iowa came what might be termed the chain grate period. From the general analysis of average Iowa coal, it was evident this type of stoker was basically more suitable than either the overfeeds or underfeeds as clinkers were avoided.

The reasons for this were, first the ash was continuously scavenged from the furnace leaving no deposit for clinker formation and the subsequent periodic dumping was eliminated. Second, the fuel bed was undisturbed, and the ash remained where it was formed, at the bottom or cooler side of the fuel bed.

Even with these characteristics in their favor, most of the early chain grate installations were very limited in performance. Difficulty was experienced in igniting the fuel at proper rates, owing to lack of knowledge of furnace design and arch length and location.

Most early installations were quite limited in the item of rating. This was attributable to two causes in so far as stoker and furnace were concerned, namely improper furnace design and insufficient grate area.

Among the successful early installations were the Des Moines City Railway Company's installation, installed about 1913, at which plant work was done on Iowa coals. The work of the Iowa Railway and Light Company has been a most valuable addition to the knowledge of the burning of Iowa coal with chain grates.

About six years ago the forced draft chain grate was successfully applied to bituminous coals. This factor added much to the performance obtainable with Iowa coals. Some of the poorer grades of Iowa coal are so inert that under natural draft conditions combustion rates are too low to maintain high furnace temperatures. This in turn reacts on the ability to ignite more coal. The use of forced draft in various zones or compartments in stokers furnishes a means of regulating the air supply which improves ignition and greatly increases the combustion rates obtainable.

One of the first in the state to make an installation of forced draft chain grates was the Fort Dodge, Des Moines & Southern Ry., at their Frazer plant. The local coal is very high in ash, frequently above 25 per cent. The calorific value is frequently below 7500 B.t.u. With natural draft chain grates they found it difficult to ignite and burn enough fuel for their required ratings. Forced draft with increased combustion rates, higher furnace temperatures, higher capacities and much less sensitive operation produced the required results.

One of the most recent installations in Iowa, the Des Moines Station of the Iowa Power & Light Company, is equipped with this stoker type and is giving excellent results with Iowa coal.

While the development of the natural and forced draft traveling grate was progressing, the multiple retort underfeed stoker was going through a similar development. An early installation of this type of stoker was made at the Cedar Rapids plant of the Iowa Railway & Light Company. Similar to other stoker types that had entered this field, the grate surfaces were not made so liberal as is now known to be desirable. This type of stoker agitates the fuel bed and clinker formation results. The higher the combustion rate the more serious the clinker problem becomes. Much improved results have more recently been obtained by stokers of this type, but they are considerably more liberal in grate area than the early types. This stoker type has been installed at the Riverside plant of the United Light & Power Company near Davenport, which is one of the more recent power plants of the state.

Iowa coal burns best when reduced to a size all of which will pass through a 1 in. round hole screen. The tempering or moistening of Iowa coal is very important, and the better combustion engineers of the state have learned much in this regard. Three to five per cent moisture added at least two hours before burning improves results in regard to combustion rates, CO_2 and carbon in the ash. From operating reports this is said to be the case with all types of stokers.

The past five years have seen the adoption of pulverized fuel by large central stations and major industrials. Naturally when the larger new Iowa plants were being designed, decision had to be made between stokers and pulverized fuel.

At the time that the Big Sioux station of the Sioux City Gas & Electric Company was contemplated, that company was thoroughly familiar with overfeed stokers, underfeeds and chain grates, having used all types in their various Sioux City stations. However, no tests had been made on Iowa coal in pulverized form. The possibility of the slagging of furnace walls and floor was a question, as were also the power requirements for pulverizing.

Accordingly the Sioux City Gas & Electric Company sent several carloads of their coal to the Lakeside plant of the Milwaukee Electric Railway Light & Power Company for tests in actual operation. The findings of these tests resulted in a decision for pulverized coal for the Big Sioux Station.

It was recognized that with the low fusion temperature of the ash, ample cooling elements should be installed in the furnace to reduce the temperature of the walls and hearth to a point below that of the melting point of the ash. This was done by means of water screens.

The Iowa Railway & Light Company have recently installed in their Cedar Rapids plant two unit systems of pulverized coal with completely water cooled furnaces.

The excellent results possible from Iowa coal in pulverized form lead to the conclusion, as with most other fuels, that the finer the degree of preparation of the fuel the better the combustion results.

It is evident that the ideal method of burning Iowa coal is in pulverized form. Whether or not this can be justified in any plant under consideration becomes a problem of first costs involving investment charges, preparation charges, in fact all items involved in the final and total cost per thousand pounds of steam.

During the last three years air preheaters have figured strongly in the equipment of modern power stations. Air preheaters utilize the heat in the escaping flue gases to raise the temperature of the air used for combustion. Sometimes temperatures of combustion air are raised to as high as 350° or 400°. The air so preheated helps the coal to ignite, raises the furnace temperature and so improves combustion that not only is there the gain due to the heat returned to the furnace, but there is the additional gain in capacity, improvement in ash and reduction in combustion losses. The use of preheated air for combustion is very desirable with Iowa coal.

As combustion rates and furnace temperatures have been increased with the use of low fusible ash coals it is evident that something other than refractory walls are necessary for certain parts of furnaces.

In part then, for furnace protection and the utilization of radiant energy from the fuel, has come a development of radiant water walls and radiant steam walls which play a most important part in the modern installation. Elements exposed to radiant heat operate at very high absorption rates. With the use of forced draft stokers and pulverized coal at high ratings, radiant walls are most desirable. Where highly preheated air is used radiant water or steam walls become more necessary to reduce furnace maintenance.

To summarize the situation as it stands to-day, in major plants burning Iowa coal we have, therefore, pulverized fuel, natural and forced draft chain grates, multiple retort underfeeds, air preheaters, water walls. Air preheaters and water walls lend themselves better to the pulverized fuel furnace than to the stoker furnace. Larger areas can be covered with radiant water walls or radiant superheaters in pulverized fuel furnaces than in stoker furnaces.

As the problem now stands the ideal furnace of to-day for burning Iowa coal would be the pulverized fuel furnace with radiant water walls or radiant steam walls or both, in combination, and the use of highly preheated air under definite regulation in connection with definite regulation of fuel.

In cases where the economics of the problem indicates stokers, the most desirable type of stoker is the forced draft traveling grate with preheated air and water walls. For those installations not requiring the higher capacity obtainable with pulverized fuel or with forced draft, the natural draft chain grate is suitable. Such installations should be made with liberal arches, at least 60 per cent of the stoker length and set high above the fuel bed. Stokers for Iowa coals should have liberal grate area and should preferably be 12 ft. long or longer.

We have, therefore, very suitable and highly efficient methods of burning Iowa coal. Such methods and such state of the art have required years of development.

Now that the methods are known, the burning of Iowa coal is indeed easier than the burning of many other supposedly superior coals from other localities.

As a supplement to this paper the author appends drawings showing the general furnace designs and some combustion results of the Big Sioux Station, Sioux City Gas & Electric Co.; the Des Moines Station, Iowa Power & Light Co.; the Cedar Rapids Station, Iowa Railway & Light Co.; the Des Moines City Railway, Des Moines, Iowa; State University of Iowa, Iowa City. (Not printed.)

The United Light & Power Company reports that they do not burn Iowa coal in their Riverside plant. To date only 4 or 5 cars have been used. They submit however, some Iowa coal tests made at the Moline, Rock Island Manufacturing Company's plant with Iowa coal.

IOWA COAL TESTS AT MOLINE
ROCK ISLAND MANUFACTURING CO.

Type of stoker—Multiple retort underfeed				
Kind of coal—2-in. screenings from Tracy, Iowa				
Per cent moisture	17.82	20.03	20.41	18.08
Per cent volatile	30.23	27.57	26.30	29.46
Per cent fixed carbon	33.67	35.15	35.21	35.32
Per cent ash	18.28	17.25	18.08	17.14
B. t. u. per pound of coal as fired	8461	8021	8113	8445
Pounds of coal per sq.ft. of grate per hr.	24.2	31.5	37.7	48.6
CO_2 in flue gases—per cent	10.82	12.13	11.01	10.65
Combustible in ash—per cent	9.30	13.40	22.51	43.59

Type of stoker—Natural draft chain grates
Kind of coal—2-in. screenings from Tracy, Iowa

Per cent moisture	16.70	18.96	15.14	18.17
Per cent volatile	31.27	30.71	32.19	30.32
Per cent fixed carbon	33.75	33.65	36.21	35.23
Per cent ash	18.28	16.68	16.46	16.28
B. t. u. per pound of coal as fired	8572	8468	9402	8760
Pounds of coal per sq.ft. of grate per hr.	27.1	30.2	32.6	37.4
CO_2 in flue gases—per cent	13.13	12.42	11.95	13.18
Combustible in ash—per cent	29.26	32.87	35.28	41.60

IOWA COAL RESULTS FROM SIOUX CITY GAS & ELECTRIC CO. BIG SIOUX STATION, WITH PULVERIZED COAL FIRING

The Big Sioux Station of the Sioux City Gas & Electric Company is equipped with the bin and feeder system of pulverized coal. They report that during the months of December, 1926, and January, 1927, they pulverized and burned coal from eight different states, namely, Iowa, Illinois, Kentucky (western), Oklahoma, Arkansas, Colorado, Indiana and Missouri, and from fifteen districts within these states. No trouble was experienced in maintaining high ratings whenever required with any of these coals.

The average boiler rating for the two months was 198 per cent. The maximum was 300 per cent. The average CO_2 was 13 per cent, and the boiler efficiency for the two months was 83.3 per cent. They report no difficulty in operating with Iowa coal at ratings of 350 per cent and more and very little difficulties with slag.

During the month of April, 1926, the major portion of the coal used was from Waukee, Iowa. This month gave the best month's efficiency in the station history. In February, 1927, practically all Iowa coal was burned. The average analysis was 9100 B.t.u. with 18 per cent ash. The monthly boiler efficiency was 84.5 per cent.

The high efficiencies of Iowa coals in this station have caused some thought to be given as to the reason. A theory has been advanced that the surfaces of the ash in suspension accelerate the burning of fuel by increasing the radiant energy and create an accelerating effect on combustion. This is in accord with tests made at the mines de Blanzy, France, in which it was proven that ash particles in suspension have a beneficial effect on combustion when pulverized fuel is burned by short flame travel.

The results with Iowa coal at the Big Sioux Station certainly establish the fact that Iowa coals burn excellently in pulverized form and indicate that Iowa coals even have advantage over many other coals in this regard.

DES MOINES CITY RAILWAY ANNUAL STATION BOILER PERFORMANCE RECORDS

Year	1922	1923	1924	1925	1926
B.H.P. banked	8,203,020	10,073,980	10,266,301	10,074,000	9,880,860
B.H.P. service	9,193,360	10,419,190	10,257,700	9,501,700	10,073,820
B.H.P. developed	17,650,748	19,365,159	18,819,379	17,564,826	17,954,963
% Banked to service	89.23	96.70	100.08	106.03	98.11
% Service to gen.	35.59	36.37	35.98	35.04	37.49
% Dev. to service	191.99	185.88	183.45	184.89	178.28
Water evaporated 1000 lb.	580,877.00	639,722.00	621,391.10	580,497.00	594,837.00

Coal burned 1000 lb.	88,228.10	105,967.30	102,722.95	93,516.70	96,967.00
Water evap. per lb. coal	6.42	6.04	6.05	6.21	6.13
% Moisture as fired	14.62	15.43	15.72	15.82	15.90
%Ash as fired	18.70	21.24	19.41	17.05	19.05
B.t.u. as fired	9152.68	8593.63	8905.63	9290.56	8933.90
B.t.u. per lb. water evap.	1426	1423	1472	1497	1456
Efficiency of boilers, furnaces and grates	71.02	71.13	68.99	67.88	69.61

The great number of these tests and the length of time covered by test periods give unusual reliance to these results.

In this station the yearly operating records also give an excellent check of test results. This station is remarkable for the keeping of unusually careful records of performance and the close relationship between test and operating results. This company is to be given much credit for results obtained.

ILLINOIS POWER AND LIGHT CORPORATION

The Illinois Power and Light Corporation has two plants in Des Moines. The old station has natural draft chain grates, no economizers and no air heaters. The new station has forced draft chain grates, economizers and air heaters on some of the units. Comparative months operating results are given on page 91.

IOWA COAL PERFORMANCE ON NATURAL DRAFT CHAIN GRATES
AT THE DES MOINES CITY RAILWAY COMPANY
DES MOINES, IOWA

No. of tests	5	34	6	12	7	9	1	1
Duration of tests hours	107½	713¾	152¾	289¼	162¼	187¼	21¼	19¾
Kind coal used	Iowa	Iowa	Iowa	Iowa	Iowa	Iowa	Iowa	Iowa
Water evap. per lb. coal	5.90	6.34	6.47	6.22	6.52	5.93	6.68	6.63
Lbs. coal burned per sq.ft. grate area per hr.	38.17	37.95	36.56	35.08	38.21	38.13	43.49	43.14
% Rating developed	168.07	185.02	176.28	162.30	185.76	168.73	216.46	213.41
Efficiency of boiler furnace and grate	73.83	70.35	72.92	74.91	73.10	71.39	70.83	72.52
Analysis of coal as fired								
% Moisture	16.33	14.82	16.51	16.31	16.99	16.64	13.31	15.53
% Ash	23.10	16.97	17.96	21.16	16.63	22.18	16.09	17.39
% Sulphur	4.20	4.87	5.23	5.15	4.11	4.38	5.20	6.24
B.t.u. per lb. as fired	8144.00	9495.02	9034.00	8435.00	9082.00	8478.00	9595.81	9316.62

DES MOINES POWER STATION OPERATING COMPARISON

	Old Station	*New Station*
Month	October, 1924	November, 1926
Name of fuel	Iowa	Iowa
Tons fuel burned	13,048	10,443
Average B.T.U. as fired	8,970	9,185
Average boiler efficiency	73%	83.3%
Average rating	127%	152%
Average combustible in ash	19%	7.1%
Average CO_2	11%	9.9%
Average uptake temp.	575°	200°
Steam pressure—gage	180 lbs.	382 lbs.
Superheat—average	90°	250°
Type of stoker	Natural draft chain grates	Forced draft chain grates
Air preheaters	None	12,420 sq.ft.
Superheaters	100° F.	250° F.
Economizers	None	10,000 sq.ft.
Furnace side walls	None	310 sq.ft. fin. walls

Fuel

At old station: from Pershing Coal Co., 9048 tons from Pershing Mine, and from Norwood White Coal Co., 4000 tons from No. 7 Moran Mine.

At new station: from Pershing Coal Co., Pershing and Tracy Mines, and from Norwood White No. 7 and No. 8 mines, Moran and Herrold, Iowa, respectively.

Quantities from different mines not known.

Boilers in Service

At old station, all boilers with exception of two in service.

At new station, all boilers in service much of month due to regulating superheat on new boilers No. 2 and No. 4. This lowered average CO_2 due to high banking H.P. hours.

New station average boiler rating is brought down due to above noted boilers in service, also due to low night loads which results in high banking H.P. hours.

The comparative results of these stations is of interest. The higher efficiency of the new station during this comparative period is due mostly to better heat absorption of boilers and economizers and air heaters. The load conditions, however, are unfortunate and the CO_2 and rating results do not represent the results obtainable from forced draft chain grates under more suitable load conditions and without such a large proportion of banked boiler hours.

POSSIBLE RESEARCHES IN IOWA COAL

B. P. Fleming

Professor of Mechanical Engineering, University of Iowa

Among the many sources of wealth with which Nature has blessed Iowa are its coal measures. Dr. Lees has discussed the extent and characteristics of these deposits, and Mr. Marsh has shown what may be done to utilize this coal effectively in processes of combustion.

Iowa coal suffers from an inferiority complex due to the fact that its disagreeable and its poor qualities have been more persistently and widely broadcast than its good qualities. It also suffers from

DES MOINES POWER STATION OPERATING COMPARISON

	Old Station	*New Station*
Month	October, 1924	November, 1926
Name of fuel	Iowa	Iowa
Tons fuel burned	13,048	10,443
Average B.T.U. as fired	8,970	9,185
Average boiler efficiency	73%	83.3%
Average rating	127%	152%
Average combustible in ash	19%	7.1%
Average CO_2	11%	9.9%
Average uptake temp.	575°	200°
Steam pressure—gage	180 lbs.	382 lbs.
Superheat—average	90°	250°
Type of stoker	Natural draft chain grates	Forced draft chain grates
Air preheaters	None	12,420 sq.ft.
Superheaters	100° F.	250° F.
Economizers	None	10,000 sq.ft.
Furnace side walls	None	310 sq.ft. fin. walls

Fuel

At old station: from Pershing Coal Co., 9048 tons from Pershing Mine, and from Norwood White Coal Co., 4000 tons from No. 7 Moran Mine.

At new station: from Pershing Coal Co., Pershing and Tracy Mines, and from Norwood White No. 7 and No. 8 mines, Moran and Herrold, Iowa, respectively.

Quantities from different mines not known.

Boilers in Service

At old station, all boilers with exception of two in service.

At new station, all boilers in service much of month due to regulating superheat on new boilers No. 2 and No. 4. This lowered average CO_2 due to high banking H.P. hours.

New station average boiler rating is brought down due to above noted boilers in service, also due to low night loads which results in high banking H.P. hours.

The comparative results of these stations is of interest. The higher efficiency of the new station during this comparative period is due mostly to better heat absorption of boilers and economizers and air heaters. The load conditions, however, are unfortunate and the CO_2 and rating results do not represent the results obtainable from forced draft chain grates under more suitable load conditions and without such a large proportion of banked boiler hours.

POSSIBLE RESEARCHES IN IOWA COAL

B. P. FLEMING
Professor of Mechanical Engineering, University of Iowa

Among the many sources of wealth with which Nature has blessed Iowa are its coal measures. Dr. Lees has discussed the extent and characteristics of these deposits, and Mr. Marsh has shown what may be done to utilize this coal effectively in processes of combustion.

Iowa coal suffers from an inferiority complex due to the fact that its disagreeable and its poor qualities have been more persistently and widely broadcast than its good qualities. It also suffers from severe economic handicaps. Take as an example the domestic use of Iowa coal in Iowa City. The freight rate on domestic sizes of a certain class of Iowa coal into this city is \$1.80 per ton and on Western Kentucky, \$3.52. If at the mine you pay \$4.00 for Iowa coal and \$1.65 for Western Kentucky you have immediately a difference of 63 cents per ton in favor of the Kentucky coal laid down in Iowa City. This discrepancy in price at mine is undoubtedly due to the greater difficulty in the securing of Iowa coal in its shallow beds and to general economic conditions affecting the cost of mining not necessary to be mentioned here. However this may be the fact that a coal considered superior to the Iowa coals which have been offered for sale here can be bought at a lower price places a handicap on the sale and use of Iowa coal which even better coals would have difficulty in surmounting. Both in domestic use and for industrial purposes Iowa coal shows certain qualities and properties which militate against its more general use. Let us catalogue a few of these disagreeable qualities.

First, a high moisture content. Aside from causing the purchaser to pay a good price for water, this moisture has the effect of causing the coal to crumble as it dries out so that for domestic purposes it is hard to stock it in any quantity in lump form.

Second, a high ash content. The ash content is due not only to inherent inorganic impurities but to deposits of earthy materials coincident with the formation of the coal bed such as partings, clay streaks, pyritic and shaly materials, as well as foreign materials such as fragments of roof and floor of the working, not removed in the cleaning processes at the mines. Unfortunately this ash is not only abundant, but it is of low fusibility, and thus clinkers readily and even may freeze to and into the air openings in grates. The low fusibility of the ash of Iowa coal along with and probably due to the high iron content of the ash may be said to be its worst characteristic and is mainly responsible for the low esteem in which it is held.

Third, sulphur content. Iowa coals in general are high in sulphur, combined of course with iron, and this characteristic not only adds to the disagreeable qualities of its smoke but makes the ash refuse particularly unpleasant to remove and handle.

Fourth, low heating value. Published calorimetric tests of Iowa coal seldom or never fall below 10,000 B.t.u. per pound. This is low as compared with many bituminous coals, but many combustion engineers regard Iowa coal as possessing even less than this low figure in heat actually available in commercial conditions.

As a résumé of these counts against Iowa coal we may therefore cite the following:

High moisture, high ash of low fusion point and with high iron and sulphur content, high volatile content and low thermal value. It would seem that Iowa coal therefore has every quality that it should not have and few things to recommend it. These qualities, however, while characteristic of coal of the state as a whole, are modified in the coals of certain localities and certain veins.

It will be evident at once that in general Iowa coals are lower in fixed carbon and higher in volatile, sulphur, moisture and ash than are the coals from Illinois and Kentucky with which they are compared. On the other hand it will be noted that although high in moisture a sample of Appanoose county (Mystic vein) coal excelled in heating value even the best of the Illinois coals and was distinctly better in every way except moisture than the poorer Illinois coals. Thus we may say that while Iowa coals as a whole are distinctly inferior to the better Illinois and Western Kentucky coals they are no worse than the poorer grades of Illinois coals, and the better grades of Iowa coal are distinctly better than the inferior grades of Illinois coal. From this statement we may derive some comfort, but it is not a solution of the way to increase the use of Iowa coal. Iowa coal will continue to be used in the vicinities where it is mined, by industrial plants, power houses and domestic users who will put up with its poor qualities or go to large expense to overcome them so long as they can buy Iowa coal cheaper than they can buy better grades of coal brought into the state from surrounding fields. The difficulties in storage of Iowa coal can be avoided by delivering it from the mine to nearby users as it is needed, and for those who must have a guarantee against coal shortage the storage of coal under water will be practiced where economically feasible. These conditions mean, however, a limitation on demand which promises little growth for the coal mining industry of Iowa and a future dominated entirely by the growth of purely local markets. No amount of advertising, no amount of organization, no amount of appeal to state pride and loyalty will cause the average Iowa consumer to pay as much or more for Iowa coal as for a coal which he believes is superior in quality even though it comes from outside the state lines. If this is admitted then an extension of the uses of

Iowa coal outside of purely local markets must lie in the discovery of entirely new uses for it, in the discovery of new and better ways of burning it for power, industrial, and domestic uses, in the devising of possible ways of storing it cheaply without deterioration in size or quality and without spontaneous combustion, in the devising of treatments and processes which will enable it to be used in ways and for purposes now forbidden by its undesirable qualities.

In outlining possible fields of research having as their aim the extension of uses of Iowa coal we should not be deterred or discouraged at the outset by a feeling that the coal is so inferior that little expectation of success may attend our efforts. We might also be inclined to say that even though some encouraging laboratory methods are evolved, the general economic situation is such that there is little hope of extending the methods into actual commercial operations. We must remember, however, that we are not building entirely for the present, new discoveries and new applications may completely change the economic conditions of to-morrow, and who knows but that Iowa coals, despised and more or less discredited to-day, may become extremely important in the commercial and industrial life of the state in the next decade. Iowa coals present to the scientist practically an unexplored field. Little has been done in an investigation of their properties by the industrial chemist.

We are attempting to burn these coals in a raw state. What may be accomplished by attempts at purification we can merely surmise.

Possible researches on Iowa coal therefore may follow along these general lines.

1. An improvement in quality by removal of those impurities which most seriously impede successful or satisfactory combustion in industrial and domestic furnaces, and which interfere with successful ground storage. Can a method of washing or of dry cleaning of Iowa coal be evolved which will so far reduce the ash and sulphur content as materially to improve the qualities of the coal? There is here a very promising field of investigation which will involve a study of the most feasible methods of separation of the heavier impurities, whether by flotation in commercial sizes and grades, or air separation after grinding and subsequent briquetting of the purified product for the market.

2. We are attempting to burn Iowa coal in domestic heating appliances which for the most part were developed for eastern coals. It is entirely conceivable that such devices are ill adapted to the

burning of Iowa coal and that designs of furnace and combustion space, grates and smoke passages, heating surface shape and disposition could be evolved that would be a great improvement on devices in use. We may say safely that in general, house heating furnaces are undersized to promote the best conditions for combustion, and in such furnaces when using a high volatile, high ash and low heating value coal such as that of Iowa it is only to be expected that extreme difficulty will be encountered in securing satisfactory heating service and that the difficulties with smoke, soot and clinkers will be such as thoroughly to discourage the user. The determination by trial and experiment of the best shape and sizes of domestic heating furnaces for Iowa coals for a given set of conditions is a problem deserving attention.

3. Iowa coals give great promise of being of value in pulverized form for industrial and boiler furnaces. We have had but little experience with this fuel in this form, however, and many questions remain unanswered as to the most efficient methods of preparation and its possible storage in the pulverized stage, whether its high moisture content is a detriment or an advantage, and what may be the effect of its high ash content. Are water screens necessary, or may their function be replaced by radiant heat water cooled walls; what is the best shape and size of furnace for a given set of conditions to produce most effective combustion and give least trouble with ash accumulation? How does the generally slow burning quality of Iowa coal affect burner and furnace design? These and many other questions will be answered in time by experimenters and pioneers in the use of Iowa coal as powdered fuel, and it will be necessary to spend much time and thought, doubtless, in full-sized experiments before a satisfactory technique will be evolved. The experiments and developments at Des Moines and Sioux City are very encouraging indeed, and it may be that in the unit pulverizer is the long sought answer to the problem of how to burn low grade coal for steam making in power boilers. If this is true for power boilers of large capacity what about similar devices for smaller heating or power installations?

4. Low and high temperature carbonization processes. Iowa coals because of their high sulphur and ash content have commonly been regarded as valueless for gas making and as a source of fuel coke or metallurgical coke. We are just beginning to realize, however, that we know very little about those curious and mysterious

substances in coal which give coking properties to one and deny them to another. It may indeed be quite possible by treatment or method to make out of Iowa coal coke of very superior quality when we learn the secret which underlies the coking property. Similarly the high volatile content of Iowa coal leads to an expectation that it should yield fuel gas and by-products of commercial value. All these matters, however, are now entirely in the field of surmise and conjecture. Much has been done in this country and in Europe in the investigation of other coals, but Iowa coals have been given practically no attention. What has been done elsewhere may be used to guide us here and stimulate our interest as well as confirm our belief in the possibility of finding ways and means of using Iowa coal for the production of marketable gas and coke.

There is an attractive possibility in power plant operation of converting low grade non-coking or indifferently coking coals by low temperature carbonization processes into a pulverized semi-coke more suitable for efficient power production than the original coal. If by such a process there may be secured by-products such as marketable gas, tars, and substances saleable to the chemical trades, the cost of power production from the standpoint of fuel only will be lowered materially by the revenue derived from sale of by-products. A combined property such as a gas and electric station would find many ways of saving in fuel costs if the carbonization process could be so far perfected as to afford the needed flexibility to meet the peak load conditions of both kinds of service. Will Iowa coal permit of such treatment, and is there any hope for the successful use of carbonization processes by plants in Iowa using our native Iowa coal?

5. A fascinating new field is that of producing oils from coal by methods distinct from distillation or carbonization. That Iowa coals should not yield to such treatment as well as those of other countries or other districts in our own country we certainly have no reason to believe. It is by no means certain of course that in our generation, coal gasoline will be manufactured at a price to compete with gasoline derived from crude oil, but if methyl alcohol made from coal can threaten the extinction in this country of an industry making the product by the older method, who shall say that a perfection of the coal process may not in a few years seriously affect the natural gasoline situation?

Of this much we may be fairly sure, and that is that the coals which in a raw state are least valuable as primary fuels will be the logical sources of raw material for a synthetic product such as coal gasoline. Are Iowa coals suitable for this purpose, and will it be possible to build up in Iowa a future industry to supply from our coal measures liquid fuel for our 600,000 automobiles, trucks, and farm engines? This is a problem for the future perhaps, but at least it opens up interesting possibilities. Other more pressing problems of Iowa coal should be solved first, but it is comforting to believe that we have, at least potentially, sources of liquid fuel which a perfection of methods and the economic urge may some day make available.

While we at the University view with concern what seems to be a gradual decline in the production and use of Iowa coal we may be accused of doing little in a practical way to help out in the situation, for as a matter of fact little or no Iowa coal is used for domestic purposes in this locality, and, so far as the University is concerned, of the 15,000 to 20,000 tons used annually perhaps 25 per cent will be Iowa coal. This illustrates two common reasons why Iowa coal is not more used.

First, the economic reason. Iowa coal because of our geographic location in eastern Iowa cannot be sold here at prices which will meet the competition of coals coming from the East.

Second, the equipment now in use at the University is not adequate for the burning of Iowa coal. With a boiler plant working up to 200 per cent of rating it is next to impossible with the combustion equipment now in use to keep up steam with Iowa coal. Firemen do not like it, do not know and perhaps cannot learn how to handle it and find an abundance of reasons why they cannot maintain pressure when they are forced to use it.

In making up specifications for the combustion equipment of the new boiler plant of the University the fact that Iowa coal was to be used was particularly emphasized. Both the mechanical combustion equipment and the arch were let to one reliable and well known concern who assume responsibility for the entire furnace design, and we have the assurance of this concern that we shall be able to burn Iowa coal successfully at 150 per cent rating with a draft of 0.35 inch over the fire. The stokers are natural draft chain grate with water back, and the arch is of the concave convex type. The grates are 13 feet long and 11 feet wide, and the boilers, which are the vertical water tubular type, are rated at 612 H.P. set with mud drum 8 feet above the floor. Thus it is apparent that we are doing what we can to make provision for the use of Iowa coal, subject of course to the limitation that when the market justifies it, coals from outside of Iowa will be bought and used when money can be saved by so doing.

One rather difficult situation here has been the storage of Iowa coal. It is no uncommon thing to see a carload of Iowa coal come into the yards on fire. To store on the ground any large reserve of Iowa coal without danger of fire is practically impossible. We hope in time to solve that problem by creating an underwater storage plant near the new power plant, the position of this plant on the river front and below the dam being unusually favorable for the development of underwater storage.

As I have said before although we here at the University recognize the problem which the miners and operators of Iowa's coal mines are now facing and are doing what little is possible, subject to practical limitations, to extend the use of Iowa coal locally, we feel that our real province and the way in which we can be of most service to the coal industry of the state is in utilizing our staff and facilities for promoting and carrying on research or investigation in the lines previously mentioned.

For some time the Department of Chemical Engineering here has been directing researches in the properties of Iowa coal by its advanced students, and some things are being learned which Dr. Olin can tell you more about than I. It is difficult, however, to conduct small sized laboratory experiments in the purifying of coal or in low temperature carbonization or in the preparation, storing, and utilization of pulverized coal from which results that may be useful in practice can be obtained or which will attract or merit the confidence of men in practice. Particularly is this true in arriving at conclusions with regard to the cost of a process. Experiments on a full sized scale are almost essential in work in combustion, carbonization, and purification.

Fortunately the University has some space and facilities which, modified to suit the requirements of the work, could be utilized in certain full sized experiments. Upon the completion of its program of providing new facilities for generating and distributing steam, the University will probably be able to retire from active service the existing main plant at the corner of Madison and Washington streets behind the Engineering Building. There is here a variety of boiler and draft equipment some of which could be adapted to experiments with Iowa coal in pulverized form and in mechanical stokers of different types. There is also considerable space which could be devoted to equipment for coal purification treatment and low or high temperature carbonization. One advantage would be that steam formed could be turned into the high pressure system of the institution, in fact there would seem to be no serious problem as to what to do with the heat products of such a laboratory.

Thus we have the enthusiasm, the space, and some of the equipment. The matter of expense is the greatest stumbling block. Although our Graduate College has funds for research it will be by no means adequate to provide for so extended and expensive a program, even were this College disposed to support it. Consequently we must wait till either the coal industry, the manufacturers of combustion and other equipment, or the State itself becomes sufficiently interested to offer us support. Meanwhile we can only stand by helplessly wishing that Iowa coal were better but knowing that unless economic conditions change very materially the Iowa coal industry will continue to decline until it becomes merely of local importance in the vicinity of the few mines which can continue to be worked.

PROF. H. L. OLIN: The possibilities of research on the better utilization of the coals of the state are so great that I can outline here only some of the most important and urgent.

Professor Fleming has pointed out the major faults of a typical Iowa coal—high ash, volatile matter, and sulfur. Moreover, because of their physical structure some of them tend to slake rapidly on exposure to air and are therefore difficult to transport and store. A beginning at least should be made on a study of the classification of the different Iowa coals, for it is highly probable that certain seams in the state are lignitic in character while others are more highly devolatilized. Coördinated with such a study should be the testing of the rate of slaking and of deterioration in storage and of determining methods for improving storage conditions.

Elaborate studies should be made on the semi-plant scale of wet and dry washing methods for the elimination of ash and sulfur. Laboratory investigations covering a period of five years or more have been made in the Department of Chemical Engineering of the University, some of the results of which have been published in the latest volume of the Iowa Geological Survey. We are now ready for practical scale work in order to determine costs. It seems possible to eliminate a large percentage of undesirable constituents without undue loss of fuel matter. There seems to be no good reason why a washed domestic or steam grade of Iowa coals should not be produced and marketed so far as technical difficulties are concerned.

The need for research in the use of powdered coal has already been discussed. The most promising feature of this method is the apparent possibility of operating with fuels of high ash content with the attainment of high thermal efficiencies. Iowa coal with high volatile matter should be particularly susceptible to treatment in this way and thorough tests under a wide range of conditions should be made on carload lots from the various seams.

The possibilities of low temperature carbonization have been a matter of keen interest to fuel technologists for more than two decades, and much advancement has been made. We know little or nothing about the coking properties of Iowa coals at either high or low temperatures, nor about the yield and character of the by-products, gaseous or tarry. Industry is preparing for expansion along this line, and scientific studies should be made without delay to meet the needs as they arise.

Such a program as I have outlined would be in itself a large one, without considering other possibilities. The University stands ready to begin this work when funds shall have been provided for carrying it on.

GEOLOGY OF LUCAS COUNTY

BY

ALVIN LEONARD LUGN

CONTENTS

LIST OF ILLUSTRATIONS

GEOLOGY OF LUCAS COUNTY

Introduction

Location and Area.—Lucas county is in the south-central part of Iowa just east of a north and south line through the central part of the state and in the second tier of counties from the Iowa-Missouri line. Its position in this tier of counties is sixth east of Missouri river and also sixth west of Mississippi river. Warren and Marion counties are on the north, Monroe county is on the east, Wayne county on the south and Clarke county on the west. It corners with Appanoose county on the southeast and with Decatur county on the southwest.

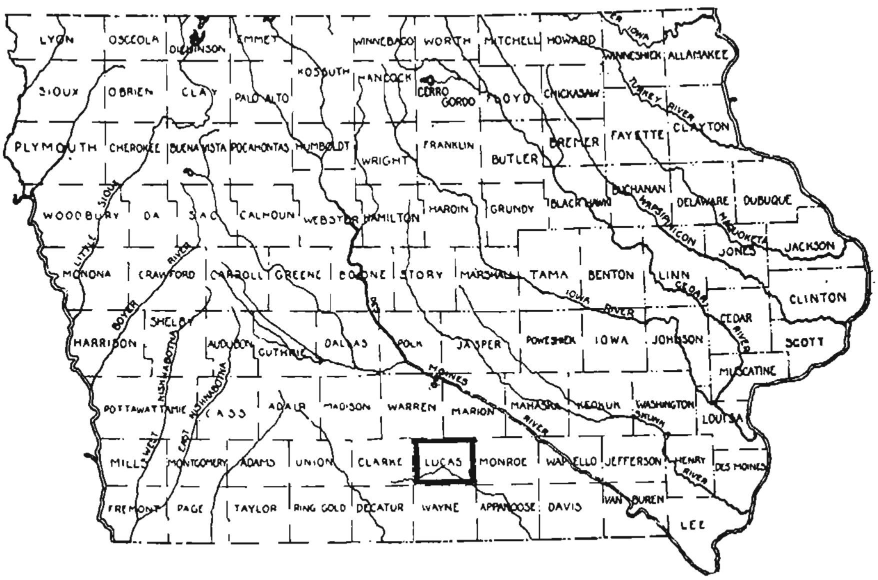


FIG. 1.—Location of Lucas county in Iowa.

This is one of the smaller counties of the state and is rectangular in shape. It contains twelve congressional townships, with approximately 432 square miles or 276,480 acres.[1] The twelve congressional townships are everywhere conterminous with the civil townships, each containing thirty-six sections, and comprise

[1] Area as given by the Fourteenth Census (1920) in Bulletin of Agriculture: Iowa.

townships 71, 72 and 73 north and ranges 20, 21, 22 and 23 west of the Fifth Principal Meridian. The latitude and longitude of the Court House in Chariton, the county seat, are 41° 00′ 55″ N. and 93° 18′ 22″ W.

This county is underlain by formations of the Des Moines series of the Pennsylvanian system and has become an important coal producing county in the last few years. It is served by main lines of the Chicago, Rock Island and Pacific and the Chicago, Burlington and Quincy railroads.

Previous Geological Work.—Very little detailed geological work has been done in Lucas county up to the present time. Most of the early surveys followed the main water courses of the state and did not pass through this county. Geological work on the coal formations has been done in all of the surrounding counties. In the Geological Report of 1870, Orestes H. St. John, under the direction of Dr. C. A. White, then State Geologist, discussed at some length some of the best surface exposures. This county has received some attention also in numerous miscellaneous papers on the general Coal Measures area of south-central Iowa. The reports of the State Mine Inspectors and the Annual Reports of Mineral Production for the state in the volumes of the Iowa Geological Survey also include Lucas county. The work of Dr. George F. Kay, State Geologist, on the Pleistocene of Iowa in its many phases both in and around this county is of the greatest value in interpreting the Pleistocene materials.[2]

Physiography

TOPOGRAPHY AND TOPOGRAPHIC DEVELOPMENT

The topography of Lucas county is of the dissected plain type. The upland areas present an aspect of planeness, though somewhat narrow valleys have been carved into this once extensive plain. This plain was developed during the Pleistocene or Glacial period. The Kansan glacier was the last ice sheet which

2 The list below includes the important references on Lucas county.
The Geology of Iowa (1870), Vol. II, pp. 77-95.
Iowa Geol. Survey, Vol. II, Coal Deposits (now superseded by Iowa Geol. Survey, Vol. XIX). Vol. XIV, Geology of Clay; Lucas county, p. 447. Vol. XVII, Geology of Quarry Products; Lucas county, pp. 475-476. Vol. XIX, Coal Deposits of South-Central Iowa; Lucas county, pp. 218-227. History of Coal Mining in Iowa; Lucas county, pp. 550-554. Fuel Values of Iowa Coals; Lucas county, pp. 409, 416, 453, 472, 475. Bibliography of Iowa Coals; Lucas county, p. 678. Analyses of Iowa Coals, Lucas county, pp. 504-505. Vol. XXI, Underground Water Resources of Iowa; Lucas county, pp. 949-955. (Same as U. S. Geol. Survey Water Supply Paper 293, pp. 783-788.) Vol. XXII, Annotated Bibliography of Iowa Geology. Vol. XXIV, Road and Concrete Materials of Iowa; Lucas county, pp. 416-417. Bulletin 2, Report on Tests of Iowa Coals.

covered this area and it mantled the pre-Kansan topography with thick drift. Hence, it is impossible to determine in detail the nature of the topography of either the pre-Pleistocene (Pliocene) or pre-Kansan (Aftonian) surfaces although it is known that the Coal Measures (sub-drift) surface, where it is still buried under glacial deposits, has a relief of at least 265 feet within restricted areas.

It is impossible to state with certainty whether the preglacial (Pliocene) surface was level or had considerable relief; whatever it was this surface was covered with a mantle of glacial drift by the Nebraskan ice and on the retreat of this first ice sheet a ground moraine plain with little relief and poor drainage remained. On this plain a considerable thickness of Nebraskan gumbotil developed in Aftonian time. It is uncertain to what extent this Nebraskan gumbotil plain was dissected before the advent of the Kansan ice but the preponderance of evidence is that it was well drained and had essentially mature topography. The streams in some places cut through the drift into the Coal Measures and only patches of the Nebraskan gumbotil plain remained.

Another outstanding fact is that, as mentioned previously, the Coal Measures were extensively eroded in some parts of the county in pre-Nebraskan (Pliocene) or pre-Kansan (Aftonian) time or in both cycles. In Otter Creek township, where the drift is at least 100 feet thick, the present streams have just reached the Coal Measures in a few places. In Jackson township the drift is still thicker, being nearly 200 feet thick. In Union township no Coal Measures are exposed and at Humeston, in the northwest corner of Wayne county, a drilling has shown a thickness of 406 feet of glacial drift.[3] The upland surface slopes from 1104 feet to 1040 feet above sea level between Humeston and Otter Creek township. Drift covered indurated rocks rise much higher both to the east and to the west of the above mentioned localities than do the rocks found at these places and so give evidence that a pre-Kansan valley or valleys extended along the west side of Lucas county.

The same kind of evidence shows that the present Chariton river is flowing over a pre-Kansan valley. Similar evidence

[3] Wayne county report, Iowa Geol. Survey, vol. XX, p. 224.

shows the Coal Measures to have been eroded deeply in parts of Liberty township and in the southeast corner of Pleasant township and also under much of Cedar township.

With the coming of the Kansan ice the Aftonian topography was greatly altered; the valleys were filled and the divides eroded. On the disappearance of the Kansan ice the surface must have been much as it was following the retreat of the Nebraskan ice. There was a level plain with poor drainage and on this plain thick Kansan gumbotil was formed in Yarmouth time. This seems to imply the passage of a very long time before efficient drainage was developed. Lucas county has not been invaded by an ice sheet since Kansan time and it is on this Kansan gumbotil plain that the present drainage has developed. In some places the courses of the present streams, such as Chariton river, were predetermined by slight initial slopes which the streams working headward into the county found advantageous. There are also many small valleys that are strictly post-Kansan in age.

Topographic development progressed to such an extent that the region became essentially mature, though probably with not quite as great relief as it now has, for during Peorian time nearly the entire surface was mantled by loess which in places is fifteen feet thick. Probably some loess was deposited during all of the time from Kansan to Peorian but the Peorian was the time of greatest loess accumulation. Since Peorian time the established streams have continued to deepen and widen their valleys and in general to further reduce the region.

The north and northeastern parts of the county are more maturely dissected than is the southwestern part, hence the maximum relief is in the northeastern part of the county and the most extensive areas of undissected upland are in the western part. One notable topographic feature is the upland divide which extends in an east-west direction across the county south of the middle. The Mormon Trace road follows this divide.

The accordant remnants of the Kansan plain show that if the plain were reconstructed it would slope gently to the northeast. The highest elevations in the county are those of the upland areas at or near Derby in Union township, which are about 1100 feet above sea level. Toward the middle of the county the uplands are at an elevation of about 1040 feet above sea level and in Pleasant township the upland flats are 1000 to 1020 feet above sea level. In Otter Creek township the Norwood upland is 1040 feet above sea level and in Washington township the upland remnants are 1020 to 1030 feet above sea level.

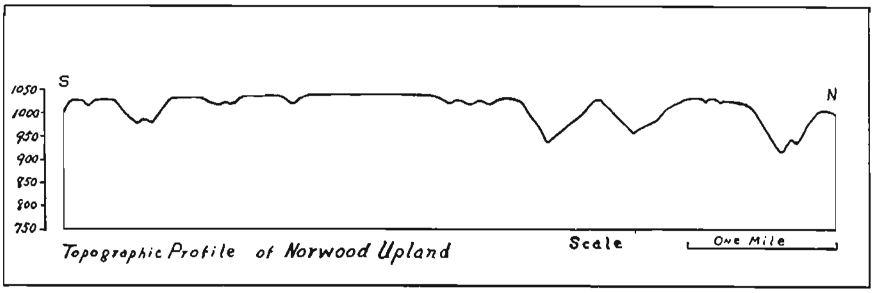


FIG. 2.—Topographic Profile of Norwood Upland.

Figure 2 is a profile from south to north through the upland area nearly one-half mile east of Norwood in Otter Creek township. The south end of the profile is about one-quarter mile north of Harmony school and the north end is at the north county line. Figure 3 is a topographic map of the Norwood remnant upland area, which is typical of all such areas in the county. The figure also illustrates how the streams are working headward and rapidly dissecting these last remnants of upland. Such upland areas are everywhere mantled by loess, which is underlain by the thick Kansan gumbotil. Other similar flat upland areas of peculiarly noticeable extent are: Williamson upland in English township, Belinda upland in Pleasant township, Chariton upland in the center of the county, Derby upland in Union township, and the Russell upland in the corners of Lincoln, Cedar, Benton and Washington townships.

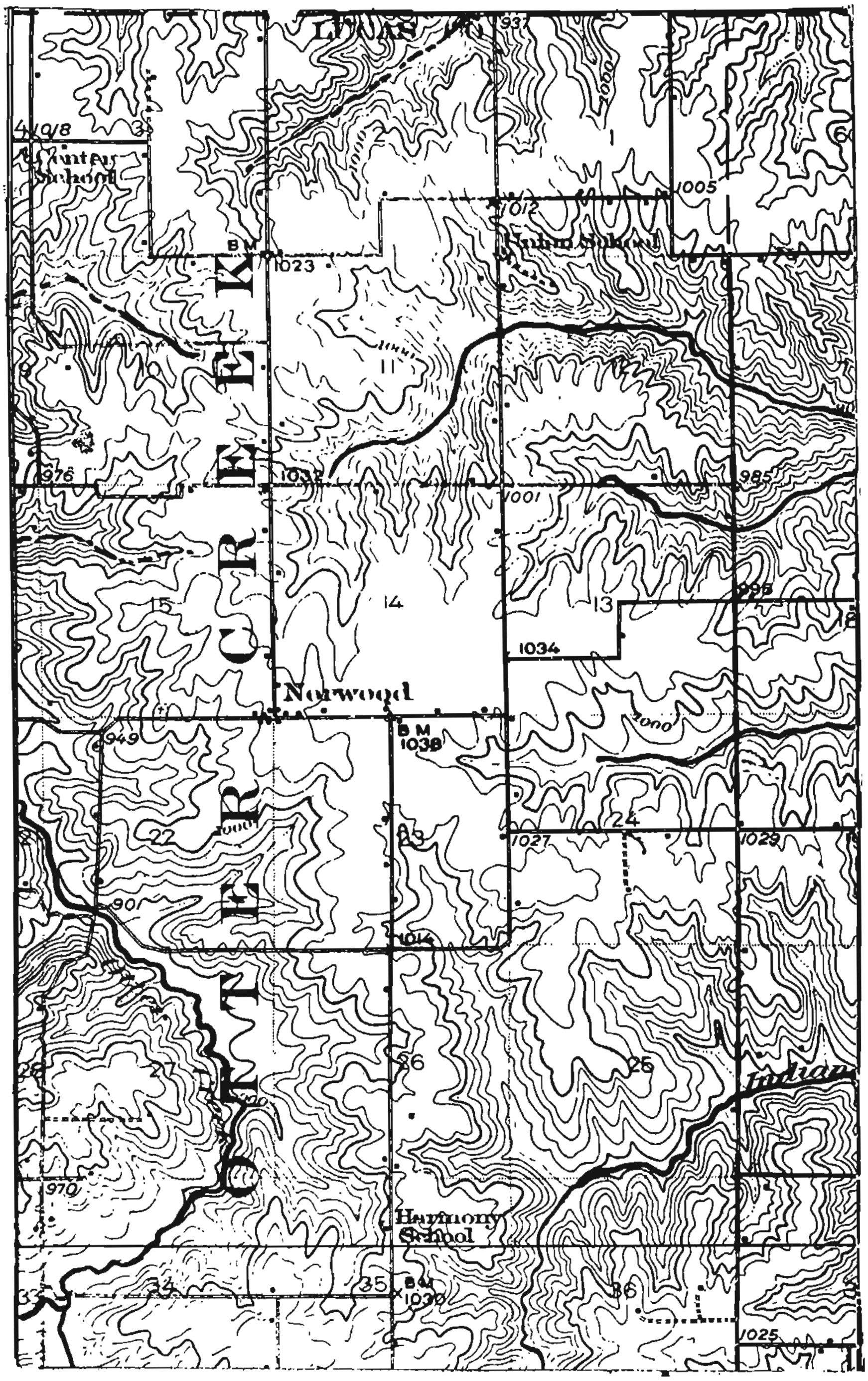


Fig. 3.—The Norwood upland.

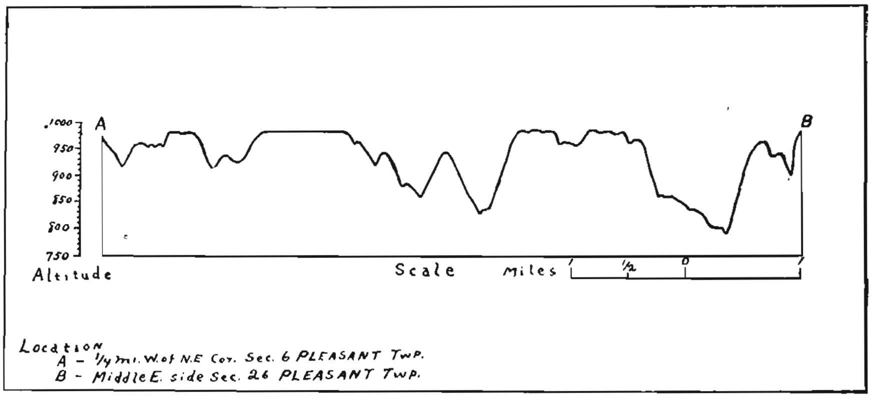


FIG. 4.—Profile across Pleasant township.

Figure 4 is a profile cross section illustrating the topography developed in Pleasant township. The section extends from (A), middle of the north side of the northeast quarter of section 6 to (B) middle of the east side of section 26.

The accompanying table gives a quantitative analysis of the topography by townships in terms of square miles and per cent. The maximum relief in each township is tabulated also.

Topographic Analysis

Township	Upland		Slope		Bottom Flat		Maximum Relief
	Sq. Mi.	Per Cent	Sq. Mi.	Per Cent	Sq. Mi.	Per Cent	
Pleasant	6	16½	28	77½	2	5½	220 ft. N. Fork, North Cedar 200 ft. N. Cedar
English	8½	23½	27	75	½	1½	180 ft. Little White Breast 140 ft. English
Liberty	5½	15½	28	78	2½	7	180 ft. White Breast
Otter Creek	10	27½	24	66½	2	5½	90—100 ft. Otter Creek
Jackson	7	19½	26	72	3	8½	200 ft. White Breast
White Breast	8	22	25½	71	2½	7	180 ft. White Breast
Lincoln	9½	26½	25	69½	1½	4	100 ft. Chariton R. 140 ft. Little White Breast
Cedar	10½	29	25	69½	½	1½	180 ft. N. Cedar 140 ft. Whites Cr.
Washington	11	30½	21	58½	4	11	100—150 ft. Chariton R.
Benton	10	27½	21	58½	5	14	100 ft. Chariton R.
Warren	12	33	20	55½	4	11	90 ft. Chariton R.
Union	16	44	19	53	1	3	90 ft. Chariton R.
County (entire)	114	26+	289½	67+	28½	6+	Highest Pt. 1100 ft. A.T. Lowest Pt. 750 ft. A.T.

Very accurate topographic maps of the Chariton and the Melcher quadrangles cover about half of the county. The townships so mapped are Pleasant, English, Liberty, part of Otter Creek, part of Jackson and nearly all of White Breast, Lincoln and Cedar. In the accompanying table of altitudes, no figures are given for the area covered by topographic maps, with the exception of the railroad stations, and only such altitudes are given as might be useful and as are at points easily located.

Table of Altitudes

	FEET ABOVE SEA LEVEL
Otter Creek township	
SW. corner sec. 16	1040
Bridge middle N. side NE. ¼ sec. 17	920
SW. corner sec. 9	1020
Jackson township	
Lucas, C., B. & Q. RR, station	885.69
Road corner, middle west side of NW. ¼ sec. 34	975
Cleveland, C., B. & Q. RR station	899
Union township	
Derby, Fair ground gate	1100
Derby, C., B. & Q. RR station	1093
Bridge, middle NE. ¼ sec. 13	1010
Warren township	
NW. corner sec. 21	1030
East middle sec. 13	1055
Chariton river, middle SW. ¼ sec. 2	970
Benton township	
East middle sec. 18	1075
Wolf creek brige, NW. corner sec. 22	930
Middle north side sec. 10	1030
Chariton river bridge, SE. corner sec. 24	915
Liberty township	
Oakley, C., B. & Q. RR station	995
White Breast township	
Indianola Junction, C., B. & Q. RR station	1040
Troy, C., B. & Q. RR station	881
White Breast, C., B. & Q. RR station	1042
English township	
Williamson, C., R. I. & P. RR station	1022
Lincoln township	
Chariton, C., R. I. & P. RR station	1014
Chariton, C., B. & Q. RR station	1041
Washington township	
Russell, C., B. & Q. RR station	1035
Middle west side of sec. 15	1010
Chariton river, NE. ¼ sec. 35	850-875
North middle sec. 11	1030

DRAINAGE AND DRAINAGE HISTORY

The drainage of Lucas county is divided into two parts. The south one-third of the county drains into the Chariton river system and the northern two-thirds drains into the Des Moines river system. The Chariton-Des Moines divide crosses the county from west to east.

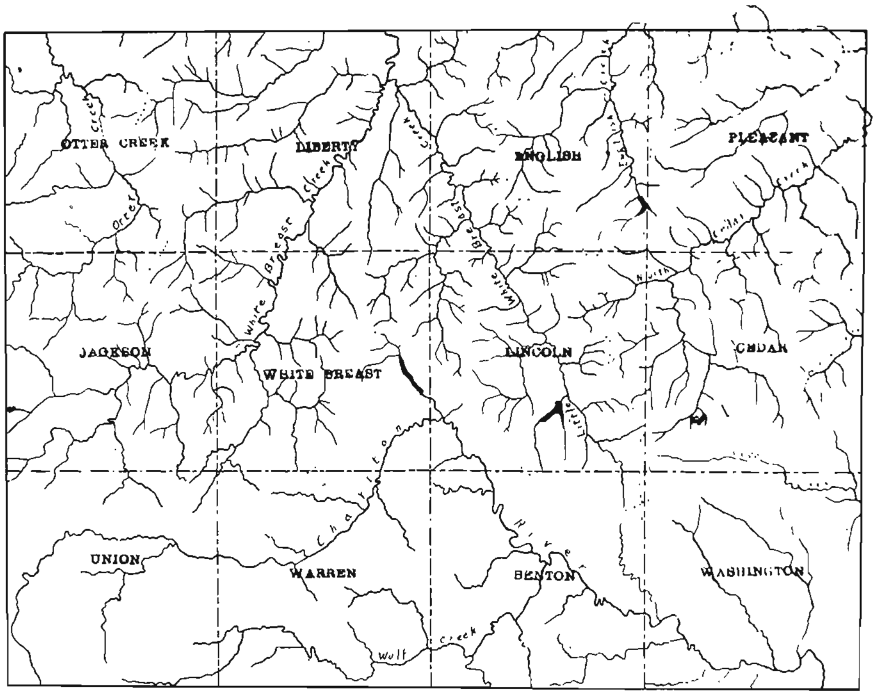


FIG. 5.—Drainage map of Lucas county.

Chariton river with its minor tributaries, including Wolf creek, drains the southern tier of four townships almost in their entirety and also parts of White Breast and Lincoln townships. It empties into Missouri river in Chariton county, Missouri, which is located in the north-central part of that state. The total area included in its drainage basin within Lucas county is approximately 138 square miles, or nearly 32 per cent of the total area of the county. The river has a widely differing gradient in this county; from the north side of section 17, Union township, to the middle of the northeast quarter of section 13, Union township, a distance of 5.3 miles, it has a gradient of approximately one foot per mile; from the latter point to the north part of the southwest quarter of section 30, Lincoln township, a distance of ten miles, the gradient is about nine feet per mile; for the next 22.5 miles of its course to its exit from the county its gradient is about 4.3 feet per mile. The average gradient for the thirty-seven miles of its length in this county is about 4.5 feet per mile. The elevation above sea level of the river at its point of exit from

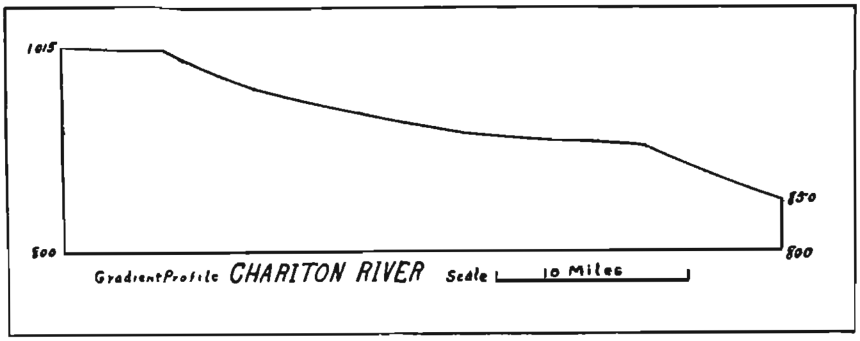


FIG. 6.—Gradient profile Chariton river.

the county is about 860 feet. Figure 6 illustrates the gradient profile of Chariton river. The valley is not deep, 90 to 100 feet below the upland areas, but it has many of the characteristics of maturity. Its walls are gently sloping, the north side having generally a more gentle slope than the south side, and it has a well developed flood plain along most of its course. Figure 7 shows a profile cross section of the valley diagonally across section 30 of Lincoln township and brings out very plainly the more gently sloping north valley wall and the level flood plain.

Coal Measures strata are exposed in the bed of Chariton river only in a few places in Benton and Washington townships. Otherwise, the valley is cut entirely in glacial drift, although it is known that on either side of the valley Coal Measures strata lie under the drift of the uplands at elevations higher than the bed of the river. It is quite obvious, therefore, that Chariton river has developed its present valley on or in a sub-drift valley of at least pre-Kansan age. Well records in section 30 of Lincoln township show the bottom of this ancestral valley to be about fifty feet below the present Chariton channel. The present stream appears to be at grade. Its present course was determined largely by initial slopes on the Kansan gumbotil plain, as

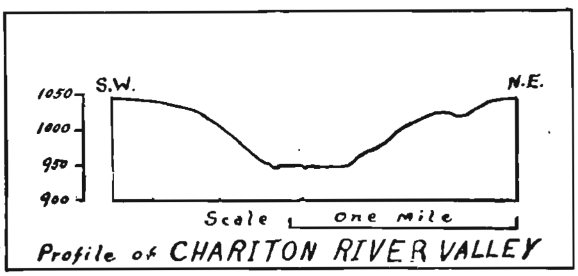


FIG. 7.—Profile of Chariton river valley.

previously explained. The ancestral Chariton river may or may not have flowed in the same direction as the present stream.

The north two-thirds of the county drains into Des Moines river through numerous tributaries and tributary systems. The main divisions of the Des Moines drainage are: Otter creek, White Breast and Little White Breast creeks, English, or Wild Cat creek, North Cedar creek and tributaries. The drainage map (Figure 5) outlines the above drainage basins.

Otter creek flows into South river in Warren county, within whose limits also South river joins the Des Moines. Otter creek drains an area of about thirty-four square miles in Lucas county, or nearly 7.9 per cent of the county, and it has a gradient of three to five feet per mile.

The White Breast-Little White Breast system including Stony creek drains a total of 154 square miles, or a little more than 35½ per cent of the county. White Breast creek proper drains 98 square miles, or nearly 23 per cent of the county, and Little White Breast drains 56 square miles, or approximately 13 per cent of the county. Little White Breast creek joins White Breast creek in Liberty township of this county and White Breast creek flows into Des Moines river in Marion county. The gradient and profile changes in White Breast creek are shown by the map of the Chariton quadrangle. In a distance of 4.8 miles between the 880 and 860 foot contour lines the fall is approximately five feet per mile. Between the 860 and 840 foot contour lines, a distance of 10.2 miles, the fall is two feet per mile and for the next five miles to the 820 foot contour line it is four feet per mile. Between the 820 foot contour line and the 800 foot contour line (outside the county), a distance of seventeen miles, the gradient is 1.2 feet per mile. This profile is shown in Figure 8.

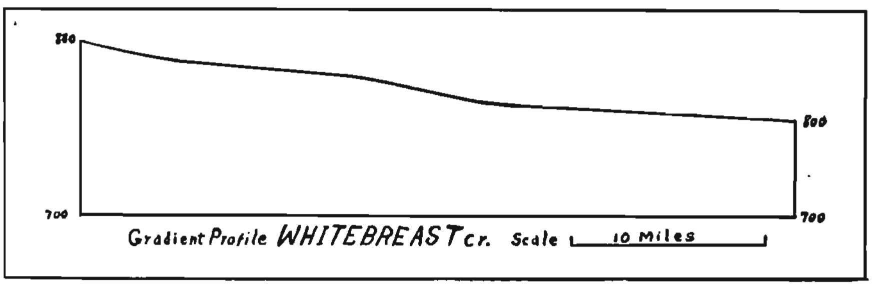


FIG. 8.—Gradient profile White Breast creek.

Figure 9 illustrates the profile of Barker creek, a tributary of White Breast creek, and figure 10 shows a cross section profile of White Breast creek diagonally from northwest to southeast, west of the town of Lucas, from the north middle of section 15 to about

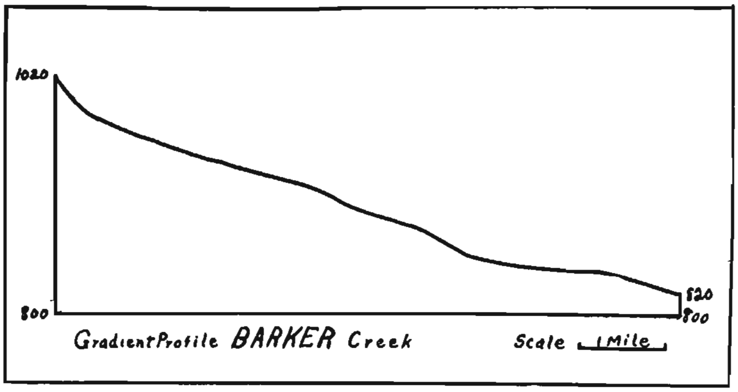


FIG. 9.—Gradient profile Barker creek.

the middle of the southwest quarter of section 23, Jackson township. It illustrates the gently sloping north valley wall and the well developed flood plain; also a tributary valley.

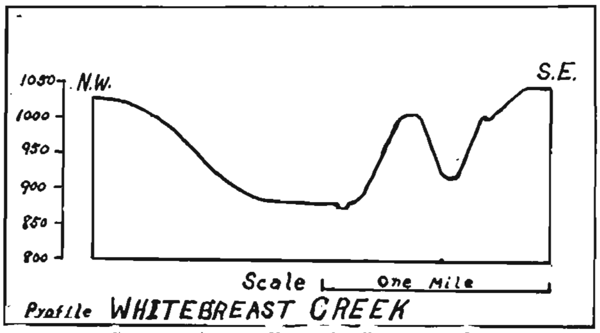


FIG. 10.—Cross section profile White Breast creek.

White Breast valley is the only stream valley in Lucas county that has any terrace development and this is very insignificant. Some suggestion of terraces exists along the south valley wall south and east of Old Cleveland; these are "rock benches" of more resistant Coal Measures materials. Another similar bench of greater extent is in sections 28 and 33, Liberty township, where there is a bench area nearly one-half square mile in extent. The creek formerly flowed west of this bench against the northwest valley wall. The bench is about thirty feet above the present stream and is now somewhat dissected by gullies. These terraces have been developed in the normal course of the stream's history and imply no diastrophic changes. St. John made note of this feature when he visited the county in 1867.

White Breast creek valley is cut in part into glacial till, in part into Coal Measures, and in part into fluvio-glacial material that underlies the till. This material was deposited in one or more preglacial valleys in front of the advancing ice, and has been exposed in the present erosion cycle. It is well exposed along the county line in the east valley wall and at other points along White Breast creek. The upper half of figure 11 shows

FIG. 11.—Coal Measures and fluvio-glacial deposits exposed on White Breast creek.

this material in section. White Breast creek is then in part following pre-Kansan drainage, as is Chariton river. The creek has a fairly well developed flood plain of rich alluvial soil that rests for the most part on Coal Measures strata. It is subject to flood in times of high water. It appears to be at grade below Lucas.

Little White Breast creek has a fall of about 5¼ feet per mile and its valley is narrow, V-shaped and young. In age it is post-Kansan. Figure 12 shows a cross section profile along the highway in sections 32, 5, and 33, Lincoln township.

Stony, Barker and Indian creeks, tributaries to White Breast creek, drain an area mostly in Liberty township where the thickness of the drift seems to be at least equal to the land relief, that is 100 to 140 feet. There seem to be no Coal Measures outcrops along Stony creek as far east as the east part of section 4, Liberty township. No Coal Measures outcrop along Barker creek west of the south side of section 9, Liberty township, with one exception noted below, and perhaps no Coal Measures occur in the valley walls for some distance north and east of this. Coal Measures do not outcrop along Indian creek west of the road in section 30, Liberty township. This seems to point to the conclusion that pre-Kansan erosion had developed a wide valley extending in a northeast and southwest direction across Liberty township. It may have connected with the main valley previously mentioned as extending along the west side of the county and may have included one or several streams. Part of the present White Breast valley also may occupy parts of this subdrift valley. The evidence warrants the conclusion that the area was reduced to a wide level flood plain, at or below the present stream grade, with a Coal Measures divide on the east rising to elevations of 940 to 950 feet above sea level and occupying the northeast part of Liberty and adjacent parts of English townships and swinging around toward the town of Lucas across the south part of Liberty and the north part of White Breast townships. The south point of another such Coal Measures divide reaches from the north into the county in sections 1 and 2 of Otter Creek township. A second explanation is possible: there may still be Coal Measures hills completely covered under the upland divide areas and the three streams, Stony, Barker and Indian creeks, may be occupying separate pre-Kansan valleys. This seems quite unlikely for it would mean a more irregular pre-Kansan surface. It is supported, however, by the presence of Coal Measures about 920 feet above sea level along Barker creek between sections 18 and 19, Liberty township. This is not a surface exposure but was reached in digging a well and is the only known point of the kind. The evidence seems to be preponderantly in favor of the first explanation.

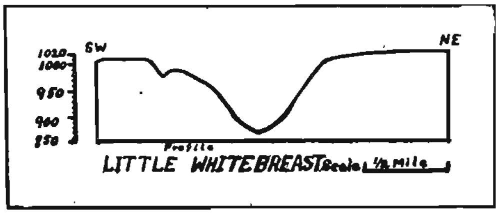


FIG. 12.—Profile of Little White Breast creek.

English or Wild Cat creek flows into Des Moines river in Marion county. It drains about twenty-five square miles, or nearly 6 per cent, of the county and has a gradient of about fourteen feet per mile. It is largely post-Kansan in age; at least most of its course in Lucas county is post-Kansan. Its valley is narrow, V-shaped and young.

The Cedar creek drainage includes a number of streams that do not unite within the bounds of the county but that farther down join Cedar creek, which enters Des Moines river in Mahaska county. The main divisions of the Cedar drainage are: North Cedar creek, Columbia creek, Flint creek, Carruthers creek, Whites creek and South or Little Cedar creek. The total area drained by these creeks is eighty-one square miles, or about 19 per cent of the county. The gradients of all are comparatively high, that of North Cedar creek being about ten feet per mile. Figure 4 illustrates the cross section profiles of some of the creek valleys of Pleasant township.

The northern part of this Cedar drainage is made up of Columbia creek, Flint creek or North Fork and Carruthers creek, which unite into Little North Cedar creek, which in turn empties into North Cedar creek in Marion county. The Little North Cedar drainage comprises about 3½ per cent of the county, or sixteen square miles, in the northeastern part of Pleasant township. All parts of the above creeks, in-so-far as their courses are in Lucas county, are occupying young V-shaped post-Kansan valleys and have exposures of Coal Measures strata at various points in their valley walls. There is evidence that the Coal Measures strata were quite deeply cut out in parts of sections 9, 10, 15, 16, 21 and 22 of Pleasant township during some previous erosion cycle.

North Cedar creek drains about forty-five square miles, or nearly 10½ per cent, of the county and flows into Cedar creek, which joins Des Moines river in Mahaska county. Its narrow valley is deeply incised into the glacial filling of the pre-Kansan valley which it follows and at a few places into the Coal Measures strata. Its very narrow rich alluvial flood plain is subject to overflow in time of high water. North Cedar creek is, like Chariton river and White Breast creek, at grade and probably has not cut quite as deeply as its ancestral pre-Kansan stream.

It does not seem to carry as much water as formerly and is building up its flood plain.

Whites creek drains about eight square miles in the east part of Cedar township and has cut deeply into the glacial drift. It joins Coal creek in Monroe county and Coal creek empties into South Cedar, which flows into Cedar creek in Marion county. Whites creek probably is post-Kansan in age though it drains part of a deeply drift covered area from which the Coal Measures strata were extensively eroded in pre-Kansan time.

South Cedar creek drains about twelve square miles in Cedar and Washington townships and like Whites creek flows into Coal creek in Monroe county. It, like Whites creek, probably is post-Kansan in age and has not exposed Coal Measures.

It has been shown that the deposition of Kansan drift filled all pre-Kansan valleys except in-so-far as such old valleys were reflected on the new Kansan surface as initial slopes, which were controlling factors in locating the present drainage lines. Active drainage and erosion did not come into existence until the Kansan gumbotil was developed and so the present drainage systems and the present topography have been developed not only since Kansan glacial time but since late Yarmouth time. The present drainage lines were established before the maximum loess deposition, that is in early or pre-Peorian time. The development of the present valleys has revealed some of the principal pre-Kansan valleys and clearly some of the present streams are flowing in valleys that coincide essentially with their ancestral valleys.

The streams seem to carry less water on the average the year around than formerly. This seems to be due not to any decrease in rainfall but rather to a quicker run-off, which is the result of deforestation of the valley slopes. This forest cover formerly retained large amounts of the rain water, which gradually was fed to the streams as ground water between rains. But when the hillsides are unprotected by the forest covering they are deeply eroded by the more rapid run-off and the material supplied by this gully-washing is carried into the main streams by the scores of small tributaries. The main streams are overloaded and, if the precipitation is heavy, the sediment is deposited on the flood plains in time of high water. The water quickly drains off and the channels are soon dry until the next heavy rain. The main streams are so overloaded throughout the period of rapid run-off that their effectiveness in deepening their channels is negligible. St. John reported a detailed section of Coal Measures strata exposed at Wheeler's bridge in Liberty township which he visited in 1867; in 1924 the same stratum is still exposed in the bed of White Breast creek and to no greater depth. White Breast creek at this point at least has not deepened its channel a measurable amount in more than half a century. If these streams were not already at grade they have been hastened to that condition through the settlement of the county by man and through his subsequent activity.

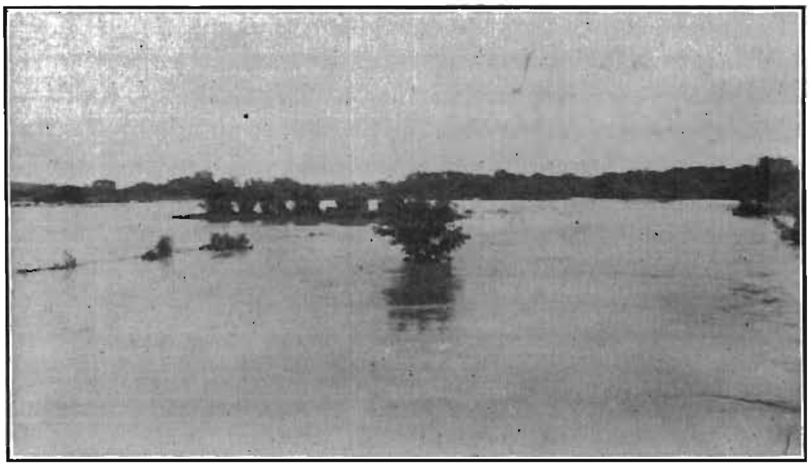


FIG. 13.—White Breast creek in flood about July 23, 1924.

Attention has been called to the more gently sloping north valley walls in connection with the cross section profiles of Chariton river valley and White Breast creek valley. In general it is true that streams whose course is east or west, or those that have much of an easterly or westerly component, have very gently sloping north valley walls while the south valley sides are steeper. This fact has been noted quite generally in southern Iowa and at least two explanations have been suggested. G. K. Gilbert[4] attributed such phenomena to deflection of the streams due to the rotation of the earth. Gilbert's theory is considered inadequate and is not further considered. The most plausible explanation

[4] Gilbert, G. K., Memoirs of the Nat. Acad. Sciences, vol. III, First Memoir, Washington, 1884.

and the one adopted here was suggested by Calvin.[5] He attributed the phenomena to a more rapid weathering and erosion on the south-facing slopes. Calvin states "As soon as these streams cut channels of any considerable depth, the two sides of each channel were differently affected by the agents of erosion. The northward facing surfaces suffered less than the opposite side of the

FIG. 14.—White Breast creek in time of comparatively low water.

channel from the alternations of freezing and thawing and consequent effects of erosion, in early winter and spring. They were less affected by the droughts of summer, which tended to check the growth of vegetation and render the surface more pulverulent and more easily attacked by dashing rain storms. The result was that as the channel was deepened the north side of the valley receded more rapidly than the south, the slopes soon became gradual."

Stratigraphy

GENERAL RELATIONS OF STRATA

The only indurated rock exposed in Lucas county belongs to the Des Moines series of the Pennsylvanian system and over much of the county this is deeply covered by glacial drift. Good exposures are limited mostly to the northeast six townships, although a very few good but small exposures are known in the south and west tiers of townships. Approximately the upper half of the Des Moines is known from surface exposures and the

5 Calvin, S., Geology of Johnson county: Iowa Geol. Survey, vol. VII, p. 51; 1896.

unexposed 50 to 250 feet of the series is known from drill records made in prospecting for coal. It is doubtful, also, if the upper division of the Des Moines series, the Pleasanton, outcrops at more than one or two places, owing to the extensive pre-Kansan erosion along the west side of the county.

The relations of the several series and stages are shown in the accompanying table. A discussion of these formations will be given in the pages that follow.

Synoptical Table

<table>
<tr><th>Group</th><th>System</th><th>Series</th><th>Stage</th><th>Character of Rocks</th></tr>
<tr><td rowspan="8">Cenozoic</td><td rowspan="8">Quaternary</td><td>Recent</td><td></td><td>Alluvium and other surface soil</td></tr>
<tr><td rowspan="7">Pleistocene</td><td>Peorian</td><td>Greatest loess deposition</td></tr>
<tr><td></td><td>Probable loess deposition</td></tr>
<tr><td>Yarmouth</td><td>Gumbotil (Kansan)</td></tr>
<tr><td>Kansan</td><td>Glacial drift</td></tr>
<tr><td>Aftonian</td><td>Gumbotil (Nebraskan)</td></tr>
<tr><td>Nebraskan</td><td>Glacial drift</td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="6">Paleozoic</td><td rowspan="3">Pennsylvanian</td><td rowspan="3">Des Moines</td><td>Pleasanton[6]</td><td>Thick shales, thin coal seams, some fairly persistent limestones, sandstone locally. Chariton conglomerate</td></tr>
<tr><td>Henrietta</td><td>Persistent beds of shale and limestone and lenses of sandstone and thin coal</td></tr>
<tr><td>Cherokee</td><td>Upper. Mostly thick shales with thin limestones and sandstone. Coal.
Lower. Shale and sandstone, some coal</td></tr>
<tr><td rowspan="3">Mississippian</td><td rowspan="3">Iowa</td><td>Ste. Genevieve</td><td>Limestone and shales (not exposed)</td></tr>
<tr><td>St. Louis</td><td>Limestone (not exposed)</td></tr>
<tr><td>Undifferentiated</td><td>(not exposed)</td></tr>
</table>

[6] The Pleasanton, with the exception of the Chariton conglomerate, is known from only one or two exposures.

NOMENCLATURE AND DEFINITIONS

The group and system names given in the above table are accepted generally. The Iowa Geological Survey has designated the Pennsylvanian as a system, making the Missouri a series.[7] Hence the Des Moines is a series paralleling the Missouri and its stages or formations are called the Cherokee, Henrietta and Pleasanton, following the nomenclature and definitions of the Missouri Bureau of Geology and Mines.[8] In Iowa the Cherokee includes all strata from the base of the Des Moines to some distance above the Mystic-Lexington coal bed of Bain, placed by him in the Appanoose formation.[9] Bain's Mystic coal bed is then in the upper part of the Cherokee. The lower part of the Cherokee has much more sandstone than the upper more persistent beds. The Henrietta formation includes the remainder of Bain's Appanoose formation. In Missouri it includes the Fort Scott limestone at its base, the Pawnee limestone at the top and the Labette shale in the middle. The Pleasanton includes strata from the top of the Henrietta to the base of the Hertha limestone,[10] the basal member of the Missouri series. In Missouri a well marked unconformity is recognized within the Pleasanton as channel sandstone deposits that have not so far been seen to lie on or cut across upper Pleasanton or higher formations have been noted in many places in that state. These sandstone deposits are considered to be younger than the Henrietta and the lower Pleasanton and to have been made at a time of general emergence and erosion. Hinds and Greene[11] state that, "Bain's Chariton Conglomerate of Appanoose County, Iowa,[12] is evidently the same as that recently found in Schuyler and adjacent counties in Missouri." The Chariton conglomerate is exposed at the surface in Pleasant township, Lucas county; at least there is a channel deposit of sandstone and conglomerate that is here so correlated. In addition several buried sandstone channel deposits seem to belong to the same type, but these are known only from drillings

7 Tilton, J. L., The Missouri Series of the Pennsylvanian System in Southwestern Iowa: Iowa Geol. Survey, vol. XXIX, pp. 223-314.

8 Hinds and Greene, The Stratigraphy of the Pennsylvanian Series in Missouri: Missouri Bureau of Geology and Mines, vol. XIII, Second Series.

9 Bain, H. F., Geology of Appanoose County: Iowa Geol. Survey, vol. V, pp. 374-409.

10 Tilton, J. L., Geology of Clarke County: Iowa Geol. Survey, vol. XXVII, pp. 105-170; also Tilton, J. L., The Missouri Series of the Pennsylvanian System in Southwestern Iowa: Iowa Geol. Survey, vol. XXIX, pp. 223-314.

11 Op. cit., pp. 94 and 95.

12 Bain, H. F., Op. cit., pp. 394-398.

and not enough is known of their extent to enable one to map them. To quote further from the above work of Hinds and Greene: "The Red Rock sandstone of Marion[13] and Jasper[14] counties, Iowa, lies in a channel 2½ to 3 miles wide that has been traced for 27 miles from Eagle Rock northeastward. This sandstone has a maximum thickness of 100 feet and has all the characteristics of the Warrensburg and Moberly sandstones. Iowa investigators have assigned its origin to contemporaneous erosion, but Miller notes its similarity to the Warrensburg, and Williams, from a study of the cross-bedding, considers it to have been made by a current of water flowing in a definite direction. There are other similar channels in Guthrie, Boone and other Iowa counties that may be contemporaneous with those in Missouri."

The Coal Measures strata of Lucas county are correlated with equivalent strata in Missouri. It would be very desirable to be able to subdivide the Pennsylvanian of the Western Interior coal field into units equivalent to the subdivisions of the standard Pennsylvania section, but sufficient data for such a step are not yet in hand.

"It is to be hoped that additional paleontologic evidence may result in the near future in a new subdivision of the Pennsylvanian into groups correlative with those in the Appalachian region. It is fairly certain that the lower part of the Cherokee shale is of Pottsville age and the upper part is of Allegheny age. From incomplete collections already made it is tentatively suggested that Allegheny time ends at the horizon of the unconformity in the upper part of the Pleasanton formation and that Conemaugh time ends well up in the Shawnee formation."[15]

The stage names Aftonian, Kansan, Yarmouth and Peorian are now quite generally accepted and need no particular explanation. In 1909 Shimek[16] proposed the name Nebraskan for the older drift in place of the terms pre-Kansan or sub-Aftonian. Kay in 1916 proposed the term Gumbotil.[17]

The two older glacial drift sheets are represented by till made

13 Miller, B. L., Geology of Marion County: Iowa Geol. Survey, vol. XI, pp. 153-161; 1901.

14 Williams, I. A., Geology of Jasper County: Iowa Geol. Survey, vol. XV, pp. 316-322; 1905.

15 Hinds and Greene, "The Stratigraphy of the Pennsylvanian Series in Missouri," p. 7.

16 Shimek, B., Aftonian Sands and Gravels in Western Iowa: Bul. Geol. Soc. America, vol. 20, p. 408; 1909.

17 Kay, G. F., Gumbotil, a New Term in Pleistocene Geology: Science, N.S., vol. 44, pp. 637-638; 1916.

up of clay, sand, gravel and bowlders in the most heterogeneous relations. On the basis of lithology, color, degree of oxidation or leaching these two tills are indistinguishable one from the other in the exposures seen in Lucas county. They are distinguishable only when they are exposed in a single section and are separated by Nebraskan gumbotil, or when the above three formations are exposed close enough together to establish their stratigraphic relations.

Aftonian time is represented by the Nebraskan gumbotil,[18] which is developed on the lower till. No peat beds occur in the county at this horizon or at any other horizon so far as is now known. The many small lenses of gravel associated with till which are present in this county would, no doubt, at a former time, have been interpreted to be Aftonian[19] but the writer finds no evidence supporting such a view. Gravels are not regarded as being necessarily indicative of interglacial time, either Aftonian or Yarmouth, though such beds may happen to occur at those horizons.

The Kansan till overlies the eroded Aftonian surface, the dissected Nebraskan gumbotil plain, as previously explained. Yarmouth time is represented in part by the Kansan gumbotil.

The Illinoian, Sangamon and Iowan stages are not represented by definite, distinguishable deposits but some of the loess may have been deposited during one or more of these times.

The time of greatest loess deposition was the Peorian, and the loess of south-central Iowa is correlated with the Iowan loess of eastern Iowa. The time since this period of greatest loess deposition is represented by weathering, erosion, the development of soil and the accumulation of alluvial deposits.

PALEOZOIC HISTORY AND STRUCTURE

Records are not available of any drillings that go more than a short distance into the Mississippian rocks. Such records as are at hand show quite clearly the stratigraphic relations of the Pennsylvanian and Quaternary systems and the Pennsylvanian-Mississippian contact. Three diamond drill holes were sunk to depths of over a thousand feet within a small area two or three miles east of the town of Lucas more than a score of years ago.

18 Kay, G. F., and Pearce, J. N., Origin of Gumbotil: Jour. Geol., vol. XXVIII, p. 89; 1920.
19 Calvin, S., Aftonian Gravels: Proc. Davenport Acad. Science, vol. X, pp. 18-31.

The records of these drillings were not filed and preserved for future reference and such records as were kept privately for a long time were completely lost by fire only a few years ago. The only value these costly drillings now have is one of inference only and that of negative results. Evidently these drillings did not penetrate anything of economic value below the Lower coal, and it was already known. They evidently did not penetrate important artesian aquifers, oil bearing horizons or zones of mineralization. The driller, not being a geologist nor informed on the subject of stratigraphy, could not draw any conclusions as to the horizons he had penetrated, so no direct information is in hand as to the elevations or thicknesses of the deeper strata that underlie the county.

Deep drillings have been made at numerous places north, east and south of the county and much can be inferred from these records, as they have been carefully interpreted. Such interpretations and conclusions as are given below for Lucas county are tentative and may not prove correct in detail, although they should be at least suggestive.

The deep well records[20] of Des Moines, Pella, Station No. 10 (sec. 8, Bluff Creek township, Monroe county), Oskaloosa, Centerville and Corydon are tabulated in summarized form in the accompanying table. The thicknesses of the systems, series or formations and also the elevations of the tops of the systems and formations are stated. A noticeable but natural feature is the great range in thickness of the various formations. Exact information for Lucas county is in hand on only the Quaternary and Pennsylvanian systems and the upper Mississippian surface. The assumption is that the stratigraphic relations of the deeper strata are essentially as they are in other parts of the state where they are known from drillings or where they outcrop. A complete upper Mississippi valley Paleozoic section from the Pennsylvanian down is quite certainly represented.

The last double column in the accompanying table gives for Lucas county the known and what seem to be the most probable thicknesses for the various strata and also the probable elevations above or below sea level of the systems, series or forma-

20 Well records taken from Underground Water Resources of Iowa, by W. H. Norton and others, Iowa Geol. Survey, vol. XXI.

SYSTEM, SERIES or FORMATION	DES MOINES		PELLA		No. 10 Monroe Co.		OSKA-LOOSA		CENTER-VILLE		CORYDON		Average Thickness	LUCAS County (Tentative Data)	
	Ft. Thick	A.T.	Ft. Thick	A.T.	Ft. Thick	A.T.	Ft. Thick	A.T.	Ft. Thick	A.T.	Ft. Thick	A.T.		Thickness	Elevation
Quaternary	14	+872	135	+868	127	+895	50	+843	90	+1017	731	+1110	?	125	+1040
Des Moines	488	+858	195	+733	None		111	+793	436	+927			310	200 to 400	+940 to +675
St. Louis etc.	200	+374	270	+538	460	+768	449	+682	515	+491	357	+379	375	375	+736 to +537
Kinderhook	160	+174	125	+268	164	+308	110	+238	50	−24	87	+22	116	116	+240 ±
Devonian	80	+14	420	+143	597	+147	356	+123	260	−83	65	−65	480	535	+124 ±
Silurian	507	−66							180	−343					
Maquoketa	33	−573	190	−277			124	−233					120	120	−411 ±
Galena-Platteville	508	−606	350	−467					200	−523			353	353	−531 ±
St. Peter	39	−1114	15	−817					40	−723			31	31	−884 ±
Shakopee	124	−1153	60	−832						−763			125(?)		
New Richmond	94	−1277											100(?)		
Oneota	175	−1371							715				200(?)		
Cambrian-undifferentiated	582	−1546													
Total Depth	3000		1760		1345		1200		2495		1240				

tions. Sea level elevations are abbreviated A. T. (above tide) plus or minus. The evidence on which these judgments are based cannot all be shown in the table, but it is believed that the data presented are the best that are now available. The conclusions, as previously stated, do not represent finality but rather, it is hoped, progress on these problems. It is desirable that additional and fuller data be obtained and preserved for use in the future.

The elevations of the Coal Measures surface can be accounted for on the basis of pre-Kansan and recent erosion for the most part but there is little doubt that this surface is in part structural. In general the strata have a southwesterly monoclinal dip, but this dip is not uniform and is less across Lucas county than it is in counties to the east and northeast or to the west and southwest. All strata seem to dip more steeply west of a line only a short distance east of the Clarke-Lucas county boundary. The structure of the Des Moines series in Lucas county will be dealt with more fully later.

The Mississippian system appears to thicken from Des Moines to the south and southeast and its surface, while very irregular, is lower at Des Moines, Centerville and Corydon than at Pella, No. 10 or in Lucas county. As will be shown later, this Mississippian surface has a relief of more than 200 feet and this fact might account for the above differences, assuming that high points had been struck at Pella, No. 10, Oskaloosa and in Lucas county, and low points at Des Moines, Centerville and Corydon. The top of the Mississippian is known to be at higher elevations near Des Moines than that given in the table. This view would seem more probable were it not for the fact that the top of the Kinderhook beds and the top of the Devonian system show a similar rise in the middle wells and by inference in Lucas county. This fact seems hardly fully explainable on the basis of unconformities and suggests a structural explanation.

The surface of the Mississippian at its lowest recorded elevation in Lucas county (541 feet above sea level) is higher than the top of the same system at Des Moines, Centerville and Corydon. The highest elevation of the Mississippian system recorded in Lucas county is nearly 200 feet higher (736 feet above sea level) and is essentially accordant with the top of the system at No. 10 and at Oskaloosa. This latter accordance may be accounted for in part by assuming the presence of younger Mississippian strata under Lucas county and at No. 10 than at Des Moines and Corydon. The higher elevation at No. 10 and at Oskaloosa is in part explainable on the basis of the southwesterly dip of the formations across this part of Iowa.

The Devonian surface shows a condition paralleling the above even more clearly than do the higher strata. It is low at Des Moines, Centerville and Corydon and higher by more than 100 feet at Pella, Oskaloosa and, by inference, under Lucas county. The combined thickness of the Devonian and Silurian systems is not so noticeably greater to the southward as is the thickness of the Mississippian. The relations of the Maquoketa and Galena-Platteville formations are not so well shown, as these strata have not been reached in all cases, and the St. Peter surface also is quite problematical. However, the St. Peter seems to be lowest at Des Moines and highest at Centerville and at intermediate elevations at Pella and in Lucas county. Its surface is more nearly a plane than are the higher surfaces.

The Geologic Map of Iowa in volume XXI of the Iowa Survey reports shows the St. Peter surface as occurring in Lucas county at depths from 1000 feet to 1250 feet below sea level, from east to west across the county. According to the accompanying table the St. Peter should be reached at depths from 800 feet to 1000 feet below sea level from east to west across the county. At Chariton the St. Peter might be expected at 2050 feet or less below the surface (surface elevation 1040 feet above sea level). There is a sharp change in dip along the west side of the county and this change becomes greater in a southwesterly direction. However, it is not believed to be great enough to carry the St. Peter as low as 1400 feet below sea level at Osceola, Clarke county, as stated by Tilton.[21] It is thought, from evidence known from Lucas county, that the St. Peter should be reached at about 1200 feet below sea level at Osceola.

The base of the Pennsylvanian (Des Moines) has been mapped as occurring a little over 500 feet to less than 400 feet above sea level, from east to west across Lucas county.[22] However, the known base of the Pennsylvanian ranges from less than 537 feet to 736 feet above sea level and rests unconformably on the Mis-

[21] Tilton, J. L., Geology of Clarke County: Iowa Geol. Survey, vol. XXVII, pp. 158-162.
[22] Iowa Geol. Survey, vol. XXI, p. 1001.

sissippian surface, which has a relief of at least 200 feet. The earlier estimate is in error by fully 200 feet.

Paleozoic deposition in this part of North America took place in a wide shallow geosyncline which varied greatly in depth and at times was entirely drained. The sediments were for the most part fine in texture and probably were derived from rather low lands. If there were high lands to the north and northeast they were quite remote. This geosyncline was, most likely, just a deeper part of the more or less widespread seas that covered the upper Mississippi valley region periodically during the Paleozoic era. As sedimentation went on this great depression deepened or sank as it filled but less rapidly. By the end of the Paleozoic era the lower formations, such as the St. Peter, came to be greatly concave while the overlying ones were less deformed by the settling that accompanied deposition and were more nearly horizontal.

The history of the deeper rocks is not revealed and a detailed interpretation is not attempted.

Towards the close of Pella or Ste. Genevieve time or possibly as late as early Chester time, the geosyncline was elevated and somewhat reversed; the deeper and more central parts were raised more than the shallower lateral parts. This tended to make the lower formations less concave and the younger formations not only less concave but even slightly convex. As the sea withdrew from the upper Mississippi valley the Mississippian rocks were subject to weathering and erosion and the area of Lucas county remained a land area to the close of Mississippian time. There may have been some tilting to the southwest at this time, giving these formations in part their southwesterly dip. This monoclinal structure is not simple but there are minor folds, small anticlines and synclines and possibly domelike warps that are not strictly classifiable as anticlines.

Following the period of uplift and erosion there was further general submergence and a return to geosynclinal conditions at "critical level", the condition favorable for coal formation. The geosyncline was now shallower than it had ever been before and it was occupied by the shallow Pennsylvanian seas and embayments that covered large areas in what is now the upper Mississippi valley. The Coal Measures formations came to overlie unconformably the older formations. The Pennsylvanian submergence involved parts of Iowa, Missouri, Nebraska, Kansas and other areas to the southwest, in general the Western Interior Coal Field.

In Pleasanton time (horizon of unconformity recognized in Missouri) there occurred a period of uplift and erosion with subsequent subsidence and deposition of channel (terrestrial) deposits. The upper part of the Pleasanton formation was deposited under conditions similar to those prevailing prior to the period of uplift and the area was generally submerged. Later, perhaps near or at the end of Pleasanton time, there was differential movement resulting in a further tilting to the southwest; terrestrial conditions prevailed to the northeast and marine conditions to the southwest. Following this the Missouri series was deposited under generally more stable conditions than had prevailed during Des Moines time, but also with many fluctuations. Lucas county at this time may have been either a land area or under the shallow sea or alternating in position. If any Missouri sediments were deposited over Lucas county they were removed prior to glaciation.

At the end of Pennsylvanian time the geosyncline involving south-central Iowa was uplifted and still further reversed, with the result that the lower formations, like the St. Peter, that had been concave came to be nearly plane and the upper formations, such as the Devonian and Mississippian, came to be relatively convex with a few minor warps. One of these minor structures extends into Lucas county from the northeast. The area of south-central Iowa was subject to weathering and erosion from the uplift following Pennsylvanian time to the Pleistocene, when the region was rejuvenated by two glaciations.

The average elevation of the Lower coal in Pleasant township is about 720 feet above sea level and its average elevation in the vicinity of Lucas is about 620 feet above sea level. This shows that the coal dips about six feet per mile in a direction approximately 18 degrees south of west. The White Breast coal horizon has a dip of about five feet per mile in the same direction. If this difference in dip is a real difference and not due to the undulatory nature of the beds the Cherokee shales seem to thicken in a southwesterly direction. West of Lucas the strata have a much steeper dip. The formations have an appreciable dip to the northwest (as much as fifteen to twenty feet per mile in places) from a line drawn from a point about three miles northeast of Lucas to the northeast corner of the county. They have a very slight dip to the south from the same line.

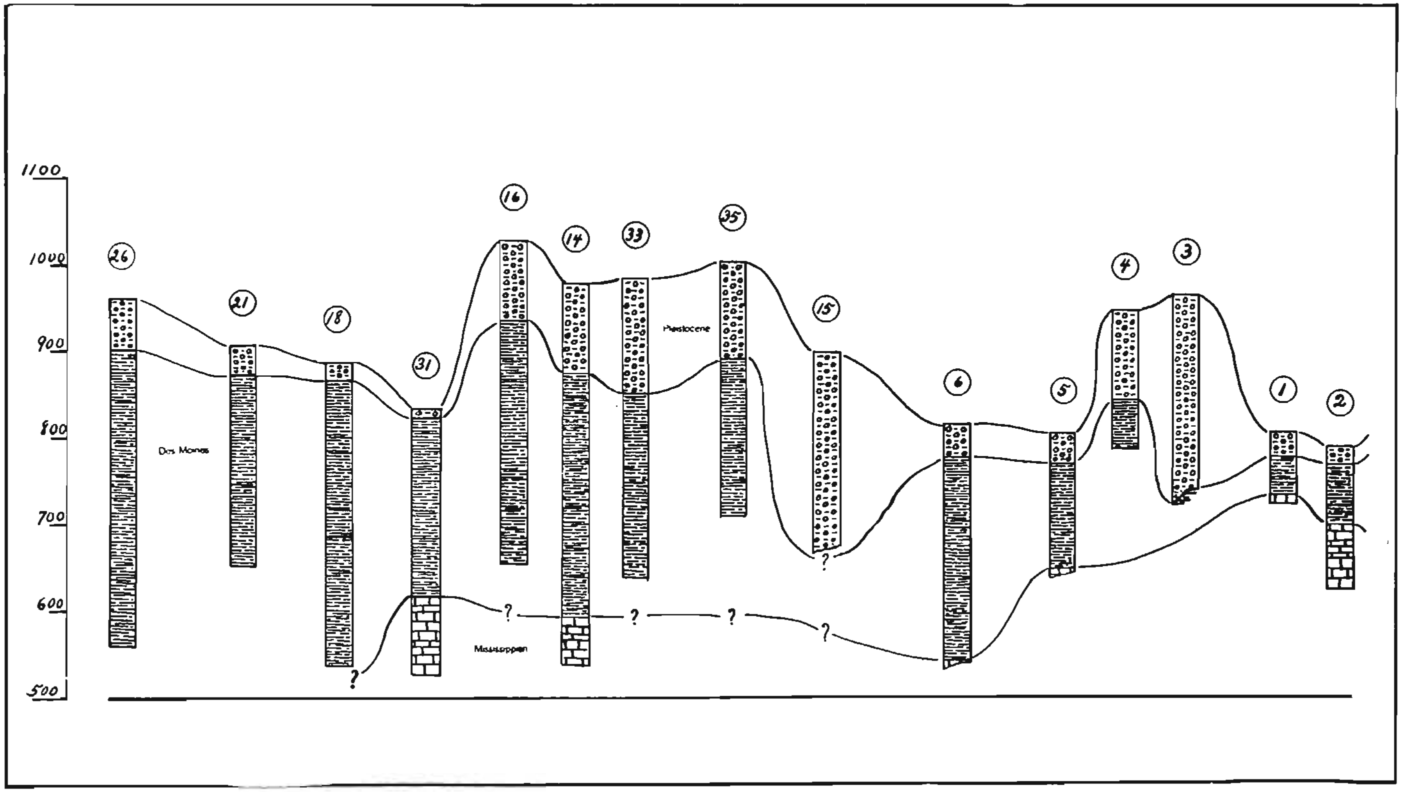
THE MISSISSIPPIAN-PENNSYLVANIAN AND PENNSYLVANIAN-PLEISTOCENE UNCONFORMITIES, AND THE THICKNESSES OF THE PENNSYLVANIAN AND PLEISTOCENE DEPOSITS

The existence of erosional unconformities between the Mississippian and Pennsylvanian and Pennsylvanian and Pleistocene systems is well recognized but quantitative data in geological reports are usually obscured by the mass of other information. In many cases such data are not given at all. The Mississippian surface in Lucas county is known only from drill records made in prospecting for coal, hence it is difficult to correctly estimate the quantitative effect that differential uplift or subsidence has had on the attitude of this surface, but that effect does not seem to have been great.

The accompanying table and Plate I summarize the important data on these unconformities. Plate I gives generalized sections of fifteen coal prospect holes. They are numbered in the circles above and are similarly designated on the general map. The vertical scale at the left refers to elevations in feet above sea level; necessarily it is greatly exaggerated. The horizontal spacing is not proportional to actual distance between holes but is relative when the holes are projected from their normal locations onto a straight line extending from section 25, White Breast township (location of No. 26), to section 13, Pleasant township (location of No. 2). This is not an exact profile section of the surface nor a true structure section of the geology, but it is of value in order to bring together the drill logs that contain the data. The conclusion has been reached, after a careful study of more than forty drill records from the same part of the county, that if enough records were available from holes drilled to great enough depth and in a straight line almost anywhere through the county, they would reveal the same relations in detail that Plate I reveals in general.

Mississippian Surface.—Logs 5 and 6 are approximately one mile apart and the relief on the Mississippian surface between

Drill Section No.	26	21	18	31	16	14	33	35	15	6	5	4	3	1	2
Township-Section	W.B.25	Ln. 7	Ln. 15	Lib. 12	Ln. 2	Cdr. 7	Eng. 35	Eng. 24	Cdr. 3	Pl. 27	Pl. 26	Pl. 22	Pl. 22	Pl. 12	Pl. 13
Elevation of Curb, feet above sea level	960	907	888	832	1030	980	986	1004	900	818	805	948	968	808	791
Thickness of Drift, feet	60	35	23	20	92	104	134	113	225	40	35	104	226	30	21
Elevation of top of Coal Measures, feet above sea level	900	872	865	812	938	876	852	891	Not Reached	778	770	844	742	778	770
Thickness of Coal Measures, feet	340	220	328	198	284	281	214	181	?	237	122	56	?	42	70
Elevation of Lower Coal, feet above sea level	Cut out	653	688	?	710	?	?	718	Cut out	?	761	794	Cut out	750 ?	721
Elevation of top of Mississippian, feet above sea level	Not Reached	Not Reached	Not Reached	614	Not Reached	595	Not Reached	Not Reached	Not Reached	541	648	Not Reached	Not Reached	736	700
Bottom of Hole, feet above sea level	560	652	537	526	654	539	638	710	675	540	647	788	742	724	623



Generalized sections of coal prospect drill holes.

these points is 107 feet. Number 6 is down the dip from No. 5 and if the dip is as much as five feet per mile (which it probably is not) still the erosional relief is over 100 feet. Numbers 1 and 6 are about $3\frac{1}{2}$ miles apart and located diagonally to the direction of the dip. In these holes the Mississippian surface differs by nearly 200 feet, as its elevation in hole No. 1 is 736 feet above sea level and in No. 6 it is 541 feet. In hole No. 18 the Mississippian rock was not reached, so at this point it must be lower than 537 feet above sea level, but as this location is down the dip from the higher points on the Mississippian surface the importance of this record is somewhat diminished. In the vicinity of the town of Lucas Mississippian rock has been reached about 620 feet above sea level, a comparatively high elevation. Near the center of Monroe county, fifteen miles east of Lucas county, the Mississippian surface is as low as 600 feet above sea level and this is up the dip from the points in northeastern Lucas county.

Even with the large number of drill records available it seems quite unlikely that either the highest or the lowest points on the Mississippian surface should have been found. The conclusion seems justified therefore, that the relief on this buried surface, in Lucas county and in south-central Iowa, is at least 200 feet and may be as much as 250 feet. The Mississippian surface has the characteristics of a mature topography.

Des Moines Surface.—Drill holes 3 and 4 are but one-eighth of a mile apart, yet in that distance the Coal Measures surface changes in elevation by 102 feet. Numbers 15 and 35 are about five miles apart along the strike and between these holes the Pennsylvanian surface differs in altitude by more than 216 feet, from 891 feet above sea level in No. 35 to less than 675 feet in No. 15, where the drill did not completely penetrate the drift. Numbers 15 and 16 are four miles apart in a line diagonal to the strike and the relief on the Des Moines surface between these places is over 263 feet, as this surface was reached at 938 feet above sea level in No. 16 and had not been reached at 675 feet above sea level in No. 15. Furthermore No. 15 is located up the dip relatively to No. 16. Surface exposures of Coal Measures are known between 940 and 950 feet above sea level and as it is very unlikely that the lowest point would have been found in hole No. 15 it seems conclusive that the Coal Measures surface has a mature topography and a relief of at least 265 feet. This surface has an average slope of about 122 feet in a distance of seventeen miles or about seven feet per mile towards the northeast from the center of the county.

The irregular surface between the Coal Measures and the Pleistocene deposits may be due entirely to pre-Pleistocene erosion or it may be the composite result of both pre-Pleistocene and Aftonian erosion. The Nebraskan and Kansan drifts cannot be separated except where their stratigraphic relations to the Nebraskan gumbotil can be determined. It is not certain to which drift such valley fills as those represented in holes 3 and 15 belong. The buried valleys may have been cut in pre-Nebraskan time and the drift may be Nebraskan, or erosion in Aftonian time may have cut through the Nebraskan drift in some places and eroded valleys into the Coal Measures, in which case Kansan drift now fills them. Both tills may be present if the valley existed prior to the Nebraskan ice invasion and was filled with Nebraskan drift and if Aftonian erosion excavated a valley along the same general lines as the pre-Pleistocene valley but did not remove all of the older drift and the Aftonian valley afterward became filled with Kansan drift. Recent erosion, no doubt, exposes in many places sections of till where the lower part is Nebraskan and the upper part is Kansan but the pre-Kansan (Aftonian) erosion had removed all of the Nebraskan gumbotil and now the similar tills lie in contact. In a few places the Nebraskan gumbotil still remains, protected by the overlying Kansan drift.

Thickness of the Des Moines Deposits.—It is apparent from the data given above that the Des Moines series is of greatly differing thickness, owing to the uneven surface on which it was laid down and to the erosion it has suffered subsequent to its deposition. The minimum thickness which has been found at any point in this area is forty-two feet, in hole No. 1. The lowest elevation of the base of the Des Moines series found in the northeastern part of the county was in hole No. 6, where the Mississippian was reached at 541 feet above sea level. In hole No. 16, about 4½ miles west of No. 6 in a line diagonal to the strike, the top of the Coal Measures surface is 938 feet above sea level. The difference between the upper and lower surfaces of the Coal

Measures at these places is 397 feet and very likely represents nearly their greatest thickness in the northeastern part of the county. Near the town of Lucas the Coal Measures are known from hole No. 26 to be over 340 feet thick and the bottom of the hole does not reach the Mississippian surface. The Lower coal in the same vicinity is about 275 feet below the top of the Coal Measures. In other parts of the county the Lower coal horizon is as much as 200 feet above the lowest known elevation of the Mississippian surface. (Compare data in holes 1, 5 and 6 in the table on page 135.) Hence the Des Moines series may be nearly 566 feet thick in the western part of the county.

Thickness of the Pleistocene Deposits.—The present known thickness of the Pleistocene deposits ranges from nothing to more than 226 feet, the latter thickness being found in hole No. 3. The drift is probably thicker in hole No. 15, where the drill penetrated 225 feet of glacial material but did not reach indurated rock. Number 15 is situated in a valley and the curb elevation is 900 feet above sea level. This valley at one time must have been filled with drift up to or nearly to the elevation of the upland, the Kansan plain. This plain, when intact, had an elevation of about 1000 feet above sea level, hence the Pleistocene deposits at this point must once have been fully 325 feet thick. Under the present surfaces of the upland areas, remnants of the once extensive Kansan plain, the Pleistocene deposits are almost nowhere less than 100 feet in thickness.

DETAILED STRATIGRAPHY

MISSISSIPPIAN

The Mississippian system is known only from drill records. No drilling has penetrated very far into these strata, but as the relief on the Mississippian surface is fully 200 feet, at least this thickness of Mississippian rock is known to some extent. Unfortunately, almost no samples or cores have been preserved, so exact identification is impossible. One small length of a drill core in hand is from Pleasant township and was taken between 632½ feet and 617½ feet above sea level. The material is a very hard calcareous white shale or shaly limestone and contains one practically perfect specimen of *Spirifer pellaensis,* index fossil of the Ste. Genevieve or Pella. The Ste. Genevieve formation in

Iowa is known to be only about fifty feet thick and in most places is less than this.

Drill Record No. 1, referred to in table on page 135, shows that the Mississippian rock rises at least 736 feet above sea level. Thus a thickness of fully 100 feet of alternating limestone and sandstone exists above the *Spirifer pellaensis* horizon and below the base of the Des Moines. This cannot all be assigned to the Ste. Genevieve, unless this formation is abnormally thick here.

On the other hand this abnormal thickness, together with the lithologic character of the upper beds, alternating limestones and sandstones, at least suggests the possibility of the presence of some strata of Chester age.

The lowest point at which Mississippian rock has been reached is 541 feet above sea level although other holes go deeper and do not reach it. This depth is seventy-five to one hundred feet below the *Spirifer pellaensis* horizon and this thickness cannot all be assigned to the Ste. Genevieve, so the lowest Mississippian known in the county probably belongs to the St. Louis or the Warsaw, and these limestones are thicker and more massive than the higher beds.

A drilling made near the east side of section 13, Pleasant township, penetrated 65 feet of Mississippian rock. This record is given in full in the appendix (Drill Section No. 2) and in condensed form below.

	THICKNESS	
	Feet	*Inches*
Surficial material	21	6
Coal Measures	81	3
Mississippian (top at 700 feet above sea level)		
Hard light colored limestone	20	
Soft blue lime shale	1	
Hard light colored sandstone	3	
Hard light colored limestone	17	6
Hard light colored sandstone	6	
Hard light colored limestone	4	6
Hard light colored sandstone	9	
Hard light colored limestone	4	

Another drilling in the southwest corner of section 7, Cedar township, reached the Mississippian at 595 feet above sea level and the drill passed through fifty-five feet of limestone. The record of this hole is given in the appendix as Drill section No. 14. Near the center of section 12, Liberty township, the top of the Mississippian was reached at 614 feet above sea level and the drill passed through eighty-eight feet of alternating beds of limestone and sandstone. The detailed section of this hole is given below.

Drill section No. 31, North of center of section 12, Liberty township.

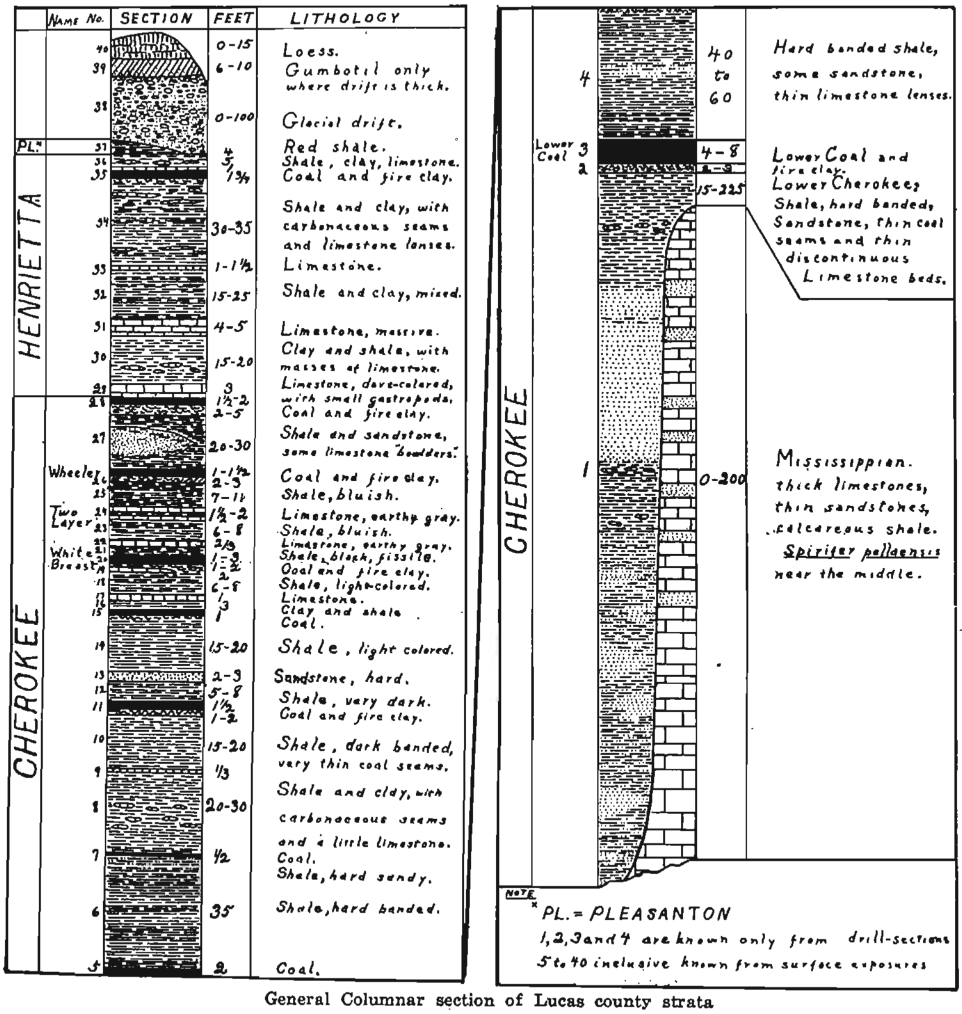
Curb elevation 832 feet above sea level.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
1.	Soil and clay	12		12	
2.	Sand and gravel	8		20	
3.	Hard blue limestone		6	20	6
4.	Soft black shale	4		24	6
5.	Soft light shale	2	2	26	8
6.	Hard light limestone		7	27	3
7.	Medium soft light sandstone	1	10	29	1
8.	Soft light shale	2	9	31	10
9.	Hard medium light shale	1		32	10
10.	Variegated shale	7	2	40	
11.	Soft light sandstone	7	6	47	6
12.	Variegated shale	2		49	6
13.	Soft light sandstone	9	6	59	
14.	Soft light sandy shale	3		62	
15.	Soft medium dark shale	3	1	65	1
16.	*Coal*		11	66	
17.	Soft light sandy shale	3		69	
18.	Soft black shale	3		72	
19.	Medium soft light sandstone	3		75	
20.	Medium soft dark shale	12	7	87	7
21.	*Coal*	2	6	90	1
22.	Light soft clayey limy shale	6	11	97	
23.	Medium soft medium dark shale	1		98	
24.	Light medium soft sandy shale	6		104	
25.	Soft light sandstone	3		107	
26.	Soft light shale	1		108	
27.	Medium dark soft shale	6		114	
28.	*Coal*	2	2	116	2
29.	Medium soft light shale	3	10	120	
30.	Soft medium dark shale	4		124	
31.	Medium soft medium dark sandy shale	10		134	
32.	Bony *coal*		5	134	5
33.	Medium light medium hard sandy shale	3	7	138	
34.	Medium dark hard sandy shale	3		141	
35.	Hard blue rock	1	6	142	6
36.	Medium dark medium soft shale with light partings and sulfide balls	26	6	169	
37.	Medium dark medium hard shale	16		185	
38.	Medium hard dark shale with quartz bands	6		191	
39.	Dark hard shale	5		196	
40.	Soft light clay shale	3		199	
41.	Dark medium hard shale	4		203	
42.	Light medium soft shale	2		205	
43.	Medium hard dark shale	8		213	
44.	Soft limy shale	5		218	
45.	Hard gray limestone (Mississippian)	6		224	
46.	Hard white limestone	19		243	
47.	Hard dark crystalline limestone	1		244	
48.	Light medium soft sandstone	4		248	
49.	Soft medium light limestone	16		264	
50.	Soft light sandstone	12		276	
51.	Hard light limestone	7		283	
52.	Medium soft light sandstone	15		298	
53.	Hard light sandstone	7		305	
54.	Hard light limestone	1		306	

Total depth 306 feet.
Top of Mississippian 614 feet above sea level.
Bottom of hole 526 feet above sea level.
Thickness of Mississippian penetrated 88 feet.

IOWA GEOLOGICAL SURVEY PLATE II

COLUMNAR SECTION



General Columnar section of Lucas county strata

DES MOINES

The lower part of the Cherokee formation is known in Lucas county only from drill records made in prospecting for coal. The Cherokee is divisible into two parts on the basis of lithology. The part below the Lower coal is extremely lensy and variable with no very persistent horizons. It is made up largely of thick lenses of sandstone and shale with smaller bodies of limestone and thin coal seams of very small extent. The Lower coal is the lowest horizon that is recognizable as being widespread, even though the coal lenses are not everywhere connected.

The upper part of the Cherokee also is made up of sandstone, shale and thin layers of limestone. The various beds are relatively persistent over quite extensive areas; such beds as the Two Layer limestone and the White Breast coal are excellent horizon markers. The strata are more persistent and less undulatory near the top of the formation. There is no definite lithologic break or discernible unconformity between the Cherokee and the overlying Henrietta formation.

The Henrietta formation is made up of relatively more limestone and very much less coal than the Cherokee, but its strata are no more persistent than are those in the upper part of the Cherokee.

Surface exposures reveal only about the upper one-third of the Cherokee formation. The Henrietta is known from a few fairly good exposures. The Pleasanton, with the exception of the Chariton conglomerate, which is well exposed, is seen in only one or possibly two exposures.

Correlation is possible with certainty only when exposures are very close together. In the detailed sections which follow, certain horizons are named and by comparing adjacent sections the geologic column for Lucas county can be pieced together. The lower sections stratigraphically are in the northeast part of the county and the highest one is in the vicinity of the town of Lucas. All sections are referable to the Columnar Section, which is self-explanatory.

Surface sections are designated by number only (as No. 9); coal prospect hole sections are designated, Drill section No. 10, etc. On the general map the drill section numbers are enclosed in circles.

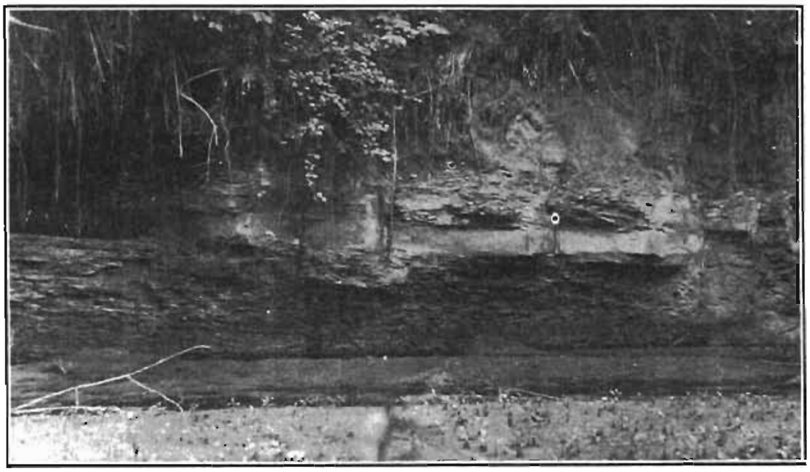


FIG. 15.—An exposure of Cherokee beds in Pleasant township, with a thin sandstone stratum through the middle.

Cherokee Formation.—The term Lower Coal is used as a proper name for the coal horizon known throughout the county by that designation. White Breast is here applied to a coal bed that was first worked along White Breast creek. This coal was called "Panora" in the Iowa Geologic Report of 1870, but this is of doubtful significance and is an inappropriate name for local use. Two Layer limestone is a persistent and characteristic earthy limestone made up of two layers, each four to twelve inches thick, which are separated by two to six inches of shale. It is nearly everywhere seen in the same sections as the White Breast coal. Wheeler coal was named by St. John in the Iowa Geologic Report of 1870 and the name is just as applicable now as it was then and has been retained. These names are suggested for local use only and are used as means of correlation in the sections which follow.

Surface section No. 1. Middle of east side of section 1, Pleasant township.

		FEET	INCHES
16.	Drift and loess mantles upper slope to top of hill	20	
15.	Shales, sandy and light	8	
14.	Clays, light and mixed	7	
13.	*Coal,* soft rotten "blossom" (11 of the Columnar Section) about 840 feet above sea level	1	6
12.	Fire clay	1 to 2	
11.	Clay and shale mixed and variegated	17 to 18	
10.	Limestone, bluish, impure, brittle		4
9.	Shales, dark bluish, in part carbonaceous	2 to 2½	

8.	Clay shales, mixed, limestone nodules	14	
7.	Shale, dark bluish, carbonaceous	1 to 1¼	
6.	Sandstone, soft, light		6
5.	Clay, yellow	1	
4.	Clay, ash-colored like underclay or fire clay	9	
3.	Carbonaceous matter, "coal blossom"		2 to 3
2.	Shale, hard, banded red and dark, upper 10 feet more sandy	35	
1.	*Coal*, No. 5 of Columnar Section, not exposed but mined at about 765 feet above sea level	2	
	Base 765 feet above sea level.		

Bed No. 1 has been rather extensively mined in this part of the county. It lies forty to eighty feet above the Lower coal, which is mined at Tipperary and Olmitz. The range in the distance of this coal bed above the Lower coal is due to the "rolls and pitches" characteristic of the lower part of the Coal Measures. It is below the coal reported from near the center of section 10, Pleasant township. Numbers 5 to 12 inclusive of the Columnar Section are represented in this surface section.

Other surface sections in this part of Pleasant township are much like the one above but naturally there is considerable variation in minor details from place to place. The coal bed, No. 13 above, outcrops at an elevation of about 865 feet above sea level near the middle of the south side of section 1, Pleasant township, only about three-quarters of a mile southwest of the location of the above section. At the same place another band of carbonaceous matter is exposed about twenty feet below the coal. This second carbonaceous bed probably belongs somewhere in horizon 8 of the Columnar Section. A nine foot bed of light buff sandstone, interbedded with thin clay laminæ, occurs about twelve feet below the carbonaceous stratum. Thus in a comparatively short distance some of the clay and shale beds of Surface section No. 1 are represented by sandstone. Such lateral variation is common in the Des Moines series and especially in the Cherokee formation of this county.

A coal bed eighteen inches thick has been worked to some extent in the vicinity of the southwest corner of section 11, Pleasant township. It seems to be the same horizon as No. 13 in Surface section No. 1, page 144, and No. 11 in the Columnar Section. Its elevation is about 840 to 845 feet above sea level.

Surface section No. 4. Near middle of north side of section 24, Pleasant township.

			FEET
5.	Shales, light, clayey		10
4.	Clay, light ash-colored	4	to 5
3.	Shale, light, sandy	15	to 20
2.	Shale, banded red and black		30
1.	*Coal,* with lime rock "bowlders"	2	to 3
	Base at 780 to 790 feet above sea level.		

This section is similar to that of Surface section No. 1, page 144, in section 1, Pleasant township. The coal bed in this exposure is the same as that mined at or below the creek level in sections 1, 11, 13 and 24, Pleasant township. It is the same horizon as bed No. 1 in Surface section No. 1, and is No. 5 of the Columnar Section.

Coal bed number 13 of Surface section No. 1, page 144, is again exposed in the creek bank a little east of the center of section 10, Pleasant township. Here it is eighteen inches thick and at an elevation of about 840 feet above sea level. This may be the same coal bed worked in the early days at Dale's mine, which was located near this point. The strata at this place are somewhat deformed, being sharply folded downward at the east end of the exposure. The folding is of very small magnitude but because of it, this coal bed has never been successfully mined to any extent in this vicinity.

The base of the above Surface section is two to five feet above the coal bed exposed in the creek bank half a mile east, which is the same as stratum No. 13 in Surface section No. 1, page 144. Strata 2 and 3 above are represented by bed No. 13 in the Columnar Section.

Surface section No. 12. Middle northwest quarter section 10, Pleasant township.

			FEET	INCHES
12.	Shale, badly slumped and covered		10	
11.	*Coal* (White Breast), about 870 feet above sea level		1	6
10.	Fire clay		2	
9.	Limestone, fossiliferous		1	3
8.	Shale, light		7	
7.	Limestone			4
6.	Shale, light and clayey		3	
5.	Shale, carbonaceous, coal blossom, at 850 feet above sea level			9
4.	Shale, badly covered	15	to 20	
3.	Sandstone, thin layered, soft		1	
2.	Sandstone, "cap rock", hard and quartzitic, light gray on fresh surface, uneven thickness		2	
1.	Shale, black, fat		5	
	Base at 825 to 830 feet above sea level.			

Several exposures along Flint creek in the northern and western part of section 16 and in the northeast quarter of section 17, Pleasant township, yield the composite section which follows:

Surface section No. 13.

		FEET	INCHES
13.	Shale, light, sandy, gray and yellowish	10	
12.	*Coal* (Wheeler), 885 to 890 feet above sea level	1	
11.	Fire clay	2 to 3	
10.	Shales, light blue, gritty, with limestone nodules	7 to 8	
9.	Two Layer limestone: Limestone, fossiliferous, earthy, 4 inches; Shale parting, 6 inches; Limestone, fossiliferous, earthy, 8 inches	1	6
8.	Shales, dark bluish	7	
7.	Limestone, bluish, impure, weathered brown		8
6.	Shale, black, fissile, overlying White Breast coal	3	
5.	*Coal* (White Breast), 860 to 870 feet above sea level	1	
4.	Fire clay	2	
3.	Clay shale, with fossiliferous limestone masses and nodules	6 to 7	
2.	Limestone, impure, brown, fossiliferous, with two inch clay parting in upper part	1	
1.	Shale, carbonaceous, black	2	
	Base about 850 feet above sea level.		

The lower beds of this section are equivalent to the upper beds of Surface section No. 12, page 146. The black fissile shale overlying the White Breast coal is unusually thick in this section. Both the White Breast and Wheeler coals have been mined to some extent in this vicinity. Beds numbered 6 to 13 inclusive in the above section are well exposed at one place in the creek bank near the middle of the northeast quarter of section 17, Pleasant township. This place was visited by St. John in 1867 and the exposure was described by him and was used as one of his type sections.

Near the middle of section 3, Pleasant township, the Wheeler and White Breast coals can again be recognized and the sequence of strata is the same as in the above section except that the White Breast coal and the Two Layer limestone are separated by about eighteen feet of shale instead of ten. The elevation of the White Breast seam at this place is about 850 to 855 feet above sea level, and the Wheeler bed is about twenty-six feet higher. The sequence of strata below the White Breast coal is almost identical with that in other sections already given except that the shale beds are thicker. A coal stratum one foot thick which occurs twenty-eight to thirty feet below the White Breast bed also is exposed in this vicinity. Probably it is the equivalent of bed number five in Surface section No. 12, page 146, but lies at a lower elevation. This bed of coal is separated from a still lower eight inch bed by about four feet of light colored shale and fire clay. The strata exposed in this locality lie at a somewhat lower elevation than they do a mile or more farther south and southeast. Thus the strata seem to have a local northwesterly dip in this part of the county.

The thin seam of coal outcropping at about 870 feet above sea level a little north of the middle of the west side of section 21, Pleasant township, may be the White Breast bed.

The White Breast coal, characteristically overlain by one foot of carbonaceous fissile shale which in turn is covered by a thin layer of earthy gray fossiliferous limestone, outcrops near the middle of the north side of section 5, Pleasant township. The above limestone, which is about ten inches thick, is overlain by seven and one-half feet of bluish dark shale and this is followed by the Two Layer limestone, which has an additional clay parting near the top. The beds exposed here duplicate almost exactly beds 3 to 10 inclusive, previously given in Surface section No. 13, page 147. However, at this place the White Breast coal bed is at an elevation of about 900 feet above sea level, somewhat higher than should be expected.

Surface section No. 19. Southeast quarter, section 7, Cedar township.

	FEET	INCHES
6. Shale and drift (covered)		
5. Clay, yellow, with 6 inch impure limestone band	1	
4. Shale, fissile, black, hard	1½ to 2	
3. Shale, carbonaceous	2½ to 3	
2. Coal and brittle shale (White Breast)		10
1. Shale and clay, light colored	8 to 10	
Base at about 860 feet above sea level.		

The White Breast coal has been mined in this vicinity. The Wheeler coal outcrops at about 895 feet above sea level, about one and one-half miles northwest of the location of the above section, near the middle of the north side of section 12, Lincoln township. It is underlain and overlain by light colored shales which are poorly exposed. The beds exposed at this place are equivalent to and seem to be almost identical with part of 10, all of 11 and 12 and part of 13 in Surface section 13, page 147. The Wheeler coal in this exposure is in the normal stratigraphic position relative to the White Breast bed exposed along North Cedar creek one and one-half miles to the southeast.

The drillings in the northeast part of the county are, for the most part, drilled from valley bottoms and the elevations of their curbs are in many cases as low as the bases of the surface sections. Drill sections can be correlated with a fair degree of accuracy, using the Lower Coal horizon as a datum plane. Drill section No. 7, which follows, represents quite typically the deeper strata in the northeast part of the county. Bed No. 10 in this hole is stratum No. 13 of Surface section No. 1, page 144. The reader should bear in mind that in most cases the Surface sections are given in greater detail than the Drill sections.

Drill section No. 7. Three hundred fifty feet east of middle of west side of southwest quarter of section 22, Pleasant township.

Curb Elevation 898 feet above sea level.

		THICKNESS		DEPTH	
		Ft.	*In.*	*Ft.*	*In.*
1.	Soil	12		12	
2.	Sand and clay	30		42	
3.	Soft light clay shale	7		49	
4.	Hard limestone	1		50	
5.	Soft light shale	4		54	
6.	Soft variegated shale	6		60	
7.	Soft light shale	2		62	
8.	Hard rock		6	62	6
9.	Medium soft dark shale	3	6	66	
10.	*Coal* (No. 11 of Columnar Section)	1		67	
11.	Medium light sandy shale	14		81	
12.	Medium soft variegated shale	7		88	
13.	Medium hard dark shale	2		90	
14.	Medium soft medium light shale	8	3	98	3
15.	*Coal* (No. 7 of Columnar Section)		9	99	
16.	Medium hard dark streaked shale	70		169	
17.	Hard medium light banded shale	14		183	
18.	Carbonaceous shale	1		184	
19.	*Coal* (Lower)	6	2	190	2
20.	Medium hard medium dark shale		10	191	
21.	Medium hard light fire clay	4		195	

Total depth 195 feet.
Top of Lower coal (19) 714 feet above sea level.
Bottom of hole 703 feet above sea level.

Drill section No. 11, located near the center of section 32, Pleasant township, and given in the Appendix, page 225, almost duplicates hole No. 7, except that the different strata show some variation in thickness and the coal beds are at slightly different elevations. Drill section No. 17, located near the center of the southeast quarter of section 12, Lincoln township, is quite typical of records from this vicinity.

Drill section No. 17. Near center of southeast quarter of section 12, Lincoln township.

Curb Elevation 1010 feet above sea level.

		THICKNESS		DEPTH	
		Ft.	*In.*	*Ft.*	*In.*
1.	Surface soil, loess, gumbotil	24		24	
2.	Sand and clay, some bowlders	68		92	
3.	Sand	23		115	
4.	Blue clay	14		129	
5.	Shale, medium hard, variegated	3		132	
6.	Shale, medium dark	6		138	
7.	Shale, hard, dark, "carbonaceous"	5		143	
8.	*Coal* (may be White Breast)		9	143	9
9.	Shale, medium hard and light	19	3	163	
10.	Shale, hard and medium dark	4		167	
11.	Blue rock, hard	3		170	
12.	Shale, hard and dark	4		174	
13.	Blue rock, hard	1		175	
14.	Shale, hard and dark	15		190	
15.	*Coal* (No. 11 of Columnar Section)	1		191	
16.	Shale, medium soft and light	9		200	
17.	Sandstone	3		203	
18.	Sandy shale, hard and light	4		207	
19.	Shale, medium hard and medium dark	7		214	
20.	Shale, medium hard and medium light	11		225	
21.	Shale, hard and dark	3		228	
22.	*Coal* (No. 7 of Columnar Section)	1		229	
23.	Shale, hard, medium dark	62		291	
24.	*Coal* (Lower)	5	2	296	2
25.	Sandstone, soft and light	2	10	299	

Total depth 299 feet.
Top of Lower coal 719 feet above sea level.
Bottom of hole 711 feet above sea level.

Coal bed No. 15 of the above section may be No. 11 of the Columnar Section. Number 8 in this hole is 857 feet above sea level and this is about the same as the elevation of the White Breast coal along North Cedar creek about a mile farther east. It seems quite probable that bed No. 8 is the same as the White Breast coal described in Surface section No. 19, page 148. Coal bed number 5 of the Columnar Section, which is mined at several places in the northeastern part of Pleasant township, does not seem to occur in the vicinity of holes No. 7 or No. 17, but it does appear in a hole drilled near the southwest corner of section 36, English township. The record of this hole is given in the Appendix as Drill section No. 32.

Drill section No. 14, given in the appendix, page 226, is the record of a hole put down a little east of the northwest corner of section 7, Cedar township. At a depth of 385 feet the Mississippian limestone was reached (959 feet above sea level) and not a single workable coal bed was passed through. This hole in relation to others previously given illustrates the fact of the lenslike character of the coal beds. Another drilling, Drill section No. 16, given in the appendix, page 227, and located near the southeast corner of section 2, Lincoln township, penetrated to a depth of 376 feet and here the Lower coal horizon together with over 100 feet of strata above and below it are entirely replaced by light colored sandstone.

The exposures of Coal Measures in the eastern part of English township along English creek essentially duplicate exposures farther east. This fact is evident when the surface section which follows, taken from the northeastern part of section 1, English township, is compared with Surface sections 12 and 13, given on pages 146 and 147 respectively. The elevation above sea level of the corresponding beds is a little higher in English township than would normally be expected.

Surface section No. 21. Middle of north side of section 1, English township.

		FEET	INCHES
14.	Glacial drift	15	
13.	Shale, light	10	
12.	*Coal* (Wheeler)	1	
11.	Fire clay	1	6
10.	Clayey shale, yellowish	6	
9.	Limestone, in two layers, Two Layer limestone	3	
8.	Shale, bluish	10	
7.	*Carbonaceous material* (White Breast coal)		10
6.	Clay and shale, mixed, varicolored	21	
5.	Shale, variegated, limestone nodules in upper 2 feet	10	
4.	Shale, blue-gray	4	
3.	Carbonaceous band		4
2.	Clay, mixed, varicolored and in part sandy	12	6
1.	Shale, bluish to gray, becoming sandy at top	12	
	Base at 840 feet above sea level.		

Bed No. 7, the White Breast coal, is not typically exposed in this section but this horizon is recognizable as such in the vicinity. The impure buff-colored limestone that usually overlies it is absent but is well developed a short distance away along the creek. This limestone "cap rock" is not continuous in this locality but is represented by a stratum of "bowlders" typical of the margin of a limestone lens. The White Breast coal again outcrops in the southeast quarter of section 2, English township, about 875 feet above sea level.

The White Breast and Wheeler coals, separated by about twenty feet of shale beds and the Two Layer limestone, which is typically developed, are well exposed in the southeast quarter of section 11, English township. The characteristic thin limestone "cap rock" overlies the White Breast bed at this place. The elevation of the White Breast stratum is about 885 feet above sea level. In addition a higher coal horizon occurs eighteen to twenty feet above the Wheeler coal. Both the White Breast and Wheeler coals have been mined in this locality.

Surface section No. 24, which follows, illustrates very typically the relations of the White Breast and Wheeler coal beds. Where these two coal beds are exposed together the character of the intervening strata and their sequence are almost everywhere the same and the beds are widespread over much of the county. The beds represented in this section are the best horizon markers in the geologic column of Lucas county. This exposure was described by St. John.

Surface section No. 24. Northeast quarter section 15, English township.

		FEET	INCHES
10.	Shale, sandy	25 to 30	
9.	*Coal* (Wheeler)	1	
8.	Fire clay	1	
7.	Shale, light yellowish, poorly bedded	15	
6.	Limestone, Two Layer	2	
5.	Shale, light bluish and yellow	10	
4.	Limestone, bluish gray		6
3.	Shale, black, fissile	1	6
2.	*Coal* (White Breast)		12 to 15
1.	Shale, mixed, limestone nodules 4 feet from top	12	
	Base at 890 feet above sea level.		

The White Breast coal has been mined in this vicinity. A four foot bed of white limestone is exposed at the same level as the White Breast coal, which occurs a short distance from the limestone exposure, along Long Branch creek near the middle of the east side of section 4, English township. This limestone is believed to be bed No. 31 of the Columnar Section and is again referred to on page 157.

The upper English creek valley area has been quite thoroughly prospected for coal and a number of drill holes have been made. In this locality the Lower coal is from four to seven feet thick and of excellent quality. Drill section No. 35, which follows, is typical of records from this area. It is quite similar to Drill sections 7 and 17 previously given on pages 149 and 150. Other sections from this field are given in the Appendix (Nos. 34, 37 and 38). The main shaft of Mine No. 4 of the Central Iowa Fuel Company was sunk on this hole.

Drill section No. 35. (Main shaft of No. 4 mine sunk on this hole.) West middle of northwest quarter, section 24, English township.

Curb elevation 1004 feet above sea level.

		THICKNESS Ft.	THICKNESS In.	DEPTH Ft.	DEPTH In.
1.	Soil and loess	18		18	
2.	Yellow clay	23		41	
3.	Gravel	2		45	
4.	Blue clay	4		49	
5.	Gravel	2		51	
6.	Blue clay	3		54	
7.	Gravel	1		55	
8.	Blue clay	8		63	
9.	Blue clay, sand and gravel	15		78	
10.	Sand and gravel	4		82	
11.	Blue clay	5		87	
12.	Gravel	2		89	
13.	Blue clay	20		109	
14.	Yellow clay and sand	4		113	
15.	Shale, light	5		118	
16.	Shale, soft, gray	6	6	124	6
17.	*Coal* (may be White Breast horizon)		6	125	
18.	Shale, soft, light and dark banded	54		179	
19.	Rock, hard, gray	1		180	
20.	Shale, hard, dark	3		183	
21.	*Coal* (may be No. 11 of Columnar Section)	1		184	
22.	Shale, medium hard, light	6		190	
23.	Shale, soft, light	3		193	
24.	Shale, hard, light, sandy	1		194	
25.	Shale, medium hard, light	15		209	
26.	*Coal* (may be 7 of Columnar Section)		8	209	8
27.	Shale, hard, gray	10	4	220	
28.	Shale, gray, sandy	12		232	
29.	Sandstone, soft	4		236	
30.	Shale, medium hard and medium dark	49	4	285	4
31.	"Shoddy" top		8	286	
32.	*Coal* (Lower)	6	9	292	9
33.	False bottom		3	293	
34.	Fire clay, light	1		294	

Total depth 294 feet.
Bottom of hole 710 feet above sea level.
Top of Lower coal 718 feet above sea level.

At a point three-eighths of a mile northeast of this drilling a fifteen inch coal seam appears in the road above the highest coal in this log (No. 17). It may be the Wheeler bed.

Surface section No. 28. General vicinity of northeast corner of Liberty township, along White Breast creek.

		FEET	INCHES
14.	Three feet covered, drift above		
13.	Sandstone, soft, no fossils	5	6
12.	Clay or silt, sandy	2	6

		Feet	Inches
11.	Shale, bluish, grading up into 3 feet of clay	12	
10.	*Coal* (No. 28 of Columnar Section)	1	
9.	Sandstone and sandy shale (plant fossils in upper part)	15	
8.	Shale and clay, sandy	20	
7.	*Coal* (Wheeler)	1	10
6.	Clay, blue, and light fire clay	3	
5.	Limestone, earthy, fossiliferous } Two layer limestone		6
4.	Clay shale, fossiliferous } Two layer limestone		6
3.	Limestone, earthy, fossiliferous } Two layer limestone		8
2.	Clay shale, blue-gray	3	
1.	Shale, sandy, buff	9	
	Base at 835 feet above sea level.		

The White Breast coal is known to occur a few feet below the base of the above section and it outcrops in the bed of White Breast creek in the northeast quarter of section 11, Liberty township. Number 7 in the above section is the Wheeler coal and number 10 is a higher coal that is well developed farther south, where it is overlain by a bluish gray cap rock limestone. Another coal bed, fourteen inches to two feet thick, which lies below the Two Layer limestone, appears in outcrops a mile to a mile and a half to the northwest. There seem, then, to be four coal beds represented in the vicinity of Surface section No. 28. The strata here have a dip to the northwest of about twenty to twenty-five feet per mile and this structural feature brings the Two Layer limestone up much higher in section No. 27, which follows. Drill section No. 31, given on page 141, shows the relations of the deeper strata.

Surface section No. 27. General vicinity of the middle of the west side of English township, along Little White Breast creek.

		FEET	INCHES
15.	Glacial drift, reddish and sandy		
14.	Shale, light, calcareous	5 to 8	
13.	*Coal* (No. 28 of Columnar Section)	1	3
12.	Fire clay	1	6
11.	Shale and sandstone	7	
10.	Clay and shale, light and sandy	11	
9.	*Coal* (Wheeler)		8 to 12
8.	Clay, yellow, grades into light fire clay	6	
7.	Two Layer limestone	1	6
6.	Shale, light gray	7	
5.	*Coal*, poor quality (White Breast)	1	
4.	Shale, light, grading into fire clay	8	
3.	Sandstone, in part calcareous	1 to 1½	
2.	Shale, sandy and in part calcareous, with fossils	2	
1.	Shale, light blue to gray	5	
	Base at 860 feet above sea level.		

The coal, No. 13 above, is the same as bed No. 10 in Surface section No. 28. This upper coal is said to be overlain in most places by a two foot layer of hard "cap rock" limestone. The sandiness of the underlying beds also is typical for these horizons. A similar sequence, with the "cap rock" limestone above the coal, is conspicuous in Swede Hollow, four and a half miles to the southwest. Both bed No. 9 and bed No. 13 of this section have been mined along Little White Breast creek.

The Wheeler coal and the coal next above it in the preceding section (No. 27) also have been worked to a considerable extent in the southwest corner of English township, in the northwest corner of Lincoln township and in section 1 of White Breast township, along Little White Breast creek and some of its tributaries. These coal beds are separated by sandy beds twenty to thirty feet thick and the upper bed is overlain by the "cap rock" limestone. It should be noted that the "lower" surface coal of this vicinity is not the White Breast coal of other localities but is the Wheeler bed, which lies above the Two Layer limestone. The stratigraphic relations of these beds have been shown in Surface sections No. 24, No. 28, No. 27, and in the Columnar Section. These relations are essentially the same for the northwest part of Lincoln township.

Near the middle of the west side and in the southwest quarter of section 4, Lincoln township, the Wheeler coal, eighteen inches to two feet thick, again outcrops at an elevation of about 900 feet above sea level, nearly the same as in Surface section No. 27. A coal that corresponds to bed No. 13 of Surface section No. 27 is known in this vicinity also. It is underlain by sandy strata and overlain by mixed shales that are not well exposed, but the capping limestone seems to be absent.

The unexposed strata of the vicinity along Little White Breast creek about three and one-half miles northeast of Chariton are quite typically shown in Drill section No. 19, which follows. Other drill records from this locality are recorded in the appendix as Drill sections 18, 20, 21 and 39. This section is the record of the hole on which the main shaft of the "Old No. 1" mine of the Central Iowa Fuel Company was sunk. The Lower coal was well developed in this basin but has now been "mined out." On account of the variability of the Coal Measures strata it is difficult to correlate all of the horizons, especially where surface exposures are few and shallow as they are in this vicinity. However, it seems quite probable that bed No. 7 of this section is the Wheeler coal horizon.

Drill section No. 19. Inland shaft or "Old No. 1", northwest part of the northwest quarter of section 9, Lincoln township.

Curb elevation 925 feet above sea level.

		THICKNESS		DEPTH	
		Ft.	*In.*	*Ft.*	*In.*
1.	Soil and clay	14		14	
2.	Clay and sandy clay	8		22	
3.	Sand and sandy clay	10	6	32	6
4.	Clay, sand and bowlders	2		34	6
5.	Shale, light, soft and seamy	7		41	6
6.	Shale, dark, soft and seamy	11		52	6
7.	*Coal*, good (may be Wheeler bed)	2		54	6
8.	Fire clay	2		56	6
9.	Fire clay, hard and sandy	3		59	6
10.	Sandstone	2		61	6
11.	Limestone	1		62	6
12.	Light sandstone	2		64	6
13.	Shale, light and sandy	11		75	6
14.	Shale, variegated	8	6	84	
15.	Shale, light	6		90	
16.	Shale, black	8		98	
17.	*Coal*	1		99	
18.	Fire clay	3		102	
19.	Shale, light	4		106	
20.	Shale, dark and hard	10		116	
21.	Limestone		6	116	6
22.	*Coal*	1	6	118	
23.	Fire clay, dark and hard	7		125	
24.	Sandstone, light and hard	3		128	
25.	Shale, light and hard	2		130	
26.	Shale, dark and medium hard	15		145	
27.	*Coal*		3	145	3
28.	Shale, dark and hard	1		146	3
29.	Carbonaceous shale		6	146	9
30.	Fire clay, hard	6	3	153	
31.	Sandstone, light and medium hard	31		184	
32.	Shale, dark and hard	10		194	
33.	Sandstone	2		196	
34.	Shale, medium dark and medium hard	43		239	
35.	*Coal* (Lower)	7		246	
36.	Fire clay	3		249	
37.	Sandstone, hard	9		258	

Total depth 258 feet.
Top of Lower coal 686 feet above sea level.
Bottom of hole 667 feet above sea level.

Surface section No. 32. General vicinity of the upper part of Little White Breast creek northeast of Chariton.

		FEET	INCHES
9.	Shale (covered) and drift	60	
8.	Limestone, very pure and white in places and divided by clay and sand partings in other places	4	6

7.	Shale, bluish in part, sandy, uneven thickness	9	
6.	Limestone, discontinuous		8
5.	Shale and clay (covered)	2 or 3	
4.	*Coal* (bed 28 in Columnar Section)	1	
3.	Shale, light, mixed, in part sandy	12 to 15	
2.	*Coal* (Wheeler, 900 feet above sea level)	1	9
1.	Shale, light, mixed, in part sandy	15	
	Base at 885 feet above sea level.		

There is little doubt that No. 2 above is the Wheeler coal of other sections. Bed No. 4 is another coal horizon of rather limited extent. These two coals have been thought to be the White Breast and Wheeler, but the White Breast probably is forty to fifty feet below the base of this section and is not exposed. The second coal (No. 4) in this section also has over it in places an eight inch cap-rock limestone which is thought to be the basal member of the Henrietta formation. Probably it is the coal that outcrops at the Chariton water reservoir spillway, about 915 feet above sea level. At this latter place it is one and a half to two feet thick and is underlain by fire clay and sandy shale which grades into a fairly resistant sandstone farther north. The overlying shales also are sandy. Both coals of this section have been mined along Little White Breast creek.

The relatively thick limestone (No. 8) of this vicinity is of very good quality and is white in color. It was quite extensively quarried in an earlier day in the southeast quarter of section 16, Lincoln township. The same limestone is poorly exposed in the southeast corner of section 16, English township. In this place it is in the proper stratigraphic relation to the Wheeler and White Breast coal beds, which are shown in a surface exposure a mile to the northeast, described in section No. 24, page 152. It is known to be present also in the east part of section 4, English township, where it was formerly exposed in the Smith quarries on Long Branch creek, about 930 feet above sea level, which is too low. These quarries were open at the time of St. John's visit in 1867 and he noted the anomalous position of these beds.[23] St. John thought they had slumped from a higher position and this seems to be the correct interpretation, as the White Breast coal occurs only a few rods distant at nearly the same level as the limestone.

A four foot bed of white limestone, which was formerly quar-

23 The Geology of Iowa (1870), vol. II, p. 90.

ried, is exposed about 910 feet above sea level, at a few places in Washington township, along Chariton river and its tributaries. A coal bed has been worked a few feet above the limestone and another bed several feet below it, but these beds are not now exposed. This rock may be the same as the relatively thick limestone, No. 31 of the Columnar Section, occurring northeast of Chariton and at other points above noted. This bed has been reported from the northeast part of Wayne county. It is believed to be Henrietta in age.

The only drill section in hand from the southeast part of the county is given below. Sandstone and sandy shale beds are more conspicuous in this section than in sections from other places in the county. Very little coal seems to have been formed in this vicinity as no prospecting has revealed a workable bed.

Drill section No. 40. Northwest corner of the northeast quarter of section 12, Benton township.

Curb elevation 979 feet above sea level.

		THICKNESS		DEPTH	
		Ft.	*In.*	*Ft.*	*In.*
1.	Soil	7		7	
2.	Blue clay	5		12	
3.	Sand	5		17	
4.	Sand and clay	10		27	
5.	Dark blue clay	21		48	
6.	Sand and gravel	6		54	
7.	Light clay	40		94	
8.	Yellow clay	16		110	
9.	Light shale	2		112	
10.	Light shale	23		135	
11.	Dark sandy shale	8		143	
12.	Gray limestone (may be about the horizon of the Two Layer limestone)	1	4	144	4
13.	Dark sandy shale	3	8	148	
14.	Soft light sandstone	36		184	
15.	Sandstone	16		200	
16.	*Coal* (may be about the horizon of No. 11 of Columnar Section)		3	200	3
17.	Limestone	3	9	204	
18.	Hard sandstone	1		205	
19.	Soft gray sandstone	19		224	
20.	Sandstone	32		256	
21.	Dark shale	4		260	
22.	Light shale	2	6	262	6
23.	Bone *coal* (about horizon No. 5 of Columnar Section)	1	6	264	
24.	Fire clay	2		266	
25.	Dark sandstone	24		290	
26.	Sandstone	18		308	
27.	Limestone	4	7	312	7
28.	*Coal* (Lower coal horizon)		3	312	10
29.	Fire clay	1	2	314	
30.	Limy shale	4	6	318	6
31.	Dark shale	4	6	323	

Total depth 323 feet.
Bottom of hole 656 feet above sea level.

No surface exposures are known in the southwestern part of the county. A number of drillings have been made southwest of the city of Chariton and Drill section No. 27, which follows, represents the sequence of strata for the area. The Lower coal occurs in this district but it has a wide range in elevation and it has not been mined here. In the section below its elevation is 693 feet above sea level and in another hole (No. 23, appendix) about two and a quarter miles east and a little north the elevation of the Lower coal was only 654 feet above sea level. In a third hole (No. 24, appendix) located in the southeast quarter of section 24, White Breast township, the lower coal is 668 feet above sea level. It occurs at an elevation of 670 feet above sea level in a hole drilled about a mile southwest of hole No. 24. In the same hole (No. 26 of the appendix) the drill penetrated 110 feet of strata below the Lower coal horizon, which in this hole was only six inches thick, and fully two-thirds of these beds were sandstone while the remainder were sandy shales. This range in elevation and the similar range in thickness of the Lower coal are not unusual. The differences in elevation of the Lower coal bed are quite large in all of the mines and are known to be more than forty feet in some. This is discussed in greater detail on pages 183 to 186 inclusive.

Drill section No. 27. Middle east half section 34, White Breast township.

Curb elevation 1012 feet above sea level.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
1.	Soil and clay, drift in part	48		48	
2.	Sandy drift	30		78	
3.	Medium hard light shale	19		97	
4.	Hard dark shale	1	6	98	6
5.	Hard medium light shale	17	6	116	
6.	*Coal*	1		117	
7.	Soft medium light shale	7		124	
8.	Hard medium light shale with sand streaks	4		128	
9.	Hard dark banded shale	6		134	
10.	*Coal*	1	6	135	6
11.	Soft light shale	8	6	144	
12.	Hard limestone	2		146	
13.	Medium soft medium light shale	5		151	
14.	Hard dark shale	1		152	
15.	Soft light shale	5		157	
16.	Medium hard medium light sandy shale	9		166	
17.	Medium hard medium dark shale	2		168	
18.	Variegated shale	8		176	
19.	Soft medium light shale	7		183	
20.	Hard dark shale	3		186	
21.	*Coal* (White Breast ?)	1		187	
22.	Soft medium light shale	6		193	

23.	Limestone (may be horizon 17 of Columnar Section)	1		194	
24.	Medium hard variegated shale	2		196	
25.	Hard medium light shale	5		201	
26.	Hard variegated shale	3		204	
27.	Hard limestone	1	7	205	7
28.	Medium hard light shale	1	5	207	
29.	Hard dark shale	2		209	
30.	*Coal,* rotten (about No. 11 of Columnar Section)	1		210	
31.	Medium soft medium dark shale	4		214	
32.	Medium soft light shale	3		217	
33.	Medium soft variegated shale	3		220	
34.	Medium light medium hard shale	8		228	
35.	Hard medium dark shale	4		232	
36.	Sandstone	6		238	
37.	Hard medium light shale	3		241	
38.	Sandstone	5		246	
39.	Hard dark shale	4		250	
40.	*Coal* (may be about horizon No. 7 of Columnar Section)		6	250	6
41.	Soft light sandstone	25	6	276	
42.	Hard medium dark shale	43	6	319	6
43.	*Coal* (Lower)	6	3	325	9
44.	Sandy fire clay	4	3	330	

Total depth 330 feet.
Top of coal (43) 693 feet above sea level.
Bottom of hole 682 feet above sea level.

Good Coal Measures exposures occur along White Breast creek from the south part of Liberty township in the vicinity of "Wheelers" bridge to the town of Lucas, and also in Swede Hollow, a small tributary of White Breast valley. The exposures in this locality essentially duplicate exposures already described from English, Pleasant and Lincoln townships. Strata exposed

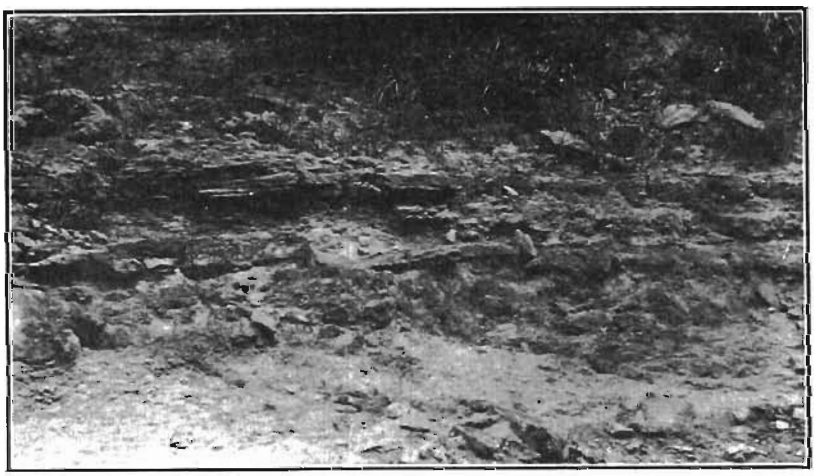


FIG. 16.—Strata of part of exposure north of Wheeler's bridge.

in outcrops in the south part of the southeast quarter of section 28, Liberty township, are almost exactly like beds 1 to 5 inclusive described in Surface section No. 13, page 147. From this point southwest along White Breast creek the strata have an appreciable southwestward dip.

Surface section No. 36. South of Wheeler's bridge near the middle of section 33, Liberty township.

		FEET	INCHES
14.	Clay, covered		
13.	*Coal* (Wheeler)	1	6
12.	Shale, light, yellowish and bluish	6	
11.	Limestone, fossiliferous } Two layer limestone		7
10.	Shale, greenish to gray }		4
9.	Limestone, fossiliferous }		13
8.	Clay shale, yellow	1	6
7.	Shale, light bluish gray	4	6
6.	Shale, dark, carbonaceous	2	
5.	Limestone, earthy and fossiliferous		8
4.	Shale, fissile, black, hard "shoddy top"		12 to 18
3.	*Coal* (White Breast)		15 to 18
2.	Shale, bluish and yellowish	3	
1.	Shale, gray, hard and calcareous with nodules	2	
	Base at 830 feet above sea level (water level).		

Surface section No. 36 is the type section from which the White Breast coal has been named by the writer. It was to beds numbered 9, 10 and 11 in this section that the writer first applied the name Two Layer limestone. It is persistent over much of the county where exposures are known, as has been seen from such surface sections as Nos. 13, page 147, 21, page 151, 24, page 152, 28, page 153, 27, page 154. The Wheeler coal received its name

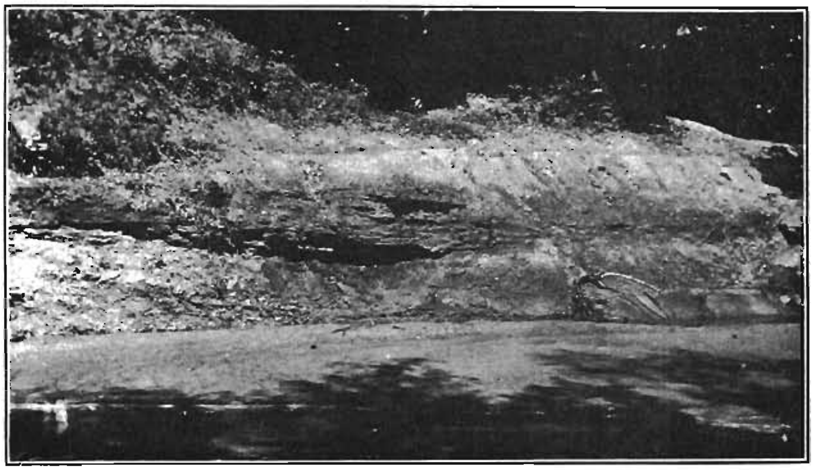


FIG. 17.—Typical Coal Measures exposure in Swede Hollow.

also from this section. The term Wheeler, applied by St. John, has been retained because of its occurrence near "Wheeler's bridge" in section 33, Liberty township. One-half mile southwest of the location of Surface section No. 36, along White Breast creek, the Wheeler coal seam, two feet thick, outcrops eleven feet above the Two Layer limestone.

Henrietta Formation.—In Swede Hollow, south middle of Liberty and north middle of White Breast townships, a higher coal outcrops and has been quite extensively mined. It occurs twenty to thirty-five feet above the Two Layer limestone. The intervening beds are made up of shales and clays that grade into sandstone locally. The Wheeler coal does not seem to have been developed here and does not outcrop in Swede Hollow. The sandstone is in places as much as twelve feet thick and at other points only a few rods distant it is less than one foot thick. In the section which follows (No. 37) the coal (No. 5) is thought to be the equivalent of coal No. 4 in Surface section No. 32 on Little White Breast creek (see page 156).

FIG. 18.—Sandstone in Swede Hollow.

Surface section No. 37. Near middle of northeast quarter section 3, White Breast township.

		FEET
10.	Drift (to the upland)	120
9.	Shale, poorly exposed	10
8.	Limestone, blue-gray, no fossils	1
7.	Shale, poorly exposed	15
6.	Limestone, dark gray or dove-colored, massive, crowded with small gastropod shells	2 to 3
5.	*Coal* (Bed 28 in Columnar Section and top of Cherokee formation)	1½
4.	Clay and fire clay	5
3.	Sandstone, thin bedded	1

2.	Sandstone, heavy, cross-bedded	3
1.	Shale, dark (may be horizon of Wheeler coal)	4
	Base at 860 feet above sea level.	

In this vicinity the coal (bed No. 5) is characteristically overlain by the heavy "cap rock" limestone and is quite undulatory. The limestone No. 6 is divided near its middle in some places by a thin clay parting. This is very probably the basal Henrietta member (basal Fort Scott). It contains an abundance of several kinds of small gastropod shells as well as other fossils.

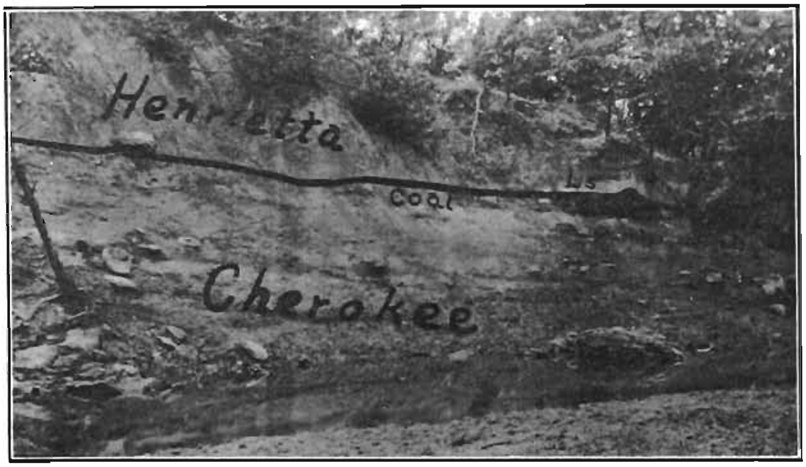


FIG. 19.—Contact of Cherokee and Henrietta formations in southeast quarter of section 5, White Breast township.

The same coal bed with its cap rock limestone is well exposed near the middle of the southeast quarter of section 5, White Breast township. The shale in the lower part of this exposure contains many large limestone "bowlders", which are in reality true septaria. Septaria occur at many places in the county and at many horizons but nowhere else are there as many nor as large ones as in this exposure.

Surface section No. 39. General vicinity of sections 16 and 17, White Breast township.

		FEET	INCHES
15.	Shale, covered	2	
14.	Limestone, hard, fossiliferous, weathers earthy	1	
13.	*Coal*, shaly, bed No. 35 of Columnar Section (about 930 feet above sea level)		22
12.	Shale and clay, variegated, with limestone bands in places	18 to 20	
11.	Shale, carbonaceous, black, slaty, lower		

		Feet	Inches
	part is calcareous and fossiliferous and dips southwest about 7°	3	
10.	Shale, gray, blue and yellowish, upper part has limestone nodules and some carbon	5 to 7	
9.	Clay and shale, mottled	5	
8.	Limestone band, hard, gray, fossiliferous		6 to 12
7.	Shale, bluish, not well exposed	7	
6.	Shale, bluish, in part sandy, molds of fossils	1	
5.	Shale, light bluish, bedded, limestone nodules at top	4	
4.	Shale, carbonaceous		6
3.	Shale, bluish and yellow, poorly bedded	5	
2.	Shale, carbonaceous and black	1	
1.	Clay, ocher-colored and bluish, upper part contains limestone nodules	4	
	Base at 890 feet above sea level.		

This section, which is not seen in its entirety at any one exposure, so far as known, represents the only good outcrops in Lucas county of these horizons, which are thought to be the middle and upper parts of the Henrietta formation. The shaly coal blossom (No. 13) outcrops and has been mined to some extent in the south and west parts of section 20, White Breast township, at 920 to 925 feet above sea level. It is there underlain by eighteen to twenty feet of shale and overlain by two feet of sandstone. At a depth of forty-two feet below the base of the preceding surface section a good seam of coal has been mined by shaft. This deeper coal may be the same bed as the coal (bed 5 of Surface section No. 37, page 162) that is mined in Swede Hollow to the northeast at a higher elevation or it may be the Wheeler coal.

The equivalents, in part, of the upper members of Surface section No. 39 again outcrop one and one-half miles west of the preceding surface section. One-eighth mile north of the center of section 18, White Breast township, a thickness of about thirty feet of shale with a thin compact white limestone layer near the top is exposed. Above the limestone layer occurs about five feet of highly calcareous shale containing thin limestone bands and small limestone lenses. A bed of carbonaceous shale about two feet thick, lying about five feet below the limestone, is thought to represent the coal horizon (bed 13) in Surface section No. 39 given above.

These beds are believed to represent the upper members of the Henrietta formation. No other exposures are known to the west, where the Coal Measures have been deeply eroded and the Pleistocene deposits are very thick.

An exposure of Coal Measures near the center of section 9, Benton township, is believed to be equivalent to part of Surface section No. 39. It is given below.

Surface section No. 45. Southwest of middle of section 9, Benton township, along Chariton river.

		FEET
5.	Shale, gray, with limestone nodules	1
4.	Clay, yellow	1 to 1½
3.	Shale and limestone, very carbonaceous	3
2.	Shale, blue	1½
1.	Clay, yellow	1
	Base at 920 to 925 feet above sea level.	

About a quarter of a mile farther west ten to fifteen feet of yellowish clay and shale, with thin interbedded limestone layers, outcrops at an elevation slightly higher than the section given above. It is very much like the upper beds in Surface section No. 39, page 163.

The unexposed strata beneath the upper White Breast creek valleys are known from drill sections, one of which is given below.

Drill section No. 28. Old Cleveland mine, one-fourth mile west of center of section 17, White Breast township.

Curb elevation about 880 feet above sea level.

		THICKNESS Ft.	THICKNESS In.	DEPTH Ft.	DEPTH In.
1.	Soil	7		7	
2.	Yellow clay	11		18	
3.	Blue clay	2		20	
4.	Blue clay, dark and gritty	11		31	
5.	Light shale	13		44	
6.	*Coal* (may be bed 28 of Columnar Section)	1	6	45	6
7.	Fire clay	2	6	48	
8.	Dark sand rock	7		55	
9.	Light shale	7		62	
10.	Dark shale	2		64	
11.	Light shale	10		74	
12.	*Coal* (may be Wheeler horizon)	2	6	76	6
13.	Fire clay	2	6	79	
14.	Gray sand rock	2		81	
15.	Dark shale with 3 inches coal and 1 foot fire clay	2	9	83	9
16.	Light sand rock with sand balls	4		87	9
17.	Light shale	10		97	9
18.	Dark shale	8	3	106	
19.	Red clay	3		109	
20.	*Coal*	1		110	
21.	Light shale	6		116	
22.	Sand rock	4		120	
23.	Light shale	12		132	
24.	Limestone	1		133	
25.	Dark fissile shale, "slate"	3		136	
26.	*Coal* (may be about horizon No. 15 of Columnar Section	1		137	
27.	Dark shale	4		141	
28.	Fire clay	4		145	

29.	Light shale	5		150	
30.	Lime rock	1		151	
31.	Blue shale	4		155	
32.	Black shale, slaty	6		161	
33.	Lime rock	1		162	
34.	Black fissile shale, ''slate''	1		163	
35.	*Coal*	1		164	
36.	Dark shale	1		165	
37.	Black ''slate''	1		166	
38.	Black rock	1		167	
39.	*Coal* (may be between horizons 7 and 11 of Columnar Section)	1		168	
40.	Fire clay	5		173	
41.	Gray sand rock	8		181	
42.	Light blue shale, ''slate''	3		184	
43.	Black shale, ''slate''	4		188	
44.	Light blue ''slate''	60		248	
45.	*Coal* (Lower)	5	3	253	3
46.	Fire clay				
	Total depth 254 feet.				
	Bottom of hole 626 feet above sea level.				

The Lower coal is known to occur 622 feet above sea level at the bottom of the shaft of the old Big Hill mine at Lucas. Two higher veins also have been worked in this mine, one at a depth of 49 feet and the other at 99 feet below the curb, which is 900 feet above sea level. A somewhat generalized record of this hole is given as Drill section No. 29 in the appendix.

The Coal Measures of Otter Creek township are known only from insignificant exposures of dark shale along Otter creek, one to two miles northwest of Norwood, from the Eaton well and from the Cackler mine shaft. The record of the Eaton well is given below. From this hole it would seem that the Lower coal occurs in this part of the county, although of course, one drilling is not sufficient to establish the presence or absence of workable coal where the beds are as lenticular as they are known to be in this county. This drilling also reveals the fact that the strata below the Lower coal horizon are predominantly sandy, for the most part sandstone. It is an interesting fact that these sandy beds were dry and since the well was drilled for water it had to be abandoned. No other attempt has been made to drill for water or to prospect for coal in this township.

Drill section No. 30, ''Eaton Well.'' Middle of southeast quarter, section 21, Otter Creek township.

Curb elevation 1000 feet above sea level.

		THICKNESS *Ft.*	DEPTH *Ft.*
1.	Soil and clay	25	25
2.	Blue ''mud'', drift	120	145
3.	Sand	1½	146½

4.	Coal Measures shale and *coal* seams, etc.	53½	200
5.	Purple clay shale	10	210
6.	Shale	34	244
7.	*Coal* and carbonaceous shale	4	248
8.	Shale and "slate"	18	266
9.	Hard rock (?) and thin shale at bottom	15	281
10.	*Coal,* may be in part shale (Lower coal)	6	287
11.	Sandstone and sandy shale streaks	113	400

Bottom of hole 600 feet above sea level.
Total depth 400 feet.
Top of coal (10) 719 feet above sea level.

An eighteen to twenty-eight inch bed of coal was formerly mined at an elevation of about 885 feet above sea level at the Cackler mine located in the northeast corner of section 2, Otter Creek township. Two four inch veins also were noted in this hole. The record of this shaft is given in the appendix, but no correlation of these beds is attempted, except that they are probably Upper Cherokee.

Pleasanton?—A few small exposures of Coal Measures strata occur along a small creek about one and a half miles southeast of the town of Lucas. One of these, near the northwest corner of section 30, White Breast township, shows a few feet of shale and two thin limestone beds, which, however, do not seem to be in place. No attempt has been made to correlate this exposure except that it may belong to the Pleasanton formation. Not far from the exposure noted above four feet of reddish and chocolate colored shale outcrops along the creek and is overlain by recent deposits of sand and gravel. This shale contains small concretionary nodules of red arenaceous limestone. Most of the residue of these nodules, the part which is insoluble in hydrochloric acid, is finer than silt. This shale may also be of Pleasanton age.

Chariton Conglomerate.—The Chariton conglomerate, a channel deposit of probable Pleasanton age, is well developed across a part of Pleasant township. Many of the conglomerate strata have limestone pebbles and cobbles from the Cherokee and possibly from the Henrietta limestones and the coarser beds contain abundant silicified pieces of the trunks of coal-making trees and plants. Almost all of the sandy beds are cross-bedded and reddish to buff-brown. The term "conglomerate" may be more or less of a misnomer for this formation as it is made up of far more sandstone than conglomeratic beds. However, the term Chariton conglomerate has been applied to a formation that is believed to be of the same nature and age as this one and the writer is averse to introducing new names for old ones that have priority.

The known outcrops of this formation in Lucas county extend almost in a straight line from the northwest part of section 3 to the middle of section 27, Pleasant township. South of the latter point the glacial deposits are very thick and no Pennsylvanian outcrops are known beyond this in Pleasant or Cedar townships. The width of the formation seems to be at no point over half a mile. Wherever outcrops of this channel deposit occur they lie between outcrops of Cherokee strata at the same elevation both east and west of the conglomerate sections. There is no possibility of these conglomerate and sandstone beds being of the same age as the Cherokee strata with which they lie in contact, but they are separate and distinct and much younger. It is thought that they may be equivalent to the Warrensburg and Moberly sandstones of Missouri. This point has already been discussed on pages 125 and 126 of this report. The lower limit of the formation was nowhere certainly exposed. Surface section No. 41, which follows, is quite typical of the sandy phase of this formation.

Surface section No. 41. Northwest corner section 3, Pleasant township.

		FEET
11.	Glacial drift and gravel	15
10.	Shale, sandy	6
9.	Sandstone, like 7 below	1½
8.	Sandstone, soft, brown, massive	2
7.	Sandstone, soft, and thin sandy shale partings	1½
6.	Sandstone, hard and cross-bedded	2 to 3
5.	Sandstone, sandy shale and clay, in part cross-bedded	19
4.	Sandstone, hard and quartzitic	½
3.	Shale and sandstone	8½
2.	Sandstone, soft, buff-colored	2½
1.	Shale, sandy, light colored	9
	Base at 840 feet above sea level.	

Near the center of the south side of section 3, Pleasant township, about twenty feet of brown cross-bedded sandstone outcrops. This is equivalent to the middle part of Surface section 41, given above.

Surface section No. 43, given below, is fairly typical of the more conglomeratic phase of the formation. A little less than half a mile east of this location about forty feet of Cherokee shale and coal seams outcrops at the same elevation. These Cherokee beds are correlatable with strata of Surface section No. 1, page 144.

Surface section No. 43. Along east and west road near southeast corner section 10, Pleasant township.

		FEET
11.	Loess	17
10.	Glacial drift and gravel, reddish	16 to 17
9.	Shale, sandy (covered)	2 to 3
8.	Sandstone, brown, hard, cross-bedded	3 to 4
7.	Sandstone, hard to soft, brown	2 to 3
6.	Conglomerate, hard, white to gray, siliceous	7½ to 8
5.	Sandstone, hard, brown	3
4.	Shale, sandy (covered)	3½ to 4
3.	Conglomerate, white, quartzitic	½
2.	Shale or soft sandstone (covered)	2 to 3
1.	Sandstone, red-brown, soft and cross-bedded	3
	Base at 825 to 830 feet above sea level.	

In the southeast part of section 22, Pleasant township, beds of conglomerate and cross-bedded sandstone are exposed. The conglomerate here is notable for its content of limestone pebbles and silicified wood. Near the center of section 27, Pleasant township, about 120 feet of cross-bedded sandstone with some interbedded shale outcrops in the slopes. Most of this undoubtedly belongs to the Chariton conglomerate formation.

PLEISTOCENE

The Pleistocene history of Lucas county has been outlined in connection with Topography and Drainage. The stratigraphic relations of the Pleistocene formations have been discussed under general stratigraphic relations and the thickness also has been given. It should be pointed out here that nearly all of the glacial drift exposures in the county are Kansan. The uplands are everywhere covered by a thick deposit of loess, which lies on Kansan gumbotil. This gumbotil is well exposed in nearly all of the newly made road cuts and in the railroad cuts over the county. When dry it has a gray-black color and a characteristic polygonal pattern of cracks over its surface. The overlying loess does not show this latter feature though in other respects the two formations are much alike in appearance. The gumbotil contains small quartz pebbles, which the loess does not have. When wet the gumbotil is exceedingly tough and is everything that the older term "gumbo" implies. It is quite impervious to water and on hillsides springs and seeps are common along its upper surface. Gumbotil makes a very unsatisfactory road bed for when wet it becomes almost impassable. It is necessary when building a road to either remove this stratum altogether or cover it up. In fields it retains the water in low places and cannot be worked satisfactorily when either wet or dry. It forms the poorest soil in the county.

The Kansan drift where exposed is oxidized as much as forty feet below the gumbotil. The upper five to fifteen feet of the oxidized till is usually thoroughly leached of all lime. Much of this lime is reprecipitated in small concretions in the oxidized and unleached zone. The oxidized till is usually a buff-brown or yellow to reddish, but the fresh and unoxidized till is drab to black. The "contact" of the till and the gumbotil is not a sharp line of unconformity but is a transition zone. In this zone granite bowlders may be seen in the process of disintegration and can be crushed by the hand. This transition zone is the best evidence of the origin of gumbotil, the leached product of glacial till. Unleached and unoxidized Kansan till is seen at only a few places in Lucas county. In the middle of the northwest quarter

FIG. 20.—Disintegrating granite bowlder in transition zone between till and gumbotil, near Williamson.

of section 23, English township, the unleached and unoxidized Kansan till was found to contain crushed fragments of small gastropod shells, some of which even show the shell markings.

The Nebraskan deposits are in appearance identical with the Kansan and can be differentiated with certainty only when the

Nebraskan gumbotil lies between the two tills. The Nebraskan gumbotil is on the average thinner than the Kansan gumbotil. The Nebraskan succession from gumbotil downward is the same as for the Kansan: gumbotil, oxidized and leached till, oxidized and unleached till, unoxidized and unleached till. The unleached and unoxidized phase is everywhere dark in color and contains fresh limestone pebbles.

The sections which follow are typical of the Pleistocene deposits of the county. The writer is indebted to Doctor Kay, State Geologist, for the details of these surface sections.

Corner of sections 9, 10, 15 and 16, Jackson township. Top of section is twenty feet below the loess covered upland.

		FEET
3.	Gumbotil (Kansan), dark gray to chocolate brown, some pebbles; grades into oxidized leached drift below. Top of gumbotil about 1020 feet above sea level	5
2.	Kansan drift, leached and oxidized	5
1.	Kansan drift, unleached and oxidized, dark yellow, many concretions, many quartzite pebbles and bowlders	15

An exposure about 400 yards long near the middle of section 20, Lincoln township, in the Chicago, Rock Island and Pacific railway cut is typical. Yellow Kansan till fifteen feet thick, the depth of the cut, is shown at the south end. The surface rises to the north until the cut attains a depth of forty feet. Here the following section is well developed.

		FEET
3.	Loess, yellowish to buff and brown	10
2.	Gumbotil, drab sticky clay, 1020 to 1030 feet above sea level	12½
1.	Kansan till, oxidized, upper few feet leached	18

One-fourth mile west of the village of Williamson, between sections 27 and 34, English township, the Kansan gumbotil is well shown at its maximum development. Here it reaches a thickness of eleven feet and is typical in all respects. Five feet of loess covers the gumbotil at this point but farther east it is much thicker. The gumbotil is underlain by thick oxidized Kansan till, the lower part of which is unleached and contains many concretions.

In a cut west of the railroad crossing along the road between sections 10 and 11, Lincoln township, a composite section is as follows:

		FEET
4.	Loess	5
3.	Gumbotil (Kansan)	12
2.	Till (Kansan), oxidized and leached	5
1.	Till (Kansan), oxidized and unleached to bottom of cut	5

There are some concretions in the gumbotil, the lime for which has been derived from the calcareous loess above.

The above sections are typical of the Kansan deposits. Such typical sections can be duplicated almost anywhere over the county where the upland areas have been cut into in road building.

Nebraskan exposures are rarely seen and those that follow are the best ones known in Lucas county.

A good exposure of Nebraskan till and gumbotil is shown on both sides of the road near the middle of section 25, English township. Here the gumbotil, which is approximately four feet thick, lies under forty-five feet of oxidized Kansan till and is underlain by oxidized Nebraskan till. The elevation of this gumbotil is 960 to 970 feet above sea level.

The Nebraskan gumbotil is fairly well developed near the north middle of section 11, Union township. At this place it is about 1040 feet above sea level and its relation to the upland and to Kansan till, a few rods farther north, offers quite conclusive evidence that it is Nebraskan gumbotil. There are other similar exposures along the main road one-half to three-quarters of a mile farther south.

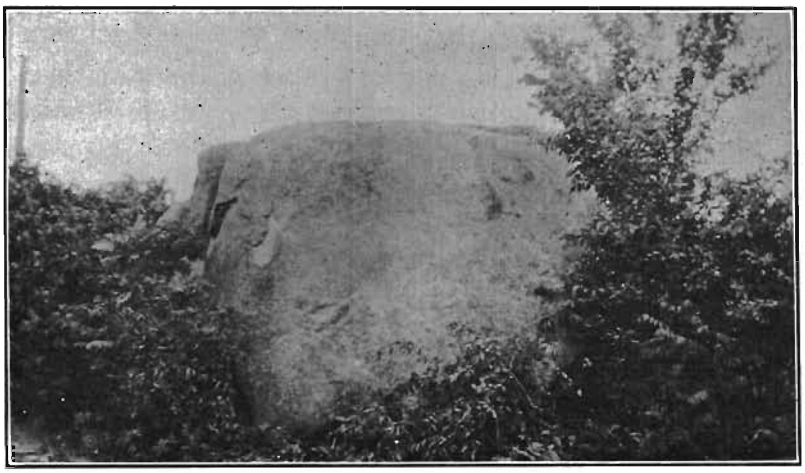


FIG. 21.—Large Kansan bowlder northwest of Norwood.

In the northwest corner of section 24, Benton township, four feet of Nebraskan gumbotil is exposed. This is a typical exposure with Nebraskan till below the gumbotil and Kansan till above it. The elevation of the gumbotil is 960 to 965 feet above sea level.

The relations of the Pleistocene deposits to the Coal Measures and the thickness of the glacial formations have been discussed already on pages 134 to 139 inclusive. The data are summarized in the table on page 135 and shown graphically on Plate I, page 136.

Dr. G. F. Kay, State Geologist, has listed and described a number of large Kansan bowlders from Lucas county.[24] Some of these are included in the following list.

Kansan Bowlders from Lucas County.

LOCATION	SIZE Feet
NW. ¼ of SW. ¼, sec. 32, White Breast township	8 by 7 by 6
West side of road between sec. 31, Benton township, and sec. 36, Warren township	10 by 9 by 6
NW. ¼ of sec. 15, Otter Creek township	25 by 20 by 16
SE. ¼ of sec. 13, Liberty township	12 by 9 by 7
NW. ¼ of sec. 36, Jackson township	9 by 6 by 3
Middle of sec. 17, Pleasant township	23 by 15 by 10
NW. part of sec. 5, Liberty township	5 by 5 by 2

All of the above bowlders are of granite. Other smaller bowlders are known in a number of places.

Economic Geology

COAL

HISTORY OF COAL MINING IN LUCAS COUNTY.

"Lucas county formerly contained the largest and deepest mines in the state. It was in this county that the first and almost only successful experiments in regard to the nature and capabilities of Iowa coal were carried on extensively. These investigations were made by the White Breast Fuel Company, which operated largely in this county. The experiments were made with special reference to the determination of the adaptabilities of the various varieties of coal; their coking properties and the utilization of slack and coal dust. In regard to the latter, briquettes were manufactured in various ways, but it was found that with the methods used the coal dust could not be economically compressed and cemented for commercial pur-

24 Iowa Geol. Survey, vol. XXVII, pp. 347-353.

poses."[25] The most practical use for which Lucas county coals have been found suitable is for boiler firing; as "steam coals" they are quite highly esteemed.

The first discovery of coal in Lucas county is accredited to a ground hog burrowing in the banks of North Cedar creek in the vicinity of or east of the Briggs drift mine. To whom or the exact date when this fact became known the writer has been unable to learn, but it was considerably prior to St. John's visit to the county in 1867. In 1860 the county produced 945 tons of coal. In the summer of 1867 when St. John made a survey of this area he recorded drift mining along North Cedar creek and its branches in the northeast part of Pleasant township and at Dale's mine near the center of Pleasant township, along English, Little White Breast and White Breast creeks. One of his type exposures, as has been previously stated, was at Wheeler's mill (near Wheeler's bridge); an upper "Wheeler" coal and a lower "Panora" coal were being mined there at that time. All these mines were small and of very local importance. No attempt has been made to record the history of all of the drift mines of the county or to locate them on the map. The duration of any one of these has been so short and their production and aggregate importance have been so small that such a record would be of little value. However, the localities where beds or seams have been worked are mentioned in the preceding section on the detailed and local stratigraphy.

In 1868 the production was 37,283 bushels or 1491 tons, but the beginning of coal mining history in Lucas county dates from 1874, when in June Mr. William Haven and others leased 540 acres of land on White Breast creek about two miles east of the town of Lucas. The leased lands belonged wholly or in part to Col. Byron O. Carr of Galesburg, Illinois. About a year later the White Breast Fuel Company was organized and Mr. Haven became associated with Wesley Jones, J. C. Osgood, Louis R. Fix of Burlington and J. T. Potter. Mr. Osgood was made president of the company.

In the first prospecting of the White Breast field a number of holes were drilled. After many delays and much trouble, due mostly to financial difficulties, on January 16, 1878, five feet, four

25 Lees, James H., History of Coal Mining in Iowa: Iowa Geol. Survey, vol. XIX, p. 550.

inches of coal was reached. This marks the beginning of development in the White Breast field, one of the most productive in its day. James H. Lees, in his History of Coal Mining in Iowa,[26] states "..., a field from which a greater tonnage has been raised in shorter time than from any other field in the state." This interesting beginning is best told by a further quotation from Lees' paper: "The shaft was 250 feet deep and an eighty horse power engine was used for hoisting the coal. Tail-rope haulage was installed in 1882. Electricity was used for lighting the mine, the first installation in the state. When the Mine Inspector made his first report in 1880, 405 men and 52 mules were employed and were raising 640 tons per day. The quality of the coal was considered superior to that of any other then produced in the state and the coal acquired a great reputation and an extensive market. White Breast No. 1 was the first mine to adopt the plan of shot firing once a day. This avoided the danger of explosions when the men were in the mine and also kept the air pure for the men and mules." This company operated several mines in this field and in 1880 the production was 126,490 tons, making the county an important Iowa producer.

About 125 diamond drill holes were put down north and east of the White Breast Company mines in the years 1884 and 1885 but did not find any additional workable coal. Conditions in parts of the field being worked were so unfavorable that by 1891 the field was considered worked out and the large mines of the White Breast Company were abandoned. Production had risen to 594,450 tons in 1886; it dropped to 339,229 tons in 1890 and then in 1891 fell off to practically nothing. Lucas county did not again become a producer until Mr. Haven resumed operations in 1899.

There were some other more or less abortive attempts to work the Lower coal but none was notably successful. In 1877 or 1878 Daniel Eikenberry of Chariton sank a shaft a mile and a half east of White Breast No. 1. This penetrated sixty or seventy feet deeper than the White Breast mine but did not find conditions favorable and hence was not developed. In 1879 a coöperative company of miners and business men of Chariton was organized. The more prominent of these men were S. H. Mallory,

26 Lees, James H., Op. Cit.

D. Q. Story and D. M. Thompson and the company was known as the Chariton Co-operative Coal Company. This company sank a shaft to a depth of 330 feet, the greatest depth of any mine in Iowa at that time. It was located about three-fourths mile north of the Eikenberry shaft. The coöperative scheme did not work well and soon a reorganization was effected, the business men taking over complete control. They, not being experts in mining, did not succeed, for as a consequence of unwise mining methods disastrous slumping and caving resulted and the venture had to be abandoned. They also had a good deal of trouble with water. The equipment was up to date and adequate.

In 1877 the Union Coal and Mining Company of Ottumwa under the direction of its president, J. C. Peasley of Burlington, sought to enter the White Breast field. This company acquired the shallow Ladow shaft, which it deepened to the Lower coal, here five feet in thickness and at a depth of 300 feet. After considerable expenditure of money and the opening of several entries, the company abandoned the mine on account of the troublesome and excessive quantity of water, which it was inadequately equipped to handle. In 1899 this mine passed into the possession of Hon. H. L. Byers, associated with George Ramsey of Oskaloosa and Messrs. Shuler and Bates of Illinois. They reconditioned the old shaft and using it as an air shaft sank a new main shaft to the west of it. The water was pumped out and the mine operated for about a year when it passed into the hands of S. W. White of What Cheer and of White City, and others. About a year later it was transferred to Mr. Reed of Illinois and he, with Mr. Byers, operated it for two months and then Mr. Moody of Kansas became part owner. Work was again discontinued late in 1907.

About 1878 the Farmers Co-operative Coal Company was organized and opened a mine at Zero on the Chicago, Burlington and Quincy Railroad a mile and a half west of the Monroe county line. The shaft was 260 feet deep and reached the Lower coal, which is five feet thick at this place. This mine passed through several changes in ownership and was last operated under lease by the White Breast Fuel Company. After being worked more or less continuously for less than ten years it was finally abandoned owing to the large amount of poor coal and the "bowlders" in the coal and also on account of water entering through the sandstone roof. Where Lucas county mines, such as this and some in the White Breast field, had a sandstone roof water has usually been one of the main causes of abandonment, but on the other hand a shale or "slate" roof usually means a dry mine.

In 1890 the county's production was 339,229 tons; in 1891 it dropped to almost nothing. Between 1891 and 1899 Lucas county was almost a nonproducer, except for the local drift mines working upper thin veins.

Mr. Haven, previously referred to, had sold his interests in the White Breast mines to Mr. Osgood in 1883 and also bound himself not to engage in mining along the Burlington line for ten years. He with others reorganized the White Breast Fuel Company in 1896 and began extensive prospecting along Little White Breast creek northeast of Chariton and also in an area southwest of Lucas. In this latter field fifty diamond drill holes were bored, which resulted in the opening of the Cleveland mine No. 4, at New Cleveland, two and a half miles southwest of Lucas, in 1899. The shaft was sunk to a depth of 326 feet to coal 4.9 feet thick. The new mine was well equipped with motor haulage and steel tipple and had a capacity of 1000 tons a day.

The prospecting of Mr. Haven along Little White Breast creek resulted in the discovery of a rich field of 1200 to 1600 acres of good coal about three and one-half miles northeast of Chariton. The Inland Fuel Company was organized and in the summer of 1901 the sinking of the Inland mine No. 1 shaft was begun. This marks the beginning of development in the northeast quarter of Lucas county. Had this area been served by a railroad development would have been rapid, but as this was not the case expansion did not take place for some years. Work in the new mine, No. 1, was limited more or less to driving entries and preparing it for large production. The coal had a shale roof and the mine was practically dry. By 1907 it was so developed and equipped that on short notice it could have been made to produce a thousand tons daily. It had no shipping facilities and was only a wagon mine, but the coal was good and was in great demand. The persons interested in the Inland mine pushed prospecting for a number of years and succeeded in locating a number of basins in the northeast quarter of the county aggregating more than 10,000 acres of coal ranging from five to eight feet in thickness. Development was delayed a number of years pending ownership settlements and the coming of transportation facilities.

In 1899 the county's production was 32,419 tons and in 1900 it amounted to 227,921 tons. Production started to decline again about 1904 and in 1908, when Cleveland mine No. 4 was abandoned, it had dropped to 74,288 tons. The Big Hill mine at Lucas had closed in 1907.

In 1908 Lucas county did not have a single mine doing a shipping business and the only mine working the lower vein was the Inland No. 1 above referred to, northeast of Chariton. The mine inspectors' report for 1908 mentions a local mine operating an upper vein by the long wall method. This was located northeast of the town of Lucas and was owned by the Skidmore Brothers. No new mines were reported and the same two referred to above were operating for local trade during the next two years. The production in 1909 from the two local mines was only 9,717 tons and only 41 men were employed; in 1910 the same mines produced 10,410 tons and employed 38 men. The same state of affairs continued through 1911, when the production was 10,895 tons and 24 men were employed, and in 1912, when the production amounted to only 15,457 tons and 40 men were employed. The mine inspectors' report in 1912 showed that the Skidmore mine had been closed but the Goben Coal Company was operating in the same vicinity. In 1914 both the Skidmore Brothers and the Goben Coal Company were operating shallow shaft mines and were mining by the room and pillar method.

In 1913 a branch of the Chicago, Rock Island and Pacific Railway was built from Des Moines to Allerton, passing through the new coal field in the northeast part of Lucas county. This gave the Inland Fuel Company's mine No. 1 the long waited-for railroad connection; it was then that Lucas county started on its present career of productiveness. The Inland Company at about the same time changed hands and the new company, known as the Central Iowa Fuel Company, with Mr. Josh Norwood as general manager, was organized, with headquarters in Des Moines. The old wooden headgear of mine No. 1 was immediately replaced by new up-to-date steel equipment, including tipple, scales, shaking screen, etc. New boilers and new first motion engines were installed also and production was increased from an almost insignificant amount to about 1200 tons per day of mine run coal. Better facilities for underground handling also were added. In 1915 gasoline motors were tried for underground haulage in mine No. 1 and proved a positive failure. Tail rope haulage was later installed with entire success.

Another mine was opened in the spring of 1914 by the Central Iowa Fuel Company in a new basin in Pleasant township, about fifteen miles northeast of Chariton. This was known as mine No. 2 and is still an important producer. The coal in No. 2 was found to be seven feet ten inches thick at the bottom of the shaft and the basin contained about 6000 acres of good coal. The entire basin has not been worked from one shaft but, as will be seen below, mine No. 3 also was sunk into this basin. The same coal will be worked also from a new shaft not yet definitely located.

In 1913 Lucas county produced 13,258 tons of coal from three mines and employed 37 men. During the last half of the calendar year 1914 the production was 175,328 tons. By the end of the calendar year 1915 Lucas county ranked fifth among the coal producing counties of Iowa, with mines No. 1 and No. 2 as the only producers except the two local mines near Lucas. The production for the calendar year 1915 was 428,682 tons. In 1916 mine No. 3, also in Pleasant township and in the same basin as mine No. 2, was opened by the same company. It was developed to a capacity of 700 tons daily. The county's production in 1916 was 619,455 tons and in 1917 it was 610,230 tons.

Production fell off somewhat in 1918 and 1919 and increased again in 1920 and 1921. The Central Iowa Fuel Company opened mine No. 4 northeast of Williamson in 1920. This mine has a capacity of 2000 tons daily and is one of Iowa's finest mines.

The Iowa-Nebraska Company opened a mine southwest of Lucas in 1919 and equipped it with steel tipple and the most up-to-date machinery. It had railroad connection with the Chicago, Burlington and Quincy Railroad. This mine operated more or less continuously with rather indifferent success due to unfavorable natural conditions and financial difficulties until the early part of 1923; in the summer of 1924 the equipment was dismantled and sold at auction. This has been the only serious attempt in recent years to reënter the old White Breast field. It was not a large producer.

The local mines at Lucas, the Goben Coal Company and the Skidmore Coal Company, continued operation until 1919. In 1922 or 1923 Mr. Evan Daniels reopened the old Big Hill mine at Lucas and has been working one of the upper veins by the long wall method. Mr. Daniels' operations are not on a large scale; he supplies only local trade and works intermittently.

During the summer of 1924 the Central Iowa Fuel Company was the only important producer, operating mines No. 2, No. 3 and No. 4 in this county and No. 5 at Melcher in Marion county. Its mine No. 1 was abandoned in 1922 after mining out about 500 acres of coal. Mine No. 3 is nearing the end of its productiveness and may now have been abandoned. The above company was planning also to open a new large capacity mine in the same field in which No. 2 and No. 3 are being operated. There is a slight temporary decrease in production due to the decrease in output of mine No. 3.

The Central Iowa Fuel Company during the summer of 1924 had its headquarters in Des Moines with Mr. E. A. Hollingsworth as president and general manager. Mr. W. M. Malone, assistant general manager, is in charge of operations, with offices in Chariton. Mr. C. O. Anderson is general superintendent, Mr. F. W. Trost mining engineer and Mr. H. L. Jackson consulting engineer. The organization has been especially successful in planning and maintaining operations so as to avoid slumps in production due to unbalanced development in the mines. It has maintained a steady production with very little loss of time or efficiency and has constantly looked after the safety and welfare of its operatives.

In 1924 only four drift mines were in operation in the northeastern part of Pleasant township; they supplied a very local trade and employed only seven men. The Cackler mine northeast of Norwood had operated in a shallow vein for a short time and supplied a good local trade but due to various difficulties, not inherent in the mine or conditions of operation, the mine was closed.

Apparently only a small per cent of the total mineable coal in the northeast quarter of Lucas county has been removed. Probably as much as 80 per cent of the original good workable coal in this general field still remains in the ground. In-as-much as some other parts of the county, as Otter Creek township and parts of Liberty township, Union, Warren, parts of Benton and Washington townships have not been thoroughly prospected there is the possibility of the discovery of new coal basins. The probability is that Lucas county will continue to be an important coal producing county for at least twenty years and possibly for thirty years at the present rate of production.

STATISTICS OF COAL PRODUCTION FOR LUCAS COUNTY.

The following tables give as complete a summary of the coal production for Lucas county as it seems possible to get. The data for years prior to 1904 have been taken from the Iowa Geological Survey reports, principally Vol. XIX, and the data including the years 1904 and up to date, have been taken from the Biennial Reports of the State Mine Inspectors. The data for the period from 1904 to date are considered as reliable as can be gotten. The two supplementary tables for the years 1920 to 1923 inclusive give the output of the mines in greater detail and also the distribution for those years.

It should be borne in mind that prior to 1915 the statistical year of the Mine Inspectors ended on June 30. The last half of the calendar year 1914 is therefore given separately. Beginning with the calendar year 1915 the statistical year ends on December 31.

Statistics of Coal Production

Year	Tonnage	Year	Tonnage	Shipping Mines	Local Mines	Total Number of Employees
1860	945	1903	295,554			
1868	(37,284 bushels)	1904	239,384			
1880	126,498	1905	165,256			
1883	546,360	1906	151,432			
1884	460,017	1907	126,579	2	2	237
1885	492,750	1908	74,288	1	2	170
1886	594,450	1909	9,717	—	2	41
1887	529,758	1910	10,410	—	2	38
1888	408,765	1911	10,895	—	1	24
1889	339,229	1912	15,457	—	2	40
1890	*351,600	1913	13,258	1	2	37
1891	*800	1914	140,758	2	2	363
1892	*1,000	1914**	175,328	2	2	512
1893	*482	1915	428,682	2	2	786
1894	*1,127	1916	619,455	3	1	848
1895	———	1917	610,280	3	1	807
1896	———	1918	499,543	3	2	710
1897	———	1919	398,859	4	2	680
1898	6,600	1920	520,371	5	?	680
1899	32,419	1921	539,225	5	?	859
1900	227,921	1922	439,107	4	1	1,020
1901	221,058	1923	704,321	4	1	906
1902	246,400	1924	640,772	3	1	726

*Combined with Jefferson county ** Last half of Calendar Year

Output of Mines in Tons

Year	Lump	Run of Mine	Slack	Total
1920	86,757	334,340	99,274	520,371
1921	52,085	447,072	40,068	539,225
1922	41,763	371,624	25,720	439,107
1923	86,229	578,642	39,450	704,321
1924				640,772

Distribution of Coal in Tons

Year	Sold to Local Trade	Shipped to Points within The State	Shipped to Points outside The State	Sold to Railroads	Used at Mines	Total
1920	5,600	37,371	12,944	449,284	16,174	521,373
1921	3,440	37,268	9,425	471,949	17,143	539,225
1922	5,276	33,902	3,351	375,265	13,310	439,107
1923	3,347	37,276	425	643,452	19,821	704,321
1924	2,538		618.073		20,161	640,772

SITUATION AND NATURE OF THE COAL

The coal beds are divisible into "lower" and "upper" horizons. The "lower" horizons, particularly the horizon designated by miners and operators in the county as the Lower coal, are the more important. The Lower coal has yielded the greater bulk of the coal so far mined. The lower coal beds are characteristically lenticular, locally thick and of only limited extent. The areal extent of these "basins" of workable coal is usually measurable in hundreds of acres, in most cases less than a thousand acres. The "upper" horizons are more persistent, more traceable and admit of correlation over wider areas. The best example of such a coal bed is the one exposed in the bed of White Breast creek at "Wheeler's" bridge in section 33, Liberty township, and also identifiable at many other widely separated places over the northern part of the county. This coal bed, designated White Breast coal, is found in sections where the sequence of coal, limestone and shale beds is nearly everywhere the same, showing that these strata are as widespread in their distribution as the coal. The upper horizons belong to the upper part of the Cherokee and to the Henrietta formations. The lower more lenticular horizons are entirely in the Cherokee formation. A coal which is workable at one point may so thin out and change in quality that a few hundred feet away it is only a carbonaceous film or a thin black shale. Some of the thinnest and most inconspicuous "coal blossoms" exposed on the slopes have been traced within only a few rods distance to workable coal as much as two feet in thickness.

This inconstant and lenticular character of the Lower coal in particular, has necessitated a large outlay of capital in prospecting the fields where it is worked. In prospecting a basin and in determining the location for a new shaft a hole is drilled on at least every forty acres and in some cases, in parts of a field, on every ten acres. A prospect hole on every ten acres is expensive and sometimes unnecessary, but it usually pays to "drill a basin" thoroughly. Most of the prospecting in recent years has been done with a small churn drill, although diamond drilling was extensively employed in the past. The effectiveness of the churn

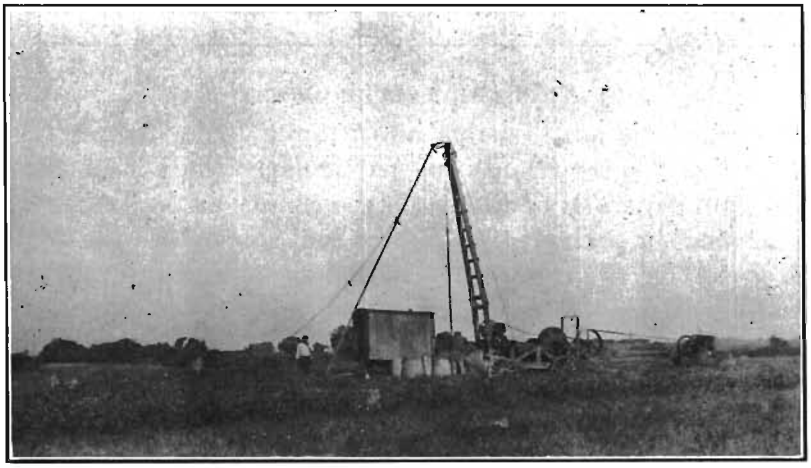


FIG. 22.—Prospecting drill rig.

drill is proportional to the skill of the driller. Where there has been extensive diamond drilling, as there has been in Lucas county, these old records serve for reference while for detailed local prospecting the churn drill is satisfactory and very much less expensive.

In locating a new shaft on one of these irregular lenticular basins many factors must be considered. Ideally a shaft should penetrate to the deepest part of the thickest coal as near the middle of the basin as possible, to facilitate underground haulage. In Lucas county this may necessitate a deep shaft sunk from the upland whereas a shaft sunk in a valley might reach the same coal a few hundred yards distant at half the depth but near the edge of the basin. It is usually easier to build a railroad track in a valley than to build a spur to a mine on an isolated upland area and the surface operating cost may also be much less in the former case. In the case of mine No. 3 it was more economical to locate the shaft in a valley near the edge of the basin, in this case nearly 2000 feet from the best coal; the hoisting distance is less than two-thirds what it would have been from the upland. Railroad spur building was facilitated in this instance and tail rope underground haulage proved economical. In mine No. 4 the shaft is ideally located with respect to the coal, and surface transportation is easy along the continuous upland divide. The hoisting distance is nearly 300 feet.

The coal beds in addition to being lenticular are also undulating. This variation from horizontality commonly is as much as forty feet and is known to be as great as sixty feet within a single basin. The coal is in few instances level for any distance, a condition which necessitates a large amount of work being done by the company in shooting down top, or shooting up bottom as the case may be, in order to maintain roadways at practical grades.

The explanation for this undulatory nature of the coal beds involves several factors. In general the thicker and better coal is at the lowest points. These places were originally the deeper places of accumulation in the "swamps". The thinner coal was formed in shallower parts of the basins on higher bottom. The undulations are then in part due to irregularities of the surfaces of deposition and are thus in part primary. Another factor is unequal settling of the Coal Measures sediments, the greater settling taking place where the newer deposits were thickest. It is believed that this is the primary cause of minor structures in the Coal Measures and is in part the cause of the undulating nature of the coal beds. It is quite certain that the "rolls and pitches" so characteristic of the Coal Measures are structures developed while the sediments were soft and are due to unequal settling. Small faults are similarly accounted for.

The shallower coal beds and the veins exposed at the surface show the same undulating character. They are thinner as the basins were shallower and the surfaces of deposition more even. The magnitude of the undulations is much less than it is for the deeper coals. It is seldom greater than fifteen to twenty feet in the upper beds.

The attitude of the strata and particularly of the coal beds is largely accounted for above. In addition these beds have been subject to all diastrophic deformation affecting this area since their deposition. This does not seem to have been locally important and diastrophism has been responsible only for the general monoclinal dip to the southwest.

Good coal may be "cut out" in places by channel or stream erosion during Pennsylvanian time or during subsequent time preceding glaciation. Exact knowledge of such "cut outs" is important where the workable basins are as small as they are in Lucas county. This also necessitates extensive drill prospecting. Faulting is practically unknown in Lucas county, so does not enter as a factor in the miners' difficulties. One true fault of very small throw was known in mine No. 1, now worked out and abandoned. Henry Hinds in "The Coal Deposits of Iowa",[27] discusses and illustrates the characteristics and peculiarities of the occurrence of Iowa coal.

PRINCIPAL KNOWN BASINS AND PRESENT HOLDINGS

Probably as many as eight or nine basins of Lower coal are known in Lucas county. Some have been worked out and are now abandoned; others have not been opened up and at least two and possibly three basins are now being worked by the Central Iowa Fuel Company.

The former White Breast Company operated in a field of probably two basins. These basins were connected by a stratum of thin coal and carbonaceous shale. The White Breast mines east of the town of Lucas, the Old Cleveland mine, and the Big Hill mine in Lucas operated in one basin. White Breast No. 4 at New Cleveland operated in the other basin. The Iowa-Nebraska mine worked the same coal as the New Cleveland mine had worked, but at a later time.

The coöperative mine at Zero, now abandoned, operated in a distinct basin, lying only in part in Lucas county.

The Central Iowa Fuel Company's mine No. 1, now abandoned, worked out a pocket or basin located about three miles northeast of Chariton. This coal lens may be more or less connected with the basins in which the same company's mines No. 2, No. 3 and No. 4 are now operating. The pockets of coal being worked by mines No. 2 and No. 3 may lie in a single basin but are more likely separate in the same manner as the White Breast basins. Mine No. 4 is operating a distinct basin but at the same

27 Iowa Geol. Survey, vol. XIX, Ch. I, pp. 25-32.

horizon as the coal in mine No. 2. A new shaft is to be put down northwest of mine No. 2 and in the same pocket.

The "Holmes" field, southeast of Williamson, has been prospected but has not been opened up. It is thought to contain about a thousand acres of workable coal. Other basins in the northeastern part of the county are fairly well known.

The Lower coal is believed to have been penetrated in the Eaton well in Otter Creek township at an elevation of 719 feet above sea level. No prospecting has been done but a workable basin of coal may exist in this township.

Prospecting in Benton township has been very unpromising and little is known of the coal possibilities in Union, Warren or Washington townships.

Little attention has been given to the shallower and thinner coal beds; none has been worked on a large scale. Some of these thinner beds have good roofs and are thick enough to work but will likely not be developed on a large scale as long as Lower coal bodies are available. So far it has seemed practicable to work but one level in a mine and in nearly every case that has been the Lower coal. This coal is believed to belong to a single horizon, although as has been shown above it lies in several basins which are more or less separate and in some cases entirely unconnected. It is believed that these basins represent coal formation during one interval of time but in more or less separate "swamps".

In 1924 the Central Iowa Fuel Company held the coal rights on about 7500 acres. The Victor Fuel Company (C.F. Osgood) held 600 acres in the basin formerly worked by Central Iowa Fuel Company's mine No. 1, but had no development under way. The Maple Block Coal Company held 600 acres of coal land in Pleasant township. The Consolidation Coal Company has a field on Whites creek in Monroe county and development of this field will likely lead to an increase in acreage, possibly into Lucas county. The Consolidated Indiana Company holds 200 acres of coal land in the northern part of this county, an extension of its Melcher field in Marion county.

MINING METHODS

All the coal mining in this county is done by the room and pillar method. The double entry system is employed in all the mines. The two entries are driven parallel and twenty to thirty feet apart. They are connected every sixty to seventy-five feet by break-throughs or connecting passages. The entries are six to eight feet wide with ample head clearance and are laid out according to a rectangular or panel plan. Rooms are driven off from these entries at distances from thirty to fifty feet, with an average distance between centers of thirty-five feet. These rooms from which the coal is removed are rectangular and average about twenty-five feet in width. They are driven to depths ranging from one hundred to two hundred feet, usually averaging about 160 feet. Room entries are so spaced that rooms worked from opposite sides of a panel break together. The pillars between rooms are relatively narrow, in some cases being as narrow as six feet, and very little pillar robbing is done.

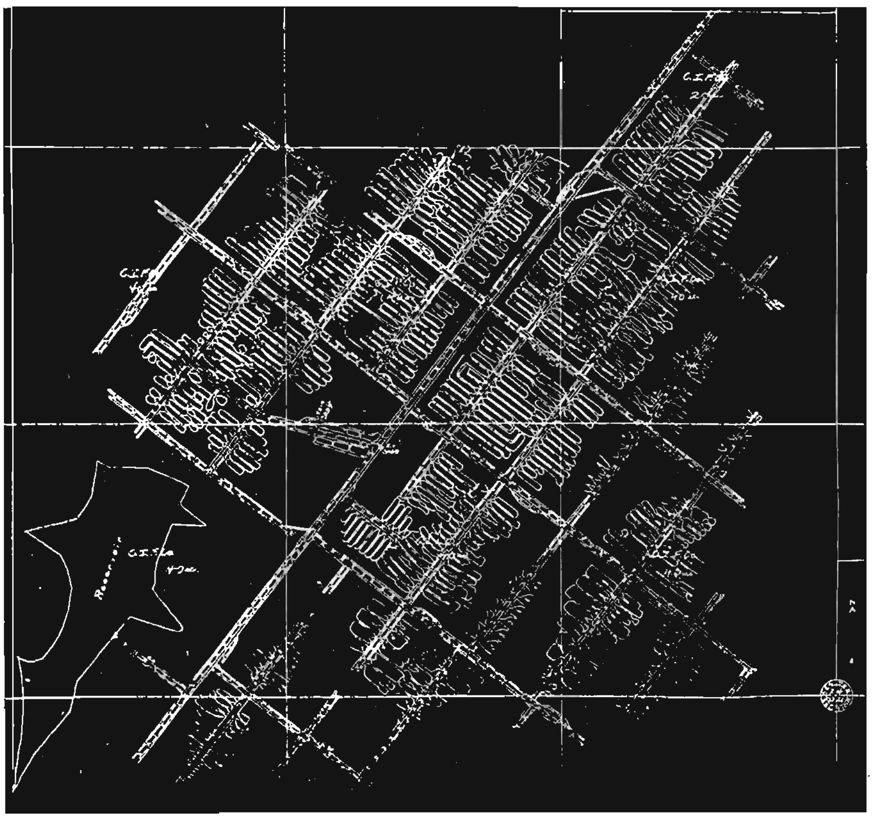


FIG. 23.—Map of underground workings of mine No. 4, Central Iowa Fuel Company.

The rooms are driven narrow for six to ten feet from the entries and thence widened rather abruptly to their full width. The neck or room doorway averages about eight feet in width. "Break-throughs" are made through the pillars at frequent intervals, connecting adjacent rooms. This facilitates the circulation of fresh air near the working face.

The thickness of the Lower coal averages about six feet; in some places it is as much as eight feet and it is seldom worked where it is less than four feet. The thickness of the coal allows ample head room in all rooms and entries without the removal of much top or bottom.

The coal is either undercut by machines and shot down or is "shot off the solid." Shot firing is done at one time and only once a day, at 4 p.m. The coal thus shot down is broken and loaded by the miners the next day. In addition the miners undercut the working face and place the shots for the next firing. In this way a day's output for a room is determined by the amount shot down the day before. Each room is worked coöperatively by two miners. They must maintain their tracks from the entry as close to the working face as possible and do

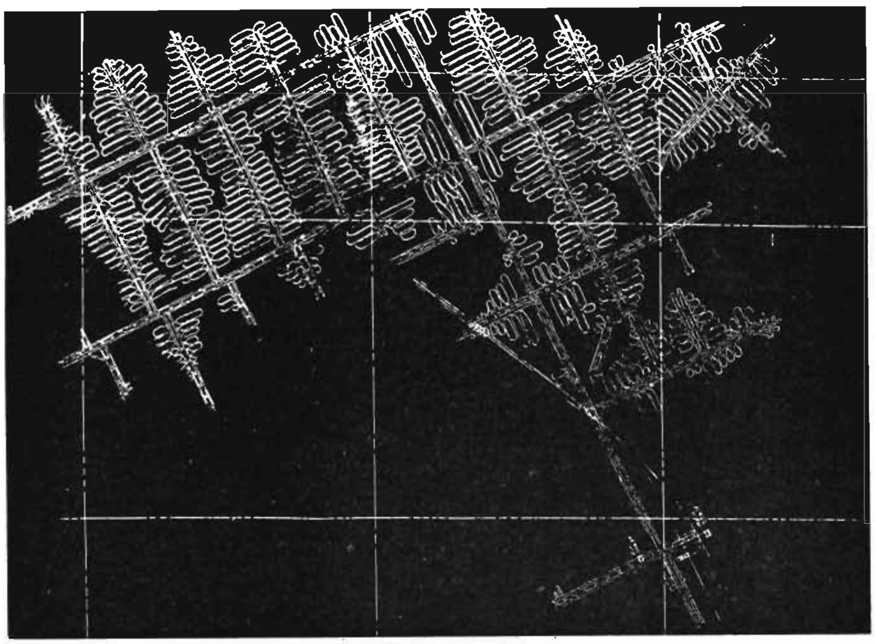


FIG. 24.—Map of underground workings of mine No. 3, Central Iowa Fuel Company.

their own timbering. The necessary props are delivered to the rooms on requisition. The timbers are placed quite regularly and are long enough to extend from the floor very nearly to the roof, where they are wedged by a cap piece.

Partings or switches are conveniently placed. Entry timbering and roadway maintainance are done by separate crews of men employed for that work. Timber supplies are kept underground near the main shafts where distribution is easy.

Ventilation is accomplished by steam or electrically driven steel fans that force fresh air down the air shafts. The proper distribution of air through the underground workings is brought about by the use of doors, curtains, brattices, stoppings, overcasts and undercasts. The Lucas county mines are free from obnoxious and poisonous gases. As firing is done only once a day, when few men are in the mine, any gases resulting from firing are easily swept out before the next working shift goes in.

Mines now working the Lower coal are essentially "dry". The thick impervious roof shales, "slates", effectively hold out the ground water from above. This was not the case in some of the early mines operated by the White Breast Company. For the most part the passage ways of the Central Iowa Fuel Company's mines are dry even to dustiness. The little water that collects in the sump, at the bottom of the air shaft, is used to sprinkle the roadways. All of the mines are equipped with pumps and collecting cisterns or sumps so as to be able to handle any amount of water likely to be encountered. So far all of the mines in the northeastern part of the county have been entirely free from water trouble.

Underground haulage is effected by mules and mechanical power. The gathering from the rooms is done by mules and the trains of loaded cars are hauled to the main shaft by electric locomotives or by tail-rope, or in part by each. The distribution of empties is accomplished by the reverse of the above scheme. Goodman electric locomotives are used. Power for the tail-rope system is in every case supplied by a first motion steam engine at the surface. The tail-rope system has proved very efficient in every case and speeds of twenty to thirty miles per hour are attained with loaded trains of twenty-four cars. The tail-rope system is especially well adapted to long hauls in one direction.

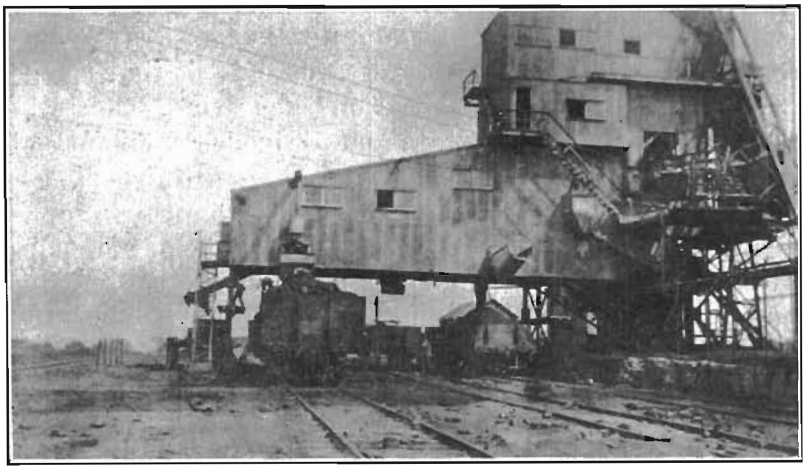


FIG. 25.—Loading tracks at Central Iowa Fuel Company mine No. 4.

The electric locomotive is better adapted to shorter hauls from several directions. This is the case in mine No. 4 where the tail-rope is not used. The prime essentials to efficient underground haulage are good road beds and carefully maintained tracks. The road beds in these mines are excellent and the tracks are good.

Hoisting is done by a system of "balanced cages". The steam engines are direct motion and operate a single drum and each cage is connected to this drum by a separate rope. The two

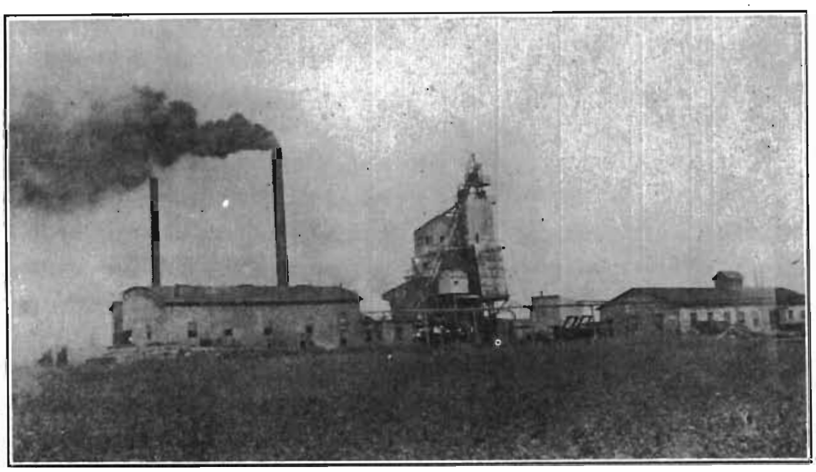


FIG. 26.—General view of power house, tipple and machine shop of Central Iowa Fuel Company mine No. 4.

cages moving simultaneously are balanced through the drum but are not attached to the two ends of a single rope. As one cage is lowered its rope unwinds from the drum and at the same time the rope of the rising cage winds onto the drum. This system of having each rope rigidly attached to the drum eliminates the possibility of slipping and the greater danger of dropping both cages in case of a break, as might happen with a single rope. It also simplifies the matter of indicator adjustment. Signals for hoisting are given to the engineer only from the bottom, except when the top man wishes to lower timber, etc.

The shafts are wood lagged with a heavy collar of concrete. Except at mine No. 3 the tipples are of steel and up to date in every respect. As many as three tracks are laid under the screen house to receive the separate grades of coal. A small screen takes out fines for boiler fuel, which is taken to the boiler house on an elevated tramway. The auxiliary power units are either steam or electric. The tendency is to electrify all auxiliary power units in the present mines. It is probable that future mines will be completely electrified, having one central generating unit and the hoisting also will be done by electric power.

FIG. 27.—Tipple of mine No. 4.

MINES IN OPERATION, 1924

Central Iowa Fuel Company, Mine No. 4.—Number 4 is the largest and most important producing mine in the county. It is located near the middle of the west half of the northwest quarter of section 24, English township, northeast of the village of Williamson, on the upland. Its topographic position facilitated railroad building and also the level ground makes surface handling of railroad cars easy. It was opened in 1920.

The detailed record of the strata in this shaft has been given in Drill section No. 35, page 153. The curb elevation is 1004 feet above sea level and the Lower coal was reached at a depth of 286 feet or 718 feet above sea level. At this point it was found to be six feet, nine inches in thickness. The thickness of the coal averages about six feet. It is overlain by a few inches of "shoddy" top and by nearly fifty feet of roof shale that is alternately red and dark banded. The bottom is a dark bluish clay grading downward into "fire clay". The total depth of the shaft is about 310 feet.

Five Goodman shortwall mining machines are used for undercutting the coal. There is also good shooting coal and some is "shot off the solid". Gathering is done entirely by mules, of which seventeen are in actual use and are stabled underground. Haulage is done by three Goodman electric locomotives, which handle trains of twenty-four cars, each car carrying an average load of 3600 pounds. The cars are handled at the shaft bottom by automatic cagers and are hoisted on self-dumping cages from which the coal is delivered to the weigh pans and then goes to the sizing screens or to the mine-run chute. Several grades of coal can be delivered to the cars under the screen house as follows: Lump, "Fancy Chunk", "Egg", "Fancy Steam", Mine-

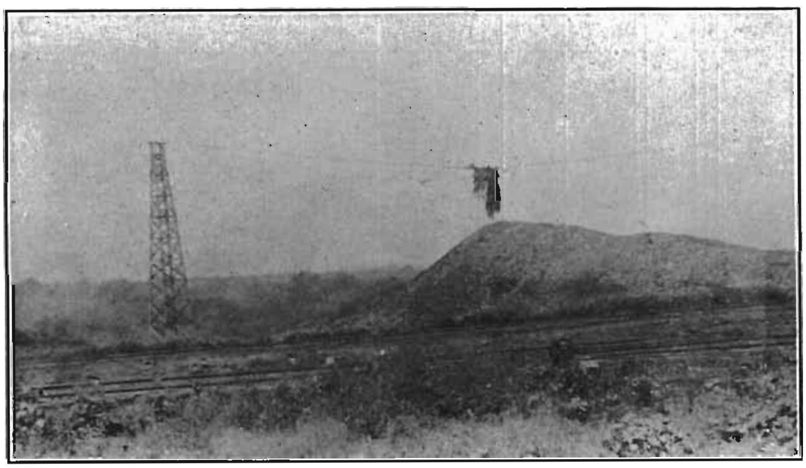


FIG. 28.—Rock dump, Central Iowa Fuel Company mine No. 4.

run and Slack. An underground timber yard is maintained near the main shaft.

The rock waste is hoisted only on the south cage and is dumped into the rock hopper from which it goes to an aerial cableway bucket. The bucket is carried by an 800 foot cable way reaching to a tower, as shown in figure 28. At any desired point along the cable a trip is placed and this automatically dumps the loaded bucket. A ridgelike dump is thus built up, reaching from any desired distance from the tipple to the tower. When the pile reaches to the tower and to the maximum height the tower is moved; the pile is thus spread out fan-shaped over a large area.

The tipple is entirely of steel and is modern in every detail. The power house is equipped with five 150 Horse Power boilers. The hoisting engine is in the tipple end of the building. To the right of the hoisting engine is a 275 K. W. D. C. engine-generator unit. There is also a 30 K. W. auxiliary unit. An adequate water supply is assured by a twelve acre surface reservoir made by damming a small creek.

The daily capacity of mine No. 4 is 1800 to 2000 tons, and about 550 men are employed. Number 4 is one of the best and most finely equipped mines in this part of the state.

Central Iowa Fuel Company Mine No. 2.—This mine is located at the village of Tipperary, in the western central part of the southwest quarter of section 22, Pleasant township. It is located in a small valley tributary to North Cedar creek. Its curb is about 880 feet above sea level. A spur track reaches it through

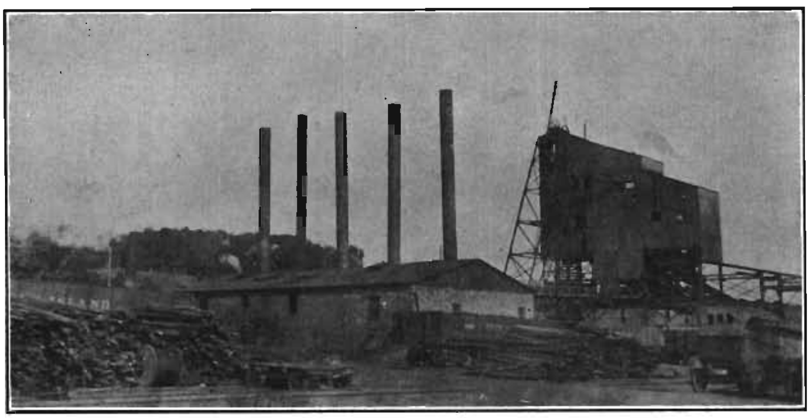


FIG. 29.—Central Iowa Fuel Company mine No. 2.

North Cedar creek valley from the southwest. Number 2 was opened in the spring of 1914 and is still an important producer. The Lower coal was reached a little above 700 feet above sea level and was found to be just a little over six feet thick at the bottom of the shaft. The thickness differs and runs up to eight feet in some rooms. The shaft is 180 feet deep but penetrates the coal body eccentrically so that the best coal in the basin lies west and northwest of the shaft. Drill section No. 7, page 149, gives in detail the strata passed through in this shaft, though the shaft was not sunk on this hole but from a somewhat lower elevation. The roof shales are almost identical with the roof in No. 4 and the bottom fire clay also is the same.

The methods of mining are essentially like those in use in Mine No. 4 except that no mining machines are employed yet. All of the coal is "shot off the solid". All three methods of underground haulage are employed. Mules gather the loaded cars from the rooms and concentrate them at points where electric locomotives pick up the short trains and concentrate them further at the end of the tail-rope. The trains of loaded cars are then hauled to the main shaft by the tail-rope and are there handled as in Mine No. 4. The distance that the trains are hauled by the tail-rope system is nearly 4000 feet and the operation is very efficient. Three electric locomotives and sixteen mules are in use underground.

Hoisting and surface handling is the same as in No. 4 and the rock waste is disposed of in the same way. The tipple is of steel and modern. Only three grades of coal are delivered to

FIG. 30.—Rock dump at mine No. 2, Central Iowa Fuel Company.

the cars: lump (six inches and up), egg (one and one-fourth inches up to six inches), and mine-run. The power equipment is much the same as at Mine No. 4 except in capacity. There are five boilers and water is obtained from North Cedar creek. The daily capacity of No. 2 is about 1000 tons and approximately 450 men are employed.

Central Iowa Fuel Company Mine No. 3.—Number 3 was opened up in 1916 and is located southwest of the center of section 32, Pleasant township, about one mile west of the village of Olmitz. Topographically it is situated similarly to Mine No. 2 and is served by the same railroad spur. The elevation of the curb is about 880 feet above sea level and the depth of the shaft is 160 feet. The Lower coal was reached 731 feet above sea level. The shaft is placed eccentrically to the best coal in the basin, which lies to the west. Drill section No. 11, page 225, gives the stratigraphic details of the Coal Measures for this general vicinity. The coal averages about the same thickness as in the

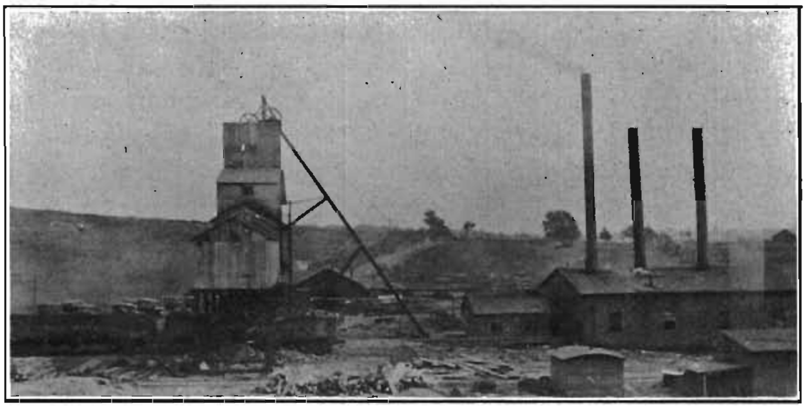


FIG. 31.—Central Iowa Fuel Company mine No. 3.

other mines above described, the roof is identical and the bottom is a little more sandy.

The methods of mining are the same as described above for mine No. 2. No mining machines are in operation and the coal is "shot off the solid". No electric locomotives are employed and haulage is done by mules and tail-rope. The tipple is of wood and is not strictly up-to-date. Only mine-run coal is delivered to the cars. An adequate supply of water is obtained from a strong spring in the valley half a mile west of the shaft. The source of the water is a sand and gravel pocket in the basal part of the glacial drift.

The daily capacity of No. 3 is about 600 tons and about 200 men are employed. This basin will soon be worked out and mine No. 3 may soon be abandoned.

The Central Iowa Fuel Company also operates a mine, known

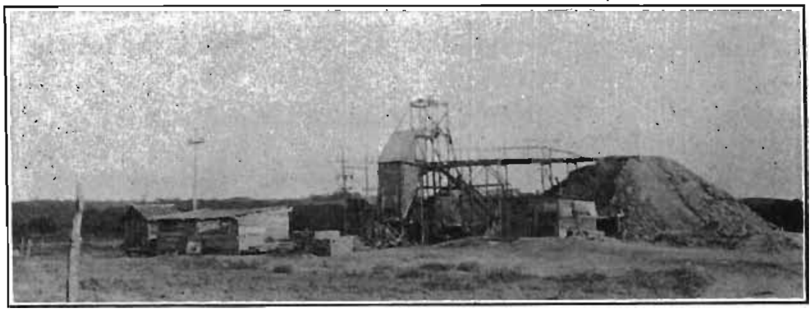


FIG. 32.—Daniels mine at Lucas

as No. 5, at Melcher in Marion county. The new mine to be opened in the No. 2 field probably will be known at mine No. 6.

The Daniels (Big Hill) Mine.—Mr. Evan Daniels has recently reopened the old Big Hill mine at Lucas and is working one of the upper coal veins, which is here two feet thick and lies at a depth of 99 feet. The elevation of the curb is about 900 feet above sea level. The detailed section is given in drill section No.

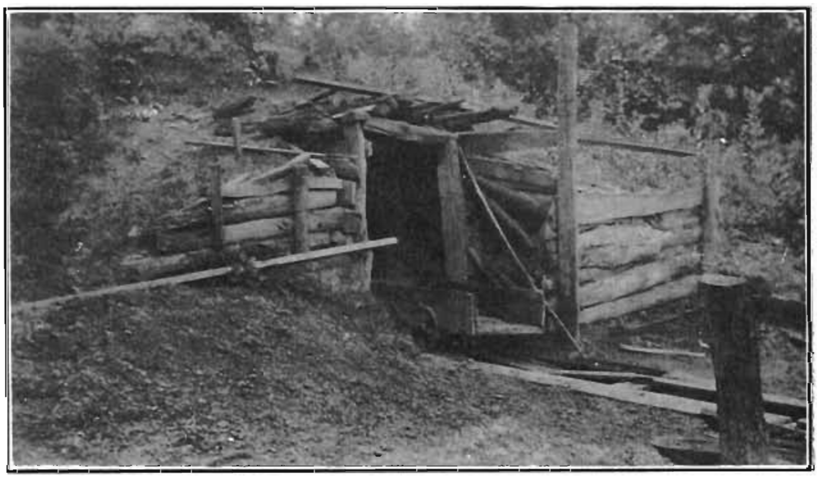


FIG. 33.—Drift mine in Swede Hollow, not in operation at the time of visit.

29, page 232. The present plant is very primitive and hoisting is done by a horse gin. The production amounts to only a few hundred tons a year. Four thousand tons have been taken out in three years. All of the coal is sold to local trade.

Drift Mines.—The only drift or wagon mines in operation in the summer of 1924 were four in number, all located in the northeast corner of Pleasant township. Some coal had been taken out of other banks in other parts of the county but these were not maintaining a trade. The location of each of the above four mines is as follows:

(1). NE. 1/4 of SE. 1/4 sec. 1, Pleasant township; coal at 770 feet above sea level.

(2). Middle of sec. 11, Pleasant township; coal at 790 (?) feet above sea level.

(3). SE. corner sec. 13, Pleasant township; coal at 775 (?) feet above sea level.

(4). NE. 1/4 of NW. 1/4 sec. 24, Pleasant township; coal at 780 feet above sea level.

The same stratum of coal is mined in all of the above mines and stratigraphically it ranges from thirty to sixty feet above the Lower coal mined in the mines of the Central Iowa Fuel Company. The coal is of fairly good quality though high in sulphur. In thickness it ranges from two to three feet and in places contains rather large amounts of rock or "bowlders", that split the seam. The bottom is of "fire clay" that is underlain by hard banded shale. The roof is of dark and red banded shale similar to the roof over the Lower coal. Water is not troublesome and on the whole the conditions for mining are favorable.

The equipment is in every case quite primitive. The coal is worked by the room and pillar system and haulage is done by hand, by hand windlass and by horse gin. In most cases the entry slopes downward slightly from the opening so that the grade is against the loaded car. In one instance, No. 1 above, a mule was used to pull the car through the main entry. The amount of coal loaded on a car differs but is never more than a few bushels and some cars carry only two bushels per load. In most cases a pump operated by a small gasoline engine removes the water. Ventilation in some of the very small drift mines is not especially provided for. In at least two of the above mentioned mines fresh air is forced into the more remote workings through stove pipes by small blower fans.

The combined production of these four mines amounts to a few hundred bushels a year and each mine employs, when it is working, from one to three men. The mines are owned by individuals and sell coal to a very local trade. If there were sufficient demand for the coal and adequate transportation facilities, this vein could yield quite a large amount of coal. Other surface veins in the county could likewise supply a large amount of coal if systematically worked.

An opening or hillside entry usually is not used for more than two or three years and more often only for a few months. Some coal is worked out within convenient reach of this entry and it is then abandoned and a new entry is made in a new location. In this way a hillside having a coal bed may have quite a number of abandoned mine openings. This practice is wasteful of much good coal that is not removed and whose subsequent removal is practically impossible. The coal thus left in the ground deterioriates to a large extent after the vein has been opened up.

A higher workable coal bed averaging about eighteen inches in thickness also is present in the general vicinity of the above mentioned mines. It is situated at a level ranging from fifty to seventy-five feet above the coal stratum above described. It has been "drifted" to some extent but has not been worked for a good many years. It is considered to be the same coal that outcrops in the creek bed near the middle of section 10, Pleasant township. In the latter location it rolls and pitches too much to be workable. This may be the coal worked at Dale's mine (location not definitely known) in the early days. The stratigraphy of the various coal beds has been discussed in a preceding chapter and the vicinities where drift mining has been carried on have been mentioned.

COAL ANALYSES AND TESTS

Volume XIX of the Iowa Geological Survey reports gives data relative to various tests and analyses of Iowa coals. Most of the tests were conducted at the United States Geological Survey's testing plant at St. Louis in connection with the Louisiana Purchase Exposition in 1904. In this volume data on coal from the Inland Coal Company's (now Central Iowa Fuel Co.) Mine No.

1 (now abandoned) are given. It is designated as "Iowa No. 5" coal. Extensive data on boiler tests conducted with this coal are given on pages 453 to 458 inclusive. These data are not repeated here.

The above volume, on pages 472 and 473, gives results on coking properties of "Run-of-mine" coal from Inland Mine No. 1. Nine thousand pounds of washed coal were burned for sixty-six hours but resulted in no coke. "Though this washed coal started off well in a hot oven, all that was gotten out of it was unburned coal mixed with pieces of charred coal and ashes." A further quotation states, "All of the Iowa coals tested are too high in sulphur to produce blast-furnace coke, and as the sulphur occurs largely as gypsum it can not be removed by washing. The ash also is high in relation to the fixed carbon."

A washing test on the same coal gave the results below:

	Car sample	Washed coal for coking test
Sulphur, per cent	3.19	2.28
Ash, per cent	12.63	7.93

Five tons of coal were used and the washing resulted in reducing the impurities as shown above.

Chemical analyses of Iowa coals are given in the same volume on pages 476 to 519 inclusive. Analyses of Lucas county coals are given on pages 504 and 505. Some of the same analyses are given in the above volume on page 416 in connection with "The Fuel Values of Iowa Coals." The analytical results are given in the accompanying tables taken from the above sources.

Localities	Moisture	Total Combustibles	Ash	Volatile Combustible Matter	Fixed Carbon	Coke Fixed Carbon plus Ash	Sulphur			Calorimetry B.T.U.	Authority
							In Sulphides	In Sulphates	Total		
Cleveland mine at Cleveland—Top of seam	9.95	80.27	9.72	37.70	42.57	52.35	3.69	.07	3.76		G. E. Patrick
Same—Middle of seam	9.39	84.21	6.43	38.62	45.59	52.02	2.69	.06	2.75		Same
Same—Bottom of seam	7.46	82.11	10.43	36.99	45.12	55.55	2.97	.07	3.04		Same
Same—Average	8.92	82.14	8.88	37.77	44.43	33.30	3.11	.07	3.18		Same
Lucas mine at Lucas Average	11.29	79.88	8.83	37.13	42.69	51.52	2.89	.08	3.97		Same
Inland Fuel Co. mine No. 1 Lump Coal	15.30	71.80	12.60	30.40	41.40				3.19	10,242	Iowa State College
Same, mine sample No. 1	18.69	73.58	7.73	31.80	41.78				2.39	10,505	N. W. Lord
Same, mine sample No. 1 Air dried	10.25	81.22	8.53	35.10	46.12				2.64	11,596	Same
Same, mine sample No. 2	18.59	74.26	7.15	34.36	39.90				3.10		Same
Same, mine sample No. 2, Air dried	12.37	79.93	7.70	36.98	42.95				3.34		Same
Same, car sample Run-of-mine	15.39	71.98	12.63	30.49	41.49				3.19	10,242	Same
Same, Run-of-mine Air dried	9.22	77.23	13.55	32.71	44.52				3.42	10,989	Same
Same, Washed	19.25	72.82	7.93	31.07	41.75				2.28		Same
Same, Washed, Air dried	13.45	78.05	8.50	30.30	44.75				2.44		Same
Average of 5	9.40	81.73	8.87	37.65	44.08				3.34		Iowa State College

Additional analyses of Inland mine No. 1 coal used in boiler tests; same sources as above. Proximate analysis of fresh coal.

	Per cent of coal	Per cent combustible
Fixed carbon	38.83	55.01
Volatile matter	31.76	44.99
Moisture	16.01	....
Ash	13.40	....
	100.00	100.00
Sulphur, separately determined	3.09	

Ultimate analysis of dry coal

	Per cent of coal	Per cent of combustible
Carbon (C)	65.21	77.59
Hydrogen (H)	4.71	5.6
Oxygen (O)	9.12	10.85
Nitrogen (N)	1.33	1.58
Sulphur (S)	3.68	4.38
Ash	15.95	....
	100.00	100.00

Analysis of ash and refuse

Carbon, per cent	15.49
Earthy matter, per cent	84.51

The following analyses are new, from car samples collected from fresh coal just loaded. The samples were collected from Central Iowa Fuel Company's Mines No. 2 and No. 4 by the writer in the summer of 1924. The authority for the analyses is Prof. H. L. Olin, Department of Chemistry, State University of Iowa.

Proximate Composition

	Mine No. 2 per cent	Mine No. 4 per cent
Loss on air drying	14.63	14.89
Composition dry basis		
Ash	7.80	12.25
Fixed carbon	51.00	46.40
Volatile matter	41.20	41.30
Sulphur	2.77	1.52
Thermal value	12,977 B.T.U.	12,500 B.T.U.

For comparison an average analysis of Iowa coals is here given, taken from volume XIX, Iowa Geological Survey, page 519. The authority for these figures is given as the Iowa State College Engineering Experiment Station.

	Per cent
Moisture	13.16
Carbon, volatile	33.36
Carbon, fixed	39.69
Ash	13.76
Sulphur	4.65
Calorific value (B.T.U.)	10,019 to 11,027

WATER AND CLIMATE

The water supply of Lucas county is entirely dependent on the rainfall. A portion of the rainfall evaporates, a second portion is surface run-off, and a third part settles into the ground as ground water. The first or evaporated portion is lost. The run-off supplies streams and reservoirs and is an important source of water supply. The part that soaks into the ground, the "cut-off", supplies the common wells and springs and in part the streams.

The distribution of precipitation and its amount, stated in inches, by months for a decade period, is given in the accompanying table. The average annual precipitation for this period is 32.62 inches. A second table gives the minimum and maximum monthly temperatures in Fahrenheit degrees for the same ten year period. The data are from the records of the U. S. Weather Bureau station located south of Chariton, in charge of Mr. C. C. Burr. The writer is indebted to Mr. Burr for his kindness and courtesy in making his records available.

The streams are important but not constant sources of water as many of them dry up in time of fairly prolonged drought. Most of the water for farm and village use is obtained from common dug or bored wells that are usually thirty to sixty feet deep. The shallower wells often "go dry" in the drier part of the summer, as the ground water level sinks below their depth. Many of the deeper wells penetrate to pockets of sand and gravel in the glacial drift and yield fairly constant supplies of water. Very shallow wells on the flood plains or valley flats of the larger streams yield a plentiful supply of water from the alluvium. This is especially true if the present stream has developed its valley in a subdrift valley, in which case the buried valley serves as an elongate reservoir for the ground water. This is true of the Chariton river valley.

In most places within the county the shales and sandstones of the Pennsylvanian strata are not water-bearing. It has been stated above that the mines are practically dry and coal prospect drill holes are usually dry except, as previously noted, in the vicinity of Lucas, hence the indurated strata are almost never looked to as sources of water. All water from the Coal Measures strata is highly corrosive and in many cases is sulphurous

Precipitation

	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	Average
January	.58	1.38	2.23	.45	.76	Trace	.44	.52	.85	.35	.756
February	.77	1.65	.68+	Trace	.86	2.20	.26	.41	1.65	.26	.874
March	3.19	1.12	1.42	1.80	.16	3.28	3.72	1.72	3.73	1.56	2.170
April	1.80	.82	2.86	6.53	2.62	5.88	7.04	4.42	1.73	1.64	3.534
May	.77	7.13	5.46	3.38	4.69	4.02	2.52	3.02	5.95	1.86	3.880
June	1.27	4.94	2.74	9.71	5.26	5.41	3.01	7.33	1.74	3.19	4.460
July	1.93	11.66	1.66	.52	1.33	4.98	5.17	2.90	7.46	1.70	3.931
August	2.13	4.09	2.83	2.68	5.45	2.53	1.87	5.07	4.14	5.17	3.599
September	10.74	7.42	2.02	4.13	2.68	6.92	6.00	9.34	2.22	3.31	5.478
October	1.88	.73	1.99	1.48	3.13	1.98	1.46	2.21	2.07	1.10	1.803
November	Trace	.78	2.79	Trace	1.76	3.26	1.50	.28	4.47	.68	1.552
December	.62	Trace	.67	.34	1.04	.28	1.41	.96	.10	.44	.586
Total	25.68	41.72	27.35	31.02	29.74	40.74	34.40	38.18	36.11	21.26	32.62

Temperature, Degrees F.

	1914		1915		1916		1917		1918		1919		1920		1921		1922		1923	
	Min. :	Max.	Min. :	Max.	Min. :	Max.	Min. :	Max.	Min. :	Max.	Min. :	Max.	Min. :	Max.	Min. :	Max.	Min. :	Max.	Min. :	Max.
January	–3 :	58	–22 :	55	–23 :	57	–12 :	55	–24 :	46	–21 :	61	–4 :	48	0 :	56	–4 :	52	–5 :	53
February	–11 :	46	6 :	57	–15 :	55	–23 :	55	–24 :	65	–2 :	63	–5 :	44	12 :	74	–5 :	64	–9 :	57
March	5 :	74	10 :	56	2 :	77	–5 :	80	9 :	78	–2 :	67	–2 :	75	12 :	76	19 :	66	–9 :	75
April	20 :	83	23 :	86	18 :	86	18 :	77	19 :	77	24 :	75	11 :	72	18 :	80	26 :	81	20 :	78
May	35 :	92	30 :	92	31 :	85	29 :	86	30 :	88	35 :	84	37 :	85	32 :	91	43 :	84	29 :	82
June	45 :	97	37 :	85	41 :	91	39 :	92	47 :	96	41 :	90	51 :	92	52 :	93	45 :	93	47 :	97
July	51 :	105	45 :	87	56 :	100	51 :	102	46 :	100	55 :	98	53 :	94	53 :	95	50 :	90	55 :	98
August	48 :	99	37 :	87	46 :	103	45 :	98	47 :	110	52 :	95	52 :	91	51 :	96	51 :	99	43 :	96
September	42 :	91	35 :	87	26 :	97	38 :	85	28 :	83	40 :	94	32 :	88	38 :	96	42 :	94	34 :	86
October	18 :	80	23 :	80	18 :	89	10 :	75	26 :	86	14 :	85	23 :	86	27 :	85	25 :	87	17 :	77
November	0 :	74	13 :	78	–3 :	76	11 :	74	6 :	70	5 :	58	8 :	67	12 :	66	23 :	69	16 :	70
December	–18 :	55	1 :	52	–21 :	62	–22 :	56	0 :	58	–20 :	49	–5 :	58	–6 :	62	–6 :	64	–13 :	57
Extremes	–18 :	105	–22 :	92	–23 :	103	–23 :	102	–24 :	110	–21 :	98	–5 :	94	–6 :	96	–6 :	99	–13 :	98

as well and so is not especially desirable even if it is available. The well drilled by Mr. J. S. Eaton in 1900 in Otter Creek township penetrated over 100 feet of sandstone but got almost no water and the hole was abandoned. The record of this well is reported in drill section No. 30, page 166 of this report.

Hillside or gravity springs are common but not plentiful and are good sources of water in just a few places. A large spring supplies water for the boilers at Central Iowa Fuel Company mine No. 3. In this case the water comes from a pocket of glacial gravel lying in a slight depression on the Coal Measures surface. The shales are practically impervious and most of the springs in the northeastern part of the county occur at the base of the drift. At other places water contained in pockets of sand and gravel in the drift gives rise to springs and seeps on the hillsides. Many of the springs are more or less intermittent. Some of the larger springs of the county are listed below:

Hanna Kent farm, three miles west of Lucas;

J. M. Taylor farm, three and a quarter miles north of Derby;

George Johnson farm, five miles northeast of Russell.

No wells which have ever been drilled in this county reach the deep artesian aquifers, as the St. Peter or Jordan sandstones. It has been shown in a preceding part of this report (p. 131) that the St. Peter should be reached at 800 to 1000 feet below sea level, the lower level being attained in the western part of the county. In the vicinity of Chariton it could be expected at a depth of about 2050 feet, from a surface elevation of 1040 feet above sea level. Even if wells were drilled into these aquifers there is a strong probability that the sandstone would be too tightly cemented to furnish an adequate amount of water. The water also might prove to be too highly mineralized to be palatable or suitable for use in boilers. This has been the experience with some of the deep wells in neighboring counties. These probable difficulties render the drilling of an artesian well as a source of water in this part of the state a rather uninviting gamble. J. L. Tilton has discussed the deep well problem for Clarke county in his report on The Geology of Clarke County [28] and the facts there presented are in the main thought to be applicable to Lucas county. The deep wells of neighboring counties are discussed

[28] Iowa Geol. Survey, vol. XXVII, pp. 107-169; "The Deep Well Problem for Clarke County," pp. 158-162.

and the detailed records are given in volume XXI of the Iowa Geological Survey. Reference has been made previously to some of these in the discussion of the Paleozoic strata.

The table below gives data of typical wells in Lucas county as reported in "Underground Waters of the South-Central District" of Iowa, in volume XXI, Iowa Geological Survey, page

Typical wells of Lucas County.

Owner	Location	Depth	Depth to rock	Source of supply	Remarks: (Logs given in feet)
		Feet	Feet		
T. 72 N., R. 21 W. (Lincoln)					
A. Culbertson	NE. 1/4 sec. 18	342	94	Drift sand; sandstone (DesMoines).	Clay, 10; sand and gravel, 84; Coal Measures, 248.
D. G. Bennett	SE. 1/4 sec. 24	304	70	Drift sand	Loess, 10; drift, 60; Coal Measures, 234.
J. A. Slattengren	SW. 1/4 sec. 23	324	65	do	Clay, 50; sand, 15; Coal Measures, 259.
L. C. Whitten	NE. 1/4 sec. 13	131	17	Sandstone (Des Moines).	Drift, 17; Coal Measures. 114.
J. M. Cowan	NW. 1/4 sec. 8	174	22	Drift sand	Clay, 11; sand, 11; Coal Measures, 152.
C. G. Erickson	NE. 1/4 sec. 2	148	21	Sandstone (Des Moines).	Clay, 18; sand, 3; Coal Measures (with 45 feet of sandstone at base). 127.

955. In the same report and on the same page a composite well section in and about the village of Russell is given as follows:

Composite Well Section Near Russell

	THICKNESS IN FEET
Soil and loess	8 to 20
Subloessial sand; scanty water.	
Yellow till (Kansan)	9 to 30
Gravel at base of Kansan till; water bearing.	
Clay, blue	10 to 60
Coarse sand and gravel; much water.	
Coal shales.	

One of the most important sources of water supply in Lucas county is the "run-off" water, which is conserved behind dams in reservoirs. These are made possible by the fact that much of the glacial drift clay is tight enough to make a nearly impervious bottom. The reservoirs on some of the stock farms are from an acre to three or four acres in areal extent. Some of these reservoirs are so fortunately situated that the feeding streams receive spring water during most of the dry season and do not dry up or become so stagnant as do those that receive only run-off water. From a sanitary point of view some of these ponds, particularly those of the latter class, are very unsatisfactory, especially during times of prolonged drought.

The larger reservoirs, as those of the Chicago, Burlington and Quincy Railroad and the city of Chariton, are fed to some extent by springs and have an areal extent of 100 acres or more. They are supplied by the run-off from a catchment basin of two or three square miles. The water is soft and especially suitable for boiler use and after chlorination is safe for household use. Reference has been made also to the surface reservoir that supplies water for the boilers at Central Iowa Fuel Company mine No. 4. It has an areal extent of twelve acres and has been very satisfactory.

The adequacy of the surface reservoir system of water supply is dependent on the amount of rainfall and its distribution throughout the year. The rainfall seems to be adequate in Lucas county and reference to the precipitation table shows on the average a very satisfactory distribution. This combination of favorable conditions does not seem to prevail to the same extent in counties farther west.

Chariton water supply.—Prior to 1906 the city of Chariton (population 5,175) had no central water supply and depended on wells and cisterns for its water. Many wells are still in use. Between 1906 and 1915 the public water supply was drawn from several shallow wells dug in the alluvial deposits underlying the bottom lands along Chariton river southwest of the city, in the vicinity of the present ball park. The well curbs were about 90 feet below the upland levels. The water was pumped from these large wells into an elevated tank with a capacity of 100,000 gallons, from which it was distributed through about seven miles of mains. The same tank and mains are still in use with the present system. It was a hazardous thing, from the sanitary point of view, to use such large quantities of water from shallow wells which received much of their supply from water draining from under the city itself. It became apparent by 1915 that the city needed a safer, larger and more reliable water supply and the present reservoir system was then put into operation.

The reservoir is located nearly three miles east of the courthouse square, in section 27, Lincoln township, on Little White Breast creek. The areal extent of the body of water varies from 70 to 100 acres. About 240 acres of ground are owned by the city. The areal extent of the catchment basin is nearly 1800 acres. The capacity of the reservoir is 300,000,000 gallons when it is full to the top of the spillway. It is thought that this capacity with the present rainfall will be adequate even with a considerable increase in population.

The filtering and purifying plant and the pumps are located at the reservoir. There are two 100,000 gallon settling basins that are used alternately, morning and afternoon. The water enters these basins by gravity and is aërated as it enters. At the same time, during aëration, lime and "sugar of iron" are introduced. These form a gelatinous precipitate which removes suspended matter on settling. From the settling basins the water passes downward through filters into a "clear well" of 100,000 gallons capacity. The filters are made up of fine white sand at the top, very coarse sand below this and very coarse gravel at the bottom. There are four filters and they are used in pairs. Each pair of filters is washed every other day by passing water up through them. The clear filtered water is pumped from the clear well to the city tank; at the same time the chlorine gas is introduced by suction at the pumping station.

On the average about 300,000 gallons of water are used daily. About 300 pounds of chlorine, four tons of hydrated lime and a little more than 2600 pounds of "sugar of iron" are used annually. A pressure of about sixty pounds per square inch is maintained in the mains, which are connected to about seventy fire hydrants.

The Chicago, Burlington and Quincy Railroad has a large reservoir which is similar to the Chariton reservoir and is located west of the city of Chariton, mostly in section 24, White Breast township. It receives the run-off from an area of about three square miles. In addition to its water supply functions, the grounds surrounding the lake, "Crystal Lake," are used by local associations for a golf course and bathing beach. This is possible through the generosity of the Chicago, Burlington and Quincy Railroad.

The Chicago, Rock Island and Pacific Railway has a reservoir lying mostly in section 25, English township. Its catchment basin is a little less than two and a half square miles.

SOILS AND SOIL CONSERVATION

The soils constitute the most important economic asset of the county, for it is essentially an agricultural area. Soil is that part of the surficial material that supports plant growth and contains more or less humus. The depth to which sampling is done, in making soil maps, is about forty-two inches, the upper six to twelve inches being the surface soil and the remainder the subsurface and subsoils.

The formation of soil is a slow process. "Year by year the growing roots penetrate the earth, separating the portions mechanically by their growth, absorb mineral constituents dissolved from the ground, then, decaying, form humic acids which aid in the decomposition of mineral matter for plant food and furnish products of decay to darken the mixture and enrich it for further plant growth. The freezing and thawing of the ground aids in loosening the soil, allowing air to penetrate more readily. Moisture from below rises to the surface by capillary action, supplying depleted moisture in the summer time and replenishing mineral food in the soil. Ants and earthworms further aid in rendering the soil porous and then add their decaying bodies to enrich the humus. Ground squirrels, gophers and larvae of beetles also contribute their labors, though the sum total of their endeavors, especially of the last two, seems more harmful than useful to man. To these agencies are added the work of those numerous bacteria that cause decay, and particularly those on the roots of leguminous plants (clover, especially) that take nitrogen from the air and convert it into forms that are later taken up by the corn and wheat in the production of nitrogenous food. It is evident that good soil, formed by such slow acting agencies, even though assisted by fertilizers and labor and conserved by the rotation of crops, is an asset that should be guarded as carefully as possible, and not allowed to deteriorate nor to wash out in newly forming trenches.''

The above quotation is taken from The Geology of Clarke County, by J. L. Tilton, previously cited. The soil characteristics and soil types given below are quoted from the Soil Survey Reports of the Iowa Soil Survey.

GENERAL SOIL CHARACTERISTICS

Soil types possess more or less definite characteristics which may be determined largely in the field, altho some laboratory study is necessary for final disposition. Usually the line of separation between adjoining soil types is quite distinct and it is a simple matter to locate the type boundaries. In some cases, however, there is a gradation from one type to another and then the boundaries may be fixed only with great difficulty. The error introduced into the soil survey work from this source is very small and need cause little concern.

The factors which must be taken into account in establishing soil types have been well enumerated by the Illinois Agricultural Experiment Station in its Soil Report No. 1:

1. The geological origin of the soil, whether residual, glacial, loessial, alluvial, colluvial or cumulose.
2. The topography or lay of the land.
3. The structure or depth and character of the surface, subsurface and subsoil.
4. The physical or mechanical composition of different strata composing the soil, as the percentages of gravel, sand, silt, clay and organic matter which they contain.
5. The texture or porosity, granulation, friability, plasticity, etc.
6. The color of the strata.
7. The natural drainage.
8. The agricultural value based upon its natural productiveness.
9. Native vegetation.
10. The ultimate chemical composition and reaction.

The common soil constituents may be given as follows:†

Organic matter	All partially destroyed or undecomposed vegetable and animal materials.
Inorganic matter	Stones—over 32 mm.* Gravel—32—2.0 mm. Very coarse sand—2.0—1.0 mm. Coarse sand—1.0—0.5 mm. Medium sand—0.5—0.25 mm. Fine sand—0.25—0.10 mm. Very fine sand—0.10—0.05 mm. Silt—0.05—0.00 mm.

SOILS GROUPED BY TYPES

The general groups of soils by types are indicated thus by the Bureau of soils:‡

Peats—Consisting of 35 per cent or more of organic matter, sometimes mixed with more or less sand or soil.

Mucks—25 to 35 per cent of partly decomposed organic matter mixed with much clay and some silt.

Clays—Soils with more than 30 per cent clay, usually mixed with much silt; always more than 50 per cent silt and clay.

Silty Clay Loams—20 to 30 per cent clay and more than 50 per cent silt.

Clay Loams—20 to 30 per cent clay and less than 50 per cent silt and some sand.

Silt Loams—20 per cent clay and more than 50 per cent silt mixed with some sand.

Loams—Less than 20 per cent clay and less than 50 per cent silt and from 30 to 50 per cent sand.

Sandy Clays—20 per cent silt and small amounts of clay up to 30 per cent.

Fine Sandy Loams—More than 50 per cent fine sand and very fine sand mixed with less than 25 per cent very coarse sand, coarse sand and medium sand, much silt and a little clay; silt and clay 20 to 50 per cent.

Sandy Loams—More than 25 per cent very coarse, coarse and medium sand; silt and clay 20 to 50 per cent.

Very Fine Sand—More than 50 per cent fine sand and less than 25 per cent very coarse, coarse and medium sand, less than 20 per cent silt and clay.

Fine Sand—More than 50 per cent fine sand and less than 25 per cent very coarse, coarse and medium sand, less than 20 per cent silt and clay.

Sand—More than 25 per cent very coarse, coarse and medium sand, less than 50 per cent fine sand, less than 20 per cent silt and clay.

---

* 25 mm. equals 1 in. †Bur. of Soils Field Book. ‡Loc. cit.

Coarse Sand—More than 25 per cent very coarse, coarse and medium sand, less than 50 per cent of other grades, less than 20 per cent silt and clay.

Gravelly Loams—25 to 50 per cent very coarse sand and much sand and some silt.

Gravels—More than 50 per cent very coarse sand.

Stony Loams—A large number of stones over one inch in diameter.

Lucas county lies in the "Southern Iowa Loess" soil area, as defined by the Iowa Soil Survey. The loess is the geologic basis for most of the soil in the county. The glacial drift constitutes the basis for much of the soil on the valley slopes where the loess has been removed. Coal Measures shales form the basis of soil in only a small part of the area, mostly in Pleasant township, and at other more or less isolated places. Alluvial soils occur principally in the valleys of Chariton river, White Breast creek and North Cedar creek. The gumbotils are usually so limited in the areal extent of their exposures that they are not important in a general consideration of the soils.

The loess and glacial drift soils are rich and productive except on hillsides where erosion prevents the retention of an adequate humus. In such places the soluble materials are quite readily leached out. The small patches of gumbotil are impervious to water, hard to work when either wet or dry, and are lean in soluble plant food. The shales are usually exposed on slopes that because of the topography wash badly and so they do not constitute the basis of very much good soil. Fortunately the areas of these latter two types are small. The alluvial soils are deep and fertile but are subject to overflow in time of heavy rainfall; for this reason they are used largely for grazing.

No soil map or soil report has been published for Lucas county but the Iowa Soil Survey Report No. 19 covers Wayne county, adjoining on the south. In-as-much as the geology and topography of the two counties are much alike over considerable areas almost identical soils may be expected in similar situations. Certain types of soils have been defined and described by the Iowa Agricultural Experiment Station and by the Federal Department of Agriculture. These types are closely adhered to in all of the soil reports and on the maps. It is not the purpose here to restate these definitions and descriptions but only to refer to the types that are likely to be found in Lucas county. For more complete information on these soil types the reader is referred to the Soil Survey Reports and particularly to No. 19, on Wayne county.

The Grundy silt loam, a loess soil, covers the extensive Kansan upland areas in Wayne county and this type no doubt persists over the flat uplands widely distributed in Lucas county. The surface soil of this type is "a dark grayish-brown to nearly black silt loam extending to a depth of 8 to 10 inches." A second type of loess soil, the Grundy clay loam, occurs associated with the Grundy silt loam in depressed areas that are not so well drained. In Wayne county the Shelby loam, a drift soil, occurs on the slopes "intermediate between the bottom-land soil and the more level uplands occupied by the Grundy silt loam." It should be similarly situated over a large part of Lucas county. Likewise the Wabash silt loam and the Wabash clay loam should occur over the alluvial bottomland flats. In the more maturely dissected part of the county, the northeast quarter, other types of soil also may occur. It is thought that such types occur as the Clinton silt loam, a loess soil typical of rough and broken topography; the Grundy silty clay loam; the Lindley silt loam, a drift soil; the Union silt loam, an indurated rock residual soil; and perhaps other minor types. These latter types are described in the Soil Survey Reports for Wapello county (No. 18) and Mahaska county (No. 29).

The tables which follow are self-explanatory and show the productiveness and the great value of the soils in this county.

Average yield per acre of crops for ten year period ending Dec. 31, 1919.[29]

CROP	BUSHELS PER ACRE
Corn	32.1
Oats	35.5
Spring wheat	15.3
Winter wheat	19.3
Barley	27.0
Rye	15.4
Potatoes	53.9
	TONS
Tame hay	1.33
Wild hay	1.07
Alfalfa	2.70

29 Data taken from records of Iowa Weather and Crop Service.

Acreage and yield of principal crops for year 1922

CROP	ACREAGE	PER ACRE YIELD BUSHELS	TOTAL YIELD BUSHELS
Corn	52,410	47	2,463,270
Oats	22,557	28	631,596
Winter wheat	81,858	18	159,444
Spring wheat	21	15	315
Barley	42	28	1,176
Rye	187	10	1,870
Potatoes	94	67	6,208
Timothy seed	9,963		38,089
Clover seed	1,706		1,370
		TONS	TONS
Hay, tame	33,296	1.5	49,944
Alfalfa	138	2.2	304

Acreage Distribution[30]

	ACRES
Total area[31]	276,480
Total acreage of farms	258,463
Acreage occupied by farm buildings, highways, and feed lots	9,267
Acreage in crops not otherwise listed	920
Waste land	2,500

Farm tenure (1922)[32]

Number of farms	1,659
Average size, acres	156
Owners	968
Relative renters	219
Renters	312
Both own and rent	146
Unclassified	14

Live Stock, Jan. 1, 1923

Horses	7,769
Mules	1,191
Swine	49,792
Cattle	28,666
Sheep	14,252

Another problem of great importance is that of soil waste and erosion. This problem is extensively dealt with in numerous bulletins and pamphlets issued by the Iowa Agricultural Experiment Station and by the Federal Department of Agriculture. It is not the purpose to treat this problem at length in this place but certain outstanding facts should be mentioned.

Over half of the area of the county is in slope. The declivity of much of this is so great that running water erodes deeply into the hillsides even in times of small showers. Soil on slopes that wash easily accumulates very slowly and then only when protected by a forest and grass covering. When hillsides are denuded of their forest growth, as has been done over so much of

30 Statistics taken from Iowa Year Book of Agriculture (1922).
31 Total acreage as given by the Fourteenth Census (1920) in Bulletin—Agriculture: Iowa.
32 Statistics taken from Iowa Year Book of Agriculture (1922).

the area of Lucas county, the slopes are exposed to the eroding action of running water. In most cases the rich humus soil, accumulated through scores of years of time, is washed away in a single season. This is still further accelerated by cultivating the slopes. Slopes thus denuded of forest covering and soil become practically worthless.

Another result of forest denudation is that more of the rain water runs off during a shower and less is retained in the porous soil and vegetal cover than when the slopes are forested. This retention of rain water, that eventually becomes ground water, is important, for it feeds the streams and springs long after the surface has become dry. A forest and vegetal cover on the slopes insures a more continuous and even supply of spring and stream water in dry seasons. If the water all runs off rapidly the streams soon dry up and the springs diminish in size or dry up. The greater volume of water that runs off a denuded surface accentuates flood scour and flood damage.

At least 10 to 20 per cent of the area of the county should be carefully forested. Native trees should be grown and it is believed that the time will soon come, if it has not already, when slope land carefully forested and conserved will yield as lucrative financial returns as much of the better agricultural land. Such slope lands as still have a native stand of timber should be conserved in that condition. Replacement should keep pace with cutting and in a systematic way.

CLAYS

Good workable clays exist in Lucas county in abundance but have not been utilized. About a score of years ago some efforts were made to manufacture brick and tile from the drift and loess clays. The industry failed, through no lack of efficiency of the methods used or for any deficiency in the clays, but for lack of a market for the products. Loess, drift and gumbotil clays exist widespread over the county in great abundance and of as good quality as any similar clays elsewhere. If a demand existed for common brick and tile or railroad ballast, unlimited quantities of these could be produced almost anywhere within the county. Fuel in the form of coal exists in abundance near at hand.

The Coal Measures shales and clays are abundant and offer a very wide range of choice of individual clays as well as possibilities for many combinations among themselves and with the glacial and loess clays. Some of the under clays or so-called "fire clays" are very pure, are available in quantity and are suitable for pottery. Many of these fire clays singly or in combination with other local clays should make excellent stone ware. Some are very free from iron and other objectionable constituents. A few beds of clay are ocherous and one such bed was noticed in particular on the Wm. Ainsley farm east of the town of Lucas.

With the combination of raw materials, clay and coal, that exists in this county a large ceramic industry with a wide range of products could thrive if it had a good market. The clays are an important potential economic resource. Beyer and Williams noted the existence of these clays in Lucas county in their report on The Geology of Iowa Clays, Iowa Geological Survey, volume XIV, page 447.

GRAVEL AND SAND

Gravel and sand in usable quantities are exceedingly rare. It is quite a striking fact that the streams and even the smaller creeks have such meager amounts of sand and gravel in their channels that it is insufficient to supply the most local demands. The beds of most of the streams are muddy and not sandy. Pockets and small beds of gravel and sand lie buried in the glacial drift, as has been noted already in connection with water supply, but they are seldom exposed and in some cases are mixed with so much silt and clay as to be of little value. Quite a large quantity of such material is exposed in the valley of White Breast creek in the north middle to the north boundary of the county.

The glacial drift in the southwest part of Benton township contains a large amount of disseminated sand and gravel. In sections 8, 20, 21, 28 and 29 fairly large hills of sand and gravel exist. The overlying materials, loess and drift, have been eroded, leaving the heaps of porous sand and gravel. The amount of this material is very great, but the writer cannot vouch for its purity except at the surface. It is probable that below a comparatively shallow zone it may contain a large percentage of very fine silt and clay, which materials have been washed out of the superficial part. The material does not seem to have been put to any use; certainly no large quantity has ever been removed.

SANDSTONE AND LIMESTONE

Building stone of all kinds is very scarce and is available at only a few places and then is usually of very inferior quality. Such rock as is available has in the past been used only in laying crude foundations and for rough masonry. Practically all of the building stone used in the county for many years has been shipped in. Not a single quarry was open or showed any evidence of having been worked for a good many years, at the time of the writer's visit. The few valuable beds of building stone that do occur are in general so associated with other sedimentary strata as to render their utilization practically impossible. They lie, for the most part, low down in fairly deep valleys, with steep slopes above. They cannot be uncovered and stripped for more than a few feet to a few yards without removing enormous amounts of overburden. This does not pay, as the beds of limestone are almost nowhere over four feet thick and the sandstones are usually not more than ten feet in thickness, generally only two or three feet.

The best sandstone which was seen by the writer is exposed along a branch of Flint creek in the northwest quarter of section 10, Pleasant township. It is a lenslike bed about two feet in thickness, is light gray in color and weathers brown. It is very hard and is very nearly a quartzite. A considerable quantity of it could be taken out at moderate expense. Its stratigraphic relations are given in surface section No. 12, page 146. Other softer sandstone beds occur to the east in the same vicinity.

Nearly twenty feet of hard gray to brown sandstones and conglomerates outcrops in the hillsides in the northeast corner of section 15 and in the southeast corner of section 10, Pleasant township. These beds are of differing hardness, the conglomerate layers being very hard and cemented closely with silica. Considerable quantities of these rocks could be quarried. These strata are believed to belong to the Chariton conglomerate. The stratigraphic equivalents of the above beds are also well exposed through section 3 and in sections 22 and 27, Pleasant township. In the northwest quarter of section 3, Pleasant township, the stratigraphic section contains at least six even and uniform beds of usable sandstone from six inches to three feet in thickness. Some quarrying has been done in this vicinity. In the southeast quarter of section 22, Pleasant township, about six feet of hard conglomerate, a second bed of similar conglomerate two feet thick, and five feet of brown cross-bedded sandstone are exposed. The material is accessible as to quarrying but transportation from this place would be rather difficult.

A soft yellow sandstone has been quarried on a branch of Little White Breast creek in the northeast quarter of section 32, English township. At numerous points along Swede Hollow in Liberty and White Breast townships there is exposed a fairly soft yellowish brown sandstone that is massive for the most part and two to eleven feet thick. It has never been quarried to any great extent.

Limestones have been quarried principally at three localities in the past, but very little has been taken out during the last fifteen years. At the "Smith Quarry" on Long Branch creek, section 4, English township, a four foot bed of light gray limestone has been worked. It is overlain by buff limestone, from which it is separated by calcareous shale. It is said to have produced a high grade of quicklime and is a good resistant building stone which weathers white. A similar limestone has been quarried and burned for lime on Little White Breast creek two miles northeast of Chariton, in section 16, Lincoln township. A large amount of this rock has been used for foundations in Chariton and has stood up well. The stratum is nearly five feet thick and is separated into about three layers, which are massive for the most part. It is described in surface section No. 32. A two to three foot bed of dark gray limestone has been quarried to some extent in Swede Hollow and much of this rock also has been used in Chariton.

The local limestones do not occur in sufficient quantity nor are they accessible enough to be of use for agricultural lime. At no point could a quarry be opened and crushing machinery installed that could produce any great amount of crushed limestone at a reasonable price. The farmers of Lucas county must look for their supplies of agricultural lime from the outside. Mine dump materials are never sufficiently calcareous to be of any value when spread on cultivated land. Such mine waste is more apt to be positively harmful.

Brief mention of these quarry products has been made by

Beyer and Williams in The Geology of Iowa Quarry Products, Iowa Geological Survey, volume XVII, pages 475 to 476, and by Beyer and Wright in Road and Concrete Materials of Iowa, Iowa Geological Survey, volume XXIV, pages 416 and 417.

ROAD MATERIALS

Practically all road materials used in Lucas county must be "imported." The scarcity of gravel and sand has been pointed out and also the absence of workable beds of quarry rock has been noted. The resources are thus well known. The value of the clays for making brick and railroad ballast has been pointed out.

Mine dump waste as a road metal of some local value has been largely overlooked. The mine dumps contain coal and slack which on burning partly slag the clay and rock waste and this makes a fairly good road bed when it is kept in condition. A good many miles of secondary country road could be greatly improved with this available material and at no very great expense.

OIL

According to Howell[33] Lucas county lies in the area designated "area in which oil should not be expected." It can only be said with certainty that oil does not occur in the Des Moines or Pleistocene series within the county. The amount of coal prospect drilling done would have revealed it if it did. It is also believed that decomposing organic matter may form either coal or oil but not both in the same place at the same horizon. In the Des Moines series of central Iowa it formed coal, so gas or oil should not have been expected even if definite proof to the contrary were not at hand. No exact knowledge of the deeper formations is available nor is much known of the minor structures. In the absence of positive knowledge it is best to conclude that the probability of oil is extremely small. The Ordovician horizon would be the most promising and drilling would have to go at least to the St. Peter sandstone to yield definite proof, either positive or negative.

33 J. V. Howell, Petroleum and Natural Gas in Iowa: Iowa Geol. Survey, vol. XXIX, pp. 1-48.

ACKNOWLEDGMENTS

In the preparation of this report the writer has received aid from numerous people. Specific mention has already been made in the body of this report of the contributions of certain individuals. Individual mention cannot be made of every person who aided in one way or another. Special mention, however, is due The Central Iowa Fuel Company for the courteous and valuable help extended the writer through their engineer, Mr. F. W. Trost. Personal thanks also are due to Mr. Trost. The writer also very greatly appreciates the valuable aid given him by Doctor Lees, Assistant State Geologist, in the revision of the original manuscript.

APPENDIX

Supplementary Drill Sections

Drill section No. 1. Northwest corner of SW. ¼ of NW. ¼, sec. 12, Pleasant township.

Curb elevation 808 feet above sea level.

		THICKNESS		DEPTH	
		Ft.	*In.*	*Ft.*	*In.*
1.	Soil, alluvium	6		6	
2.	Sand, alluvium	20		26	
3.	Gravel, alluvium (?)	4		30	
4.	Hard light sandstone	2		32	
5.	Soft light sandy shale	2		34	
6.	Soft dark shale	8		42	
7.	Hard blue rock	2		44	
8.	Soft light shale	2	6	46	6
9.	Medium hard limy shale	2		48	6
10.	Hard light sandy shale	4	6	53	
11.	Medium soft dark shale	2		55	
12.	Hard light sandstone	2		57	
13.	Hard dark shale	1	6	58	6
14.	*Coal*		6	59	
15.	Medium light soft shale	9		68	
16.	Medium light hard shale	2		70	
17.	Medium light hard sandy shale	2		72	
18.	Medium light hard limestone (Ste. Genevieve)	12		84	

Total depth 84 feet.
Top of limestone 736 feet above sea level.
Bottom of hole 724 feet above sea level.

Drill section No. 2. Middle east side sec. 13 of Pleasant township.

Curb elevation 791 feet above sea level.

		THICKNESS		DEPTH	
		Ft.	*In.*	*Ft.*	*In.*
1.	Surface soil, may be alluvium	21	6	21	6
2.	Soft sandstone	1	6	23	
3.	Soft light shale	5		28	
4.	Soft dark shale	3		31	
5.	Soft light shale	3		34	
6.	Soft dark shale	5	6	39	6
7.	Hard dark rock		6	40	
8.	Hard dark sandstone		6	40	6
9.	Soft light shale	1	6	42	
10.	Soft light sandstone	15		57	
11.	Dark medium soft shale	12	6	69	6
12.	*Coal,* bony	1	3	70	9
13.	Fire clay	2		72	9
14.	Sandstone	3		75	9
15.	Soft dark shale, with sand balls	15		90	9
16.	Soft light shale	1		91	9
17.	Hard limy shale	11		102	9
18.	Hard light limestone (?) Top 700 feet above sea level	20		122	9
19.	Soft blue lime shale	1		123	9
20.	Hard light sandstone	3		126	9
21.	Hard light limestone	17	6	144	3

22.	Hard light sandstone	6		150	3
23.	Hard light limestone	4	6	154	9
24.	Hard light sandstone	9		163	9
25.	Hard light limestone	4		167	9

Total depth 168 feet.
Bottom of hole 623 feet above sea level.

Drill section No. 3. Near middle east side NE. ¼ sec. 22, Pleasant township.

Curb elevation 968 feet above sea level.

		THICKNESS Ft.	DEPTH Ft.
1.	Yellow clay	35	35
2.	Blue clay, sand and bowlders	165	200
3.	Sand and clay	26	226
4.	Sandy shale reached at 226 feet.		

Total depth 226 feet.
Bottom of hole 742 feet above sea level.

Drill section No. 4. NE. ¼ of sec. 22, Pleasant township.

Curb elevation 948 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Soil, gray drift, blue clay and bowlders, 2 feet of sand 25 to 27 feet from top	104		104	
2.	Shale, gray, hard	49	9	153	9
3.	"Shoddy" (fissile shale)		1	153	10
4.	*Coal*, not "Lower"	4	3	158	1
5.	Brown bottom		2	158	3
6.	Fire clay	1	9	160	

Total depth 160 feet.
Top of coal (4) 794 feet above sea level.
Bottom of hole 788 feet above sea level.

Drill section No. 5. NW. ¼ of sec. 26, Pleasant township.

Curb elevation 805 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Surface soil } May all be alluvium	9		9	
2.	Sand and gravel } May all be alluvium	26		35	
3.	Shale, soft, light	6		41	
4.	Shale, medium dark to dark	3		44	
5.	*Coal*, soft, "rotten"	1	3	45	3
6.	Rock (may be "bowlder")	1	1	46	4
7.	*Coal* (good) "Lower", mined at mine No. 2	3		49	4
8.	Fire clay, soft	1	2	50	6
9.	Shale, light, soft	14		64	6
10.	Shale, light, soft (limestone nodules)	5		69	6
11.	Shale, variegated, medium soft	14		83	6
12.	Sandstone, soft, with shale partings	43		126	6
13.	Sandstone, coarse, medium soft, medium light	14		140	6
14.	Shale, green, with limestone nodules	2		142	6
15.	Shale, medium hard, variegated	10		152	6
16.	Shale, medium hard, limy	3		155	6
17.	Limestone, hard (may be Mississippian)	1		156	6

Total depth 156 feet, 6 inches.
Top of Lower coal 761 feet above sea level.
Bottom of hole 647 feet above sea level.

Drill section No. 6. Middle NE. ¼ of SW. ¼ sec. 27, Pleasant township.
Curb elevation 818 feet above sea level.

		THICKNESS Ft.	DEPTH Ft.
1.	Surface soil	10	10
2.	Sand	25	35
3.	Sand and coarse gravel	5	40
4.	Soft light shale	3	43
5.	Streaked sandy shale	7	50
6.	Soft medium dark streaked sandstone	20	70
7.	Soft medium dark streaked sandy shale	66	136
8.	Streaked sandy shale	12	148
9.	Sandstone	2	150
10.	Medium dark medium soft streaked sandy shale	44	194
11.	Medium dark to medium light shale	23	217
12.	Medium dark medium soft banded shale	51	268
13.	Dark medium soft shale	5	273
14.	Dark medium soft sandy shale	4	277
15.	Limestone (Miss. ?)	1	278

Total depth 278 feet.
Bottom of hole 540 feet above sea level.

Drill section No. 8. Middle east side SW. ¼, sec. 20, Pleasant township.
Curb elevation 933 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Soil, loess	24		24	
2.	Sand and clay, drift	69		93	
3.	Soft clay shale	2		95	
4.	Soft light shale	4		99	
5.	Medium soft dark shale	2		101	
6.	*Coal,* rotten		4	101	4
7.	Soft light shale	11	8	113	
8.	Soft sandstone	3		116	
9.	Hard limestone	2		118	
10.	Hard medium dark shale	5		123	
11.	*Coal* (May be No. 7 of Columnar Section)	2		125	
12.	Fire clay	2		127	
13.	Medium light sandy shale	12		139	
14.	Dark sandy shale with banded sand streaks	83		222	
15.	*Coal* (Lower)	6	3	228	3
16.	Hard dark shale		3	228	6
17.	Medium hard sandy fire clay	5	6	234	

Total depth 234 feet.
Top of Lower coal 711 feet above sea level.
Bottom of hole 699 feet above sea level.

Drill section No. 9. Record at probable location of new shaft. North center of NE. ¼, sec. 20, Pleasant township.
Curb elevation 917 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Soil, clay and drift	65		65	
2.	Shale, mixed	15		80	
3.	Shale, gray	20		100	
4.	Shale, light gray, mixed	15		115	
5.	*Coal*	1		116	
6.	Shale, gray, slaty	73		189	
7.	Shoddy top	1		190	
8.	*Coal* (Lower)	5	3	195	3
9.	False bottom		3	195	6
10.	Fire clay	2	1	197	7

Total depth 197 feet, 7 inches.
Top of Lower coal 727 feet above sea level.
Bottom of the hole about 719 feet above sea level.

Drill section No. 10. Southeast corner of NW. ¼ of SE. ¼ of sec. 29, Pleasant township.

Curb elevation 928 feet above sea level.

		THICKNESS Ft.	DEPTH Ft.
1.	Surface clay	28	28
2.	Sand and clay	90	118
3.	Soft dark shale	2	120
4.	Soft variegated shale	8	128
5.	Hard sandstone	5	133
6.	Soft medium dark shale	15	148
7.	Medium light shale	10	158
8.	Medium dark shale	2	160
9.	Medium hard medium dark streaked sandy shale	54	214
10.	Medium hard medium dark sandy shale with sandstone partings	46	260
11.	Light sandstone	4	264
12.	Medium dark medium hard shale with sandstone partings	23	287

Total depth 287 feet.
Bottom of hole 641 feet above sea level.

Drill section No. 11. Center section 32, Pleasant township.

Curb elevation 895 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Soil, probably loess	20		20	
2.	Clay and sand, drift	48		68	
3.	Soft dark shale	1		69	
4.	*Coal* (May be No. 11 of Columnar Section)		9	69	9
5.	Fire clay		3	70	
6.	Soft light shale	5		75	
7.	Mixed soft variegated shale	2		77	
8.	Medium soft sandstone	5		82	
9.	Soft dark shale	12		94	
10.	*Coal* (May be No. 7 of Columnar Section)		6	94	6
11.	Sandy fire clay	1	6	96	
12.	Medium soft sandstone	9		105	
13.	Hard gray rock	4		109	
14.	Medium soft dark sandy shale	1		110	
15.	Medium dark and medium hard shale. Some sand..	54	6	164	6
16.	*Coal* (Lower)	5	4	169	10
17.	Light medium hard very sandy shale	6	2	176	
18.	Hard gray rock with sandstone partings	12		188	
19.	Soft light sandstone	28		216	

Total depth 216 feet.
Top of coal (16) 731 feet above sea level.
Bottom of hole 679 feet above sea level.

Drill section No. 12. 400 feet east of the middle of west side of NW. ¼, sec. 5, Cedar township.

Curb elevation 854 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Clay, alluvium	20		20	
2.	Sand, alluvium	4		24	
3.	Gravel, alluvium	2		26	
4.	Hard gray rock	1		27	
5.	Soft light shale	6		33	
6.	Soft variegated shale	7		40	
7.	Soft dark shale	2		42	

8.	Soft light shale	6		48	
9.	Soft light sandy shale	8		56	
10.	Soft light shale	3		59	
11.	Soft light sandstone	4		63	
12.	Hard medium dark shale	3		66	
13.	Hard blue rock	2		68	
14.	Hard medium dark shale	10		78	
15.	*Coal*	2	5	80	5
16.	Hard medium light shale	1	7	82	
17.	Hard light sandstone	15		97	
18.	Hard medium light sandy shale	7		104	
19.	Hard medium dark shale with sand streaks	37		141	
20.	Sandstone	14		155	

Coal should have come in just above No. 20
Total depth 155 feet.
Bottom of hole 699 feet above sea level.

Drill section No. 13. 750 feet east of west side of section along north side of SW. ¼ of SW. ¼ of sec. 6, Cedar township.

Curb elevation 867 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Surface clay, alluvium	14		14	
2.	Sand, alluvium	6		20	
3.	Soft light shale	4		24	
4.	Soft variegated shale	3		27	
5.	Light hard limestone		6	27	6
6.	Soft dark shale	4		31	6
7.	*Coal*		6	32	
8.	Soft light mixed shale	9		41	
9.	Light medium soft sandstone	8		49	
10.	Medium soft variegated shale	5		54	
11.	Dark medium soft shale	7	3	61	3
12.	*Coal*	1	6	62	9
13.	Soft light shale	3	3	66	
14.	Light medium soft sandy shale	3		69	
15.	Medium hard dark shale	13	5	82	5
16.	Hard blue rock		7	83	
17.	Medium dark medium hard shale	7	3	90	3
18.	*Coal* (Lower)	2	9	93	
19.	Light medium hard sandstone	32		125	
20.	Medium soft variegated sandstone	5		130	
21.	Soft light fine sandstone	26		156	
22.	Soft light coarse sandstone	78		234	
23.	Light green limy shale	4		238	

No. 23 is very close to the Mississippian.
Total depth 238 feet.
Top of Lower coal (18) 777 feet above sea level.
Bottom of hole 629 feet above sea level.

Drill section No. 14. 483 feet east of NW. corner of sec. 7, Cedar township.

Curb elevation 980 feet above sea level (?)

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Drift	104		104	
2.	Shale, gray and fine textured	11	6	115	6
3.	*Coal*	1	8	117	2
4.	Fire clay	7	10	125	
5.	Blue shale	10		135	
6.	Blue gritty shale	12		147	
7.	Dark blue fine textured shale	5		152	
8.	Black fine textured shale	1	6	153	6

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
9.	Blue gritty fine textured shale with lime nodules	16	6	170	
10.	Blue-gray fine textured shale	13		183	
11.	Black fissile shale	5		188	
12.	Blue soapy shale, gritty inclusions	8		196	
13.	Black soapy fissile shale	5		201	
14.	Dark gray fine textured shale	9		210	
15.	Sandstone and shale, micaceous	40		250	
16.	Black soapy shale with linguloid shells	10		260	
17.	Blue shale and mixed clays	125		385	
18.	Limestone (Mississippian)	55		440	
19.	Sandstone	1		441	

Total depth 441 feet.
Mississippian limestone 595 feet above sea level.
Bottom of hole 539 feet above sea level.

Drill section No. 16. NE. corner sec. 2, Lincoln township.

Curb elevation 1030 feet above sea level.

		THICKNESS Ft.	THICKNESS In.	DEPTH Ft.	DEPTH In.
1.	Soil and clay (loess and gumbotil)	38		38	
2.	Sand	50		88	
3.	Gravel	4		92	
4.	Soft medium light shale	2		94	
5.	Medium soft medium light shale	15		109	
6.	*Coal*	1		110	
7.	Soft medium light shale	3		113	
8.	Hard medium dark shale	5		118	
9.	Medium light sandy shale	5		123	
10.	Hard medium dark shale	7		130	
11.	*Coal*	1	6	131	6
12.	Fire clay	2	6	134	
13.	Soft medium light calcareous shale	7		141	
14.	Limestone		8	141	8
15.	Medium light sandy shale	7	4	149	
16.	Hard medium dark shale	6		155	
17.	*Coal*		6	155	6
18.	Fire clay	1	6	157	
19.	Medium light sandy shale, lime concretions	7		164	
20.	Variegated shale	7		171	
21.	Hard medium dark shale	4		175	
22.	*Coal*		6	175	6
23.	Soft medium light shale	6	6	182	
24.	Limestone		8	182	8
25.	Medium hard medium light shale	3	4	186	
26.	Medium hard dark shale	4		190	
27.	Hard variegated shale	4		194	
28.	Medium hard medium dark shale	3	6	197	6
29.	Soft light shale	4		201	6
30.	Soft variegated shale	6		207	6
31.	Medium hard medium light sandy shale	12		219	6
32.	Sandstone	6	6	226	
33.	Soft medium dark shale	4		230	
34.	*Coal*		11	230	11
35.	Hard medium dark shale	10	1	241	
36.	Medium dark sandy shale	5		246	
37.	Sandstone	3		249	
38.	Hard medium dark shale (sandy streaks)	9		258	
39.	Sandstone	4		262	
40.	Hard medium dark shale	1		263	
41.	Soft light sandstone (Lower coal horizon at about a depth of 320 feet or at an elevation of 710 feet above sea level)	102		365	
42.	Hard medium dark sandy shale	8		373	

43.	Soft light sandstone	2		375	
44.	Hard sandstone	1		376	

Total depth 376 feet.
Bottom of hole 654 feet above sea level.

Drill section No. 18. Near middle NW. ¼ of NW. ¼, sec. 15, Lincoln township.

Curb elevation 888 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Soil	8		8	
2.	Sand	2		10	
3.	Yellow clay	9		19	
4.	Sandy clay	4		23	
5.	Dark shale	2		25	
6.	Light shale	4		29	
7.	Light gray sandstone	18		47	
8.	Light shale	2		49	
9.	Light shale	5		54	
10.	Light shale	7		61	
11.	Light shale	3		64	
12.	Black carbonaceous shale	3		67	
13.	Fire clay	8		75	
14.	Limestone	1		76	
15.	Shale	6		82	
16.	White sandstone	3		85	
17.	Light shale	2		87	
18.	Limestone	1	6	88	6
19.	Light shale with fire clay and limestone bands	11	6	100	
20.	Light shale	8		108	
21.	Black slate	3		111	
22.	Light shale	3		114	
23.	Shale with limestone and sandstone bands	10		124	
24.	Sandy shale	55		179	
25.	Hard light sandstone	21		200	
26.	*Coal* (May be horizon of Lower coal)		1	200	1
27.	Red sandstone	5	5	205	6
28.	Dark sandy shale	13		218	6
29.	Sandstone	2		220	6
30.	Dark sandy shales	130	6	351	

Total depth 351 feet.
Bottom of hole 537 feet above sea level.

Drill section No. 20. One-fourth mile NW. of Inland shaft No. 1, NW. corner of NW. ¼, sec. 9, Lincoln township.

Curb elevation 879.5 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Soil and yellow clay	7		7	
2.	Shale, brown	1		8	
3.	Coal, very soft, dirty	2	6	10	6
4.	Fire clay	1	6	12	
5.	Sandstone, red and gray	13		25	
6.	Shale, light and dark	12	6	37	6
7.	*Coal*	1	6	39	
8.	Fire clay	4		43	
9.	Shale, light, sandy in middle	33		76	
10.	Shale, dark	5		81	
11.	*Coal*	1		82	
12.	Fire clay	3		85	

			Ft.	In.	Ft.	In.
13.	Limestone		1		86	
14.	Shale, light	may be mixed shales with lime-	2	6	88	6
15.	Limestone	stone septaria	1	6	90	
16.	Shale, variegated		11		101	
17.	Limestone			6	101	6
18.	Shale, dark		4		105	6
19.	Limestone, black			6	106	
20.	*Coal*		1	2	107	2
21.	Fire clay		6	10	114	
22.	Shale, variegated		9		123	
23.	Shale, dark		4	5	127	5
24.	*Coal,* bony			7	128	
25.	Sandstone, dark		2		130	
26.	Shale, dark, slaty			10	130	10
27.	*Coal*			2	131	
28.	Dark "slate"		2		133	
29.	Sandstone, light and coarse		6		139	
30.	Shale, light		5		144	
31.	*Coal*			2	144	2
32.	Fire clay			10	145	
33.	Sandstone, light gray		10		155	
34.	Shale, dark, sandy		47		202	
35.	Shale, light, sandy "roof"		6		208	
36.	*Coal,* impure, slaty			9	208	9
37.	*Coal,* pure (Lower)		4		212	9
38.	Fire clay, hard and sandy		6	3	219	

Total depth 219 feet.
Bottom of hole 660.5 feet above sea level.
Top of coal (36) 671.5 feet above sea level.

Drill section No. 21. Northeast corner of NW. 1/4 of SW. 1/4, sec. 7, Lincoln township.

Curb elevation 907 feet above sea level.

		THICKNESS		DEPTH	
		Ft.	*In.*	*Ft.*	*In.*
1.	Loam and clay	10		10	
2.	Sand	5		15	
3.	Blue clay	5		20	
4.	Sand, gravel and bowlders	15		35	
5.	Medium soft sandy shale	30		65	
6.	Conglomerate	5		70	
7.	Limy shale	1		71	
8.	Black shale and 3 inches of *coal*		7	71	7
9.	Variegated clay shale	8	5	80	
10.	Sandy shale with clay bands	6	6	86	6
11.	Soft clay shale	3	6	90	
12.	Very hard limestone	1	6	91	6
13.	Very soft reddish clay shale	4	6	96	
14.	Very soft black shale	6		102	
15.	Blue clay shale	6		108	
16.	Very hard limestone	2		110	
17.	Medium soft variegated sandy shale	10		120	
18.	Medium hard clay shale	3		123	
19.	Black shale		6	123	6
20.	*Coal*		6	124	
21.	Coarse sandstone	9		133	
22.	Medium dark medium hard banded shale	21		154	
23.	Dark shale	1	2	155	2
24.	*Coal*	1	6	156	8
25.	Fire clay	1	4	158	
26.	Limestone		6	158	6
27.	Hard variegated shale	11	6	170	
28.	Very hard limestone	1	6	171	6
29.	Hard shale	8	6	180	

30.	Hard streaked sandstone	5		185	
31.	Medium soft streaked sandy shale	20		205	
32.	Medium hard sandstone	22		227	
33.	Soft sandstone with limestone bands	12		239	
34.	Sandstone	6		245	
35.	Limestone	3		248	
36.	Soft sandstone	5	8	253	8
37.	*Coal* (Lower)		2	253	10
38.	Soft sandstone	1	2	255	

Total depth 255 feet.
Bottom of hole 652 feet above sea level.

Drill section No. 22. 1200 feet west, 300 feet south of center of sec. 30, Lincoln township.

Curb elevation 955 feet above sea level (?).

		THICKNESS	DEPTH
		Ft.	*Ft.*
1.	Drift	72	72
2.	Shale, light	11	83
3.	Rock, hard	2	85
4.	Shale, light	5	90
5.	Shale, red and white	34	124
6.	Slate, black	4	128
7.	Shale, light	12	140
8.	Shale, red and white	23	163
9.	Shale, darker	7	170
10.	Sandstone	101	271
11.	Shale, sandy	2	273
12.	Sandstone and shale	20	293
13.	Report missing (?) (no coal)	17	310
14.	Shale, sandy	10	320
15.	Rock, hard	1	321
16.	Shale, sandy	20	341
17.	Rock, hard	1	342

Total depth 342 feet.
Bottom of hole 613 feet above sea level.

Drill section No. 23. 874 feet N. and 47½ feet E. of SW. corner of sec. 30, Lincoln township.

Curb elevation 972 feet above sea level.

		THICKNESS		DEPTH	
		Ft.	*In.*	*Ft.*	*In.*
1.	Soil	7		7	
2.	Clay, yellow	7		14	
3.	Clay, dark	6		20	
4.	Sand	2		22	
5.	Clay, blue	18		40	
6.	Sand	5		45	
7.	Clay, blue	30		75	
8.	Sand	3		78	
9.	Shale, dark bluish	9		87	
10.	Shale, gray, clayey	17		104	
11.	Shale, green	4		108	
12.	Shale, dark	3		111	
13.	*Coal*		11	111	11
14.	Fire clay	3	1	115	
15.	Shale, light	2		117	
16.	Limestone	1		118	
17.	Shale, light	5		123	
18.	Limestone	1		124	
19.	Shale, light	4	6	128	6
20.	Slate, black	1	6	130	

21.	Shale, light	28		158	
22.	Pyrite		6	158	6
23.	Shale, dark and light	5	6	164	
24.	Sandstone, hard	2		166	
25.	Shale, light	3		169	
26.	Limestone, black and white	2	6	171	6
27.	Slate, light	7		178	6
28.	Limestone	1		179	6
29.	Shale, dark	3	6	183	
30.	Limestone		6	183	6
31.	Shale, dark and light	13	6	197	
32.	Sandstone, soft	48	6	245	6
33.	Limestone	4	6	250	
34.	Sandstone	3		253	
35.	Shale, sandy	9		262	
36.	Sandstone	6		268	
37.	Limestone	1		269	
38.	Sandstone	47		316	
39.	"Bowlder"	2		318	
40.	*Coal* (Lower)	1		319	
41.	Carbonaceous shale, "slate"		7	319	7
42.	Shale	3	11	323	6

Total depth 323 feet, 6 inches.
Top of coal (40) 654 feet above sea level.
Bottom of hole 648 feet, 6 inches above sea level.

Drill section No. 24. 1000 feet NW. of SE. corner sec. 24, White Breast township.

Curb elevation 960 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Drift	62		62	
2.	Shale	3		65	
3.	Clay	5		70	
4.	Shale	18		88	
5.	Slate		9	88	9
6.	*Coal*, impure and slaty	1	9	90	6
7.	Shale	2	6	93	
8.	Sandy shale	14		107	
9.	Dark shale	3		110	
10.	Light shale	12		122	
11.	Red shale	2		124	
12.	Shale	4		128	
13.	Limestone	2		130	
14.	Black fissile shale, "slate"	6		136	
15.	*Coal* (White Breast)		6	136	6
16.	Shale	20	6	157	
17.	Dark shale	2		159	
18.	Shale	14		173	
19.	Limy shale	13		186	
20.	Limestone	3		189	
21.	Shale	2		191	
22.	Black fissile shale, "slate"	4		195	
23.	*Coal* (about No. 11 of Columnar Section)		6	195	6
24.	Shale	4	6	200	
25.	Red shale	4		204	
26.	Sandy shale	7		211	
27.	Sandstone	6		217	
28.	Shale	7		224	
29.	Sandy shale	11		235	
30.	*Coal* (about No. 7 of Columnar Section)	1	5	236	5
31.	Shale		7	237	
32.	Sandstone	8		245	
33.	Sandy shale	8		253	

34.	Black slaty shale	37	8	290	6
35.	Black rock	1	6	292	
36.	*Coal* (Lower)	3	4	295	4
37.	Fire clay		8	296	

Total depth 296 feet.
Bottom of hole 664 feet above sea level.
Top of Lower coal 668 feet above sea level.

Drill section No. 26. 200 feet west of center of sec. 25, White Breast township.

Curb elevation 960 feet above sea level (?)

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Drift	60		60	
2.	Yellow clay of Coal Measures	29		89	
3.	Shale	5		94	
4.	*Coal* and shale	1	6	95	6
5.	Shale	4	6	100	
6.	White shale	12		112	
7.	Black shale	4		116	
8.	*Coal* (White Breast ?)	1	2	117	2
9.	Shale	9	10	127	
10.	Limestone	2		129	
11.	Shale	18		147	
12.	Red shale	7		154	
13.	Shale	4		158	
14.	Limestone	2		160	
15.	Shale	46		206	
16.	Black shale—slate	5		211	
17.	*Coal*	1		212	
18.	Shale	8		220	
19.	Rock	2		222	
20.	Sandy shale	12		234	
21.	Sandstone	11		245	
22.	Sandy shale with sandstone partings	45		290	
23.	*Coal* (Horizon of Lower coal)		6	290	6
24.	Shale	13	6	304	
25.	Red shale and rock	6		310	
26.	Red shale	11		321	
27.	Sandstone	25		346	
28.	Light sandy shale	3		349	
29.	Sandstone	12		361	
30.	Light sandy shale	18		379	
31.	Sandy shale	12		391	
32.	Sandstone	9		400	

Total depth 400 feet.
Bottom of hole 560 feet above sea level.
Top of coal (No. 23) 670 feet above sea level.

Drill section No. 29. Shaft of Daniel's (Big Hill) mine near railway track at Lucas.

Curb elevation 900 feet above sea level.

		THICKNESS Ft.	DEPTH Ft.
1.	Alluvium, etc.	10	10
2.	Blue shale	10	20
3.	Light clay, "mud", may be fire clay	4	24
4.	Blue shale	25	49
5.	*Coal*	1½	50½
6.	Fire clay	6½	57
7.	Shale	42	99
8.	*Coal*	2	101
9.	Fire clay and clay shale	12	113
10.	Shale	125	238

11.	Sandstone and shale, "slate"	40		278	
12.	*Coal* (Lower or "Thick Vein"), irregular	3–9			
13.	Fire clay				
	Top of coal (12) 622 feet above sea level.				

Drill section No. 32. Southeast corner of SW. ¼ of SW. ¼, sec. 36, English township.

Curb elevation 976 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Surface soil	27		27	
2.	Sand	8		35	
3.	Clay	23		58	
4.	Gravel	3		61	
5.	Sand clay and gravel	51		112	
6.	Hard blue rock	1		113	
7.	Hard dark shale	12		125	
8.	Hard blue rock		9	125	9
9.	Hard dark shale	7	3	133	
10.	Hard medium dark shale	7		140	
11.	Soft medium light shale	4		144	
12.	Hard medium light shale	4		148	
13.	Limestone		6	148	6
14.	Hard dark shale	3	6	152	
15.	*Coal* (No. 11 of Columnar Section)	1	3	153	3
16.	Soft light shale	3	9	157	
17.	Hard limy shale	2		159	
18.	Soft light shale	4		163	
19.	Soft light sandstone	6		169	
20.	Soft medium dark shale	5		174	
21.	Hard medium dark shale	3		177	
22.	*Coal* (No. 7 of Columnar Section)		6	177	6
23.	Soft medium light shale	4	6	182	
24.	Hard medium dark shale	6		188	
25.	Hard medium light shale	3		191	
26.	Hard medium dark shale	5		196	
27.	*Coal* (No. 5 of Columnar Section)	1		197	
28.	Hard medium dark shale	39	9	236	9
29.	*Coal* (Lower)	5	4	242	1
30.	Hard dark fire clay	11		243	
31.	Medium hard light fire clay	2		245	
	Total depth 245 feet.				
	Bottom of hole 736 feet above sea level.				
	Top of coal (29) 739 feet above sea level.				

Drill section No. 33. Near center east side sec. 35, English township, 20 feet below the upland.

Curb elevation 986 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Surface soil	31		31	
2.	Blue clay	19		50	
3.	Sand with clay streaks	57		107	
4.	Gravel and bowlders	2		109	
5.	Quicksand	25		134	
6.	Soft clay shale	5		139	
7.	Hard medium dark shale	1		140	
8.	Hard fossiliferous limestone		8	140	8
9.	Hard medium dark shale	5	4	146	
10.	Hard dark shale	4		150	
11.	Soft light shale (limestone nodules)	6		156	
12.	Medium light hard shale	4		160	

13.	Hard variegated shale	5		165	
14.	Medium light hard shale	11		176	
15.	Hard medium dark shale	5		181	
16.	*Coal*		6	181	6
17.	Fire clay	3	6	185	
18.	Soft medium light shale (Limestone nodules)	11		196	
19.	Medium soft variegated shale	4		200	
20.	Hard medium dark shale	3	10	203	10
21.	*Coal*		9	204	7
22.	Medium hard medium dark shale	4		208	7
23.	Soft light shale	4		212	7
24.	Soft light sandstone	7	5	220	
25.	Hard medium dark shale	10		230	
26.	Sandstone	3		233	
27.	Hard medium dark shale	8		241	
28.	*Coal*	1	6	242	6
29.	Medium light medium hard sandstone	1		243	6
30.	Soft light sandstone	3		246	6
31.	Hard dark shale	14		260	6
32.	Hard medium dark shale (streaked)	3		263	6
33.	Hard blue rock	1		264	6
34.	Hard medium dark sandy shale	3		267	6
35.	Sandstone	4		271	6
36.	Streaked sandy shale	14		285	6
37.	Hard medium dark sandy shale	12		297	6
38.	Soft light sandstone	3		300	6
39.	Hard blue rock	1		301	6
40.	Hard medium dark shale sand streaks	44		345	6
41.	Hard light sandstone	2	6	348	

Total depth 348 feet.
Bottom of hole 638 feet above sea level.

Drill section No. 34. Near center (NW. of) sec. 24, English township.

Curb elevation 899 feet above sea level.

		THICKNESS		DEPTH	
		Ft.	*In.*	*Ft.*	*In.*
1.	Surface soil and clay (alluvium ?)	16		16	
2.	Shale, medium hard, light and dark	33		49	
3.	*Coal* (Wheeler ?)	1	1	50	1
4.	Shale, hard, light	8	11	59	
5.	Limestone, hard, may be Two Layer	1	6	60	6
6.	Shale, hard, light, lower part variegated	11	6	72	
7.	Limestone		6	72	6
8.	Shale, hard and medium dark	4	6	77	
9.	*Coal*, may be White Breast		9	77	9
10.	Shale, medium light, soft and hard	12	3	90	
11.	Sandstone	3		93	
12.	Shale, hard, medium dark	7	7	100	7
13.	*Coal*		5	101	
14.	Shale, medium hard, medium light and dark	11	6	112	6
15.	*Coal*	1	6	114	
16.	Sandstone, light	2		116	
17.	Shale, hard and medium dark	45	6	161	6
18.	Shale, carbonaceous	1	3	162	9
19.	*Coal*, middle 18 inches slaty and bony	6	10	169	7
20.	Sandstone, light	7	5	177	
21.	Shale, medium hard, light, sandy	8		185	
22.	Shale, hard, dark	3		188	
23.	Shale, limy	1	6	189	6
24.	Shale, light, sandy	1		190	6
25.	Sandstone	1	6	192	
26.	Shale, limy	1		193	

		Ft.	In.	Ft.	In.
27.	Shale, hard, medium dark, sandy	3		196	
28.	Sandstone	3		199	

Total depth 199 feet.
Bottom of hole 700 feet above sea level.
Top of Lower coal 735 feet above sea level.

Drill section No. 37. Middle north side of NE. ¼ sec. 23, English township.

Curb elevation 932 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Surface soil and loess (?)	10		10	
2.	Sand and clay	14		24	
3.	Blue clay (drift)	36		60	
4.	Shale, soft, dark	6		66	
5.	*Coal*		6	66	6
6.	Shale, light, medium hard	12	6	79	
7.	Shale, hard and medium light	3		82	
8.	Shale, soft and variegated	2		84	
9.	Limestone	1		85	
10.	Shale, hard, medium dark	5		90	
11.	*Coal*		6	90	6
12.	Shale, hard, medium dark	1	6	92	
13.	Shale, soft, medium light, limestone nodules	6		98	
14.	Shale, medium soft, variegated	7		105	
15.	Shale, hard, light, sandy	3		108	
16.	Shale, hard, medium dark	11		119	
17.	*Coal*		6	119	6
18.	Shale, hard, dark	7	6	127	
19.	*Coal*	1	3	128	3
20.	Shale, hard, medium dark	30		158	3
21.	*Coal*	3	9	162	
22.	Sandstone, medium hard, light	1		163	
23.	Shale, medium hard, light, sandy	5		168	
24.	Rock, hard, gray	2		170	
25.	Shale, hard, light	3		173	
26.	Rock, hard, gray		3	173	3
27.	Shale, medium light, sandy	3	4	176	7
28.	Shale, medium dark	6		182	7
29.	Limestone, hard	1		183	7
30.	Shale, medium dark, banded	17		200	7
31.	Sandstone, shale bands	10	5	211	

Total depth 211 feet.
Bottom of hole 721 feet above sea level.
Top of coal (21) 774 feet above sea level.

Drill section No. 38. North of center of NW. ¼, sec. 32, English township.

Curb elevation 966 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Surface soil	18		18	
2.	Soft clay	9		27	
3.	Soft clay shale	11		38	
4.	Soft medium light shale	3		41	
5.	*Coal* (Wheeler)	1		42	
6.	Soft medium light shale	9		51	
7.	Limestone, Two Layer	1		52	
8.	Soft medium dark shale	6		58	
9.	Limestone	1	(?)	59	
10.	Dark shale	1		60	
11.	*Coal* (White Breast), two layers separated by 1 foot carbonaceous shale	3		63	
12.	Soft, light shale	10		73	

		Ft.	In.	Ft.	In.
13.	Soft variegated shale	2		75	
14.	Soft light shale	4		79	
15.	Medium hard variegated shale	5		84	
16.	Medium soft medium dark shale	3	10	87	10
17.	*Coal*	1	2	89	
18.	Hard light sandy shale	5		94	
19.	Hard medium dark shale	8		97	
20.	*Coal*		6	97	6
21.	Soft medium light shale	10	6	108	
22.	Hard medium dark shale	5		113	
23.	*Coal*	1	6	114	6
24.	Soft medium light shale	3		117	6
25.	Limestone	1	6	119	
26.	Soft light shale	4		123	
27.	Medium soft variegated shale	5		128	
28.	Soft light sandy shale	2		130	
29.	Hard dark shale	5		135	
30.	Medium soft sandstone	5		140	
31.	Limestone	2		142	
32.	Hard medium light shale	6		148	
33.	Hard medium dark shale	2		150	
34.	Carbonaceous shale	2		152	
35.	Hard medium dark shale	66		218	
36.	Sandstone	16		234	

Total depth 234 feet.
Bottom of hole 732 feet above sea level.

Drill section No. 39. Near south center sec. 32, English township.

Curb elevation 865 feet above sea level.

		THICKNESS Ft.	In.	DEPTH Ft.	In.
1.	Sandy soil	12		12	
2.	Sand and gravel	5		17	
3.	Soft light shale	7		24	
4.	Medium soft dark shale	2		26	
5.	Medium soft light shale	15		41	
6.	Limestone	1		42	
7.	Medium soft light shale	8		50	
8.	*Coal*	2		52	
9.	Soft medium light shale	6		58	
10.	Medium hard light sandstone	9		67	
11.	Medium hard dark shale	8		75	
12.	*Coal*		6	75	6
13.	Soft light shale	1	6	77	
14.	Dark shale with coal bands	2		79	
15.	Light sandy shale	16		95	
16.	Hard medium dark shale	20		115	
17.	Hard blue rock	1		116	
18.	Hard dark shale	2		118	
19.	Hard medium dark shale	25	6	143	6
20.	*Coal* (Lower)	4	9	148	3
21.	Medium soft medium dark shale		3	148	6
22.	Medium hard light sandy fire clay	1		149	6

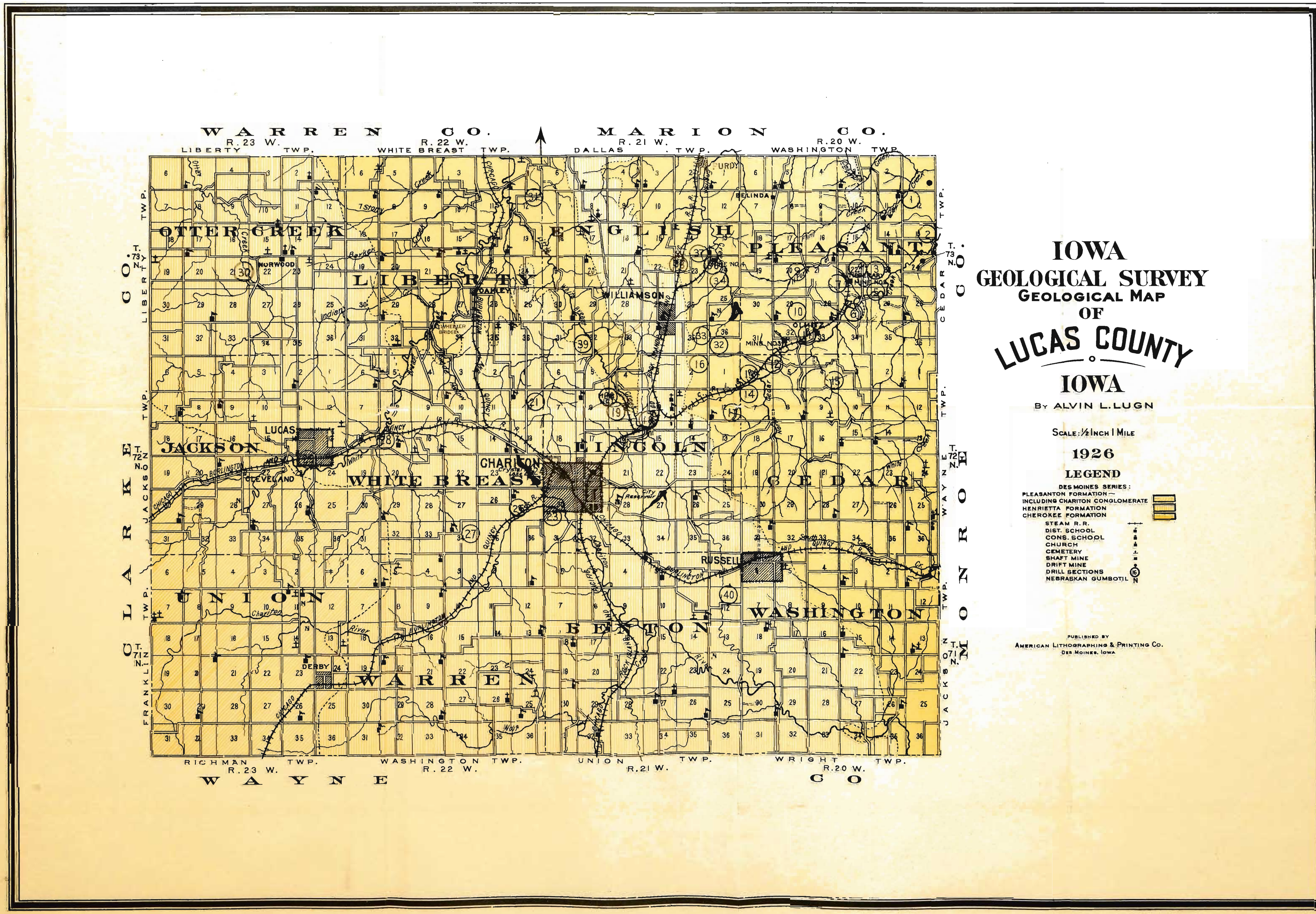
Total depth 149 feet, 6 inches.
Top of coal (20) 721 feet, 6 inches above sea level.
Bottom of hole 714 feet, 6 inches above sea level.

The Cackler mine shaft. Northeast corner of section 2, Otter Creek township.

Curb elevation 960 feet above sea level.

		Feet
1.	Clay and gravel	10 to 12
2.	Shale, blue	5
3.	Rock, hard	12
4.	*Coal*	1/3
5.	Shale, sandy and with limestone bowlders	8
6.	Limestone (?)	8
7.	? (record uncertain)	14
8.	Shale	5
9.	*Coal*	1/3
10.	Fire clay	2
11.	Clay, blue-gray	2
12.	Shale	6
13.	*Coal*	1½ to 2⅓

Total depth 76 feet.


IOWA
GEOLOGICAL SURVEY
GEOLOGICAL MAP
OF
LUCAS COUNTY
IOWA
BY ALVIN L. LUGN
SCALE: ½ INCH 1 MILE
1926
LEGEND
DES MOINES SERIES:
PLEASANTON FORMATION — INCLUDING CHARITON CONGLOMERATE
HENRIETTA FORMATION
CHEROKEE FORMATION
STEAM R.R.
DIST. SCHOOL
CONS. SCHOOL
CHURCH
CEMETERY
SHAFT MINE
DRIFT MINE
DRILL SECTIONS
NEBRASKAN GUMBOTIL
PUBLISHED BY
AMERICAN LITHOGRAPHING & PRINTING CO.
DES MOINES, IOWA
WARREN CO.
MARION CO.
R. 23 W.
R. 22 W.
R. 21 W.
R. 20 W.
LIBERTY TWP.
WHITE BREAST TWP.
DALLAS TWP.
WASHINGTON TWP.
CLARKE CO.
MONROE CO.
WAYNE CO.
RICHMAN TWP.
WASHINGTON TWP.
UNION TWP.
WRIGHT TWP.
T. 73 N.
T. 72 N.
T. 71 N.
OTTER CREEK
ENGLISH
PLEASANT
LIBERTY
JACKSON
LINCOLN
WHITE BREAST
CEDAR
UNION
BENTON
WASHINGTON
WARREN
LUCAS
CHARITON
CLEVELAND
RUSSELL
DERBY
NORWOOD
WILLIAMSON
OAKLEY
BELINDA
OLMITZ
PURDY
CHICAGO BURLINGTON AND QUINCY
Chariton River
White Breast Creek

GEOLOGY OF CRAWFORD COUNTY

BY

JAMES H. LEES

CONTENTS

ILLUSTRATIONS

GEOLOGY OF CRAWFORD COUNTY

Introductory

Location and Area.—Crawford county lies immediately west of the Mississippi-Missouri divide and is separated from Missouri river by only one county—Monona—which forms its western boundary. It lies in the middle east-west tier of counties and is therefore practically equidistant from the north and south boundaries of the state. Ida and Sac counties form the northern border of Crawford, Carroll bounds it on the east and on the south are Shelby and Harrison counties.

When Doctor White was making his survey of western Iowa in the late sixties he stated that Crawford county comprised sixteen congressional townships and had an area of 576 square miles. The map which accompanies his report, however, shows the county as having the same area as at present, twenty congressional townsips. Each of these townships is conterminous with a civil township and the area embraced within the county is 720 square miles. The county embraces townships 82 to 85 north and ranges 37 to 41 west.

History.[1]—In 1830 the area of Crawford county was first ceded to the United States by treaty with the Sacs and Foxes and other Indian tribes. It remained in an unorganized condition, however, until 1851, when by act of the legislature its boundaries were defined and it was named in honor of William Harris Crawford, at one time senator from Georgia, and Secretary of the Treasury of the United States. The county was then attached to Shelby county. It became an independent organization in 1855, the county seat being located at Denison, a town founded by the Providence Western Land Company, of Providence, Rhode Island, and named in honor of its agent, J. W. Denison. The county then contained sixteen government townships. In 1865, by joint action, four townships were detached from Monona county and added to the west boundary of Crawford county,

[1] The outline of Crawford county history was kindly furnished by Mr. F. W. Meyers, formerly of Denison, who has written a comprehensive history of the county.

since which time the county lines have remained unchanged. The first permanent settlement was made in 1849 by Cornelius Dunham and Franklin Prentice, at Dunham's Grove, six miles east of Denison. The next settlement was made by Jesse Mason at Mason's Grove, in the vicinity of Deloit. Among the earliest settlers were Benjamin Dobson, Thomas Dobson, John R. Bassett, the first county judge, J. W. Denison, H. C. Laub, Morris McHenry, and S. E. Dow, after whom the town of Dow City is named. The first telegraph line was in 1866 and this was followed in 1867 by the building of the Chicago & North Western railroad. The first newspaper was the Boyer Valley Record, published in 1861. It was succeeded in 1867 by the Denison Review. Prominent names in Crawford county's history are Governor Leslie M. Shaw, Congressman J. P. Conner, Colonel Alonzo Abernethy, J. Fred Meyers, W. A. McHenry, Carl F. Kuehnle, J. B. Romans, Charles Bullock and P. E. C. Lally.

Previous Geological Work.—The earliest geological studies in this area were carried on by Orestes H. St. John in 1867, under the direction of Doctor Charles A. White, at that time State Geologist of Iowa. St. John was instructed to make a reconnoissance of that part of the state embraced within the fourth, fifth and sixth tiers of counties lying between Des Moines and Missouri rivers and the prosecution of his work necessarily led him over Crawford county. The results of his study were transmitted to his chief and published in the Second Annual Report of Progress of the State Geologist for 1867 under the title "Geology of the Middle Region of Western Iowa."[2] Frequent mention is made of Crawford county and its various natural features—streams, topography, geological formations and forests. The loess of western Iowa was described by St. John, as well as by other workers of his day, under the name of the Bluff formation, an appelation derived from the great development of the formation on the Missouri bluffs. St. John also recognized the presence of the drift, although there is no evidence that he distinguished more than one stage. The evidence of the lacustrine origin of the "Bluff" was considered conclusive. On this point St. John says:[3] "The fine nature of the material which

[2] First and Second Ann. Rept. Progress by State Geologist, etc., pp. 191-201, Des Moines, 1868.
[3] Op. cit.: p. 193.

comprises the bluff seems to furnish conclusive evidence of its lacustrine origin. On the other hand, the coarse materials which enter so largely into the composition of the drift, were deposited at the bottom of the great fresh-water sea at the close of the glacial period." St. John makes particular mention of the gravel deposits at and near Denison, which, he states, were utilized for making concrete brick, and some of which were sufficiently indurated to be used for building up rough walls. He also recognizes and comments upon the sharp distinction between the mature erosional type of topography so typically developed in Crawford county and the youthful constructional phase presented in Sac county, with its absence of the "Bluff" and its abundance of surface bowlders and drift ridges.

In the final report of the State Geologist[4] White describes the rivers which drain Crawford county, although the county is not mentioned by name. The Drift and the Bluff deposit also are discussed in this volume.

In the same report[5] St. John devotes several pages of his discussion of the "Geology of the Middle Region of Western Iowa and Other Counties" to a résumé of the surface features and geology of Crawford county. He describes briefly the streams, surface configuration, soils and forests of the county and speaks of the presence of the Drift, the gravels and the Bluff Formation. The absence of exposures of the indurated rocks underlying these loose deposits is noted and the author wisely remarks that: "Of the coal-measure series, even if it does underlie the area embraced in Crawford county, the productive or Lower formation probably lies at so great a depth beneath the surface as to render its development for the present impracticable." The accuracy of St. John's observations has been abundantly proved by subsequent developments.

St. John also urges the advisability of tree planting to provide fuel. The cessation of prairie fires since his day makes the carrying out of his advice especially easy and its wisdom will not be questioned.

The earlier workers in Iowa—Owen and Hall—did not extend their labors to this part of the state, nor have the investigators

[4] Geology of Iowa, C. A. White, vol. I, pp. 48-51; 1870.
[5] Idem, vol. II, pp. 168-171.

of the present Survey until recently attacked the problems of Crawford county, since the field offers but little of special interest to the student of economic problems.

Several of the bordering counties have received attention at the hand of the workers on the Iowa Geological Survey. Carroll county was surveyed by Bain,[6] Sac and Ida counties by Macbride,[7] Woodbury by Bain,[8] and Shimek a few years ago discussed Harrison and Monona counties.[9] Shelby and Audubon counties are still under investigation.

Kay has described the splendid exposures of glacial drift along the main line of the Chicago, Milwaukee and St. Paul Railway as these are located in this county. His descriptions are found in a paper entitled "Pleistocene Deposits between Manilla in Crawford County and Coon Rapids in Carroll County, Iowa," which appears in volume XXVI of these reports.

Calvin and Shimek described various deposits of gravels which they considered to be of Aftonian age and they discussed the abundant mammalian remains found therein. Some of these remains came from the gravel pits near Denison. The papers of Calvin and Shimek are found in Volumes XX and XXI of the Bulletins of the Geological Society of America.

6 H. F. Bain, Iowa Geol. Survey, vol. IX, p. 51.
7 T. H. Macbride, Op. cit., vol. XVI, p. 509.
8 H. F. Bain, Op. cit., vol. V, p. 241.
9 B. Shimek, Op. cit., vol. XX, p. 271.

PHYSIOGRAPHY

Topography

Topographically Crawford county forms part of a great upland plain which includes all of western Iowa. This statement needs qualification insofar as the main drainage courses are concerned, since they have assumed the form of flat bottom lands. But these are relatively an unimportant topographic feature and hence the first statement practically covers the conditions. This upland plain, as here defined, is drained into Missouri river as distinguished from that part of the Iowa prairies which slopes toward and whose run-off finds its way into the Mississippi. The dividing line between these two drainage areas—the Missouri-Mississippi watershed—extends across western Carroll county within two or three miles of the Crawford-Carroll boundary as far south as the southern boundary of Arcadia township whence it swings southeastwardly to the middle of the south county line. The towns of Arcadia and Templeton are situated on this divide and the rains which fall in their immediate vicinity find their way eastward to the Mississippi or westward to the Missouri according as they fall to the east or west of these towns.

The Height of Land.—Under these conditions we should expect to find a more or less uniform slope from the divide across Crawford county to the west and southwest. And this is in part true as will be seen from an inspection of the list of altitudes for the county. Yet we shall scarcely be prepared for the discovery that there are within the county many points which have an elevation considerably above that of the divide as that feature is developed in Carroll county and indeed above the surface of the divide for some distance north or south of Carroll county. But that this is the case may be shown by comparing a series of elevations along the watershed with a similar series to the west. Thus the former series from north to south gives, in feet above sea level: Alta, 1514; two miles east of Early, 1388; two miles west of Lake View, 1370; uplands north of Arcadia, 1476; two miles southwest of Halburn, 1414; Templeton, 1431; Adair, 1398 at the station, increased to nearly 1500 feet on the uplands. Between Templeton and Adair no figures are available but it is not likely that the elevation is any higher than that of Adair since the town crowns the summit of the watershed and erosion has been very active along the flanks of the divide in Guthrie and Audubon counties.

West of Alta the highest point on the Illinois Central railroad is 1459 feet at Cleghorn. The highest land here seems to coincide nearly with the divide. West of Early on the Chicago & North Western railway we have: one mile east of Schaller, 1440, and one mile west of Holstein, 1456. The uplands around Schaller are somewhat higher than the highest point on the railroad. Holstein is built on the highest land in the region, as was noted by Macbride.[10] He also described a series of hills representing this plateau which extend southeastwardly across Ida and Sac counties and into Carroll county. It is also doubtless represented in Crawford by the high upland ridges and divides of the eastern and central parts.

Continuing southward, however, we find that the highlands north of Ida Grove reach an elevation of 1500 feet, while the divide between Maple and Soldier rivers rises to nearly the same level. Further east along the extension of this same ridge the prairie immediately east of Odebolt rises to 1415 feet as compared with the 1370 feet west of Lake View on the main divide, which here also separates the waters of the Boyer from those of North Raccoon river and its tributaries. Whereas the high points of northwest Carroll rise to 1476 feet those to the west in Crawford rise to 1500 feet in central Jackson township and to greater heights in Morgan township a mile or two west of Schleswig. A number of points in Crawford county must approach or reach elevations of fifteen hundred feet, such for instance as the uplands in central Hays township, those in the northeast part of Washington township, in southwest Paradise township, and in Willow township two miles south of Ute. The divide between Botna and Aspinwall reaches about fifteen hundred feet, about fifty feet higher than Templeton. Around Manning the hills

---

10 T. H. Macbride, Geology of Sac and Ida Counties: Iowa Geol. Survey, vol. XVI, pp. 514, 515.

rise 175 feet above West Nishnabotna river which here flows at about 1320 feet above sea level.

If we wish to carry this study to the northern part of the state we find the following altitudes north of the Illinois Central. Along the Chicago & North Western: Laurens, 1313 feet; Marathon, 1392—where the road crosses the divide; Sioux Rapids, 1278, in the valley of Little Sioux river; a mile west of Sutherland, 1480; a mile north of Gaza, 1520; Granville, 1447; Orange City, 1411. Along the Chicago, Milwaukee & Saint Paul: Crippen, 1260 feet; Ruthven, 1428—at the divide; Hartley, 1456; Sanborn, 1547; Sheldon, 1409; Perkins, 1455; near Big Sioux river, 1463. If we follow the line of the Chicago, Rock Island & Pacific from Laurens to Sibley we get the following altitudes: Laurens, 1303 feet; Leverett, 1365—on the divide; Maclay, 1365; Royal, 1417; Hartley, 1465; Plessis, 1522; Melvin, 1585; Sibley, 1522. A line of altitudes across the northern tier of counties shows: Armstrong, 1249 feet; Gruver, 1311; Raleigh, 1440; Divide Spur, 1548; Spirit Lake, 1465; Lake Park, 1469; Ocheyedan Mound, about 1670; upland northeast of Sibley, about 1670; Worthington, Minnesota, 1585; Ellsworth, Minnesota, 1455; Larchwood, 1468; Granite, one mile south of, 1440; Sioux Falls, South Dakota, 1405. A north-south series of elevations near the divide runs as follows: Huntington, 1345 feet; Divide Spur, 1548; Raleigh, 1440; Terrill, 1415; Ruthven, 1432; Webb, 1368; Marathon, 1392; Rembrandt, 1332; Truesdale, 1359; Storm Lake, 1442; Alta, 1514; Early, 1388. Compare this with a similar series farther west, as follows: Sibley, 1522; Melvin, 1585; Sanborn, 1547; Primghar, 1504; Gaza, 1508; Cleghorn, 1459; Holstein, 1456; near Schleswig, about 1535; or near Schaller, 1440; near Odebolt, 1380; central Jackson township, Crawford county, about 1500 feet.

This multiplicity of figures cannot fail to show that there is a gradual increase in the elevation of the surface of northwestern Iowa from the east to a region some distance beyond the watershed whence there is a gradual decline toward the Missouri and Big Sioux. This divergence of the watershed and the region—it cannot be considered as a line—of greatest altitude does not seem to be continued northward beyond Worthington in southern Minnesota, and apparently the two come into closer coincidence toward the south where they approach the main line of the Rock Island Railway, in the latitude of Adair. There is a secondary watershed which leaves the main one near Greenfield and passes through Creston and Mount Ayr. This is higher than the main divide but it is to be noted that it *is* a watershed, that in Iowa at least, no streams cut through it, although streams do rise on both flanks. Herein it differs essentially from the high land of western and northwestern Iowa.

There are, then, two questions which call for solution. First, why should the surface continue to rise to the west of the divide instead of sloping down toward the great river to the west? This is a most anomalous condition and seems to be in direct contradiction to the law of stream divides. Second, why have the larger streams cut through this high land and why do they now head on lower ground to the east, near the dividing line between the two major river systems? Why should they not all, as indeed some of them do, take their rise on the western slopes of this highland and thus place the divide where it seems to belong? This is in part a restatement of the first question, since the answer to it involves the location of the divide. But there are other elements in the question which make it advantageous to discuss it apart from the first.

Let it be understood that the problem is not complicated by warpings or other disturbances of the underlying strata. The formation immediately under the glacial drift lies essentially horizontal and rests upon the edges of an older series of rocks which dip gently to the east or southeast. Therefore the superior elevation of any point must be due to the greater thickness of either the indurated rocks or the superficial materials. It is true, of course, that there is a gradual elevation of the surface from the Mississippi across the Great Plains to the Rocky mountains. And this is without doubt one of the factors in the problem. But as will be seen later the surface of the indurated rock is at about the same elevation wherever it has been reached by wells in Crawford county, with one or two exceptions. This indicates a thickening of the overlying clays and other surface deposits in order to make up the increase in elevation. As the valley of the Missouri is approached the surface naturally slopes off to the southwest, due both to a lowering of the rock surface and to the thinning of the overlying material, probably by erosion in part. It may well have been that in Pleistocene time, when the continental ice-field covered Iowa, it left a greater thickness of detrital material along this strip of prairie extending from Osceola county to Crawford county and perhaps beyond, than was deposited either to the east or to the west. An inspection of the geological sections given in Norton's reports on the Artesian Wells of Iowa[11] will sustain this hypothesis. The answer to the first question is, then, that the greater elevation west of the divide is due very largely to an increase in thickness of the superficial deposits[12] and in lesser amount to the natural slope from the Mississippi upward toward the Rockies.

Passing to the second question, the reason for the streams taking their rise east of the "height of land" we note that along most of the region we are discussing the divide is approximately parallel with and very close to a line marking the margin between two regions of very mature and very immature drainage respectively. These will be described later as the areas of the Kansan and the Wisconsin drifts. Now the streams on the western side of this line, in the Kansan drift area, have been at work making their valleys and cutting down the hills for long, long centuries. The rivers and creeks of the Wisconsin area, on the contrary, began their work only a comparatively short time ago. Studies of these two areas in different parts of Iowa have led Doctor Kay to the conclusion that if we consider the time since the streams of the Wisconsin area began their work as unity then the age of the Kansan streams will be more than one hundred sixty times as great. In other words the streams to the west of the Wisconsin drift margin, or of the watershed, which amounts to practically the same thing, have been at work more than one hundred sixty times as long as have those to the east of these lines. Doubtless when the tributaries of Missouri river began to run they headed on the western slopes of this high ground described as extending from Osceola to Crawford counties. But all through the centuries and milleniums they have been cutting back and lengthening out by headward erosion until some of

11 W. H. Norton, Iowa Geol. Survey, vol. VI, opp. pp. 178, 202, 236. Also vol. XXI, opp. pp. 310, 458.

12 For further discussion of this point see the description of the Kansan Drift, under head of Stratigraphy.

them have worked entirely across the height of land, and those which have not yet attained this end are working toward it as fast as they can. Two continental glaciers have invaded central Iowa since these streams began their erosive action and the floods of water accompanying the melting of these glaciers may have aided somewhat in this work.

On the contrary the upper parts of Des Moines river and its tributaries have had only a short time to work and have not advanced very far toward making wide valleys or toward lengthening their courses. Probably these streams were very nearly as long immediately after the retreat of the Wisconsin glacier as they are now. Moreover the Des Moines has but a few tributaries while the Missouri has many. The area of the Wisconsin drift may be distinguished on a map by this difference in its drainage conditions.

A study of the stream gradients does not throw much light on the problem but the evidence may be reviewed briefly. Des Moines river rises in Minnesota at an elevation of about 1850 feet. The fall to the state line, 100 miles, is 600 feet or 6.00 feet per mile. Between here and Fort Dodge, 100 miles, the valley drops from 1250 to 975 feet, an average of about three feet per mile. If the sinuosities of the stream be considered the fall is between one and one-half and two feet per mile. In Humboldt county the valley gradient is increased to eight and one-half feet per mile.[13] From Fort Dodge to Des Moines the river falls in about eighty miles practically 200 feet or 2.5 feet per mile. From here to the mouth, 201 miles, the fall is 301 feet or about 1.5 feet per mile.[14]

The only tributaries of large size from the west above Des Moines are the Raccoon rivers. The North Raccoon falls from 1430 feet at Storm Lake to 780 at Des Moines, a drop of 650 feet in about 135 miles, or a gradient of 4.8 feet per mile. The Middle Coon rises near Arcadia at an altitude of about 1400 feet and falls 620 feet in its course of about 100 miles. North Coon is entirely within the Wisconsin drift area while Middle Coon is almost entirely outside this area, just along its margin.

13 Rept. Iowa State Drainage, Waterways and Conservation Commission, pp. 67-69, 123; 1910.

14 See Letter from Secretary of War, transmitting Reports on Examination and Survey of Des Moines River. 62d Congress, 3d Session, H. R., Doc. No. 1063, pp. 4, 49, 82. Ordered printed Dec. 6, 1912.

Passing to the western side of the state we find that the Big Sioux falls 300 feet in the approximately 100 miles of its course between Sioux Falls and Sioux City. The altitude of the river at Sioux Falls is about 1400 feet. Below the falls the water level will certainly be twenty-five feet less. Low water in the Missouri at Sioux City is 1076 feet. From the mouth of the Big Sioux to Council Bluffs the main river has a course of 137 miles, in which it falls only 114 feet, less than a foot per mile. Todd[15] states that in the Elk Point quadrangle, north of Sioux City, the Big Sioux has a fall of two feet per mile and the Missouri one of six inches per mile.

Rock river, the only considerable tributary of the Big Sioux, falls along the eighty-five miles of its course, from an altitude of 1850 feet at the crest of the Coteau des Prairies in Minnesota to 1180 at its mouth, an average of 7.9 feet per mile. Floyd river falls from 1550 feet to 1076 feet, an average of 6.6 feet for each of the seventy miles of its course. The Little Sioux rises at an elevation of 1500 feet and flows 185 miles to its junction with the Missouri at an elevation of 1020 feet. Its fall is about 2.55 feet per mile. The Boyer falls from 1450 feet to 980 feet in 105 miles, a fall of 4.5 feet per mile. West Nishnabotna river rises at about 1450 feet in southwestern Carroll county and reaches the Missouri 135 miles away at an elevation of 870 feet, a fall of 580 feet or 4.3 per mile. The Nodaway at its head near Adair is about 1375 feet above sea level and at its mouth is 830 feet above sea level. It falls 545 feet in 135 miles, or four feet per mile. Of these streams the Nishnabotna, the Boyer and the Little Sioux head near the divide, and have cut through and across the high land to the west of this line to take their rise on the eastern side of the ridge. Rock river system rises on the western slope of the Coteau des Prairies in southwestern Minnesota, where the highest land is coincident with the stream divide, north of Worthington. It is significant that Floyd and Maple rivers, both of whose gathering grounds are strictly limited by their neighboring systems, have not cut across the high land but still head on its western slope. Really, the divide is not a ridge but merely a sinuous

15 Todd, J. E., U.S. Geol. Survey Geol. Atlas, Elk Point folio (No. 156), South Dakota, Nebraska, Iowa, 1908.

strip on a sloping plain where the feeders of the two great river systems have their sources.

The statements given above are incorporated in the appended table.

Mississippi System.

Name	Length, miles	Elevation From	To	Fall	Gradient
		Feet	*Feet*	*Feet*	*Feet per mile*
Des Moines	100, source to state line	1850	1250	600	6.0
Des Moines	100, to Fort Dodge	1250	975	275	2.75
Des Moines	80, to Des Moines	975	778	200	2.5
Des Moines	201, to Mississippi R.	778	477	301	1.5
North Raccoon	135	1430	780	650	4.8
Middle Raccoon	100	1400	780	620	6.2
Average gradient					3.96

Missouri System.

Big Sioux	100, Sioux Falls to Sioux City	1375	1076	300	3.0
Missouri	137, Sioux City to Council Bluffs	1076	962	114	0.83
Rock	85	1850	1180	670	7.9
Floyd	70	1550	1076	474	6.6
Little Sioux	185	1500	1020	480	2.55
Boyer	105	1450	980	470	4.5
West Nishnabotna	135	1450	870	580	4.3
Nodaway	135	1375	830	545	4.0
Average gradient					4.21

The figures given above do not indicate much difference in the gradients of the streams flowing either way from the divide as these streams exist at present. It is probable that the streams emptying into the Missouri at one time headed on the western slope of the high ridge west of the present divide and that by reason of their high grades at that time they were able to cut back swiftly and thus they eventually cleft the ridge which formed the old divide and so caused the actual watershed to migrate eastward. The streams emptying into the Des Moines have not been working so long and in addition have not the cutting power given by high gradients in their upper reaches. Hence they have not been able to compete with the streams on the other side of the watershed.

Applying the problems within the limits of our own territory we find that the superior elevations of central Crawford county are due to the greater heaping up of the glacial drift here than farther east. We find also that the watershed, which doubtless once extended across this county, has been pushed farther and farther eastward until now those streams of the county which head near the divide have cut through the ridge and now rise either in the eastern townships, such as the West Fork of Nishnabotna river, or entirely beyond the limits of the county, as, for example, Boyer river. Several streams do rise on the western slope of the ridge. Some of these rise in Crawford, among them the branches of Willow creek and South and Middle Soldier rivers; others rise extraterritorially, as does the North Soldier. None of these are such large streams as the two first mentioned and while they have no doubt accomplished a large amount of erosion they have not yet been able to cut back so far across the ridge as have larger streams like the Boyer.

TOPOGRAPHIC PROVINCES

Crawford county may be divided into two topographic provinces, though these can nowhere be sharply set off one from the other. The first province extends from the east line of the county westward well into the fourth tier of townships, where it grades insensibly into the second province, which stretches across the western tier into Monona county. The first province is prevailingly a rather strongly rolling plain deeply dissected by the major streams and their tributaries. The character of the surface of this region is determined almost entirely by the action of running water on unconsolidated deposits. Nowhere have the streams cut down to solid rock and that even though they now run in some cases 300 to 350 feet below the tops of the ridges which separate the minor drainage systems. Doubtless the surface of Crawford county was once as level as is that of Greene or Calhoun counties today. But the waters of the region, acting through uncounted centuries, have so cut up this old level plain that today as one stands upon one of the high ridges that are all that remain of the former surface it seems as though there is nowhere a section of land, or indeed a quarter section, which approaches anything like flatness. Probably the area embracing a few square miles east and southeast of Schleswig is the largest surviving remnant of the original plain. See figure 37 for a view of this plain. Whether the surfaces of this and similar smaller areas actually coincide in level with the surface of the old plain is not, of course, definitely known, although it is possible that in the case of the largest ones they very nearly do so. Stream erosion has not yet reached all these surfaces, but it may be that sheet erosion and weathering have lowered the level somewhat. However, taken as a whole this province has a typical erosion topography and one that has reached a mature stage

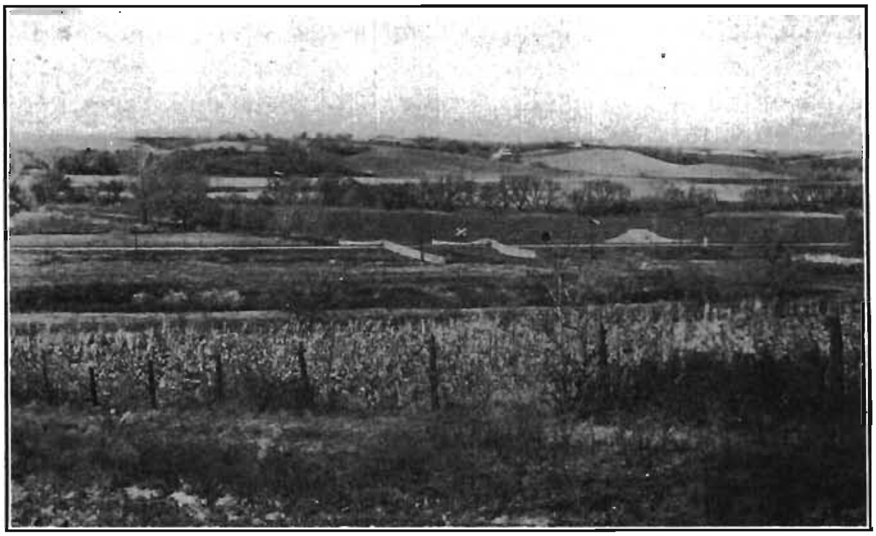


FIG. 34.—Looking west across Boyer valley above the junction with the East Boyer, in the west part of Denison.

of development. While most of the streams are still actively cutting away the land and transporting it to lower levels, yet some of them have formed flood plains of more or less importance which extend for considerable distances from their mouths. In the case of the largest stream of the county, Boyer river, this flood plain is a very well marked feature, stretching as it does entirely across the county. Figure 34 shows the valley at Denison. This stream has reached the stage where it is no longer reducing the surrounding country to any large extent but is devoting its energies chiefly to working over its valley filling. The real work of cutting down the land and carving out those forms typical of an erosion topography is being carried on by the smaller streams aided by water in sheet form. This latter is, of course, active during times of rain or melting snow and its function is a very important one, increasingly so in a land so rough as is most of our area.

Processes of Erosion.—These two agents—stream water and sheet water—have produced by their combined action the relatively short convex curves of the divides and upper hill-slopes and the long concave curves of the lower slopes and the stream valleys. These curves have been very thoroughly analyzed by Bain[16] and need be discussed only briefly here.

When sheet water runs over a surface which has any slope it tends to produce a curve which is convex since it carries away more and more material as its own volume, and hence its transporting power, increases. But when the water reaches a place where the slope is reduced the load will be deposited. This tends to build up a concave curve as most of the load is dropped where the velocity is first checked, and less and less material is carried beyond. In this way a compound curve is formed. If this agent alone be considered the curve will tend to flatten out by the cutting down of the upland and the building up of the lowland.

But every land surface shows some inequalities and the water flowing as a sheet is quickly gathered into the depressions. By this means its potential energy is concentrated and a channel is soon cut. If a channel be conceived as being originally a perfectly straight line it will soon become concave because at its mouth its velocity will be checked, both its erosive and its carrying powers will be diminished and its bed will be built up, or by continued cutting in the upper reaches a curvature will be produced. This curvature will be very gentle in the lower part of the stream but increasingly great as the source is approached, owing to several causes. At the immediate head of a stream the rills have little energy to either corrade or transport. This power increases as the volume is enlarged. Hence at some point there will be a maximum of (downward) channel cutting and this will mark the point of greatest concavity. The lengthening of a stream is accomplished by the rills at the head cutting back into

16 Bain, H. F., Relations of Wisconsin and Kansan Drift Sheets in Central Iowa, etc.; Iowa Geol. Survey, vol. VI, pp. 449-458; 1896.

and washing away the material of the surrounding land. This will tend to continue the concave curve backward. If the stream has a long course or its slope is gentle the upper reaches will have a low gradient. If, on the other hand, the streams are short or have a steep fall to their master stream the gradient at the gathering ground is correspondingly high. This is very well brought out by many of the streams of Crawford county. For example most of the streams tributary to East Boyer river have fairly gentle grades even up to their heads and the country

FIG. 35.—Deep saucer-like depressions at the headwaters of the tributaries of the Boyer, in sections 32 and 33, Goodrich township.

around them is not very rough. But when one passes over the divide between East Boyer and Boyer rivers a difference is at once observed. Boyer valley is deeper and its secondary valleys have steep courses and their heads present deep basin-like hollows carved out of the hillsides, as, for example, the one shown in figure 35. The same difference is shown in the headwaters of Paradise creek and East Soldier river, which drain Hanover township. The ravines and creeks supplying Soldier river have gentle slopes, those feeding Paradise creek are steep and the streams are swift. Soldier river drops from perhaps 1450 feet or less near Schleswig to 1160 feet at Ute, sixteen miles away, a fall of about eighteen feet per mile. Paradise creek falls from perhaps the same elevation to 1120 feet at Dow City, descending

330 feet or more in not over ten miles. The effect of these grades on the topography at the sources is easy to understand.[17]

Eastern Province.—We may proceed to the discussion of some of the details of the topography of this eastern province.

The dominating stream of this region is Boyer river. The southeastern part is drained by the two forks of West Nishnabotna river and the branches and feeders of Soldier river carry the run-off from its northwestern flank. All these streams have their secondaries and tertiaries and so on until a complete

FIG. 36.—Upland of southern Jackson township, looking northeast from the northwest quarter of section 29 across Trinkle creek valley.

dendritic drainage system is developed. On many of the hillsides these minor branchlets are outlined like the delicate tracing of a beautiful pattern. If one stands on any of the numerous ridges which separate these sub-systems a splendid panorama is opened before his view. As an instance let us imagine ourselves on one of the hilltops of southern Jackson or northwestern West Side townships. From our feet the hills roll easily away to broad gently sloping valleys. Looking northwest we see the deep valley of the Boyer, whose floor lies 300 feet below us, with the uplands beyond stretching off into Sac and Ida counties. To the northeast are the headwaters of Tucker, Trinkle and Beaman creeks. See figure 36. If we turn to the south we look over East Boyer to the blue hills beyond. On every hand is the beautiful

17 For an extensive discussion of erosive processes see Gilbert, G. K., Geology of Henry Mts.: U. S. Geog. and Geol. Survey Rocky Mt. Region, pp. 99-150; 1877.

prairie scenery so typical of Iowa. Rich farms with their abundant harvests, gently rolling slopes covered with fields of corn and oats—all these lie spread out to delight the beholder. He would indeed be lacking in appreciation who failed to be touched by such a scene. These hills must be among the highest of the county, rising as they do to heights not far from 1500 feet above sea level or about 250 feet above the East Boyer at Vail.

The difference in the character of the streams entering the Boyer and East Boyer has been mentioned above. To the southeast of the watershed the slopes are not very high nor steep. But on the other side a different type of topography has been developed. The slopes on this side the divide, say along the north line of section 6, West Side, are steeper than those on the south side, all the ravines and valleys are deeper and in consequence the hills stand in bolder relief. Between Trinkle and Beaman creeks the country is strongly dissected and most of it has been cut down below the level of the highest ridges. This condition will be found repeated in many other parts of the county.

The surface of Stockholm and Milford townships repeats in many respects the features found to the east, and the same is true to a large extent of most of East Boyer, of Denison and of Goodrich townships. East Boyer and Boyer rivers have cut deep gashes in the surface and where the tributary valleys open into the major streamways steep slopes have been formed and the neighboring land is more or less strongly rolling. Northern East Boyer and southeastern Milford show rather gentle slopes; the abrupt declivities characteristic of the area tributary to the Boyer are not here developed to such an extent although there is noticed a tendency in this direction as the master stream is approached. The northwest half of Milford, being drained into the Boyer by short watercourses, shows the rugged topography described previously. The ridge which separates the waters running into the Boyer from those flowing into the East Boyer rises 300 feet above Denison. An inspection of the map shows that it divides the township nearly equally. On its south slopes the ravines all have a broad cross section, with gentle grades except near their upper ends, and the creeks flow in wide flat valleys.

The topography of northwest Denison and southwest Goodrich is typical of a mature region. It is well dissected and thoroughly drained. The streams and ravines all have fairly deep valleys and more or less steep walls. In the northwestern part of Goodrich township, however, the hills are less steep, the draws are not so deep and all the contours are toned down and softened. What valleys there are here have very gentle slopes in all di-

FIG. 37.—Upland south of Schleswig, looking north toward the divide from the east line of section 6, Goodrich township. Schleswig may be seen on the horizon.

rections. In fact we are nearing the divide between Boyer and Soldier rivers and the region, as before indicated, doubtless is the largest surviving representative of the old glacial plain. This divide takes the form of an elongate shield stretching from the county line a little to the east of Schleswig and across the western tier of sections in Goodrich township. It reaches an altitude between 1500 and 1550 feet above sea level. A part of this plain is shown in figure 37.

Apart from the region which is directly influenced by the river, Stockholm and eastern Otter Creek townships show fairly gentle upland slopes. From Boyer at 1217 feet the country to the west rises by easy stages 200 feet to where the Chicago & North Western passes under the viaduct between sections 4 and 9, Stockholm. From here a long slope extends to Otter creek a mile west of Kiron whence an equally gradual one rises to Schleswig. As already indicated we shall not expect to find great differences of elevation here but some of the gentle swells around Schleswig rise to 1540 feet, forty feet above the station, 360 feet above Denison. The streams have as yet affected the topography comparatively little. While they have broad valleys these are not far below the general surface of the country. But we must not fail to note that all the land is well dissected, there are no flat areas, all is rolling and reached by drainage lines. From this shield streams radiate in all directions; branches of Otter and Buffalo creeks to east and southeast, forks of Beaver creek and Soldier river to north, northwest, west, southwest and south. From the tops of these swells we can look far south across Boyer river and see the distant hills wrapped in blue haze, or facing northward we may see the broad prairies of Ida county.

The north two-thirds of Washington and the southeast third of Denison are drained by two tributaries of the Boyer, Buck and Friends creeks. They have common characters of high gradients in their upper reaches, and are cutting deep gashes in the hillsides and causing the surface to be strongly rolling. From the tops of the ridges between these streams one may overlook the surrounding country for miles. The deep valley of the Boyer is easily traced and nearer at hand is one swell succeeding another. Descending from the highest hills toward the Boyer valley are a series of long ridges with very gentle slopes toward the river but with steep side slopes to the lateral ravines. These are not sharply set off from the uplands and they extend for almost a mile to the edge of the river valley. There they drop off sharply to the flat bottoms. They seem to be present on both sides of the valley. Possibly they represent a stage in river erosion when the processes of down-cutting were not so active as they have been since, while the inner valley was being cut.

Southern Washington, nearly all of Nishnabotany, the southeast corner of East Boyer, most of Hayes and all of Iowa townships are drained by the two forks of Nishnabotna river and their tributaries. This part of the county illustrates very well the difference in topography produced by streams which empty into a deep, well developed master valley and those which are tributary to a master which has not yet advanced so far in the cycle of erosion. While northern Washington township shows deep valleys with precipitous slopes, south of the watershed the streams present lower gradients and their valleys are marked by slopes which are notably less steep and high than is true of those across the divide to the north. While on that side are steep ravines on this side are gentle swales.

The road from Denison to Manilla follows the ridge between the streams emptying into the East Boyer and those which are directly tributary to Boyer river. In Nishnabotany township the ridge separates the waters of Nishnabotna river from those of Willow creek and the feeders of the Boyer. The divide is nowhere wide, merely a ridge, and overlooks on both sides long slopes usually not very steep except at the heads of draws. These are in some cases quite abrupt. In the vicinity of the East Boyer —Nishnabotany township line the valleys are not so deep as farther north and the surface is less trenched by streams. Still all drainage and erosion lines are mature and the dendritic form of valleys is well developed. In central and southern Nishnabotany the hills are somewhat steeper and higher as the valleys are here nearer to Nishnabotna river and have been cut down toward their base level as determined by the present position of the master stream.

Eastern Nishnabotany and East Boyer townships are a rather strongly rolling upland away from the immediate basin of the river. The northern part of East Boyer is lower and descends gradually to East Boyer river. Numerous short streams trench this slope and render it quite rough in the neighborhood of the valley.

The relief of Iowa township is not so great as is that of some parts of the county, probably not over 200 feet, as shown by the difference in altitude between the east fork of West Nishnabotna river, which just cuts the southeastern corner, and the uplands to the north and northwest. The river flows at about 1300 feet, the uplands stand at 1500 feet or thereabouts. No other township of the county is so little affected by stream work, unless it be Otter Creek. The valleys are all wide and shallow and the same is true of southeastern Hayes even in the vicinity of the river. Most of southwestern Hayes is rather strongly rolling, but as one stands on the road between sections 20 and 29 and looks northeast the country appears nearly level as is shown by figure 38. There are no deep gullies or steep hills, only a few gentle slopes to the east and west. This is on the divide between the two branches which form the west fork of West Nishnabotna river. This divide reaches an altitude of about 1500 feet.

Western Province.—Passing now to the western province of Crawford county we find a different type of topography. It is the resultant of two opposing agencies—erosion and deposition, the latter in part at least contemporaneous with the former. In

FIG. 38.—Level upland in section 20, Hayes township, looking northeast from the southwest corner of the section.

our territory the results probably balance at present although in the country bordering the Missouri the topography is still depositional.

If we journey from Schleswig to the west boundary of the county we shall find that the country is blanketed with an increasingly heavy covering of a very fine yellow silt, which will be described later under the caption "Stratigraphy" as loess. The skyline in this western region is rather more wavy than in the eastern townships, indicating that the loess is piled on the hilltops.

The surface of Soldier and Morgan townships away from the main streams is fairly strongly rolling; erosion lines are well developed though not so strong as in some parts of the county. At the headwaters of the streams the bordering slopes are quite steep but lower down the slopes are more gentle and grade up to the country beyond very easily. These townships are drained by Beaver creek, tributary to West Soldier, and by the headwaters of Middle and East Soldier rivers. The fact that these streams all rise within the area under discussion explains in part the character of the topography. West from the divide at Schleswig, although there is a well-defined slope to the west, the hills become more and more prominent and the valleys deeper, owing largely to the influence of the West Soldier in northwest Soldier township. Nowhere are there any level areas left on the uplands, only narrow ridges which persist in rare instances for a quarter of a mile and then slope off to some valley or ravine.

The four townships to the south—Charter Oak, Hanover, Willow and Paradise—show very well the influence of the streams and the loess on the topography. One characteristic of the border townships is the knobs and cols which form a prominent feature of the skyline and which probably are due partly to deposition of loess, partly to subsequent erosion. In many road-cuts ten to fifteen feet deep nothing but loess is visible, showing what great quantities have been deposited on the hills. As we proceed toward Berne or Charter Oak we note that another feature is the long rolling swells separated by quite deep ravines with slopes which as a rule are fairly gentle, although in some cases they are rather steep, but in every instance are rounded, nowhere angular or sharp. The valleys here are broad and mature and the uplands rise about 300 feet above them, that is, the ridges, for here as elsewhere in the county there is no level land. Indeed the effect of the loess is to accentuate the differences of level since it lies much thicker on the hilltops than in the valleys.

The forks of Soldier river as seen in Charter Oak township have broad flat valleys bounded by low, very gentle slopes. This holds true for Hanover township also. These long slopes rising so gradually may be seen from the ridge road which runs irregularly across Hanover from east to west. (See figure 47, p. 291.) This rises 300 feet above Charter Oak but the ascent is so easy that it does not appear to be such a prominent feature of the landscape. But as we proceed a little farther and get into the basin of the Boyer we see a marked difference, as noted on page 260. Here the slopes are steeper and the gullies have high gradients and very steep heads and appear as deep gashes in the hillsides. Some of the streams have cut their channels ten to fifteen feet deep below the valley bottoms. Paradise creek is of this type. Lower down, as along the north line of section 28, Paradise, the valley is wider but the road which crosses it climbs practically 250 feet in half a mile. Farther west there is another rise of fifty feet or more to the highest points.

The surface of Hanover and Paradise townships is quite deeply loess-covered, but not so much so as is the western tier of townships. Nor is the tendency to the hummocky topography so marked. This difference is plainly marked as we stand on the high ridges between Paradise and Willow townships and look east or west. The sky-line in the two directions is very characteristic of the two types of topography developed here.

The topography of Willow township is decidedly rough, with rounded knolls piled high with loess and rather steep slopes to the minor drainage courses. The roads are continually up and down, over one ridge after another. There is more of the knobby effect than is true farther east and many of these knobs seem to bear no immediate relation to the drainage lines. These tend to give a rolling, wavelike effect to the surface. The major streams, the branches of Willow creek, have fairly gentle valley walls except near their heads. But some streams in the southeastern sections are tributary to the Boyer and these affect the topography in typical fashion. Their master stream is close by and in a deep valley, while Willow creek has a long gentle course before it reaches its master—the Missouri.

While Boyer and western Union townships belong in the western province they are so far under the influence of Boyer river that their topography for the most part resembles that of the eastern province. This is especially true of Union township. The eastern part of this township resembles Washington in showing the effect of the short streams running north to the Boyer and the longer ones which flow southwest into Shelby and Harrison counties before they finally empty into the Boyer also. This township, therefore, presents very little if any of the typical loess-built topography so characteristic of Willow township.

Northwestern Boyer township is far enough from the river to allow of the development of the loess topography and in this it resembles adjacent parts of Willow township.

Benches.—As a minor topographic feature but one still worthy of note may be mentioned a series of benches occurring along some of the streams. These were observed only along the Boyer below Denison and in the valley of West Soldier river. At a few places in the lower part of Beaver valley there seem to be indications of small benches, as in section 8, Morgan. At the junction of the creek with West Soldier another bench occupies the fork and at two places along the Soldier are well-defined benches, namely one in sections 2 and 11 and one in 20, with a smaller one in section 30, all in Soldier township. All of these stand about ten feet above the flood plain, while this in turn is five feet or less above the stream. They may have a foundation of drift and no doubt have, but they are completely covered, so far as could be seen, with a veneer of loess. At the free edges where the steep slopes are in some cases bare of vegetation only loess can be seen, even to the bases. They are in general well marked from the flood plain both by superior height and by the presence along most of their free edges of a steep slope. In some places a narrow flood plain separates them from the stream, elsewhere the water washes their bases. The junction between the benches and the upland is generally marked by a well defined curve.

Along the Boyer the benches are larger and stand at greater heights above the valley floor. The principal ones are a large one just south of Friends creek, one in section 11, Union, small ones on either side of the mouth of Paradise creek valley and a long narrow one stretching across sections 23, 22, 26 and 27, Boyer. This is less than half a mile wide and is two miles or more long. On a hillslope, about fifty feet above the valley, back of the schoolhouse at the west line of section 13, just where the bench begins as a narrow strip between hills and plain, a small pit has been opened in coarse sand and gravel to a depth of eight feet. The gravel is rust red and gray, with its granites rotten and crumbling. It extends to the grass roots. One hundred feet higher the hill is capped with loess, of which twenty feet are exposed by slumps along the steep slopes. A mile to the southwest in the center of section 23, where the road ascends the face of the bench from the flood plain, it has been cut through twelve feet of loess which completely covers the underlying materials. A line of seeps and springs along the base of the bench from this point southwest for over a mile seems to mark the outcropping edge of a sand bed which lies between drift and loess. Near the middle of the west line of section 26 several gravel pits have been opened at the low edge of the bench and show ten feet of sand with streaks of gravel and abundant coarse material. Some bowlders which have been thrown aside are four by five by two feet in dimensions. The sand here is clean, gray and cross-bedded and is overlain by three to six feet of yellow loess. Nowhere was drift observed along this bench, although it may form its foundations, beneath the later materials. The same is true of the bench on the east angle of the mouth of Paradise valley, in

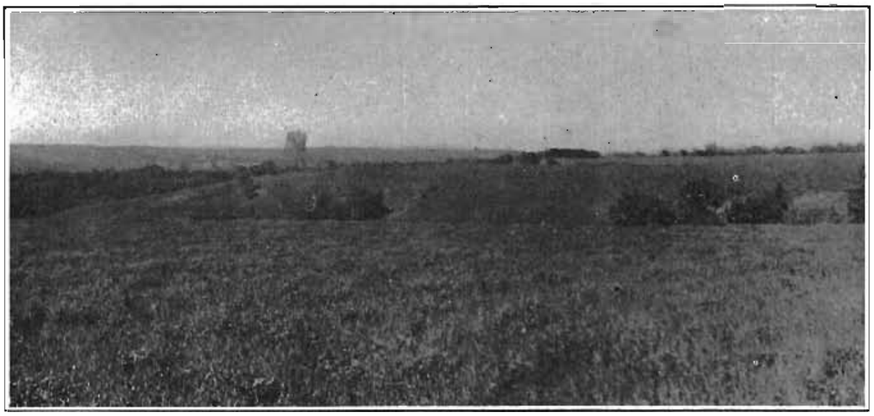


FIG. 39.—A bench on the south side of Boyer valley between Arion and Dow City. Shows abrupt slope to the river and the flat top. Arion in the distance.

which the Riddell gravel pit is located, and of the bench northeast of Dow City in which two pits expose twenty feet or more of sand and gravel with some silty bands near the top. Four to eight feet of loess overlies the sands of the Riddell pit. Sands and gravels are exposed also in the mouth of Friends creek and on the bench just south of it.

These benches rise forty or fifty feet above the valley and have rather steep slopes on the free edge. Their surfaces are fairly level and are in some cases trenched by ravines which cut back into the country for several miles.[18] Figure 39 shows one of these benches below Arion.

ALTITUDES

The greatest range in altitude in Crawford county is about 450 feet from the high points of Morgan township to where the

[18] The subject of river benches is thoroughly discussed by Professor Shimek in his report on Harrison and Monona counties, this series, vol. XX, pp. 287-292.

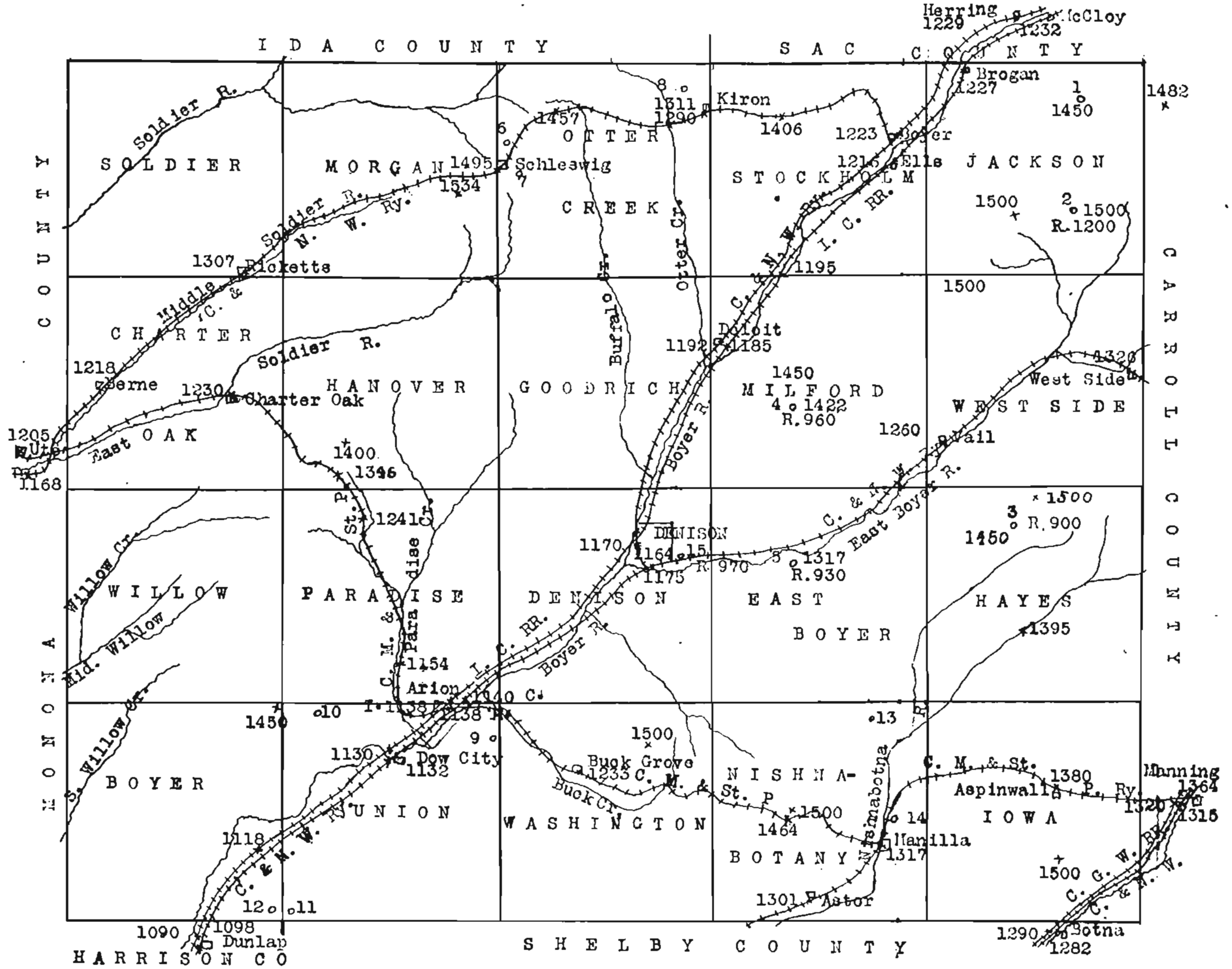


Fig. 40.—Outline map of Crawford county showing elevations (large numbers) and principal wells (small numbers). Well numbers are: 1, Lorenson; 2, McCaffery; 3, King; 4, Miller; 5, Franklin; 6, Herring; 7, Naeve; 8, Shurkey; 9, Talcott; 10, Woodruff; 11, Kern; 12, Davie; 13, Baker; 14, Woodard; 15, Denison.

Boyer crosses the south county line at Dunlap. For any limited area the relief is, of course, less than this. In the territory drained by the Nishnabotna system it is scarcely over 200 feet, in that tributary to the Soldier forks it is about 300 feet and in the basins of the Boyer and East Boyer it amounts to 300 to 375 feet. These figures represent the depths to which the stream valleys have been incised below the level of the divides except that an unrecorded lowering of unknown amount doubtless has taken place over the entire county. If we consider how slowly this process of stream erosion is going on we may gain some idea of the vast length of time during which the rivers and brooks of Crawford county have been at work.

In common with all of western Iowa our area shows a slope to the southwest, but this slope is very gradual and in some cases seems to be almost nonexistent. Still it is true that the northern townships rise to greater heights than do the southern and the southwestern township is certainly lower than the northeastern. On this point consult the accompanying diagram, figure 40.

The altitudes of the railway stations along the Boyer valley are given below. Those in *italics* are Illinois Central stations, those in roman are Chicago & North Western stations.[19] *Mc-Cloy, 1231 feet;* Herring, 1227; *Brogan, 1232*; Boyer, 1217; *Ells, 1221*; *Newcom, 1200*; Deloit, *1190,* 1185; crossing of North Western and Illinois Central tracks at Denison, *1169,* 1170; Denison, *1169,* 1171; Arion, *1143,* 1138; Dow City, *1136,* 1131; *Haley, 1122*; Dunlap, *1095,* 1094. From Arcadia to Denison the altitudes are: Uplands just north of Arcadia, 1430 feet; Arcadia station, 1386; West Side, 1324; Vail, 1257; Denison 1171. A section along the Mondamin branch of the Chicago & North Western railway gives: Boyer, 1217; ridge, section 9, Stockholm township, 1420; Kiron, 1307; Otter creek, 1290; ridge, section 10, Otter Creek township, 1455; Schleswig, 1493; hill crests one mile west of Schleswig, 1534; Ricketts, 1303; Berne, 1213; Ute, 1166. A similar section along the main line of the Chicago, Milwaukee & Saint Paul railway gives: Manning, just east of the county line, 1364 feet; Aspinwall, 1380; divide two miles west of Aspinwall, 1428, Manilla, 1317; Astor, 1301. Elevations along the Sioux

[19] The altitudes along the railroads of Crawford county are taken from profiles of these roads very courteously furnished by the chief engineers.

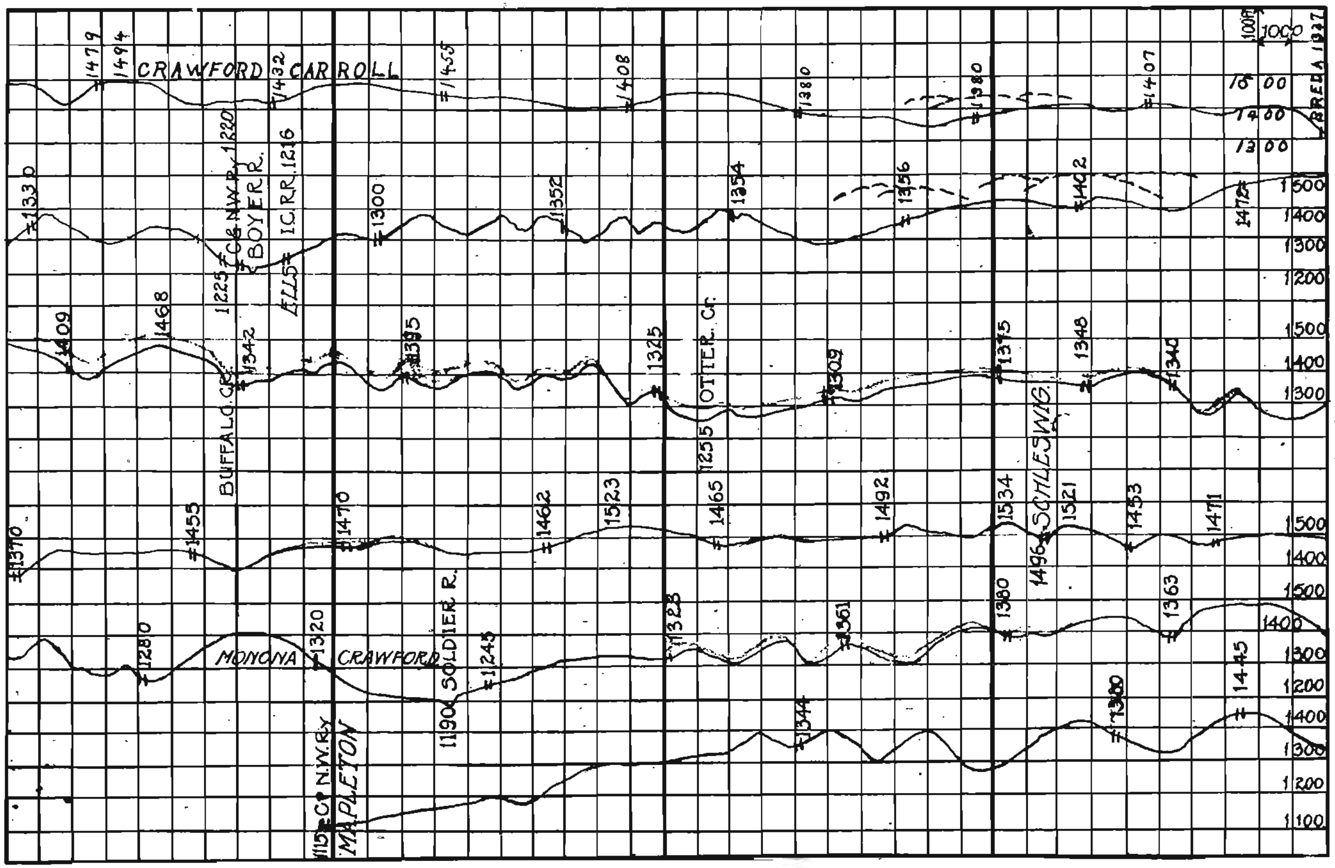


FIG. 41.—East-west profile from Breda in Carroll county across Crawford county to Mapleton in Monona county. Short double lines indicate north-south roads. Elevations in feet above sea level.

City line are: divide three miles west of Manilla, 1464 feet; Buck Grove, 1233; Arion, 1138; Bell, 1155; Kenwood, 1241; saddle between Paradise and Emigrant creeks, section 32, Hanover township, 1346; Charter Oak, 1230; Ute, just west of the county line, 1202. The Chicago & North Western station at Manning is 1324 feet above sea level and that at Botna, just south of the southeast corner of the county, is 1292 feet above sea. The Chicago Great Western stations at these two towns are at 1320 and 1290 feet respectively. The stations of both roads are in the valley of the Nishnabotna, while the Milwaukee station at Manning is above the valley floor. The profile from Breda to Mapleton, figure 41, will give an idea of the nature of the topography in the northern part of the county.

Drainage

It has been mentioned above that the drainage of Crawford county is to the Missouri. Several sub-systems of streams take part in this drainage and all but one of them, Nishnabotna river, reach the great stream within the limits of Iowa. Most of the streams of the county are gathered together beyond its borders to form larger tributaries of the Missouri although the main drainage course of the county, the Boyer, empties its waters directly into the master stream a few miles above Council Bluffs.

The discussion of the topography of the county will have shown that the drainage of Crawford is very thorough. Probably there is scarcely a square mile anywhere within the county, unless the Boyer valley near Dunlap be excepted, which is not thoroughly drained. And the drainage systems themselves give every evidence of maturity, for even the smaller streams flow in broad valleys and meander across more or less perfectly developed flood plains. It is very plain to be seen that the present drainage courses of the county have been at work a long time and have had plenty of opportunity to become thoroughly established.

The drainage of the county is without exception *consequent*. That is, the position and direction of the valleys are dependent upon the topography of the surface after the retreat of the Kansan ice. So far as can be determined none of the valleys are preglacial nor are they affected at all by the underlying bed

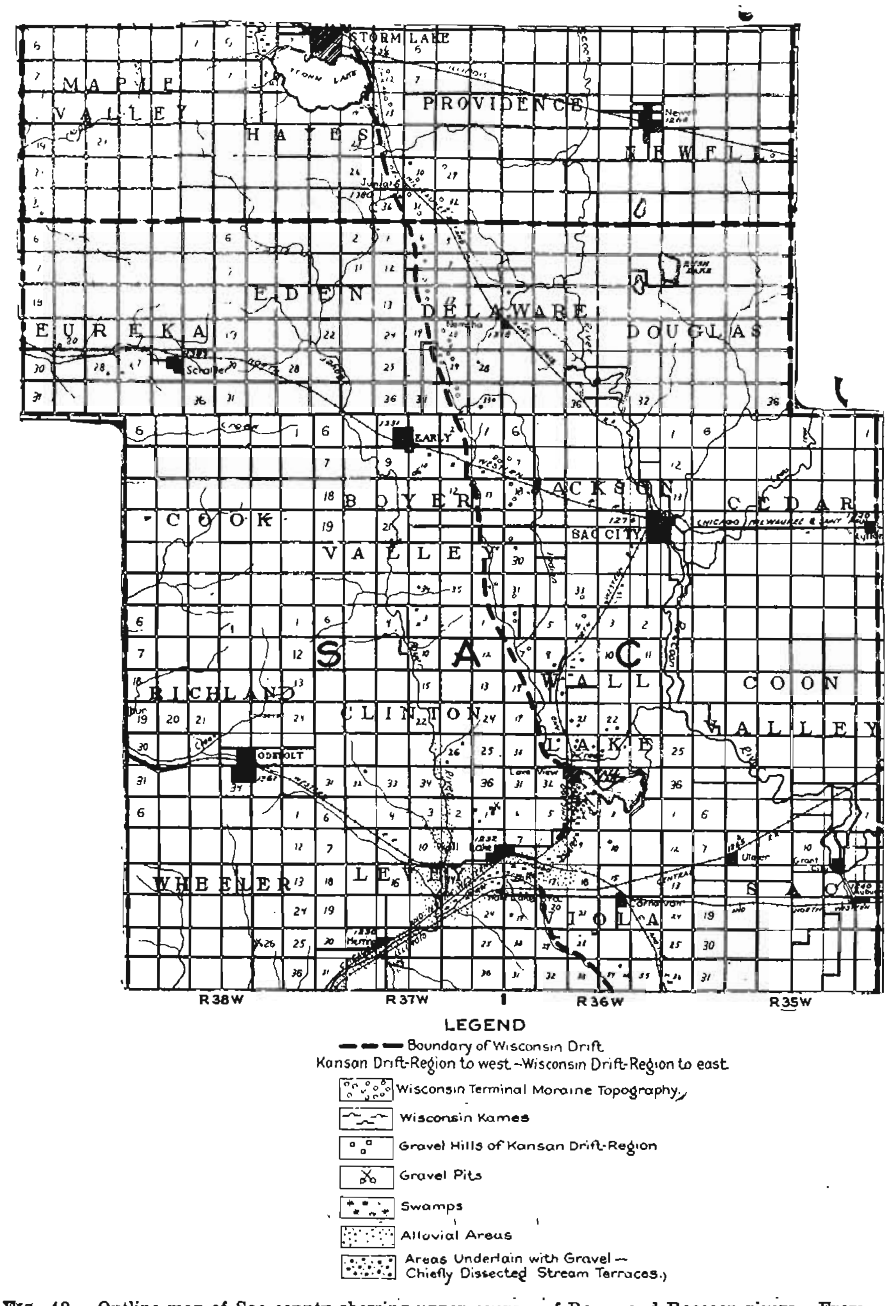


FIG. 42.—Outline map of Sac county showing upper courses of Boyer and Raccoon rivers. From Carman.

rock. Indeed none of them has cut through the mantle of glacial debris to the rock below. The valleys now occupied by the Boyer and perhaps some of the other streams in the county may have been in existence before the Kansan glacier covered the region but if so they were filled to a greater or less degree during the Kansan invasion and have had to be reexcavated since that time. Hence the present streams are post-Kansan, whatever the age of their valleys.

FIG. 43.—View southwest down the wide sag and the narrower valley of Boyer river at their junction in section 22 of Levey township, Sac county. The river is marked by the line of trees across the view in the middle distance. The bluff on the right marks the narrowing of the valley.

Boyer River.—By far the largest stream of the county and the most important in its influence on topography is Boyer river. This stream rises in the Kansan uplands south of Storm lake and flows a little east of south across Sac county past the town of Wall Lake where it turns to the southwest. In this direction it crosses Crawford county, which it divides into practically equal parts. In its course across Crawford county Boyer valley

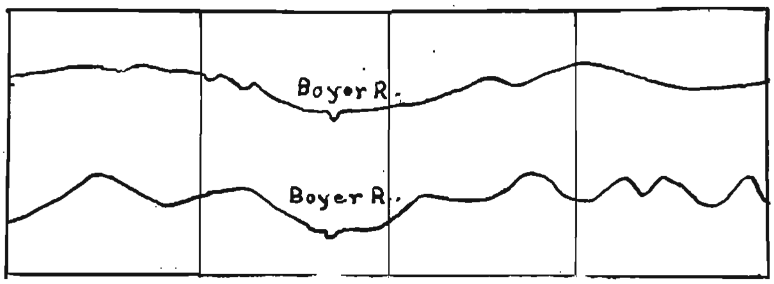


FIG. 44.—Profiles across Boyer valley. The upper one, west of Lake View, Sac county, shows the wide shallow sag valley. The lower one, at Ells, Crawford county, shows the deep narrower steep-sided valley below the sag. Scale: horizontal, 1 inch equals 4000 feet; vertical, 1 inch equals 400 feet.

is of the normal mature type but in southern Sac there opens into the valley from the northeast a broad sag which extends southwestward from Wall Lake. Digitate alluvial plains also extend several miles up the valley of the Boyer above the mouth of this sag and up the valleys of two tributaries from the eastern flank of the high ridge east of Odebolt. The flat undrained sag although two or three times as wide as the Boyer valley at Herring or Boyer is nevertheless a direct continuation of it. On the other hand the present course of Boyer river north of the sag is out of line and out of harmony with the valley below. These features are shown in the map of Sac county which forms figure 42 and in the view shown in figure 43.

While, as will be explained below, Boyer valley in Crawford county and in southwestern Levey township of Sac county is flat floored and steep sided, above the junction with the sag the valley has a sloping floor and widely flaring walls. The two profiles across the valley given herewith as figure 44 will make this more clear than words can do.

In strong contrast also to the valley in Crawford county is the character of the sag in the vicinity of the town of Wall Lake. Its floor is almost perfectly flat and its sides slope rather gently away to the upland, especially east of Wall Lake. West of here they are somewhat steeper and higher, in the vicinity of the valley of Boyer river and of the high ridge west of the upper Boyer.

What seems to be the most reasonable explanation of this unoccupied sag is that it is a fragment of a branch of an ancient Boyer valley which once included the basin of Wall lake, or at least a part of it, and possibly Indian creek. An arm of the sag extends to the southeast as far as Carnarvon and may represent the lower part of another branch of this old-time system. A little stream now comes down along this branch from the higher land near Breda in northwestern Carroll county and empties, or did empty, into the southern arm of Wall lake.

It is very natural to assume that the lower part of Indian creek valley, east of Lake View, and Raccoon river above the mouth of Indian creek may have formed the main upper Boyer river. However, there are several facts which seem to stand in the way of such an assumption. Opposite Lake View the valley of Indian creek is half a mile wide and fairly flat floored. It is capacious enough to accommodate a much larger stream than the one which now occupies it. But within a mile to the west the valley is shallower and the walls are gentler. This is perfectly normal, but it seems anomalous to find on descending the valley from Lake View that about a mile and a half below the town the valley walls approach each other abruptly and from here to the mouth are nowhere more than one-fourth mile apart and in many places are so close as to leave almost no room for a flood plain. The outlet creek of Wall lake is likewise a small stream in a narrow rather shallow valley.

Indian creek northwest of Lake View lies just within the edge of a belt of rough country known as the Wisconsin moraine which forms the margin of a sheet of glacial drift which is called the Wisconsin. This moraine is much less prominent about the lower course of Indian creek, and the country here is much smoother and more level prairie.

Wall lake is separated from the valley of Indian creek at their closest approach merely by a strip of hills and hollows not over one-fourth mile wide. The lake level is about twenty feet higher than that of Indian creek, although this probably is due to inequalities in the thickness of the moraine. The sag just south of Wall lake is filled with gravel to a height of thirty feet above the original floor and similar gravel no doubt underlies the lake. The assemblage of facts seems to indicate that while the ancient valley may have included the sag, the western part of Wall lake and the wide part of Indian creek near Lake View it could hardly have included the lower valley of the creek to the east.

If Raccoon river above the mouth of Indian creek once formed part of the Boyer system we should expect to find some differences in the character of the valley above and below this point. The valley above the creek mouth should show some evidence of being older than the lower part. But the evidence does not point in this direction.

Opposite the mouth of Indian creek valley Raccoon valley is remarkably wide, stretching nearly a mile from rim to rim. However, the actual flood plain is quite narrow and is nowhere more than two hundred or three hundred yards wide. The remainder of the valley is occupied by a high second bottom or terrace which is really a valley filling of gravel and clay from the

Wisconsin glacier. The old walls rise rather gently above this terrace and mark the former limits of the valley. A very significant feature of the valley filling is the fact that it extends from two miles above the mouth of Indian creek at least two or three miles below that point. That is, there is no change in the character of Raccoon valley near the mouth of Indian creek. In fact all along its course below here the valley shows evidences of its pre-Wisconsin age in its dimensions and its form.

Above the point already mentioned where the valley widens out and is partly filled by Wisconsin drift materials the valley is narrow and deep, steep bluffs flank the narrow flood plain and in its present aspects the gorge presents the appearance of post-Wisconsin age. Similar features are the rule in the valley from here to and beyond Sac City and as far at least as the north county line. In a few places, however, the valley shows what seem to be remnants of an original pre-Wisconsin drainage course. One of the best of these is in sections 25 of Delaware and 30 and 31 of Douglas townships, where the valley flares out into a wide open bay about a long oxbow. Another is just above Sac City, where the valley shows evidences of filling; and other indications of the incomplete filling of an old valley are not wanting.

The conditions seem to point, then, to a pre-Wisconsin age for Raccoon valley throughout its extent across Sac county. There can be no doubt of this age in its lower portions. If, therefore, Raccoon valley is pre-Wisconsin in origin and its stream flowed to the Des Moines then as now, where was the pre-Wisconsin course of the upper Boyer? In view of the width of the valley of Indian creek opposite Wall lake, although it is just within the terminal moraine where deposition would naturally be great, and in view also of the narrowness of the valley farther east and of the character of Raccoon valley, it seems as if we must look for the northward continuation of the ancient Boyer valley in this wide segment of Indian creek valley and possibly in the narrower portion to the northwest. Possibly, of course, the old valley above this larger segment may have been entirely filled up and obliterated.

It seems evident from the character of the modern upper Boyer valley that it has had a different history than the valley in Crawford county, and it probably was only a branch which united with the other which came from the northeast. Macbride indeed sketched such a history as this in one of his reports,[20] but later in discussing Sac and Ida counties[21] he postulated an *eastward* flowing Boyer river whose headwaters were gathered from the ridge which stretches between Schaller, Odebolt and Herring (see figure 42) and now is cut through at the latter village. This theory seems to be based on the narrowness of the valley at Herring and Boyer, but it seems as though this narrowness may well be explained by the presence of the high ridge which would naturally require more work to excavate and hence might well be cleft by a valley narrower than that above or below. It may freely be admitted that the unoccupied valley in the vicinity of Wall Lake is abnormally wide but this may be accounted for in part by the fact that several streams converged south of Wall lake and in part by the greater ease with which the river could widen its valley here than in the much deeper and more steep sided part between Herring and Deloit. On the other hand it is hard to believe that a stream would normally make such a sharp turn as would be necessary for the present upper Boyer if it had to flow eastward past Wall Lake to the Raccoon.

Again it is only since the time of the last glacial invasion, the Wisconsin, that these drainage changes could have occurred and in view of the immaturity of much of the upper part of the Raccoon valley as sketched above we should according to Macbride's theory expect similar immaturity in the Boyer at Herring. However, the valley here is uniform with that below in its maturity, and it would be unlikely that either the very short stream postulated as rising on the eastern slope of the divide near Herring and flowing eastward past Wall Lake, or even the much longer one rising on the western side and flowing southwest, should, during the brief time allotted, have cut out such a wide valley and developed such a mature flood plain as now exist, both in the unoccupied sag valley near Wall Lake and in Boyer valley near Herring and in increasing measure to the southwest.

20 Geology of Cherokee and Buena Vista counties, Iowa Geol. Survey, vol. XII, pp. 330, 331, 337.

21 Geology of Sac and Ida counties, Iowa Geol. Survey, vol. XVI, pp. 520, 523, 524; 537.

Professor Todd[22] has recently argued that Niobrara river of northern Nebraska during pre-Pleistocene time "followed the courses of James and Missouri rivers as far as Onawa, Iowa, thence east and northeast through Ida and Sac counties past Wall Lake and thence southeast along the Raccoon river. This conclusion rests on a few apparently reliable reports from wells which show that the preglacial surface indicates a valley whose bottom is less than 900 A.T., in some cases less than 850." "The fact that Wall Lake lying on the summit formerly drained into Boyer river and now into the Raccoon, and another fact that the Boyer rises east of the crest of the divide, has first a course east of south and at this point turns southwest" are considered to be explained by this theory. Such well records as are available to the writer do not indicate such a valley as Professor Todd postulates and while Wall lake and the sag valley doubtless partly suggested the theory it must be remembered that the lake is of late Wisconsin age and the valley doubtless is to be dated not earlier than the close of the Kansan. These facts seem to invalidate the whole argument since Professor Todd is discussing a preglacial stream.

Professor Todd further states that: "There was a fall of 350 feet from Sioux City to Wall Lake." But at present the elevation of low water in Missouri river at Sioux City is 1076 feet, while the elevation of Wall lake is about 1225 feet. There is no indication of such a warping as would be necessary to equalize the discrepancy between these figures and the grade indicated by Todd. In fact the evidence seems to point to uplift in northwestern Iowa during glacial times rather than to the depression which seems to be necessitated by Professor Todd's hypothesis.

Doctor Carman has recently restated the theory of an eastward flowing Boyer in his report on the Pleistocene Geology of Northwestern Iowa.[23] Carman emphasizes the facts that the Mississippi-Missouri divide is lower than the minor divide a few miles to the west and that the pattern of drainage on opposite sides of the Mississippi-Missouri divide is the same while

22 Todd, J. E., The Pleistocene History of the Missouri River: Science, N. S., vol. XXXIX, Feb. 20, 1914, pp. 263-274.

23 Iowa Geol. Survey, vol. XXVI, pp. 318-320; 1915.

that on opposite sides of the minor divide is different. He states his theory in the following language:

> In pre-Wisconsin time the Boyer river turned eastward and passed through the Wall Lake outlet toward Raccoon river. When the ice-edge blocked this eastward drainage the ponded waters in the valley broke over a low place in the great watershed near Herring, in southwestern Levey township (Sac county), and escaped to Missouri river. This course was cut so low during ice-occupancy, and the old valley to the east was so much filled that the Boyer continued to flow to the southwest and did not again take its eastward course to the Raccoon.

Some of the objections to this theory have been set forth in previous paragraphs. The fact that the pattern of drainage on opposite sides of the minor divide is different may be explained by the statement that the Boyer is close to the crest of this divide and there is little room for west-to-east tributaries to develop, while the Maple flows, in a nearly parallel course, be it noted, several miles distant from the crest, and therefore a well developed system of east-to-west tributaries drains this western slope.

The question rises as to why this overflow from the ice-ponded waters should seek escape over the highest part of the bounding rim rather than over some lower col. A study of the altitudes of the region shows that in northwest Carroll county, along the margin of the Wisconsin moraine, the highest point reached by the railway between Carroll and Wall Lake is 1366 feet, at Breda. This is practically at the upland level. The railway between Wall Lake and Odebolt crosses the high divide west of the Boyer at 1378 feet. But in northeast Crawford county, where the Boyer has cut its valley through the ridge, the latter rises 1500 feet or more above sea level east of the river and over 1450 feet between the Boyer and Otter creek, while a little farther west, near Schleswig, the hills reach altitudes well over 1500 feet above sea level. There is no obvious reason why this high plateau, apparently the highest land south of Alta, should be chosen as the locus of overflow for the glacial flood-waters. On the other hand, however, if the southwestward flowing post-Kansan Boyer be conceived of as extending its valley to the northeast by headward erosion there is apparently no reason why one of the vigorous members of its dendritic system should not work its way up the slopes of the highlands and eventually cut through what was once the real Mississippi-Missouri divide and so come to gather in a part of the run-off which really belonged to the Raccoon system, although perhaps the Boyer never actually tapped any of the chief feeders of that system. This would seem to account satisfactorily for the deep narrow valley through the ridge and the broader shallower one to the east of it. Then when the Wisconsin glacier overwhelmed the east branch of the upper Boyer system and the moraine obliterated most of its valley the empty sag remained as a testimonial to former conditions and the west branch became the main stream of the system.

Note may be made here of the presence in Porter creek valley north of Boyer, as well as in Otter and Buffalo creek valleys and also in Boyer valley at several points, of gravels which are older than the Wisconsin stage and which therefore show that the present drainage features were established before the Wisconsin ice disturbed the pre-existing drainage. These gravels will be described later in connection with the glacial materials. (See pages 328 to 338.)

Mention may be made also of the fact that at several points along the walls of Boyer valley, below the junction with the sag, as for instance in the southwest quarter of section 14 and the middle of section 31, Levey township, Sac county, loess is present only about fifty feet above the valley floor, or fully half way down the slopes. This would seem to be inconsistent with a Wisconsin age of this part of the valley, as the loess is older than the Wisconsin drift, and should have been eroded away while the valley was being cut if it were present at that time.

It seems to the writer, then, to summarize, that Boyer valley originated at some time following the retreat of the Kansan glacier from western Iowa and that the river developed the course now occupied across Harrison and Crawford counties, while in Sac county there were two branches, the western of which is now the upper Boyer, while the eastern is represented by the empty sag extending from the river to Wall lake, and beyond here perhaps by upper Indian creek. The Wisconsin glacier blotted out the upper part of this eastern branch, leaving the lower part as a partly filled undrained marsh beyond the glacier's margin. It seems that the sag valley and the river valley as well are too mature to have been the result of Wisconsin and post-Wisconsin erosion alone. Their history goes far back of Wisconsin glaciation through the uncounted years and centuries of the development of the deep-cut topography on the Kansan plain.

Where Boyer river enters Crawford county it occupies a comparatively shallow valley. The immediate valley walls are not over one hundred feet high although the more distant hills of the uplands rise another hundred feet or more. The flood plain is approximately one-fourth mile wide and shows numerous abandoned channels and oxbows which give evidence of the meandering of the stream. One of these oxbows, in section 7, Jackson township, is especially well marked. Many of these channel-remnants are filled with water, making miniature lakes. However, the entire valley with these exceptions is well drained and raises excellent crops of corn and other cereals. This condition holds true in Sac county as far east as section 23, Levey, or in other words as far as the valley is occupied by the river. East of here, however, where there is no natural drainage the valley was formerly marshy and was useful only for pasture or meadow land. In recent years, however, two large drainage ditches have helped to make these fertile fields more available for agriculture.

From the county line, then, southward past Boyer the valley retains similar characters, although it is appreciably deeper toward the south. With the increase in depth comes also a greater steepness of slope which is especially noticeable on the east wall of the valley. In connection with this feature may be mentioned that of a greater covering of timber on the east—the northwestward—facing wall. This holds true down the river and even to a greater degree as the walls grow steeper with increasing height. This difference in steepness and growth of vegetation on the two sides of a valley has been noted often in the studies of Iowa geology and is explained below in connection with East Boyer river.

Nearer Deloit the valley is deeper and the same is true toward Denison, but it does not grow much wider. Near the latter town it is about a third of a mile wide and is filled with alluvium to a considerable depth. The river channel is cut in this mass of filling to a depth of ten feet and meanders across the plain from side to side. Beneath this modern filling is a layer of gravel which forms the aquifer for numerous wells, such as those which formerly supplied the city of Denison.

At Denison the East Boyer joins the main stream and from here to the county limits the valley is much wider, from two-thirds to one mile. Between Denison and Arion the relations of the valley walls are reversed and the west wall is steeper than the eastern. There is very little timber on either side, only a little brush at intervals. The east wall is in many places so gentle that it is tilled from the uplands to the river and there is no break in the slope.

Between Arion and Dunlap, which latter town is just beyond the county border, the Boyer valley is quite wide, a mile or more, and the immediate valley walls are gently sloping and not very high. However, the surrounding country rises fully three hundred feet above the stream. In the last mile or two of its course in the county the valley is somewhat swampy and a few ponds are present. Elsewhere it is well drained and very fertile.

East Boyer River.—The principal tributary of the Boyer is East Boyer river. It is formed by the meeting in central West Side township of two groups of small streams which rise on the uplands of western Arcadia township, Carroll county, and southern Jackson township, Crawford county. Their united waters flow southwest to meet the Boyer at Denison. While not a large stream it has a wide valley and is of considerable topographic importance. The valley in West Side township and for a few miles west of Vail is not so deep as is that of the Boyer above Denison. It may be said to be a mile wide between the tops of the walls in the vicinity of Vail, although the upland levels are not reached for more than this distance from the flood plain. The slopes are very gentle for the most part and merge gradually into the flood plain. These gentle slopes persist within three miles of the river's mouth, but are replaced by steeper and higher walls near the Boyer valley. These are shown in figure 45.

All the secondary streams which empty into the East Boyer have made wide valleys and the larger ones have developed alluvial plains in their lower courses. But all are quite swift and have a fairly steep fall. This is true also of the main stream as the elevations of West Side (1324 feet), Vail (1257 feet) and Denison (1171 feet), show. A notable feature of these tributaries is that many of them maintain their gentle slopes right up to their heads and do not show the steep head concavities developed by some of the steeper ravines and other streams in some parts of the county and elsewhere in the state, notably in the loess

FIG. 45.—View east of south across East Boyer valley from the southeast part of Denison.

bluff region. Almost every valley and ravine has its little stream, fed for the most part by seepage springs, which are very abundant.

It will be seen from an inspection of the map that East Boyer river along nearly its entire length flows much closer to the south edge of its flood plain than to the northern margin. At the same time the south facing slopes are gentler than are those which look toward the north. The laws governing these conditions have been so well stated by Calvin[24] in his report on Johnson county and the situation there described applies so admirably to the present case that no better means of presenting these laws here can be taken than to insert his statement bodily. Doctor Calvin's discussion follows:

The original gently sloping surface of the great drift sheet after the retreat of the Kansan ice, in the region under discussion (Johnson county), was drained by a number of parallel

24 Calvin, Samuel, Iowa Geol. Survey, vol. VII, p. 51; 1896.

streams, each flowing toward the east. As soon as these streams cut channels of any considerable depth, the two sides of each channel were differently affected by the agents of erosion. The northward facing surfaces suffered less than the opposite side of the channel from the alternations of freezing and thawing and consequent effects of erosion, in early winter and spring. They were less affected by the droughts of summer, which tended to check the growth of vegetation and render the surface more pulverulent and more easily attacked by dashing rain storms. The result was that as the channel was deepened the north side of the valley receded more rapidly than the south, the slopes soon became gradual, the small lateral streams on the north cut back into the highland with greater facility and greater speed, robbing the secondary streams developed on the south side of the next drainage area to the north; and so as a result of normal causes each drainage basin became unsymmetrical and was converted into a sloping plane with the main drainage stream along its southern margin. The east-west streams of the driftless area show similar effects as a result of the same cause, only the effects are modified in consequence of the fact that the stream valleys are cut in indurated rocks in place of the loose materials of the Kansan drift. The northward facing bluffs, however, are steeper than those on the opposite side of the valley. They are generally wooded, or at least are clothed with ranker vegetation that affords protection from atmospheric disintegration. As a result of the larger amount of material carried down from the southward facing slopes on the northern side, the bottom of the valley inclines southward, and the stream runs close to the foot of the steep bluffs that face toward the north.

Minor Tributaries.—The other tributaries of Boyer river are for the most part small streams of no great consequence. The most striking characteristic about these small branches is the fact that they occupy valleys whose size seems entirely out of proportion to the small amount of water now flowing through them. Of course this is due not so much, and not chiefly to the presence of greater amounts of water in times past, but to the fact that the streams meander across their valleys and also to wastage of the valley walls as described by Doctor Calvin.

From the east there enter the Boyer between the north county line and Denison, Beaman creek which drains northern Jackson township, Trinkle creek, a smaller stream carrying the runoff from the central part of the same township, and Tucker creek in southern Jackson and Stockholm townships. All of these have typical wide valleys, broad flat bottoms, with rather gently sloping walls, especially on the north side, and in each case the stream is cutting into its south bank. As an instance of the size of these valleys it may be stated that that of Trinkle creek is over two miles wide from ridge to ridge in section 17, Jackson. This creek is also fairly typical in its rate of fall. It drops thirty feet in the last mile of its course, forty feet in the next to the last and fifty feet in the third mile. Beaman creek has about the same fall.

Between Tucker creek and East Boyer river there are only small brooks entering the Boyer from the east. South of Deni-

FIG. 46.—Steep headwater slopes of the tributaries of Buck creek. View in sections 9 and 10, Washington township.

son Friends creek and Buck creek are the only tributaries of consequence on the east side. Friends creek still flows through a deep, narrow, steep-sided valley in most of its course, although this is wider in the last mile or so. The gorge is filled down to its mouth with forest trees of various species. Friends creek drains southeast Denison together with a few sections in East Boyer, Nishnabotany and Washington townships. Some of its headwaters are gathered close to the sources of Buck creek, which gathers in a large part of the runoff of Washington township. A narrow flood plain extends up Buck creek as far as Buck Grove, beyond which village the valley has the usual characters of Kansan streams: great depth with considerable width, high gradient in its upper reaches and strongly concave slopes at the heads of its secondary and tertiary branches, as is typified by figure 46. These branches head about 1450 feet above sea, three hundred feet above the Boyer at Arion, and in the first three miles of its course the stream falls about one hundred and fifty feet, a good instance of the high gradients of the short streams emptying into the Boyer. The master stream with its superior cutting power and consequent deep valley has forced its tributaries, in order to keep their valley mouths at the level of the larger valley, to adopt steep grades with consequent high velocities. This process has, however, ceased for many of the tributaries in their lower reaches, and they are now engaged in building up alluvial plains.

The upper branches of Friends creek give a good illustration of the dendritic type of drainage which is so well developed in this county. Three or four branchlets stretch up into the country with fairly gentle grade, with broad, gently rounded valleys and with numerous little gullies and feeders which reach up the walls and end in rather deep concavities in the hillsides. As one looks over the brink of the valley this miniature drainage system appears incised into the depths beneath as if engraved by a giant sculptor.

The streams which enter the Boyer on this side below Buck creek are of insignificant proportions and this is true also for those which drain those parts of Boyer and Union townships to the west of the river.

The chief tributaries of the Boyer from the west are Paradise creek, which drains the township of the same name, as well as southeast Hanover; Buffalo creek, which drains central Goodrich and Otter Creek townships; Otter creek, which flows near the east line of these two townships; and Porter creek, which joins the main valley at Boyer. These streams have the usual characters of the Boyer tributaries. The headwater ravines of Paradise creek have very steep slopes and are cutting into the hills. Lower down where the gradient is less a flood plain has been built up. Here the side slopes are less steep but still the valley is increasingly deep, two hundred and fifty to three hundred feet from ridge to flood plain.

Buffalo creek is worthy of mention because of its extremely long though narrow alluvial plain. This extends across Goodrich and two or three miles up into Otter Creek township. The valley is very mature and is bounded for the most part by rather gentle slopes. In section 15, Goodrich, the hills stand close to the stream and reduce the width of the valley to almost nothing. Below this point the valley again is wider to the Boyer.

Otter creek is a typical Kansan stream, with broad, mature alluvial floored valley for several miles above its debouchure at Deloit, and with side walls gently sloping for the most part, here receding far from the stream, there drawing closer together and encroaching on the valley with steep slopes gashed by ravines or covered with a growth of small timber. The bottom lands are mostly clear of trees, but in many places the stream is lined with a fringe of timber which here and there spreads out into the flats. The valley walls are lined along parts of their extent by gravels which outcrop in numerous exposures. Porter creek likewise is noteworthy chiefly for its gravels, which will be described later.

It may be said here that practically all the streams of the county have one characteristic in common. They all flow through alluvium-filled valleys. This is true of all the larger streams, and even many of the small ravines show some filling in their side walls and floors, due chiefly to lateral wash. But all, from the Boyer to the merest runnel, are now cutting into this filling and flow in deep trenches, and consequently the secondary and tertiary tributaries have cut gashes in their valleys many of which are deeper than their width. In some cases this cutting has gone through the filling into the original drift material, as is shown in a small gully in the northwest quarter of section 33, Stockholm. Drift is exposed along nearly the entire length of the gully and the black filling is distinctly marked off from the yellow till below. Many of these streamlets drop nearly three hundred feet in their short courses and so have great erosive power.

These facts seem to indicate an increase in cutting power, of the smaller streams at least. It may be that the larger streams have not experienced any change, or not so much as their tributaries. If this is true the cause of the change in these small streams must be local. Probably one factor has been the cultivation of the soil, the cutting of timber from the hillsides, the consequent lowering of the water level and other effects of the progress of agriculture and pasturing. These changes would aid in the washing of soil from the hillsides to the valleys and by the increase and concentration of the runoff deeper incision of the ravines would be possible.

West Nishnabotna River.—Southeastern Crawford county, including Iowa, most of Hayes and Nishnabotany and parts of East Boyer and Washington townships, is drained by the upper branches of West Nishnabotna river. The eastern of the two branches barely touches the county as it cuts across the two southeastern sections of Iowa township. With its tributary, Elk creek, it carries the surplus waters from nearly all of this township. As developed in this county the river is but a small stream flowing in a shallow trench. The flood plain is nearly a fourth of a mile wide and is bounded on both sides by very gentle slopes reaching back in some cases one-fourth to one-half mile before they meet the uplands. The topography is all so rolling, however, that exact limits can not be set. The stream is here so high —see elevation of Botna, 1290 feet, just beyond the county margin—that its valley is comparatively shallow, only about one hundred and fifty feet below the upland ridges.

The west branch of West Nishnabotna rises in eastern Hayes township and in western Washington township of Carroll county. It has a general southwesterly course across Hayes and Nishnabotany townships past Manilla. Like the east branch this stream has a wide valley with very gentle slopes and even in the eastern part of Hayes it shows some flood plain. This is wider toward the south so that in northeastern Nishnabotany township it is a quarter of a mile wide owing to the merging here of several small streams. Below this point the alluvial plain is well marked although the boundary walls are everywhere of low slope and descend to the plain very gradually. The river winds back and forth across this plain, though with quite a swift current and considerable fall.

The members of this system as found in Crawford unite in Shelby county to form the West Branch of West Fork Nishnabotna river which unites with the East Fork in Fremont county. The combined stream empties into the Missouri in Atchison county, Missouri.

Soldier Rivers.—That part of Crawford county west of the territory tributary to the Boyer is drained by the several branches of Soldier river and Willow creek. The general features of these streams and their valleys are similar to those just given for the Nishnabotna. There are three branches of the Soldier, Soldier river proper, much the largest, Middle Soldier, only a short stream, and East Soldier. They may be said to receive the waters of the four northwest townships of the county. The main fork extends diagonally across Soldier township, which it enters from Ida county, the southern townships of which county send most of their waters to the Missouri by this stream. Its chief auxiliary in Crawford is Beaver creek, which extends across the northern sections of Morgan township. At the headwaters of Beaver creek, as well as of the other streams of the region, the bordering slopes are quite steep. But lower down the slopes are more gentle and grade easily up to the country beyond. The valleys are not very deep and all, barring the smallest, have flat bottoms and well defined alluvial plains, narrow in the upper courses but wider where the streams are of greater importance. Beaver creek has a flood plain almost entirely across Morgan township and that of Soldier river is well defined across all of its course in Soldier township.

Middle Soldier shows the same type of shallow valley and gentle slopes as those which characterize the main branch. West of Ricketts it has developed a flood plain which unites with that of East Soldier at the county line. The two streams join their waters just beyond the line, in Monona county, and the united stream meets that of the main Soldier just west of Ute. The gathering grounds of Middle Soldier are entirely surrounded by those of Beaver creek and East Soldier, hence the growth of this branch to the east is strictly limited.

East Soldier rises on the flanks of the divide southwest of Schleswig and in its general course is only two to three miles distant from the middle branch. Its valley is quite broad and shallow with very gently sloping sides as may be seen by inspecting the accompanying figure 47. For example the road along the north line of section 23, Charter Oak, rises only forty feet in the half mile from the river east to the section corner. However, the ridge road across central Hanover rises nearly three hundred feet above the river at Charter Oak, so that the total relief is, after all, high. The stream gradient also is fairly gentle as is shown by the fall of forty-five feet between the middle of section 7, Hanover, and the north line of section 23, Charter Oak, an average of about eighteen feet per mile. This is, probably, a fair average for the river in this county. In a number of places the valley is narrowed by ridges, hardly level enough or large enough to be classed as benches, which run down from the higher level into the valley.

There is not much flood plain east of the Charter Oak town-

FIG. 47.—View north across East Soldier valley from the divide in the southeast quarter of section 15; Hanover township.

ship line but below here it is quite broad and well defined. For the most part the stream follows the south edge of the valley and has cut into its south bank at a number of points.

The chief tributary of East Soldier is Emigrant creek, which enters the larger stream at Charter Oak. It is of the usual type of stream. The Chicago, Milwaukee & Saint Paul Railway utilizes the valley of this creek for its line, which rises 115 feet in the four miles between Charter Oak and the divide which separates Emigrant and Paradise creeks.

Willow Creeks.—The branches of Willow creek, North, Middle and South, are of only small import in our country. They do not differ in character materially from the Soldier and their effect on the topography is similar. As is true of other headwater streams of the county their fall is gentle except at the immediate heads, and the same holds good for their laterals. The middle branch, for example, falls seventy-five feet from the north line of section 23, Willow, to where the combined streams leave the county, an average of about fifteen feet per mile. The Willow creeks are far from their master, the Missouri, and hence are not cutting very rapidly. But just over the divides are some laterals of Boyer river which are vigorous swift flowing streams in steep sided valleys and surrounded by rough rolling uplands. It must be kept in mind, however, that the natural erosional effect of these systems of streams has been somewhat masked by the excessive deposition of the Missouri river loess, whose topographic features are discussed under the caption of Topography.

North and Middle Willow creeks have but little alluvial bottom lands except near their junction just within the county line. But in their cross sections they show to good advantage the characteristic broad flattened curve, concave upward, rising to the hills where it meets the convex curves of the uplands.

Areas of Drainage Basins.—The area of Crawford county is apportioned among its different drainage systems about as follows: Boyer basin, 429 square miles; Nishnabotna system, 113 miles; Soldier river basin, 146 miles; and the Willow rivers 32 square miles, a total of 720 square miles.

STRATIGRAPHY

General Summary

The formations exposed within Crawford county carry its history back through only the last two epochs of geologic time—the Pleistocene or Glacial and the Recent. While as viewed from the standpoint of human history the Pleistocene epoch seems a long one, stretching back as it does over hundreds of thousands and possibly several millions of years, yet as compared with the vast lapse of earth history this epoch is but a span. And yet it is certainly of the utmost importance to us for the deposits of that epoch are our soils and sands and gravels today. The Recent Epoch may be said to be practically co-extensive with the period of human history, although there is evidence to show that man existed, in Europe and Asia at least, during the later interglacial ages of the Pleistocene epoch.

For any knowledge of the underlying strata we must rely on those wells which have penetrated the deposits of Pleistocene or later age and have reached or entered the indurated rocks beneath. Within the county there are but few such wells and only one which pierces to any great depths these hidden strata. Outside the county a large number of wells in western Iowa have been sunk to great depths. Those nearest to Crawford county are at California Junction, Dunlap and Holstein. The strata which these penetrate and the probable relations of these strata in Crawford county will be discussed beyond.

The succession of the deposits exposed within the county is shown in the following table.

Synoptical Table.

Group	System	Series	Stage	Character
Cenozoic	Quaternary	Recent		Alluvial and aeolian deposits
		Pleistocene	Wisconsin	Alluvium ? Sand and gravel
			Peorian	Loess
			Iowan Sangamon Illinoian	Gravel
			Yarmouth	Soils and peat Kansan Gumbotil, Gravel
			Kansan	Drift
			Aftonian	Soils Nebraskan Gumbotil
			Nebraskan	Drift

Underlying Formations

As stated above no deposits older than the Pleistocene are exposed within Crawford county. A few wells have been sunk to the rock or a few feet into it and the city well at Denison penetrated the rock formations to the Prairie du Chien (see the table on page 301). Mr. Frank Hoffard of Arcadia reports that the King well, in section 9, Hayes township, altitude of curb 1450 feet, penetrated a rather coarse gray sand rock for twenty-two and one-half feet. The well ends in this rock at a depth of 572½ feet. A well on the farm of McCaffery Brothers in the south half of section 29, Jackson township, whose curb is about 1500 feet above sea level, struck a very hard yellow limestone at 305 feet. The well continues in rock to a depth of 662 feet, giving a penetrated thickness of rock of 357 feet. The Miller well, in section 16, Milford, beginning at 1422 feet above sea level, struck, at a depth of 462 feet, a blue-gray limestone, which it penetrates thirty feet. The Franklin well in section 17, East Boyer, altitude of curb 1317 feet, reached a very coarse sandstone at 390 feet and is sunk into it for the remainder of its depth of 404 feet. It will be observed that the two southern wells are in sandstone, the two northern ones in limestone. The elevations of these wells as given above would place the top of the rock at approximately 900 feet at the King well, 1200 feet at the McCaffery well, 960 feet at the Miller well and 930 feet at the Franklin well. Rock was struck in the Denison well at an altitude of 970 feet beneath 200 feet of unconsolidated material. The rock is chiefly shale. These wells give some indication of the irregularity of the rock surface and of its lack of relationship to present day topography.

The list of typical wells given in the report on the underground water resources of Carroll county[25] includes the Shrower well, two miles east of Arcadia, which, sunk from a probable elevation of about 1425 feet, struck sandstone at 360 feet and penetrated it forty feet. The Anderson well five miles northeast of Arcadia, and the Eklers well, six miles south of the same town, are both 400 feet deep and reached sandstone or cemented sand. These wells must end at about 1050 and 1025 feet above sea respectively. Mr. Hoffard reports that in the Hanerkamp well, in section 22, Arcadia township, he struck "rock" at 375 feet and drilled 37½ feet into it. The rock surface here probably stands at about 1050 feet above sea and the rock is doubtless sandstone, as in the Shrower well close by.

25 W. J. Miller, Iowa Geol. Survey, vol. XXI, p. 1026; 1912.

It may be admitted that these wells furnish slight basis for a judgment as to the age of the rocks which they enter. Such judgment must be based also upon our knowledge of other wells and of the strata in other localities. Limestone is exposed in Boyer valley at Logan and is reached at Woodbine twenty-eight feet below the surface. Doctor Shimek assigned the rock at these and several other localities in Harrison county to the Missouri series partly because of the character of the rock itself, partly on the basis of a collection of fossils obtained by Doctor Calvin from Logan.[26] However, Doctor Tilton has more recently presented an elaborate argument for considering these strata to be of Des Moines age. Tilton draws the north border of the Missouri series about the latitude of Atlantic in Cass county. He claims that the fossils found at Logan are of Des Moines facies rather than Missouri.[27] The lithologic character of the beds exposed at Logan and reached in several wells in Harrison county is more like that of the Missouri strata than that of the Des Moines beds as they are exposed in the Des Moines valley. However, it must be remembered that if the beds in the two regions are contemporaneous limestone might be forming in the deep sea to the west while shale and coal were forming along the shore in the Des Moines valley region. The strata penetrated in the Cox well near Missouri Valley, as recorded by Shimek, may at least be correlated with the Des Moines series as readily as with the Missouri series. This record is as follows:

	FEET
Surface material, clay, etc.	144
Limestone, in layers of 3 to 9 feet	36
Coal	3
Rock (record not definite)	97
Soft coal	3

Another well which perhaps should be mentioned here is that at Onawa, nearly due west of Denison, in Monona county. It is 863 feet deep, has an altitude at the curb of 1054 feet and penetrates 130 feet of valley filling, 150 feet of alternating shale and

26 Iowa Geol. Survey, vol. XX, pp. 301-303.

27 Tilton, John L., Missouri Series of Pennsylvanian System in Southwestern Iowa: Iowa Geol. Survey, vol. XXIX, pp. 310-312. See also The Strata near Stuart, Iowa; Bull. Geol. Soc. America, vol. 33, p. 153.

sandstone and thence limestone to the bottom with some shale at 350 feet. Perhaps the alternating shale and sandstone belong to the Des Moines series. The limestone at 300 feet is assigned to the "base of the Pennsylvanian."[28]

The deep well at Denison penetrates a series of shales which extend from a depth of 200 feet to 480 feet. They are chiefly gray with blue, chocolate-colored and black variations. Fragments of coal are present in the sample from 360 feet, and limestone is mixed with shale from 380 to 410 feet. This assemblage has quite a marked Des Moines appearance.

In the case of the sandstones penetrated in Hayes and East Boyer townships and in the wells near Arcadia in Carroll county there must be considered the possibility of a Cretaceous age. Doctor Bain assigned without any doubt the sandstones of Carroll county to the Cretaceous, both those which outcrop along the Raccoon and those which are reached by wells near Arcadia. Probably this disposition need not be questioned so far as the exposures along the Raccoon are concerned although if we are to classify the other strata discussed above as of Des Moines age we must also take into account the possibility that the sandstones reached by the wells in western Carroll and eastern Crawford counties likewise belong to the same series. The geological maps of Iowa represent the Cretaceous deposits as extending over all of the area here discussed but it is well known that as a matter of fact the actual distribution of these deposits is very patchy. Their exact extent can not be accurately mapped on account of the thick mantle of glacial drift. Hence it is quite possible that the Cretaceous beds have been eroded away from the areas where these wells are located. One argument in favor of the Des Moines age of these sandstones is their relatively low altitude—900 to 930 feet above sea level in Crawford county while those near Arcadia are about 1100 feet above sea. The exposures of Cretaceous beds in southeastern Carroll county are about 1165 feet above sea level, and those in the northeastern part of the county have an altitude of about 1140 feet. While we can not place great confidence in these figures on account of the irregular

28 Miller, W. J., Underground Waters of Monona County: Iowa Geol. Survey, vol. XXI, pp. 1054-1058.

erosion of the preglacial surface it seems only reasonable to assign the sandstones of Crawford county, with some degree of doubt, to the Des Moines series.

One other well in the county may reach rock. This is the well of Mrs. Mary Herring in the southeast quarter of section 18, Otter Creek township. It is 410 feet deep and the lower twenty feet is in "soapstone." The elevation of this well is about 1500 feet above sea level, hence the rock surface, if rock is reached, is in the vicinity of 1110 feet above sea level. The Benton shales of the Cretaceous outcrop on Middle Raccoon river near Auburn, Sac county, at a similar elevation, and this "soapstone" may belong to the same body, although of course, it may be merely very fine-grained glacial clay or perhaps it belongs to the Des Moines shales. If the latter is the case the Cretaceous strata must be eroded away. These wells are discussed in more detail on pages 352 to 354.

ARTESIAN WELLS

The city well at Denison is the only one in the county which pierces the indurated rocks to any great depth. It is sunk to a depth of 1810 feet from an altitude of 1170 feet, in the East Boyer river bottoms. An excellent set of samples was collected by the city engineer, Mr. Frank Woolston, and a record of these as examined and interpreted by Dr. W. H. Norton is given below.

Record of strata in City well No. 1, Denison.

	DEPTH IN FEET
Pleistocene and Recent, 200 feet thick, top 1170 feet above sea level.	
Alluvium, silts, clay and glacial tills; 20 samples	10-200
Pennsylvanian, Des Moines (?), 170 feet thick, top 970 feet above sea level.	
Shales, gray, brown, black; fragments of coal at 360; 17 samples	210-370
Mississippian, Devonian (?), Silurian, 780 feet thick, top 800 feet above sea level.	
Limestone, whitish and light yellow gray, crystalline-earthy, rapid effervescence in cold dilute HCl, in flaky chips, with some chips of black shale	380
Flint, yellowish; limestone of same color; a little shale	390
Limestone, buff and gray, fine-grained, effervescence moderately slow	400, 410
Shale, gray, calcareous, in concreted masses	420, 430
Chert, white; limestone, gray; some brown ferruginous limestone; shale in concreting powder	440
Shale, gray; with some limestone, white crystalline-granular and light yellowish, cryptocrystalline, rapid effervescence; white chert	450
Shale, gray; limestone, white, gray and buff, rapid effervescence; chert, chalcedonic silica and quartz sand in fine irregular grains; 3 samples	460-480
Limestone, gray, fine crystalline-granular; much blue-gray flint	485
Flint, blue-gray, and limestone, yellow-gray and whitish, crystalline-granular, rapid effervescence	490
Limestone, whitish and yellow-gray, rusted buff, encrinital, rapid effervescence	500
Limestone, blue-gray and whitish, subcrystalline and earthy, rapid effervescence; at 520 laminated and with chips of vein or geodic quartz; 4 samples	510-540
Limestone, light yellow-gray, calcilutite, and buff, fine crystalline-granular	550
Limestone, light yellow-gray, whitish and gray, crystalline-earthy and fine crystalline-granular, oölitic at 580, cherty at 570 and 690; rapid effervescence, with considerable quartz sand in cuttings at 610 and 630, and some in all; 14 samples	560-690
Limestone, light yellow-gray, effervescence moderately slow, some rapid	700
Limestone as above, cherty; 3 samples	710-730
Limestone, light yellow-gray, fine-grained, rapid effervescence; light gray chert	740
Limestone, drab, cherty, argillaceous, rapid action in HCl	750
Limestone, light buff, fine crystalline-granular, rapid effervescence, cherty	760
Limestone, buff, rather slow reaction to acid	770
Limestone, light gray, rapid effervescence	780
Dolomite, light blue-gray, fine crystalline-graular, in fine sand; 4 samples	790-820
Limestone, gray, earthy, rather rapid action in acid, some chips slow	830
Dolomite, light blue-gray; 3 samples	840-860
Dolomite as above, with some limestone chips of rapid effervescence	870
Dolomite, light yellow-gray, fine crystalline-granular with some chips of rapid effervescence, 5 samples	880-920
Dolomite, light gray, somewhat argillaceous	930
Limestone, whitish and blue-gray, earthy, in flaky chips, rapid reaction to acid; some dark gray, finely laminated, highly argillaceous; some green shale, fissile, calcareous	940
Dolomite, light buff	950
Shale, blue gray, highly calcareous, in hard concreted masses	960

Dolomite, light yellow-gray, cuttings unwashed, in friable concreted masses, washed cuttings in crystalline sand	970-980
Dolomite and shale; dolomite, light yellow-gray, in sand; shale blue-gray	990-1000
Dolomite as above, some flakes of gray green shale; in hard concreted masses	1010
Dolomite and shale; dolomite, light yellow-gray, in sand; shale in concreting powder	1020
Dolomite, in light buff sand; 4 samples	1030-1060
Dolomite, light yellow-gray and buff, crystalline-granular, effervescence somewhat more rapid than Le Claire dolomite; at 1100 majority of grains of cuttings show rapid effervescence; 9 samples	1070-1150
Ordovician	
Maquoketa shale, 40 feet thick, top 20 feet above sea level.	
Dolomite, blue-gray, earthy, moderately slow reaction; and shale, dolomitic	1160
Dolomite, dark blue gray, moderately slow, in sand; shale in powder, considerable pyrite	1170
Shale, light drab, in hard concreted masses gritty with fine limestone particles	1180, 1190
Galena and Platteville, 480 feet thick, top 20 feet below sea level.	
Dolomite, buff, subcrystalline, considerable pyrite at 1220; 3 samples	1200-1220
Chert, white, gray and blackish, mottled; and dolomite	1230
Dolomite and chert as above	1240
Chert and dolomite, light gray	1250
Dolomite and chert	1260
Dolomite, light gray, 3 samples	1270-1290
Dolomite, gray, vesicular, crystalline-granular, rough, cherty	1300
Dolomite, gray and dark gray, subcrystalline, and white chert; some cuttings with pepper and salt appearance. 8 samples	1310-1380
Dolomite, gray, argillaceous; cherty	1390, 1400
Dolomite, light gray, with flint of same color	1410
Dolomite, whitish, in flour, argillaceous, cherty, with particles of crystalline quartz too minute to polarize in strong colors	1420
Dolomite, gray and buff, mostly in fine crystalline sand, cherty at 1440 to 1470, 1510 to 1540; 15 samples	1430-1570
Limestone, blue-gray and yellow; gray, in small chips, rapid effervescence	1580
Shale, light blue-gray, highly calcareous, in hard concreted masses, quartzose with minute grains and angular particles; 3 samples	1590-1610
Limestone, light yellow-gray, earthy, soft, rapid effervescence, in flaky chips; and chips of green-gray, fissile calcareous shale	1620
Shale, blue-gray, green-gray and drab, calcareous; 4 samples	1630-1660
Limestone, light gray, rapid action with acid; pyrite, chips of gray shale	1670
Saint Peter sandstone, 60 feet thick, top 500 feet below sea level.	
Sandstone, white, fine grains well rounded, frosted; a few chips of limestone of brisk effervescence at 1680; a little green shale in chips at 1710-1720; 5 samples	1680-1720
Sandstone, minute ill-rounded grains of pure quartz, some stained with iron; chert; much pyrite	1730
Prairie du Chien, penetrated 80 feet, top 560 feet below sea level.	
Dolomite, whitish, light yellow-gray and pink, somewhat rusted, sparsely arenaceous with imbedded grains; cuttings in coarse sand with considerable quartz sand and green shale	1740
"Drillings washed away"	1750-1760
Dolomite, light gray, and oölitic chert	1775
Dolomite, light yellow-gray, in sand, arenaceous, particles of dolomite largely in excess of quartz grains	1785
Dolomite as above, some quartz grains with secondary enlargements	1795,1805
Dolomite, as above, arenaceous, grains of quartz sand, rounded, coarser and more numerous than above; considerable chert	1810

NOTES

In the Denison section the Coal Measures may seem exceptionally thin, but it must be taken into account that their base lies 45 feet higher than at Audubon, for example, of points southeast, while the preglacial surface stands 88 feet lower.

The base of the Mississippian is undetermined. If it lies about the same distance above the top of the Saint Peter as at Audubon, it may occur at 780 feet (390 feet above sea level) where dolomites or magnesian limestones begin in heavy beds.

The thickness of the Silurian at Stuart, where it is believed to be marked by gypsiferous beds, leads to the inference that the dolomites at Denison from 790 to 1150 feet may belong to that system. The shales and argillaceous limestones at the latter depth seem to correspond stratigraphically with the Maquoketa at Stuart. The underlying dolomites and limestones and basal shales to the Saint Peter sandstone at 1670 feet are thus assigned to the Galena and Platteville.

The Saint Peter is here too fine of grain to be a bountiful water-bed. The main supply comes from the creviced dolomites and sandy layers of the Prairie du Chien. The upper beds of these dolomites, and perhaps all of them, belong to the Shakopee, but possibly the highly arenaceous stratum struck at 1805 represents the New Richmond sandstone.

It may be added that the cuttings were unwashed. The colors given are those of the individual chips after washing and are thus different from the color of the cuttings in mass, which was pretty uniformly a gray.

Driller's Record of Denison Well.

262 feet of 14 inch hole, cased with 14 inch pipe.
10 inch hole to 1618.6 feet, cased with 10 inch pipe, 261 feet long to 500 feet, overlapping 14 inch and swaged.
8 inch hole 1618.6 feet to 1810 feet. Cased with 46 feet, 6 inches of 8 inch casing from 1618.6 feet to 1665 feet, over shale.
Struck shale at 245 feet.
"Drift" and shale to 485 feet.
Brown limerock to 950 feet.
Lime rock with traces of shale to 1600 feet.
Shale and rock to 1665 feet.
Lime rock to 1680 feet.
Sand rock to 1730 feet.
Brown lime rock to 1810 feet.
Numerous crevices in this lower part, 1730-1810, also most water in this part.
Not a great deal of water from 1680 to 1730.
In hard rock.

In the table below are given summaries of the strata penetrated by the Denison well and also by a few others in neighboring counties, together with other information of interest. The Holstein well is sunk from the upland; the others are on the lowland and therefore do not represent the full thickness of the Pleistocene.

Table of Elevations of top of Strata and Thickness of Strata in Wells at:[29]

	Holstein (No. 2)		Denison		Dunlap		California	
		Feet		*Feet*		*Feet*		*Feet*
Altitude of curb	1457		1170		1151		1010	
Altitude of bottom	–583		–640		–384¾		–450	
Depth of well	2040		1810		1535¾		1460	
Formations penetrated	Alt-itude	Thick-ness	Alt-itude	Thick-ness	Alt-itude	Thick-ness	Alt-itude	Thick-ness
Pleistocene and Recent	1457	420	1170	200	1151	225	1010	122
Cretaceous (?)	Absent		Absent		926	307	Absent	
Pennsylvanian	1037	170	970	170	?		888	342
Mississippian	867	140	800		619	288		
Devonian	Absent ?		?	780	331		546	663
Silurian	Absent ?		390?		?	715¾		
Ordovician	727	900	20	660	?		–117	333
Maquoketa	Absent ?		20	40	?		–117	55
Galena-Platteville	727	700	–20	480	?		–172	278*
Saint Peter	27	20	–500	60	–366?	18¾*?		
Prairie du Chien	7	180	–560	80*				
Cambrian	–173	350						
Jordan (?)	–173	10						
Saint Lawrence and undifferentiated	–183	340						
Algonkian (?)								
Red clastic beds	–523	40						
Archean ? granite	–563	20*						

* Well ended in this formation.

The table gives a fair idea of the range in character of the strata in western Iowa, although it will be noted that there is much conjecture as to the thickness and limits of some of the beds. There are some surprising variations in the strata which perhaps are to be explained by differential erosion or possibly by differences in deposition, as well as by the natural dip of the rocks. Holstein, the most northerly of the towns here listed, is seventy miles northeast of California, the most southerly of the four, and thirty-four miles northwest of Denison. Dunlap is eighteen miles southwest of Denison and California is about thirty miles southwest of Dunlap. The table shows how unevenly the beds dip and how irregular are their thicknesses in the short distances between these towns.

The rock level is shown at a number of other localities near

[29] The Holstein Well No. 2 is described somewhat in An Unusual Well Record in Northwestern Iowa: James H. Lees, Proc. Ia. Acad. Science, vol. XXX, pp. 445-450; 1923. Doctor Norton has kindly furnished his determinations of the complete set of samples from the new Holstein well for reference in making this table. The record of the Denison well as given here and on pages 298 to 300 is taken from Doctor Norton's determinations. For details regarding the Dunlap well see, W. H. Norton, Underground Water Resources of Iowa: Iowa Geol. Survey, vol. XXI, p. 1131; 1912. The California record is summarized from the driller's log and from records of the drillings made by Doctor Norton and the writer.

The Holstein, Denison and California wells will be described by Doctor Norton in volume XXXIII of these reports.

Crawford county and some of these may be enumerated. Low water in the Missouri at the Blair railroad bridge west of California is 986 feet above sea level. Rock was reached in borings at a depth of forty-five feet or at 941 feet above sea level. The altitude of the railroad station at Missouri Valley is 1,006 feet and wells sunk here reach rock at ninety feet—916 feet above sea level. The station at Logan is 1,035 feet above sea level. Rock is found in the river bank rising sixteen to eighteen feet above low water in Boyer river, that is 1,000 feet or more above tide. At Woodbine limestone occurs twenty-eight to thirty feet below the surface of the flat along the Chicago and North Western railway, which lies at 1,058 feet. This places the rock surface about 1,030 feet above sea.[30] At Arcadia, according to Bain,[31] the altitude of the sandstone is about 1,100 feet, and Mr. Frank Hoffard, who has drilled wells in that vicinity, also states that it lies about 300 feet below the surface. The railway station is 1,387 feet above the sea.

The altitude of the rock surface at Odebolt is about 1100 feet, according to Bain. He states, however, that wells go down 350 feet in drift, and this is borne out by the record of the city well at Odebolt. Since the elevation of the town is about 1360 feet and it is near the divide, the rock surface would seem to be about 1000 or 1050 feet above sea level. A well sunk in section 10, Jackson township, in our county, penetrates the drift to a depth of 500 feet without striking rock. The rock here must be 1,000 feet or less above sea. Some holes near Manilla are sunk 300 to 515 feet in drift. This again places the rock surface at 1000 feet or below. Mr. W. A. Davie has sunk wells in Boyer and Union townships to depths of 235 to 270 feet entirely in drift. As these wells are near the upland they probably do not approach the rock nearer than 200 feet, as rock was reached at an altitude of 926 feet in the deep well at Dunlap, and at 970 feet at Denison.

The Pleistocene

The table of formations given on page 294 shows that there are within the county deposits representing three glacial ages and

30 Shimek, B., Iowa Geol. Survey, vol. XX, pp. 301-303.

31 Iowa Geol. Survey, vol. IX, p. 75. On page 77 Bain puts the surface of the rock at 1290 feet, but this seems very high. The lower figure is more consistent with other data.

at least three interglacial ages. Only the first two glaciers, the Nebraskan and the Kansan, covered the territory which is now Crawford county. The Illinoian glacier, which followed the Kansan, was too far away to affect our region directly, as it advanced only a few miles west of Mississippi river. Recent studies by Carman show that the Iowan glacier extended into Sac county but did not reach Crawford county. The Wisconsin glacier approached within a few miles of the county's northeastern bounds and Boyer valley evidently formed one of the main outlets for the waters from the ice front, as large quantities of sand and silt are spread over its floor and some of these may be traced to the Wisconsin boundary at Wall Lake.

The three interglacial ages which are represented are the Aftonian, the Yarmouth and the Peorian. In addition there is the long period representing the Illinoian and Iowan glacial ages and the intervening Sangamon interglacial age during which the everyday erosive and depositional activities of Nature were in practically uninterrupted operation in our territory. The materials which represent these interglacial ages are gumbotil, gravel, sand, soils, peat and loess. Gumbotil, it may be explained, is a gray to nearly black clay of very fine texture and with very few pebbles and these of types extremely resistant to decay, chiefly quartz. When it is wet gumbotil is very sticky and gummy, even more so than the ordinary pebbly drift clay or till. When it is dry gumbotil is crumbly and somewhat starchlike in structure. Gumbotil is the residuum from the chemical alteration of the drift clay which has resulted in the dissolution and transportation of all those parts which are soluble in water and in the weak acids formed in soils and elsewhere by natural processes and carried in ground water. Consequently all the lime is gone, most of the pebbles and bowlders are decayed and the whole mass of the drift affected has suffered profound alteration. We have no way of knowing how much of the drift has been altered in this way but gumbotils fifteen feet thick have been found at different places in Iowa, so we are certain that at least that thickness of drift was altered. Of course it was the upper part of the layer of drift which suffered these changes and there is a gradual but still rather abrupt change from the gray noncalcareous gumbotil downward through a pebbly drift clay oxidized to a yellow color and leached of its lime to the yellow limy unleached drift clay below. This change in most cases takes place within one to five feet. The unleached and unoxidized drift may be found below this yellow drift wherever erosion has progressed far enough to cut away all of the yellow portion and expose the blue or gray drift beneath. It will be evident that where a gumbotil has a pebbly limy drift clay overlying it and a similar one below, it must be derived from the one below but must be older than the one above. This fact can often be used in determining the age of a gumbotil and of the drifts underlying or overlying it.[32]

It must be understood that while the gumbotils found in Crawford county were formed during interglacial times and hence are classified in the table as Aftonian and Yarmouth nevertheless because they were derived from the alteration of glacial drifts they must be called Nebraskan gumbotil and Kansan gumbotil respectively.

In the course of his studies of the drifts and gumbotils of western Iowa Doctor Kay has found a number of excellent outcrops in Crawford county and has kindly given his notes to the writer for use in preparing this report.

THE NEBRASKAN AND AFTONIAN STAGES

Most of the exposures of deposits of Nebraskan and Aftonian age within the county fall naturally into two groups, both of which are in the eastern part of the county. The more extensive group is found in a series of cuts along the new line of the Chicago, Milwaukee and St. Paul Railway between Manning in western Carroll county and Manilla in southeastern Crawford. The other group is found along Boyer valley and its tributaries in the northern part of the county. Additional outcrops have been seen in road cuts in the southeastern townships and a few are known also from northwestern townships.

In the road between section 6, Jackson township, Crawford county, and section 31, Levey township, Sac county, a gully has

32 For original descriptions of the gumbotil the reader is referred to the following papers by George F. Kay. Some Features of the Kansan Drift in Southern Iowa: Bull. Geol. Soc. America, vol. 27, pp. 115-117. Reprinted in Iowa Geol. Survey, vol. XXV, pp. 612-615. Gumbotil, a New Term in Pleistocene Geology: Science, N. S., vol. XLIV, Nov. 3, 1916. Reprinted in Iowa Geol. Survey, vol. XXVI, pp. 217-218. The Origin of Gumbotil, George F. Kay and J. N. Pearce: Jour. Geol., vol. XXVIII, pp. 89-125, 1920.

been cut by storm waters and has exposed the following materials:

		FEET
2.	Till, Kansan, yellow, calcareous in lower part; pebbly, with some bowlders a foot or more in diameter; no loess above, lower surface irregular but in general fairly horizontal. Exposed in gully..........	0–6
1.	Gumbotil, Nebraskan, black, coarsely blocky, sticky; only very few small pebbles seen, these being one-eighth to one-fourth inch in diameter. A few small lime concretions. Contact with No. 2 irregular but very sharp, may be detected within less than one inch by acid test as well as by color. Exposed to floor of gully....	6

This exposure is on the west side of Boyer valley, about fifty feet west of the Chicago and North Western railway track. A

FIG. 48.—The Nebraskan gumbotil overlain by Kansan till in the road-cut between Sac and Crawford counties. Note how the Kansan stands with nearly vertical edge while the gumbotil surface has a decided slope.

part of it is shown in figure 48. The floor of the gully is practically at the same elevation as the railway track, or about 1235 feet above sea level. The same sequence may be seen along the railway track about one hundred yards below the road crossing. Here the gumbotil rises five feet above the track and is overlain by yellow pebbly calcareous Kansan till, while the gumbotil is not responsive to acid. The underlying strata are not exposed to view.

A little brook crosses the south part of the southwest quarter of section 11, Stockholm, extending from west to east and joining Porter creek just at the northern outskirts of Boyer village. About one-fourth mile up the valley of this brook the stream has cut into its south bank and exposed a very interesting section which is as follows (see also fig. 49):

		FEET
5.	Soil	1
4.	Till, Kansan, yellow, pebbly; calcareous below, and with some gray streaks in the lower foot	5
3.	Gumbotil, Nebraskan, noncalcareous, very dark gray, almost black, very sticky when wet, starchy fracture; some sand grains	5 1/2
2.	Clay, Nebraskan, sandy, some pebbles; shows intermingled patches of typical dark gray gumbotil and lighter gray, more sandy till. This clay is noncalcareous in the upper part but is slightly calcareous in the lower part. It grades into the overlying and underlying beds	5 1/2
1.	Till, Nebraskan, mingled gray and yellow, pebbly, calcareous; lower three feet dark blue-gray; to water level	11

The presence of typical Kansan till above the gumbotil fixes the age of the latter as Nebraskan. A few small pebbles one-

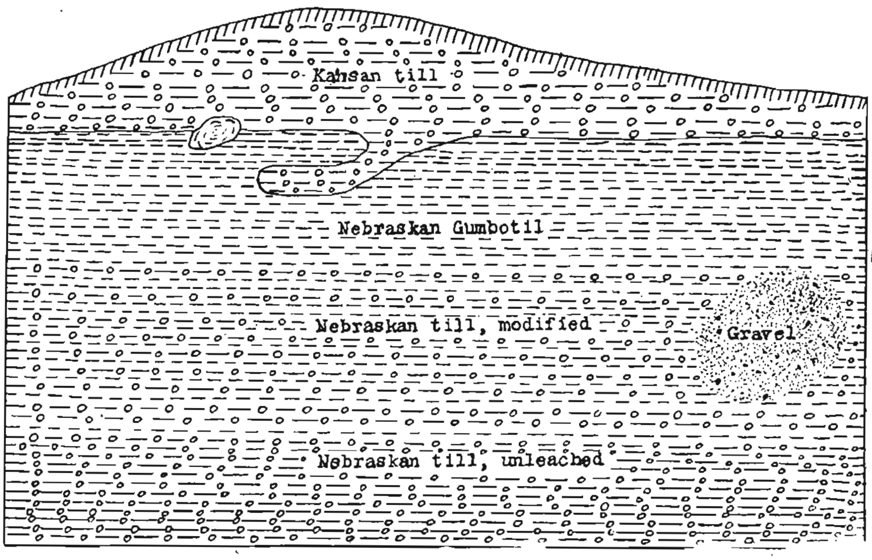


FIG. 49.—Section of the exposure of drift materials in the ravine northwest of Boyer, in the east half of the southwest quarter of section 11, Stockholm township.

eighth to one-fourth inch in diameter, which were seen on the surface of the gumbotil, most probably belong with this member and one polished pebble one-half inch in diameter was picked out of this clay. A few lime concretions were found in the lower part of the gumbotil and must have been deposited from ascending or descending waters. The contact of the Kansan till with the Nebraskan gumbotil is very abrupt and may be differentiated within an inch. Just at the contact is a gneissoid bowlder two feet long and fifteen inches high which is embedded about equally in the two strata. It is completely disintegrated except for a thin lens at the center and may be cut easily with the hoe. Below this bowlder is a layer of gray limy clay one-half to one inch thick which helps to preserve the outlines of the rock. At the center of the exposure a tongue of yellow calcareous till extends from the base of the Kansan downward and to the left a distance of about three feet, and is here overlain by a foot of gumbotil. At the right end of the exposure is a large mass of gravel which is overlain by the gumbotil and otherwise is enclosed by Nebraskan drift, as if it had been a gravel bowlder picked up in frozen condition by the Nebraskan glacier. The altitude of the top of the gumbotil is about 1270 feet above sea level.

For the sake of comparison a count was made of pebbles from the two tills. Pebbles from the Kansan till were gathered from the surface above the Nebraskan gumbotil. Pebbles from the Nebraskan till were dug out of the bank to insure the exclusion of any pebbles which might have slid down from higher levels. A few of the granites and greenstones and limestones in the Nebraskan till are so decayed that they may be cut through readily but most of these rocks appear fresh and hard. The results of the pebble count were as follows:

Nebraskan		*Kansan*	
Limestone	46	Limestone	36
Greenstones	20	Greenstones	31
Granites	14	Granites	13
Quartz	9	Quartz	6
Chert	4	Chert	4
Quartzite	2	Quartzite	4
Sandstone	2	Sandstone	1
Greenstone schists	2	Greenstone schists	5
Feldspar	1		
	100		100

There is but little difference in composition shown here. The preponderance of limestone in the Nebraskan till is not surprising, since when the Nebraskan glacier advanced over the preglacial surface it found only a residual covering rather than the thick glacial mantle which was present when the later glaciers covered our state. Hence it would be easy for the glacier to pick up a large amount of limestone. The igneous rocks in the Nebraskan must have been brought from central or northern Minnesota or still farther north, in Canada, as there was at that time no source of supply nearer the present resting place of this material. This implies a long journey beneath and within the ice. The Kansan ice-sheet may, of course, have accumulated part of its load from the Nebraskan drift.

A small gully one hundred feet east of this exposure shows the Nebraskan gumbotil with calcareous Kansan till above and calcareous Nebraskan till below.

Nearly a mile north of this exposure on the west side of the railway track just south of the bridge over the highway between sections 2 and 11 a low cutting reveals about four feet of yellow weathered Kansan drift, which is calcareous in its lower part. Beneath it is a gray Nebraskan gumbotil which for the most part shows no lime reaction with acid although in places a slight effervescence is noted. It is about four feet thick and grades down into yellow calcareous Nebraskan till which is exposed for six feet above the ditch. The surface of the gumbotil slopes to the north and within twenty-five feet the entire section as given above is replaced by loess. The Kansan till is replaced midway in the section by an eighteen inch stratum of sand upon which the loess overlaps. The elevation of the gumbotil here is about 1280 feet, or ten feet higher than that of the gumbotil exposed in the ravine a mile to the south. This difference is probably due to irregularities of the surface rather than to a general dip. It is worthy of note that in the two exposures described above the gumbotil lies at about the same altitude as the gumbotil in the Chicago Great Western railway cut east of Carroll—1270 feet.

About midway between the two exposures just described Porter creek has cut into the bluff along whose base it flows and has revealed a section which rises perhaps forty feet to the railroad track. Most of this space is occupied by sand and gravel, but the lower thirteen feet is occupied by a black sticky joint clay, the upper two feet of which is oxidized to a mixed buff and blue-gray. This extends below the level of the stream, which here is about 1225 feet above sea level, or practically fifty feet below the gumbotil exposed to the south and the north. Above the railroad track the sands rise to the surface of the ground except for a veneer of loess, hence there is nothing except stratigraphic position on which to determine the age of this till. However, its position certainly lends force to the argument that it is Nebraskan and it is here so classed. It was formerly thought that one of the characteristic features of Nebraskan till was its black color and starchy fracture. But subsequent investigations have shown that not a great deal of reliance can be placed on physical structure or composition in determining the age of the older drift sheets. In the last analysis stratigraphic relationship must be the decisive factor. Along the road on the south line of section 16, Stockholm township, on the hillside west of the creek, at an elevation of 1285 feet, there is shown two feet of gray noncalcareous sticky clay with some sand grains. Above it is five feet of yellow pebbly till and then yellow loess. Also below the gray clay there is yellow till. The upper till clearly is Kansan, the gray clay is Nebraskan gumbotil and the lower till is Nebraskan.

Kay has recently found and examined two exposures of Nebraskan gumbotil which may be added to the series just described. One of these is in the southeast quarter of section 22, Stockholm, along the road between Deloit and Boyer. Kay speaks of it as "a remarkably fine outcrop and one which will be exposed for many years." Twenty feet of oxidized till is exposed below the gumbotil and several feet of oxidized Kansan till lies above it. The gumbotil is 1255 feet above sea level.

The other exposure is one-eighth mile south of Tucker creek on the road between sections 25 and 26, Stockholm. Oxidized and unleached Kansan till with concretions and sand and gravel pockets overlies the gumbotil and forms a sharp irregular contact with the latter. The gumbotil itself contains many concretions and has been plowed by the Kansan ice. It lies 1285 feet above sea level and is about eight feet thick.

Another outcrop of Nebraskan gumbotil is exposed at an elevation of 1275 feet in the northwest quarter of section 23, Stockholm.

A much more extensive series of exposures of Nebraskan drift and gumbotil is to be found along the Milwaukee railway between Manning and Manilla. In 1913 the Railway Company changed the grade of its line across central Iowa and in so doing made a number of deep cuts which have revealed a great deal regarding the Pleistocene history of Iowa and the Mississippi valley. The cuts in the region we are discussing give sections of the loess, the Kansan gumbotil, the Kansan drift, the Nebraskan gumbotil and the upper part of the Nebraskan drift. Some of

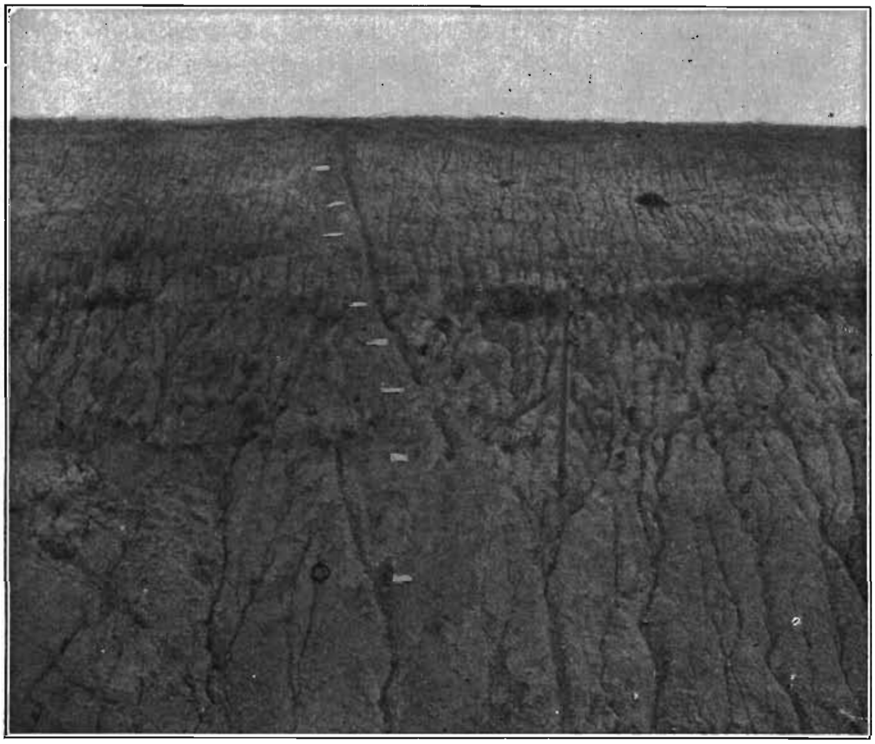


FIG. 50.—The cut along the Milwaukee railway just east of the viaduct one and one-half miles west of Manning, in the southwest quarter of section 18, Warren township, Carroll county. The cut shows from the surface the loess, Kansan till, soil band, Nebraskan gumbotil and Nebraskan till. Photo by Kay.

these sections as well as others farther east have been described in these reports[33] and some of the typical ones which include the Nebraskan deposits will be described here.

One of the best of these cuts and indeed one of the most complete sections of the Pleistocene deposits in western Iowa is just east of the county line viaduct over the railway and therefore is in the southwest quarter of section 18, Warren township, Car-

[33] Kay, George F., Pleistocene Deposits Between Manilla in Crawford County and Coon Rapids in Carroll county, Iowa: Iowa Geol. Survey, vol. XXVI, pp. 213-231; 1917.

roll county. The section exposed on the south side of this cut is described by Kay as follows. It is illustrated in figure 50.

		FEET
6.	Loess	
	Leached, yellowish gray on dry surface, yellowish brown to buff-brown on damp surface; no shells or concretions	7
	Unleached, lighter colored on dry surface than the leached loess, and when damp is buff with gray streaks. Contains shells and concretions	5
5.	Drift (Kansan), yellow, unleached, with calcareous concretions; numerous pebbles including granites, quartzites, etc. Below the oxidized, unleached drift is gray drift with a few pebbles. It is gumbotil-like but effervesces freely. It was probably picked up from the gumbotil zone below	5
4.	Soil band (Aftonian) containing carbonaceous material	1/3
3.	Gumbotil (Nebraskan), gray to drab, few pebbles. The upper six feet is fine-grained, gray and is less sticky and gumbotil-like than the lower seven feet, which is leached, but has some calcareous concretions	13
2.	Drift (Nebraskan), oxidized, apparently leached but has calcareous concretions, upon which are films of manganese dioxide	2
1.	Drift (Nebraskan), unleached, oxidized, light yellowish on dry surface, mottled brownish with gray when damp; many calcareous concretions, especially in upper ten feet	17

The surface of the lower unleached part of the loess is covered with small lichens which give it a gray tint. It seems as if the lichens must need lime for their growth. This unleached loess thins to east and west and its upper surface is parallel with the present surface of the hill. The concretions in the Kansan till are especially abundant in the upper part, as if they had been carried down in solution from the overlying material, which was leached and then eroded away before the loess was deposited. The clay below the five feet of typical Kansan till has a thickness of about three feet. At its base is six inches of light gray laminated clay without pebbles or concretions.

The contact of the different members of this section is decidedly unconformable. This is shown in part by the fact that at the ends of the cut the loess comes down over the Nebraskan till. The Kansan till and the Nebraskan gumbotil were cut away in the development of the preloessial topography. The irregularity of the succession is further shown by the north face of the cut, where, east of the crest, the loess is eighteen feet thick and is yellow and leached, but still fossiliferous, in its upper part, while the lower part is gray and calcareous. Below the loess is a pebble band and then gray gumbotil, which lies on a four foot layer of finely sandy laminated clay. Beneath this is the Nebraskan till. Just west of this point eight feet of yellow unleached Kansan till underlies loess and overlies Nebraskan gumbotil. There is here no soil band and there are no mixed layers such as underlie the Kansan till on the south face. The elevation above sea level of the track in this cut is about 1392 feet, consequently the top of the gumbotil is about 1425 feet above sea level.

A mile west of this cut, near the southwest corner of section 13, Iowa township, Crawford county, another deep cut shows at the east end about thirty feet of loess of which the upper six feet is reddish and leached and that below is buff. The lower part of the cut is covered by slump and may be in drift. The loess here bears horizontal iron bands and calcareous plates which because of their superior hardness stand in relief on the face.

A little farther to the west in the cut the loess is about twenty feet thick and beneath it is seen eight feet of yellow Kansan till and then ten feet of gray gumbotil which extends to the bottom of the grade. At the middle of the cut is the following exposure:

		FEET
7.	Loess, mixed gray and yellow with red spots; leached, grades down within two feet into next member	8
6.	Loess, buff, unleached, fossiliferous	18
5.	Drift, Kansan, yellow, unleached, oxidized, reddish near the top. The upper part carries many concretions and here pebbles of limestone, quartzite, granite, etc., are so abundant as to form a pebble band. In places a two to six foot bed of sand lies at the top of the drift	17
4.	Soil, Aftonian, gray to black, grading into lower member	2
3.	Clay, gray, fine-grained, modified gumbotil	5
2.	Gumbotil, Nebraskan, typical, medium gray, starchy structure; exposed	3
1.	Slump, to railroad level	10

When this cut was newly opened it showed ten feet of gumbotil and modified gumbotil and a few feet of underlying yellow pebbly Nebraskan till. The gumbotil as then examined is described as being very hard to pick and containing some sand grains and pebbles. At one place, above the black soil band there was exposed six feet of light blue-gray horizontally laminated clay which probably was a deposit from waters in front of the Kansan glacier. The top of the gumbotil is level almost the entire length of the cut nearly to the east end where it breaks off and the younger formations come down over it. Here the gumbotil is overlain directly by the blue clay, which is pebbly but yet not like typical till. Over it is the bed of sand mentioned above, which may have been blown up from lower levels after the development of the Kansan topography. The elevation of the track here is 1410 feet.

About two hundred yards west of the public road in the southeast corner of section 14 is another cut which shows the normal succession of loess, Kansan till, Nebraskan gumbotil and Nebraskan till. Adjoining this cut on the west, and just west of the "station one mile" post east from Aspinwall, is another cut

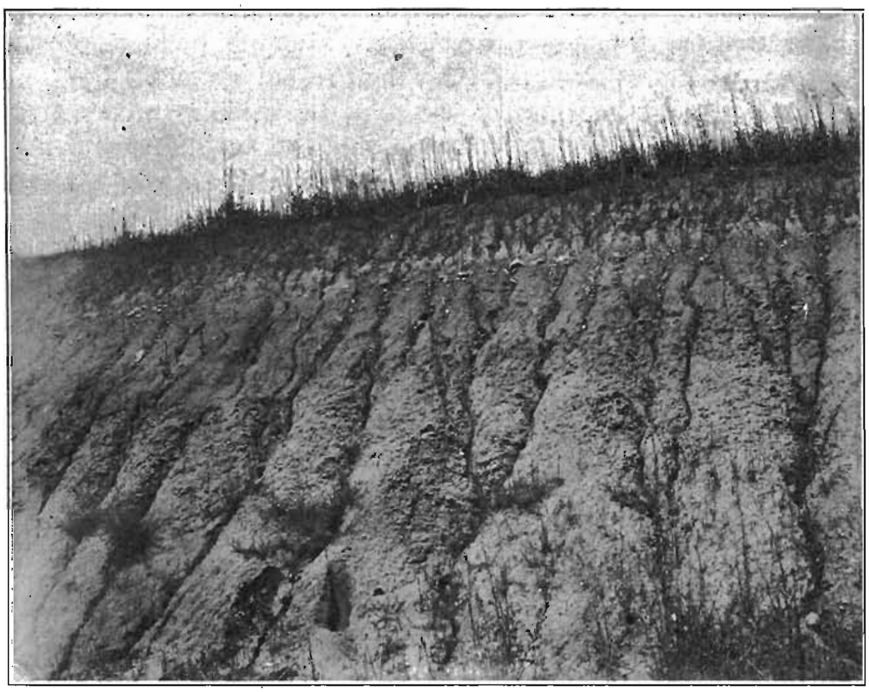


FIG. 51.—Cut in the Milwaukee railway just west of the "station one mile" post east of Aspinwall. The section shows loess, Kansan till, Nebraskan gumbotil and oxidized Nebraskan till. Photo by Kay.

which while not so deep as some, reveals several interesting features. The north side of this cut is described by Kay and is illustrated in figure 51.

		FEET
5.	Loess, yellow	4
4.	Pebble band on which is about one foot of leached loesslike clay with small pebbles	
3.	Drift (Kansan), oxidized and leached	4
2.	Gumbotil (Nebraskan), gray, sticky, starchlike fracture, some concretions	5
1.	Drift (Nebraskan), oxidized, in lower part calcareous; exposed	5

It is evident that much weathering of the Kansan drift materials had transpired before the deposition of the loess, for the reddish concentrate above the pebble band evidently represents the residuum of the Kansan gumbotil while the underlying pebble zone represents the residuum from the Kansan till, which is here very thin and wholly leached. Another interesting feature is the fact that the Nebraskan till is calcareous within a foot of the base of the gumbotil. Still another noteworthy character is the thickening of the loess down the slopes of these cuts, which shows that the preloessial topography was one of more abrupt contours and steeper slopes than the present surface.

The south side of this cut shows at the middle three feet of yellow loess which is concretion-bearing and fossiliferous below, then three feet of brownish sticky noncalcareous Kansan till with decaying granites and other pebbles, then light gray sticky Nebraskan gumbotil which shows the usual starchy structure and contains very few pebbles. The top of the gumbotil is 1420 feet above sea level.

A section about half a mile west of Aspinwall, in the northwest quarter of section 15, Iowa township, is of interest because the basal exposed member, the Nebraskan gumbotil, of which only

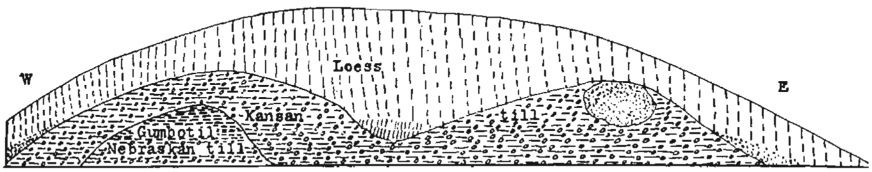


FIG. 52. Diagram of the cut along the Milwaukee railway, two miles northeast of Manilla in the northeast quarter of section 13, Nishnabotany township. Note the two knolls of Kansan till.

four feet appears above the railroad grade, is only about 1395 feet above sea level, twenty-five to thirty feet lower than in the cuts east of Aspinwall. The gumbotil rises as a low dome near one end of the cut and is covered by Kansan till. This section will be described in detail in the discussion of the Kansan stage, on page 324. The only other cuts of this series which show Nebraskan materials are two in section 13 of Nishnabotany township. One of these is in the northeast quarter and is peculiar in that the Kansan till rises in two knolls beneath the loess. It is shown diagrammatically in figure 52. The valley between is filled with drab loess. The upper part of the loess is brownish yellow and the entire body is here twenty-five feet thick. When the cut was opened there was exposed in the north wall a large sand pocket which extended to the top of the old preloessial hill. Bedded sand also overlaps the till beneath the loess, rising upon both slopes of the old hill. Beneath the Kansan till is eight feet of gumbotil of which the upper two or three feet shows some effervescence, owing probably to the mingling of the Nebraskan gumbotil with Kansan till. Four feet of leached yellow Nebraskan till is exposed beneath the gumbotil. The Kansan till is unleached throughout its thickness and carries concretions all through its mass. The altitude of the top of the gumbotil is about 1380 feet.

The other cut, in the southwest part of the section, shows the same succession but the gumbotil is here eroded away until only about three feet remains. The altitude of the gumbotil must be not far from 1370 feet.

The exposures of Nebraskan materials previously mentioned as being found in the northwestern part of the county were seen by Doctor Kay. One of these is about an eighth of a mile east of the southwest corner of section 14, Otter Creek township. It shows from above downward: oxidized Kansan till, 11 feet; drab to gray Nebraskan gumbotil with concretions, 8 feet, at 1375 feet altitude; and oxidized unleached till with a narrow upper leached zone, 5 feet.

In the northwest quarter of section 20, Morgan, about one-fourth mile south of the highway bridge, a little stream has exposed the following section, as described by Kay.

		FEET
4.	Loess	
3.	Till, Kansan, oxidized, pebbly; in lower part gray, unoxidized, unleached	5
2.	Gumbotil, Nebraskan, gray on dry surface, dark to drab on moist surface; a few pebbles and concretions; some shells; dark organic matter in upper part. Elevation, 1360 feet	8
1.	Till, Nebraskan, oxidized, brownish, unleached; gray where least oxidized	5

Another section found by Kay in this part of the county is in the northwest quarter of section 34, Hanover, and shows oxidized unleached Kansan till above Nebraskan gumbotil.

One of the most interesting exposures of Pleistocene materials in the county is in the northeast corner of section 23, Soldier township, and was discovered by Kay. Here, about two hundred yards southwest of the corner of the section, a little stream has cut into its bank and laid bare a most unusual series of materials. The section as described by Kay is as follows:

		FEET
5.	Loess	4
4.	Till, Kansan, pebbly, unleached, mostly oxidized; gray where unoxidized	16
3.	Peat, Aftonian, consolidated into distinct layers	1/12 to 1/2
2.	Silts, dark gray to drab, highly calcareous and containing many shells, except in upper foot, which is leached	7
1.	Till, Nebraskan, oxidized, highly calcareous and with many concretions, gray to bluish where least oxidized. Bed of stream is unoxidized and unleached till	3

The peat lies 1355 feet above sea level and evidently accumulated in a depression on the Nebraskan gumbotil plain. It is exposed for twenty yards along the stream.

One of the noteworthy features of this series of exposures is their elevation, which ranges from 1355 to 1400 feet above sea level, an average of about a hundred feet above the exposures of Nebraskan gumbotil near Boyer valley, which lie 1240 to 1280 above sea level. Either the four exposures just described must have been on eminences rising above the Nebraskan gumbotil plain or else they represent the general elevation of that plain and the exposures found in and near Boyer valley represent a depression in the plain. The evidence is not sufficiently abundant to be conclusive, but these phenomena should be considered in connection with the discussion of the elevation of the Nebraskan gumbotil plain which is given below.

Elevation of the Nebraskan gumbotil plain.—It is interesting to note the elevation of the Nebraskan gumbotil plain, both in Crawford county and in other regions where it has been examined. The surface of the gumbotil in the first section west of Manning is about 1425 feet above sea. Thence it declines to the west so that near Manilla it stands at about 1370 feet. Eastward, likewise, it is lower, for in a cut a mile west of Coon Rapids, Carroll county, described by Kay, the Nebraskan gumbotil is only about 1180 feet above sea level. To the north as we have seen in Stockholm township, Crawford county, the gumbotil lies 1240 to 1280 feet above sea level. Still farther northwestward the writer found Nebraskan gumbotil under Kansan till in the east part of section 4, Silver township, Cherokee county, eight miles south of Cherokee, in a gully tributary to Silver creek. The altitude here is about 1260 feet. Again, sixty miles east of Cherokee along Des Moines river near Bradgate the writer found beneath Wisconsin till a gumbotil which must be Nebraskan. It lies at an elevation of about 1100 feet, too low for the Kansan gumbotil. South of Crawford the gumbotil has been found in several counties. For example in Cass county, as noted by Tilton,[34] it lies approximately 1220 feet above sea level. He states further that "It appears to be higher in the northwestern part of the county than in the southeastern part." In Adams county as determined by the writer the remnants of the Nebraskan gumbotil plain now lie at about 1175 feet near Prescott, 1160 feet near Corning, 1150 feet in the northwestern part of the county and 1130 feet in the southwestern part. East of Portsmouth, in Shelby county, the gumbotil lies 1245 feet above sea level, according to Kay. Those remnants which are found in eastern Montgomery county also lie from 1110 to 1150 feet above sea level.

Farther east, in Clarke county, Tilton[35] has determined the altitude of the Nebraskan gumbotil, by the barometer, to be "at a level of about 1040 feet above sea level in the eastern part of the county, about 1113 feet above sea level in the central part of the county, and about 1156 feet above sea level in the western part of the county."

The evidence thus far in hand, then, if we exclude for the moment the three outcrops in the northwestern part of the county, seems to show that the Nebraskan gumbotil plain as it exists at present reaches its maximum known elevation, 1425 feet, in the vicinity of Manning. Thence, with the exception above noted, it seems to slope in all directions, to 1370 feet near Manilla, to 1270 feet near Carroll, to 1240 and 1280 feet near Boyer, to 1234 feet near Atlantic, to 1160 feet near Corning, to 1113 feet near Osceola. It is interesting to speculate as to the cause of this flattened dome. Was it because of a greater heaping up of Nebraskan drift in the neighborhood of Manning, or was it because Af-

34 Tilton, J. L., Geology of Cass County: Iowa Geol. Survey, vol. XXVII, p. 225.
35 Geology of Clarke County: Iowa Geol. Survey, vol. XXVII, p. 140.

tonian drainage and erosion were less effective there than elsewhere? If it is true that the gumbotil was developed before erosion had affected the Nebraskan drift plain to any great extent it seems hardly probable that later Aftonian erosion could have shaped the contour of the Nebraskan gumbotil plain. It seems most likely that the solution of the problem will have to await the accumulation of more complete and extended data.

There may arise a question as to the extent of the Nebraskan drift and gumbotil at the present surface. Of course it is impossible to know definitely where the Nebraskan is the surface drift, but it seems probable that where the streams have cut below the level of the Nebraskan gumbotil plain the lower parts of their valleys are in Nebraskan drift. This will be more likely to be true if the valleys are post-Kansan in age, as seems to be the case. If they were older than the Kansan stage the Kansan drift would, of course, fill them and would be the drift to be exposed by erosion. It is evident that this is not the case universally. Again, the Kansan drift undoubtedly fills hollows in the Nebraskan and may therefore be uncovered locally by erosion at levels lower than that of the Nebraskan gumbotil plain. All these factors make impossible a definite answer to the question as to the present superficial extent of the Nebraskan drift.

Almost equally difficult of answer is the question as to the thickness of the Nebraskan drift, because of our lack of knowledge of the elevation and character of the preglacial surface. That surface must be quite irregular as is shown by the depth to rock in the few deep wells which have reached it. For instance the Lorenson well described on page 353, which was sunk to a depth of 500 feet from an elevation of about 1500 feet above sea, does not reach rock. The McCaffery well, three miles south, sunk from about the same elevation, reaches rock at 305 feet or about 1200 feet above sea. If the Nebraskan gumbotil plain lies here at about 1270 feet as it does near Carroll and Boyer there is only about seventy feet of Nebraskan drift present at the maximum. However, all the other wells in the county which reach rock find it at much lower levels—970 feet above sea at Denison and at similar altitudes in other wells near by; possibly about 1100 feet near Schleswig. This allows a greater thickness for the Nebraskan, reckoning from the altitude of the buried gumbotil plain, a thickness which may amount to as much as three hundred feet.

Deposits of Uncertain Age.—An examination of the accompanying sketch map of Crawford county will show that most of the larger valleys are cut below the level of the Nebraskan gumbotil plain. It is at least possible, therefore, that some of the deposits exposed near the bottoms of these valleys may be of Nebraskan age. Hence a few exposures so located will be described here before we pass to the description of those materials whose Kansan age and origin are beyond question.

Where Beaman creek debouches into Boyer valley, in the center of section 6, Jackson township, there is an exposure showing ten feet of till which is blue-black at the base, yellow and blue-gray above. While as before indicated but little reliance can be placed on physical characters in distinguishing Nebraskan from

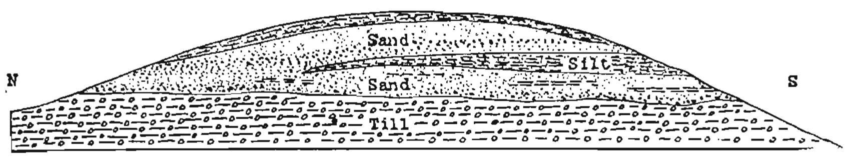


FIG. 53.—Diagram of a cut along the Illinois Central railway two miles south of Deloit, in section 24, Goodrich township.

Kansan till, yet this till is darker than is most of the Kansan till exposed in this region. This, with its position, gives plausibility to the suggestion that it may be Nebraskan. Above it lie sand and silt beds nine feet thick with a foot of soil overlying them. There are similar exposures of blue-black till along Trinkle creek which while it is at somewhat higher altitudes may possibly be Nebraskan in age. In the northwest quarter of section 2 of Stockholm township Porter creek has cut into its west bank and has exposed eight feet of till which is almost black near water level and is bluish gray to yellow above. This till is similar to that exposed a mile down stream as described on page 308.

The Illinois Central Railroad Company has made several cuts along the east wall of Boyer valley but little above the level of the floor. One series lies between Brogan and Ells and another is between Deloit and Denison. The best of these cuts is the first one north of Denison and is located in section 24 of Goodrich township. It shows the following section, which is illustrated in figure 53:

		FEET
5.	Clay, pebbly, yellow, or clayey sand	2
4.	Sand and gravel bed, fine, yellow in lower foot, coarser above, particularly just above the lower fine layer	5
3.	Silt, sandy, gray, in lenslike layer; pinches out to north and No. 4 overlaps No. 2	4
2.	Sand, fine, yellow, some clay streaks, coarser below, where some cobbles are six to eight inches in diameter	6
1.	Till, black or dark gray, sticky, small pebbles, starchy fracture, forms water table for seepage springs; exposed	12

Number 1 may be Nebraskan till while the overlying members probably belong to the gravel series discussed on pages 328 to 338.

On the west side of Boyer valley between Deloit and Denison is a group of natural exposures which are of interest as showing well the character of the materials in which the lower part of the valley is cut. One of these, a gully trenching the bluff about the middle of section 13, Goodrich, shows a dense pebbly till which is blue-gray below and yellowish above. It is exposed for over sixty feet above the valley floor, and is overlain by a very red sand with some clay streaks and gravel layers near the top. This sand rises to the humus. The till is abundantly bowlder-bearing, the chief types being granites, quartzites and other light colored rocks with some of the darker varieties. Again, the bank of a small stream between sections 13 and 14, Goodrich, shows, about one-fourth mile above its mouth, an interesting section consisting of a foot of soil, twenty feet of leached yellow loess, eight feet of blue-gray loess with shells and concretions, ten feet of sand and gravel, four feet of fine gray silt, and ten feet of dense, tenacious blue-black pebbly till to water level. A somewhat similar succession may be seen at the mouth of the creek valley, between the bridges, and at several other points along the river valley wall as far as Denison. Below here outcrops of till are but few and indecisive. An outcrop, similar to those described above, is found up Buck creek, however, in the southwest quarter of section 8, Washington. This outcrop extends from the railway bridge over the creek one hundred feet up stream and reveals a total of eight feet of stiff, pebbly blue-black calcareous till which is overlain by silts and sands, over which in turn lies abundant loess.

Common characteristics of these exposures are the very dark color of the till, its tenacity and the fact that in most cases it is overlain by nothing more determinative than sand, gravel, silt and loess. In other words, if we lay no stress upon physical characters there is nothing but topographic location to aid in determining the age of the deposits. They all lie below 1200 feet above sea level or but little above that altitude, well below the probable elevation of the Nebraskan gumbotil. In view of the irregularity of the surface of the much eroded Nebraskan gumbotil plain when it was covered by the Kansan glacier it is not possible to affirm to which of the two drift sheets which have covered the area of Crawford county the exposures mentioned, as well as others in similar locations, belong.

THE KANSAN AND YARMOUTH STAGES.

With the exception of the area possibly covered by Nebraskan drift as discussed in the preceding paragraphs the uppermost drift the county over is the Kansan. Of course it is almost everywhere covered by the loess and so it can be rarely observed, except upon hillsides and in other localities where natural or artificial cuttings bring it to view. The Kansan till of Crawford county is similar in character to that found elsewhere—it is oxidized to yellow or even to red in its upper parts and is gray or blue-gray below. It is pebbly except in the leached portions where the pebbles have been dissolved away, and it is quite markedly bowlder-bearing, the number of quartzites being especially noticeable. Like the Nebraskan drift it has had developed in its upper parts a sheet of gumbotil—the Kansan gumbotil. It used to be thought that Nebraskan and Aftonian time was longer than Kansan and Yarmouth time and this indeed may be true. Nevertheless it seems to be significant, as pointed out by Doctor Kay, that whereas the average thickness of Nebraskan gumbotil is between eight and nine feet, the average thickness of Kansan gumbotil is more than eleven feet. Of course erosion following the development of the gumbotils introduced a time factor of unknown value, but at least it seems likely that the period of gumbotil formation was longer in Yarmouth than in Aftonian times. It may be that the period of erosion was longer during Yarmouth time, but we have no measure of this in our region as erosion went on here presumably without interruption from its beginnings following the formation of the Kansan gumbotil to the time of the deposition of the loess.

Yellow or reddish weathered Kansan drift is exposed along numbers of the hillsides and steep slopes of the eastern and southern townships where the loess blanket is not too thick for the underlying formations to be revealed. In some cases the fresher, unleached, more or less unoxidized till is revealed, as along Tucker creek in the northwest quarter of section 30, Jackson, where the basal part of a fifteen foot outcrop is bluish with reddened bands along joints. On the other hand some exposures show the upper part of the till changed to a red pebbly ferretto, as where the public road crossed the old line of the Milwaukee railway on the west line of section 13, Iowa, where it appears as a very hard compact band under gray loess.

Naturally the best exposures of Kansan till and overlying materials are those made where the railways trench the uplands. Here again the best series of cuts are those along the "High line" branch of the Chicago and North Western railway between Boyer and Schleswig and those along the Chicago, Milwaukee and St. Paul railway between Manning, Manilla and Buck Grove. Along the High line there are several cuts north of the one showing Nebraskan gumbotil which reveal the ordinary succession of yellow till with loess or ferretto and some in which a bed of gravel or sand is intercalated between till and loess. A long cut just west of where the railroad curves to the west shows above the slump an old hill of yellow very pebbly Kansan till with uneven surface on which is spread two feet of fine yellow sand with a thin pebble zone between. Over the slope of the old hill lies twenty feet of yellow fossiliferous loess.

The cut on this line which parallels in interest the one exposing Nebraskan gumbotil is in the region where the railroad crosses the divide between Boyer river and Otter creek. Here it reaches an altitude of 1400 feet or over and the uplands rise to 1450 feet above sea. This cut is in the northwest corner of section 9, Stockholm. It shows above the railroad track the following section:

		FEET
3.	Loess, yellow, leached except in the lower six inches	5½
2.	Gumbotil, Kansan, gray to dark, chocolate-colored to red at the top; fine-grained, starchy structure, very sticky when damp, few pebbles, a yellow sandy layer in basal part	3
1.	Drift, Kansan, leached and reddened in upper foot and a half, lime balls in lower unleached part	6

The upper part of the gumbotil is what Doctor Kay has called the gumbotil concentrate, a resultant of the further weathering of the gumbotil. It is remarkable how thin the zone of transition from gumbotil to unleached till is—only one and one-half feet. This is a general condition and seems to argue for great resistance of the till against leaching. The base of the gumbotil forms a practically horizontal plane and both gumbotil and till were cut away by erosion until steep slopes were formed. Over these slopes the veneer of loess was later deposited, in a relatively thin layer at the top and on upper slopes, in thicker beds on lower slopes, thus toning down the steep declivities of the later Yarmouth and subsequent topography.

Kansan drift is exposed again at the railroad bridge over Otter creek where it shows a bowlder band at the contact with the overlying loess, indicative of a large amount of preloessial erosion. A few cuts between Kiron and Schleswig show drift beneath loess, but owing to the greater thickness of the loess toward the west drift exposures are but rarely encountered. This is true of all the western townships and as here the railways follow the streams there are very few opportunities presented to study the till in this region. A few of these which are observable may be noted because of the characters they present. A dark blue-black till is exposed in a stream-cut along the north line of section 9, Soldier. It grades up into blue-gray and then into yellow till. Almost at the county line along the road on the north line of section 30, Soldier, where it rises from Soldier valley, is an exposure of very rusty clayey sandy residual material under the loess. A road-grading on the south line of section 32, Morgan, near the church, cuts into the top of an old Kansan hill and exposes beneath the loess a very hard rusty red pebbly ferretto. A small knoll on the east wall of Middle Soldier valley opposite Berne shows a gravelly till with pebbles as large as three or four inches in diameter. A short distance north of Ells is a cut on the Illinois Central railway showing thirty feet and gravel, which probably was picked up by the glacier from of till, which lies underneath and on either side of a mass of sand the frozen gravels at its foot. Some of the exposures seem to make it plain that the Kansan till had undergone great alteration and weathering before it was protected by the blanket of loess.

One of the best series of exposures of the Kansan till and gumbotil is that to be seen along the line of the Chicago, Milwaukee and St. Paul railway between Manning and Manilla and that between Manilla and Buck Grove. Some of the cuts along the former line have been discussed already under the Nebraskan. One of these, which was mentioned on page 314, may be de-

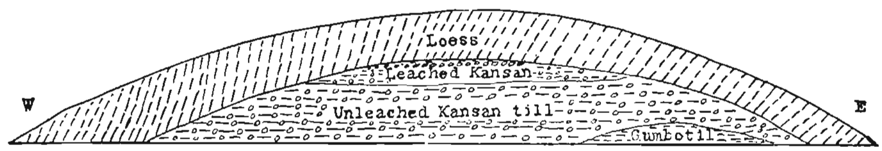


FIG. 54.—Diagram of a cut along the Chicago, Milwaukee and St. Paul railway one-half mile west of Aspinwall, in the northwest quarter of section 15, Iowa township.

scribed in detail here. It is in the northwest part of section 15, Iowa township, half a mile west of Aspinwall, and shows very well the stages of weathering through which the Kansan till has passed. On the north side of the cut the section is as given below. A diagram of the face is shown in figure 54.

		FEET
5.	Loess, gray, covering entire section	10
4.	Concentrate from Kansan till or gumbotil, with thin pebble band at base	1
3.	Till, Kansan, leached	3
2.	Till, Kansan, unleached, some lime concretions	20
1.	Gumbotil, Nebraskan, gray, exposed only for fifty feet in east part of cut, rising above railroad track	4

The gumbotil lies at an altitude of about 1390 feet, and it seems remarkable that the concentrate zone of the Kansan till should be such a short distance above it. This section in connection with the one next to be described seems to show some irregularity in the surface of the original Kansan plain. The section also is most illuminating in its revelation of the course of Pleistocene events. It shows that after the development of the Nebraskan gumbotil the surface was eroded and carved into an irregular topography; that later the Kansan ice overrode the gumbotil plain, covering it with its sheet of drift; that after the disappearance of the Kansan ice the Kansan drift was subjected to intense weathering until the upper part was changed into a practically insoluble residuum and the part immediately below was entirely leached of its lime content. Following this period of weathering there ensued a time of more active erosion, during which the Kansan gumbotil, which doubtless was originally present here, and the leached Kansan till were cut through in places and locally even the fresh unleached Kansan till was deeply trenched with the resultant formation once more of a markedly irregular surface, although the crests of the newer hills were not in all cases coincident with those of the older eminences. After the post-

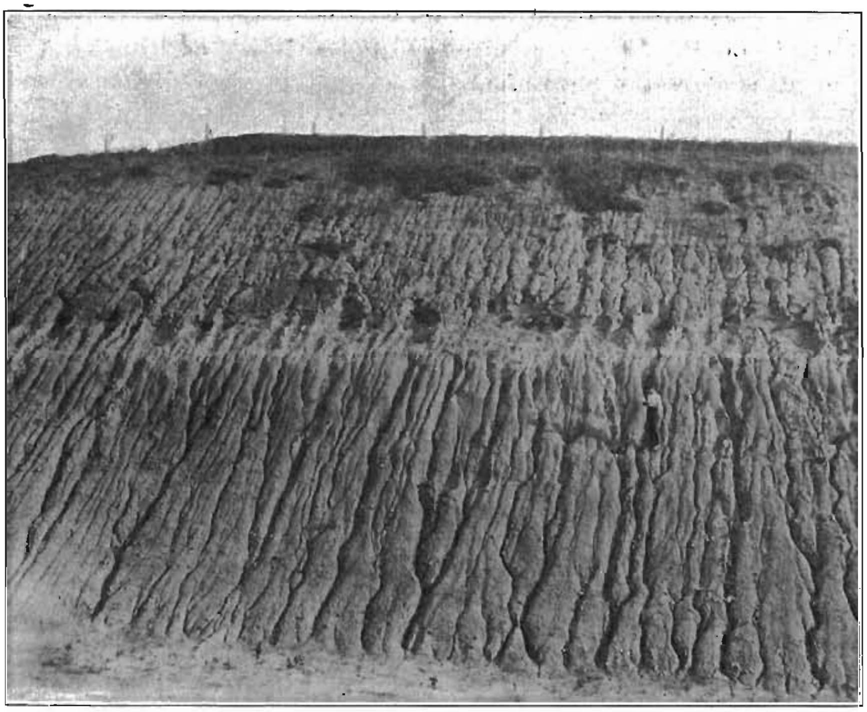


FIG. 55.—Divide cut on the Milwaukee railway between Manilla and Aspinwall. The cut shows loess, Kansan gumbotil and Kansan till. Photo by Kay.

Kansan topography had come to a stage of maturity the whole surface was blanketed with a veneer of loess, which has had the effect of protecting it, in large part at least, from further erosion or weathering.

A mile farther west, in the southwest corner of section 9, is a cut which shows a further stage in the erosion of the Kansan plain. Here there is, under ten feet of loess which is gray and calcareous below and brownish above, an exposure of twenty-five feet of yellow till which is calcareous and concretion-bearing to the base of the loess. There are traces of a pebble zone at the contact of drift and loess, but there is no gumbotil and no brown leached zone at the top of the till. The railway grade here rises to the highest point between Manning and Manilla—1428 feet—hence there is no doubt of the Kansan age of the till.

The divide cut between Manning and Manilla is about the middle of section 8, Iowa, and shows the best section of the Kansan deposits to be seen along this line in Crawford county. It has been described and illustrated by Kay on page 221 of the paper already cited. His description is quoted below and his view of the cut is shown in figure 55.

		FEET
4.	Loess	
	Buff, leached	12
	Buff, unleached, shells and concretions, lighter in color than the leached loess; lower part gray, but closely related to the buff loess	12
3.	Gumbotil (Kansan), dark gray to chocolate-colored	3
2.	Drift (Kansan), oxidized, leached, closely related to the gumbotil, contains disintegrating bowlders	4
1.	Drift (Kansan), oxidized yellowish to buff, unleached; abundant lime concretions, many of which are in vertical joints	17

The evidence indicates that several feet of gumbotil was eroded from here before the loess was deposited. The base of the gumbotil in this cut has an elevation of about 1440 feet above sea level, which is only about twenty feet lower than the base of the gumbotil in the Templeton cut ten miles east. In the Templeton cut fifteen feet of gumbotil was found over Kansan till.

Kay has recently found in southeastern Crawford county three exposures which are of especial interest both because of their elevations and because of the relationships of the drifts and gumbotils. One of these exposures is one-fifth mile south of the school house in the northwest corner of section 32, East Boyer, and shows eight feet of till, of which the lower three feet is still gray, unoxidized and unleached. Below the till and in sharp though irregular contact with it is gray leached gumbotil in which a few siliceous pebbles were found. The elevation of this gumbotil is 1450 feet.

The second exposure is on the south side of the road about the middle of the south side of this same section, 32, and it shows beneath fifteen feet of loess and soil a gray sticky gumbotil with chocolate colored mottlings and containing but few pebbles. This gumbotil is seven feet thick and lies at an altitude of 1485 feet. It grades down into yellow oxidized and leached till of which a thickness of three feet was exposed.

The third of this series of outcrops is about a mile east of the second, near the middle of the south line of section 33, East Boyer. It shows gumbotil-like material on till and is about 1450 feet above sea level.

It seems evident that the two lower gumbotils here described, those at 1450 feet elevation, are Nebraskan, that the till which overlies the northwestern of the three outcrops is Kansan till and that the gumbotil at 1485 feet in the middle exposure is Kansan gumbotil. The remarkable features of the exposures are the extreme thinness of the Kansan till—only about thirty-five feet—and the unusual elevation of the Nebraskan gumbotil—1450 feet, as compared with elevations of 1370 and 1385 feet near Manilla.

On the road between sections 17 and 20, Iowa township, a road cut studied by Doctor Kay is of unique importance because it shows two gumbotils on one slope. The Nebraskan gumbotil is exposed near the base of an east facing hillside and may be seen along the roadside for forty yards. No drift is exposed below this gumbotil but above it two to three feet of pebbly oxidized bowldery drift may be seen. About fifty-five feet above this gumbotil lies the Kansan gumbotil, which grades down into chocolate colored till which in turn grades into leached and oxidized till and this again into unleached but oxidized till. Over the Kansan gumbotil lies the loess. The lower gumbotil lies 1385 feet above sea level while the upper one is about 1440 feet above sea. Both gumbotils show the usual features of gray or drab color, compact texture with polygonal fracture, stickiness when damp and only a few small pebbles. No concretions were seen.

Along the Sioux City division of the Chicago, Milwaukee and St. Paul railway there are a number of cuts between Manilla and Buck Grove. Several of these show a normal succession of loess overlying till, and in some cases the upper part of the till is much weathered and is reddened almost to a ferretto, while in others the till is calcareous to the contact with the loess. The cut at the overhead bridge in the northeast part of section 20, Nishnabotany township, shows eight feet of yellow loess with ten to fifteen feet of gray loess below. The gray loess is banded by red streaks. Below the loess a yellow pebbly till rises about ten feet above the grade. This is here 1465 feet above sea level, hence there is no doubt of the till being of Kansan age.

In the northwest quarter of section 19, Nishnabotany, a cut shows four feet of dark leached loess, then four feet of gray, hard, sticky jointed gumbotil, below this four feet of leached till, of which the upper two feet is red and the lower part yellow, and at the base ten feet of yellow pebbly till. This cut is much lower than the divide cut at the viaduct—the railway is about 1400 feet above sea—but there is no reason to question the actuality of the gumbotil here.

There are several cuts west of this one which show normal yellow pebbly till and one on the east edge of section 14, Washington, presents at the top of the yellow till a layer of dark red starchy clay which evidently is nearly a gumbotil. The last important cut is in the center of this section and reveals a sand and gravel band five to ten feet thick with six feet of ferruginous much weathered till above and calcareous blue-gray till beneath. A gully below the railroad grade reveals twenty feet of gray to brown pebbly joint clay beneath the eight feet of blue-gray till seen above the grade. The railway grade is here at about 1340 feet, so it is perhaps a question whether this till may not be Nebraskan.

THE GRAVELS.

Certain deposits of sand and gravel along a number of streams, particularly those in the eastern part of the county, excite unusual interest because of their relationships. These sands and gravels line the valley walls and floors. In the former location they rise in some cases fifty feet or more above the bases of the walls.

It may be said in general that these gravels are rather fine in texture. There is comparatively little coarse material and cobbles over six inches are rarely seen. A few bowlders have been found, but most of the material is quite fine sand. Furthermore much the greater part of these deposits is clean and fresh. Very little of it is rotted or even rusted.

Probably the best known exposure is at the Mill pit at the southwest corner of Denison, in the northwest corner of section 14, Denison township. Here is exposed a face of fifty feet or more, of which nearly the whole extent is rather fine cross-bedded sand with streaks of gravel intercalated. The character of the

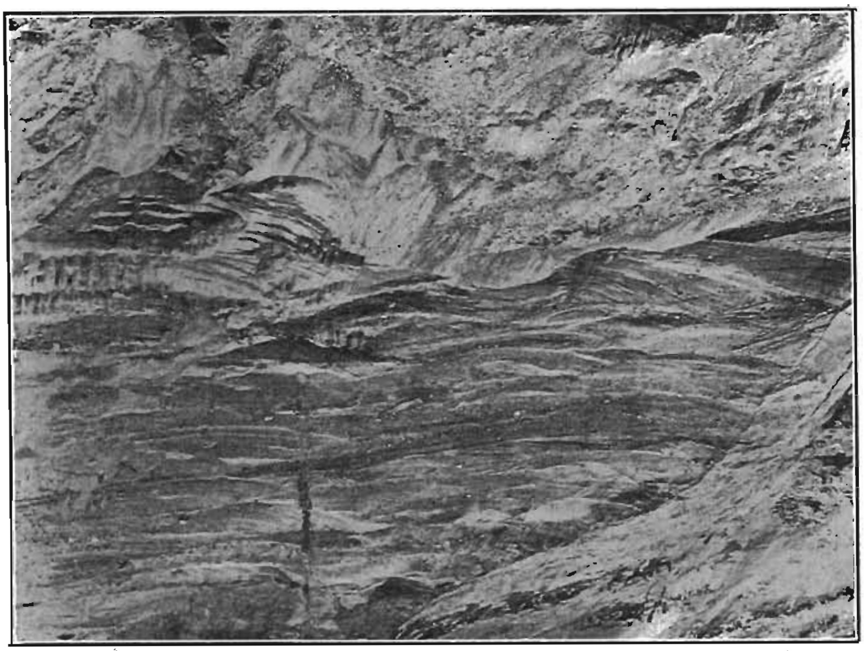


FIG. 56.—The Mill sand pit at the southwest edge of Denison. Photo by Calvin.

beds is well shown in figure 56, from a photo by Calvin. The sands are yellow, gray, and in a few places deep rust red. Above the sand is a three foot layer of yellow to brown loess in which were found shells and lime concretions as well as an elephantine rib about twenty-four inches long. Above the loess in places is a sandy loamy layer two to three feet thick. A number of mastodon teeth and other skeletal remains have been found in the sands of this pit and have given rise to some interesting speculations as to the age of the deposits.

Another pit which shows well the character of these valley deposits is one owned by G. McAhren of Denison. It is in the northeast corner of section 13, Goodrich, and showed at one time eight feet of cross-bedded gravel with irregular streaks of sand. This layer grades down into fine cross-bedded sand with intercalated layers of gravel. About fifteen feet of this lower bed is exposed. The gravels are not very coarse; very few pebbles are six inches in diameter. Some of the upper gravel layers are blackened by manganese dioxide while a few are reddened with iron oxide, but most of the material, coarse or fine, is clean gray or yellow. An older opening shows above the gravel four feet of loess, of which the upper half is yellow and contains abundant lime concretions, and the lower half is gray and calcareous and carries fossil shells and iron pipestems. The contact of loess

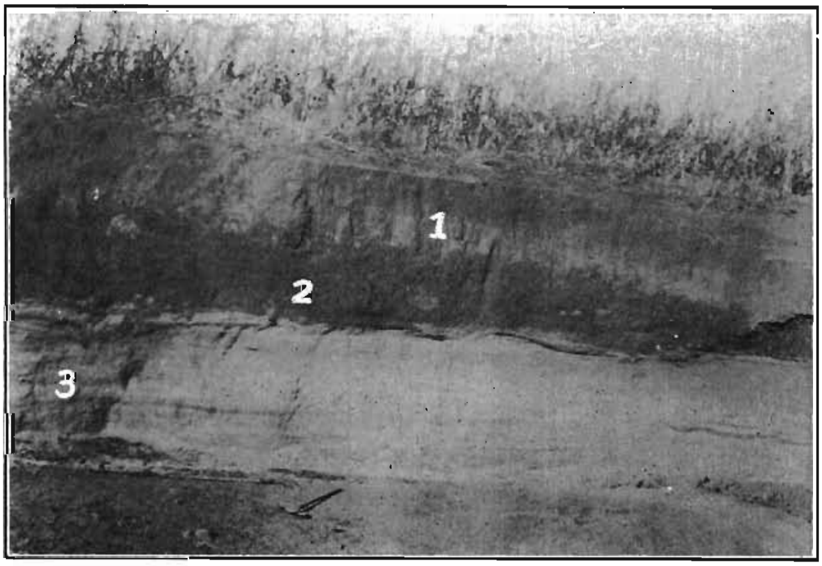


FIG. 57.—The Riddell gravel pit in the northeast quarter of section 3, Union township. The view shows yellow loess (1), gray loess (2), and gravel (3).

and sand is very irregular; indeed the two are intermingled in bands and masses and there are locally slopes along the contact which are as high as thirty or forty degrees. The sand and gravel must have been in the form of a knoll when the loess mantled them.

These two pits give a very good idea of the character of these gravels and sands. Similar deposits may be found along Boyer valley at intervals from Boyer to Dunlap, but it will be sufficient to mention a few localities. Among these are some of the cuts along the Illinois Central railway between Ells and Deloit and several between Deloit and Denison; openings at several points near Denison; a large pit at the mouth of Buck creek operated by the Milwaukee Railway; several pits between Arion and Dow City, particularly the Riddell pit just below Arion (Fig. 57) and the Butler pit across the valley; and the three small pits in section 26, Boyer township, which were described on page 267. A number of the valleys tributary to the Boyer also are lined with these gravels. Thus there is a close lying succession of benches and shoulders of gravel in Porter creek valley from near its head in southern Sac county to its mouth. Some of these deposits rise at least fifty feet above the valley floor. Similar conditions hold good in Wheeler creek valley just east of Porter creek, also in Beaman and Trinkle creek valleys, on the east side of the main drainage course. There are some beds in East Boyer valley, though these are not so common or so extensive as those in the larger valley. Among those may be mentioned a bed in the southeast quarter of section 5, East Boyer township, which has been used in road improvement and which was visited recently by Doctor Kay, who described the material as being mostly under two inches in diameter and quite fresh except near the surface, where it is somewhat oxidized and stained black with manganese oxide. Otter and Buffalo valleys north of Denison and Buck creek east of Arion have large amounts of these gravels which by their characters go far toward making clear certain parts of the physiographic history of the region.

Among the other valleys of the county in which these gravel deposits are found may be mentioned West Nishnabotna river, on which are several outcrops between Astor and the upper reaches of the east branch in southern Hayes township. One of the best is at the bridge on the Nishnabotany-Iowa township line where under fifteen feet of loess, yellow and leached above but gray and calcareous below, is to be seen three feet of coarse gravel and cobbles, including granites, quartzites, greenstones, limestones and sandstones. Several of the exposures are at the edge of the slope from the upland and hence the material has not been moved since these slopes assumed their present form. A bed of fine sand rises a few feet above the water just west of the bridge south of Astor and is overlain by twelve feet of yellow loess. A few thin intercalated streaks of sand and loess mark the contact but otherwise the gradation is abrupt.

A few gravel beds are visible along West Soldier valley, as in sections 9 and 29, Soldier, and one or two on Middle Soldier, as at the bridge between 26 and 27, Hanover. But most of the valleys in western Crawford are so heavily blanketed with loess that all other materials are concealed. For the most part these valley gravels blend with the slopes of the valley walls and hence give rise to no distinctive topographic features. In some cases, however, they stand out as narrow terraces or shoulders, as in Porter valley, or they outcrop at the edges of broad low benches, as in the case of the beds exposed in section 26, Boyer, above Dunlap. It should be noted in addition that the larger valleys at least seem to have, under the upper stratum of alluvium, a lower layer of sand and gravel. The presence of these deposits is attested by the town wells of practically every municipality which is situated in a valley and has a public water system. Doubtless these gravels are related in age and origin to those exposed along the valley sides, although some of them may be valley trains of the Wisconsin drift margin at Wall lake.

The relationships of these sands and gravels are such as to excite considerable interest. This interest is increased by the presence on the hillsides of a coating of sand and gravel beneath the loess. This coating is very commonly present and is the source of the water supply of many of the farmers who live among the hills and valleys of the county. Even the town of Schleswig, situated on the highest prairies of the county, finds a supply of water in gravels at the head of a shallow draw at the edge of town. From the fact that these gravels may be found at all elevations from on or near the hilltops almost to the valleys it seems evident that they are to be correlated with the thicker deposits found lining the valley walls and floors. The thickness of the layer is reported as ranging in different wells from two to eight feet.

Age and Origin of the Gravels.—The fact that these gravels occur in all topographic positions from the floors of the valleys to the upper slopes of the hills makes certain the deduction that they were not gathered into their present position until the Kansan gumbotil plain had been carved into a form approximating its present strong relief. This calls first for a period of downcutting following the development of the gumbotil, during which the materials eroded were being carried away from our region. Later there must have succeeded a time when erosion was so rapid that only the finer materials were entirely removed while the coarser parts—the sands, gravels, cobbles and bowlders—were concentrated on the hillsides or swept into the valleys, doubtless clogging the latter at least to the height of the present terraces and banks of gravel. This later stage of erosion implies some change in conditions which caused greater downcutting but did not permit corresponding transportation to go on. What could the processes have been which led to these results?

It is a well known fact that the Kansan drift of northwestern Iowa is quite pebbly and in addition contains large gravel masses, as Doctor Carman demonstrated during his work on the Pleistocene Geology of Northwestern Iowa.[36] Some of these now rise above the drift plain as gravel hills.

Doctor Kay has stated as one thesis of his theory of the gumbotils and the events following their formation the apparent necessity for uplifts after the gumbotils had developed on the drift plains. This would allow the erosion of the plains and the carving of valleys and other irregularities in their surfaces. In the case of the Kansan drift plain, after the development of the gumbotil there must have been a general uplift which permitted deep erosion in the Kansan gumbotil and underlying drift. Following this general erosion there must have been another uplift—this time greater in northwestern Iowa than farther south, and perhaps accompanied by climatic changes—which accelerated erosion in the parts of the state affected, but for some reason did not cause transportation to be equally effective. That this uplift was differential is shown by the fact that whereas in southern Iowa and as far north as southern Crawford county the Kansan gumbotil is present, and is locally fifteen feet thick, as we have seen, in northern Crawford it is only three feet thick and farther north it is absent. Furthermore in northwest Iowa

[36] Carman, J. E., Iowa Geol. Survey, vol. XXVI, pp. 232-445. See especially Chaps. IV and V.

the Kansan drift is in many places unleached to its contact with the loess. Both the gumbotil and the leached zone are gone. Crawford is just at the border between the thick gumbotil and leached drift of the south and the region of no gumbotil nor leached drift to the north.

Doctor Carman found that in the region studied by him—that is, north of Crawford county—practically every valley contained preloessial gravels similar to those described for Crawford county, and that these extended in many cases to the heads of the draws. There the gravels apparently were mostly swept into the depressions. In Crawford some of the gravels still remain on the hillsides. Farther south the gravels are still incorporated in the drift. In northwestern Iowa the Kansan drift has been eroded to an almost level plain while in Crawford and the southern counties the rugged type of Kansan topography is still very decidedly predominant. All these facts point to differential uplift of northwestern Iowa as the cause of the second period of erosion which still further cut away the drift and resulted in the releasing and accumulation of the great bodies of sand and gravel which are now present north of Crawford county as well as eastward to the Wisconsin drift margin. There do not seem to be many nor extensive beds of sand or gravel in the valleys south of Crawford county. The waters which carried the wastage into the valleys evidently were not of sufficient force to carry the coarser parts much farther south.

It is a fact perhaps worthy of mention here that these gravels are found indifferently in valleys extending in any direction. Thus the writer found them in abundance in the valley of Brushy creek, a branch of South Coon flowing southeast across Carroll county, as well as along Silver creek, which flows northward from near Holstein to join Little Sioux river below Cherokee.

It is plain then that the formation of these gravel and sand beds occurred long after the retreat of the Kansan ice-sheet from this region. Was it during Yarmouth interglacial time, or during the period when the Illinoian ice-sheet lay across southeastern Iowa, or during the Sangamon interval, or while the Iowan glacier was covering northern Iowa? Was the upwarp caused by the melting away of the ice and the lightening of the load on the land? It is impossible at present to answer these questions although the series of events between the recession of the Kansan ice and the formation of the loess required so much time that it seems probable that the circumstances we are discussing here may have occurred after the close of the Yarmouth, long as that time was. The upper time limit, of course, is marked by the deposition of the loess, which is considered to have taken place very soon after the Iowan ice was melted back, that is in early Peorian time. How long before the beginning of the Peor-

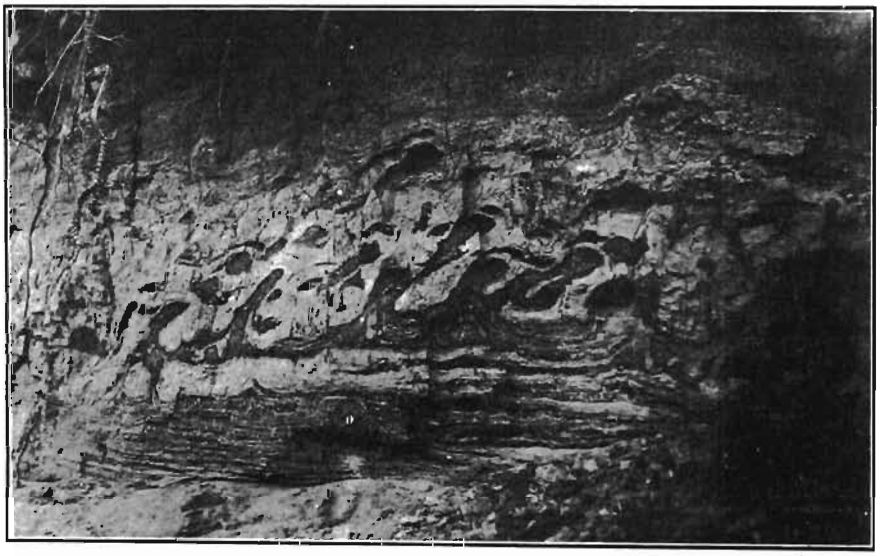


FIG. 58.—Contorted sand streaks and pockets in gray loess in the Butler pit in section 1, Union township, a mile south of Arion. The dark bands and patches in the middle of the picture are sand while the lighter parts are loess. Probably the contortions in the interbedded sand and loess are due to hillside slumping while the loess was being laid down. See W. J. Miller, Intraformational Corrugated Rocks: Jour. Geol., vol. XXX, p. 597; 1922.

ian the events occurred is, again, doubtful. The gravels are for the most part fresh and unleached of their lime content. In some instances they are interbanded with loess, as for instance in the Butler pit, shown in figure 58. In some cases they make distinct terraces or shoulders on the valley walls, in others their slopes seem to merge into those of the previous surface. At least the loess has concealed any topographic differences which may have originally existed. The first fact seems to point to a short interval between the release of the gravels from the till and the deposition of the loess. The second fact may point in the same direction although not necessarily so. The topographic features may indicate that after the gravels were carried into the valleys the whole topography was again so modified by erosion as to bring the slopes of valley and gravel into uniformity before the loess blanketed the surface.

There is another factor which should be considered. Originally, of course, the gravels must have extended from wall to wall of the valleys. Now they exist as mere remnants of their former mass. If the clearing out of the valleys took place before the loess was laid down it means a rather long interval between the formation of the two types of material. Some of the gravel de-

FIG. 59. Deep gully in loess in the north edge of the Boyer flood plain, in the southeast quarter of section 5, Union township. Looking north toward the upland.

posits have no loess over them, some have a few feet and some are heavily covered. It is usually difficult to determine whether the loess extends down the slopes of the gravel beds or not. One or two exposures in Boyer valley may be significant. In the southeast quarter of section 3, Union township, a deep gully extends from the north edge of the valley southward to the river, across a low bench. It is twenty feet deep and scarcely as wide at the top, and is cut down to the level of the flood plain. Through its entire depth and extent it shows only loess, which is yellow for the most part although in the lower foot or two it is brownish gray. Figure 59 gives a view of this gully. Again, the ditch cut for straightening the Boyer channel shows, at the bridge just north of Dow City and near the gully just described, beneath three feet of black humus and alluvium eight feet of yellow or brownish compact loesslike silt very similar to that found in the gully, and probably of the same origin and nature. These exposures are between the gravel pits below Arion and those above Dunlap. They seem to show that the valley had been fairly well cleared of gravel before the deposition of the loess took place.

Because of the fossil remains found in the sands of the Mill pit at Denison these were formerly considered to be of Aftonian age. But there is no drift over these sands, nor indeed over any of the similar deposits found in this and other counties. Furthermore, similar remains have been found in and upon glacial and interglacial deposits of much later age, as, for instance, in the loess of this same pit. Hence the presence of fossils in these sands and gravels has no bearing upon their age, and the fact that the deposits are nowhere overlain by drift renders an assignment of a pre-Kansan age very doubtful indeed. Besides we have reviewed evidence for considering them to be younger than Kansan.

The gravels here considered must be distinguished clearly from certain other deposits which have been assigned to the Aftonian but whose geologic relations are quite different from those of the gravels herein discussed. These so-called Aftonian gravels were considered to be of that age because they are usually overlain as well as underlain by till, and also because in many of them fossil remains of various mammals were found. We have already mentioned the value of the fossils as evidence and it may be said of the presence of till that there is nothing to prove that both underlying and overlying till are not of the same age. It was formerly thought that the underlying till was Nebraskan while the overlying was Kansan. But it is possible that the till is all of the same age and it may be either Kansan or Nebraskan. Hence the gravels probably are not horizon markers neither is it certain that they are interglacial in age, as are the gravels in which we are interested. Probably they represent masses of gravel which were carried out from beneath the ice by escaping waters and later were picked up by the advancing glacier. Such enclosed masses are very common in Monona county, as for example near Ute, Mapleton, Grant Center, Turin; and also in Harrison county, notably near Missouri Valley. They are present also in the counties to the north but have not been found to be so numerous in Crawford county.[37]

To summarize: the evidence indicates that these sands and gravels which are now spread over the hills and gathered in the valleys were released from the Kansan till—and locally from the Nebraskan—by rapid erosion made possible through differential uplift centering to the north of Crawford county. This erosion occurred long after the close of Kansan glaciation and probably a considerable period before the deposition of the loess. Later much of the material was carried farther down the valleys out of our region, but some still remains along the valley walls and elsewhere. There is no evidence to show that the deposits are older than Kansan time but they must be older than Wisconsin glaciation because they are covered by loess, which was deposited in Peorian time, between Iowan and Wisconsin glaciations.

Wisconsin Gravels.—Since the western margin of the Wisconsin glacier lay across the sag which opens into Boyer valley in southern Sac county probably there were some sands and gravels carried down this opening when the Wisconsin ice was melting. These gravels are very prominent around the west end of Wall lake and probably furnish the water for the city well at the town of Wall Lake. Here they are overlain by fifteen to twenty feet of black sandy material. It is possible, of course, that these sands and gravels in the valley bottom are partly Wisconsin and partly preloessial in age, and the same may be true of the gravels farther down, as at Denison, where the old city wells reach them. These wells are described under the heading of Water Supplies.

THE LOESS

It has been necessary to mention the loess frequently in preceding discussions but it may be best to describe it and its rela-

[37] For further discussion of these gravels see the following papers: Kay, George F.; Twenty-eighth and Twenty-ninth Annual Reports of the Director: Iowa Geol. Survey, vol. XXIX, pp. xv-xviii. Lees, James H., Valley Gravels of Northwestern Iowa: Bull. Geol. Soc. America, vol. 32, pp. 49, 50.

tions here in some detail. In its present form loess is an eolian deposit, that is it is wind-blown material carried up from river flats and other areas of loose fine clays where scarcity of vegetation in the past permitted the winds to pick up and convey large quantities of dust, to be dropped when and where the force of the wind abated. The Missouri river bottoms afford the best field in western Iowa for these operations of the wind and consequently the lands bordering the great valley are piled high with this fine dustlike material known as loess. The hills and fields of Crawford county have shared in this blanketing and so are covered by an almost universal veneer of loess, except along the valleys. There is quite a noticeable difference in the general thickness of the loess in the eastern and western parts of the county, so that while in the eastern townships the drift may be found projecting through the loess in spots or is frequently reached in road gradings and similar cuttings, in the western townships it is but seldom that one will see drift, so thick is the loess covering. We have seen that in railway cuts in eastern Crawford thicknesses of twenty feet and more of loess have been penetrated and farther west the thickness will average even more than this.

It is a notable feature that the loess is usually thicker on hillsides than on the hilltops, showing that it has smoothed out a topography which before the loess covered it was more rugged than now, with steeper slopes and sharper profiles. In eastern Crawford the resulting surface has smoothly flowing contours and a fairly level skyline. Farther west, where the loess is thicker, it is piled on the hills in billowy masses, giving a wavy profile to the topography. Still farther west near the Missouri bluffs, the surface is extremely rugged and is characterized by sharp-edged ridges and exceedingly steep slopes.

Age of the Loess.—When the Kansan glacier melted away and left its sheet of glacial drift this drift doubtless had a fairly level surface. But the loess was laid on a surface of great irregularity, made so by the erosive action of rains and streams and all the forces which cut down the land and carry it away to lower levels. The formation of such a topography as that over which the loess was laid takes a great length of time. Indeed Yarmouth time, during which that topography was in the making, is estimated to have covered hundreds of thousands and perhaps several millions of years. Hence it is certain that the period of great loess formation followed that of Kansan glaciation by an exceedingly long interval. Again, as was suggested on page 334, the Yarmouth interglacial age was followed by two glacial ages —the Illinoian and the Iowan—and by an interglacial age—the Sangamon—between these two glacial ages before the loess was formed. We know this because in eastern Iowa the Iowan drift

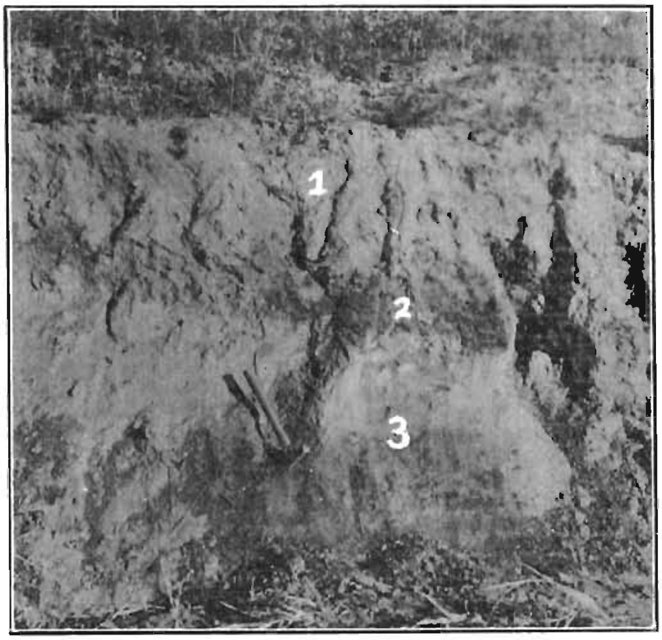


FIG. 60.—Yellow loess (1) over gray (3), with a red band (2) between. The northeast quarter of section 26, Willow township.

is margined and, in places along its edge, overlapped by loess, which, while undoubtedly of local origin is probably of the same age as the loess of the Missouri slope. On the other hand we know that the loess is older than the Wisconsin drift because in some places loess has been found under that drift, while there is no loess on it. From all these facts it is quite certain that the loess was formed, at least the major part of it, during the period succeeding the Iowan invasion, that is during the Peorian interglacial age, and probably during the early part of that age, before vegetation had covered the sources of supply whence the loess dust was derived.

Character of the Loess.—The typical loess shows two phases, aside from the surface part, which has been modified somewhat by plant growth and decay and is usually brownish. In a thick bed there may often be seen an upper yellow part and a lower gray part, as for example the exposure shown in figure 60. In some cases there is a gradation or an interfingering from yellow to gray while in others the transition is abrupt. It does not

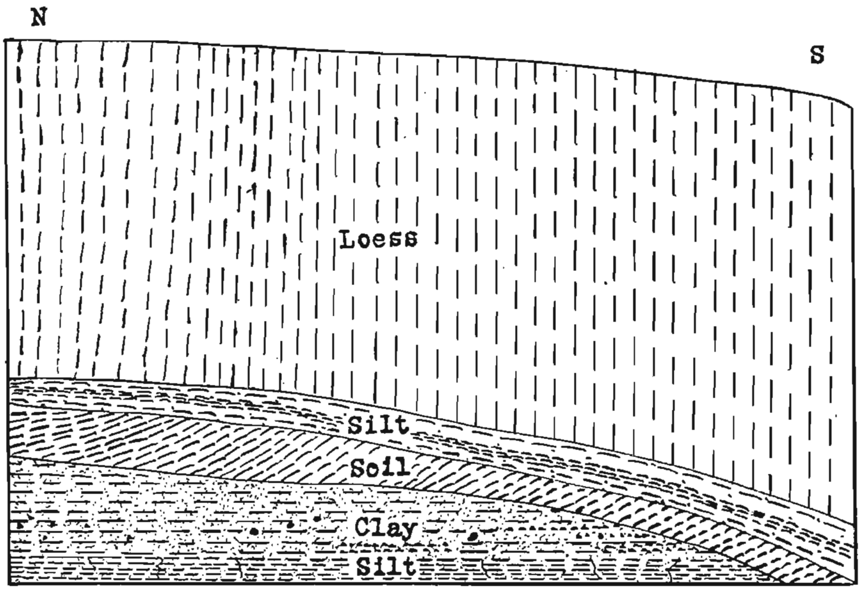


FIG. 61.—Diagrammatic section of the face of the Green and Ward clay pit, on the east edge of Denison.

seem likely that the two colors represent distinctions in age or origin. The upper parts of the loess are as a rule leached of their lime content, but the inferior parts of thick beds, whether yellow or gray, are usually quite calcareous. In many cases irregularly spherical balls of lime called loess kindchen are scattered throughout the loess. These are formed by secondary concentration of lime which has been leached from the parts above. In addition, in most places, there are in the calcareous parts numerous small snail shells, remains of the life forms which existed on the ground while the loess was being deposited. Since these snails were land forms they bear additional testimony to the eolian origin of the loess.

Relations of the Loess.—We have seen that the loess overlies indifferently Nebraskan till or gumbotil, Kansan till or gumbotil or the post-Kansan gravels. The contact with the tills and gumbotils is usually sharp and there is little difficulty in distinguishing the two classes of material. Where the loess is thin and

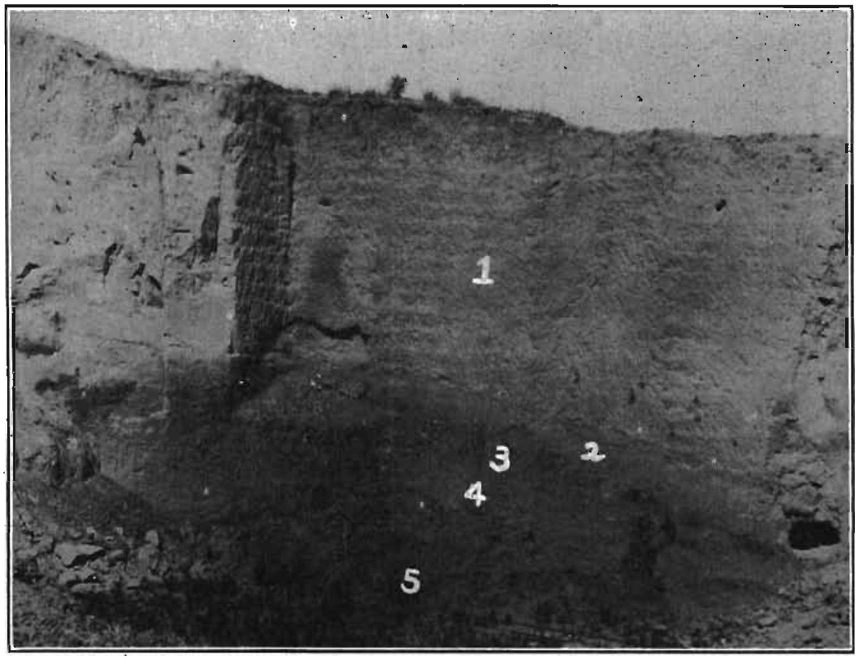


FIG. 62.—View of the face of the Green and Ward clay pit (Denison Brick Co.), Denison. 1, Loess; 2, silt, with small cave; 3, soil band; 4, sandy clay; 5, silt.

leached and modified in color as well as in texture it comes to resemble the modified gumbotil, which like this loess bears no pebbles and has no lime content, unless it should be in the form of small secondary lime balls. Where the loess overlies the gravels it is in some cases interleaved at the contact. Because the loess is so widely distributed over Crawford county it is the most important soil in the county and as such will be discussed at greater length under the heading of Soils.

It is not needful to give here detailed sections of the loess, as several have been presented in connection with other members of the Pleistocene. However, it is perhaps worth while to describe one section because of the rather unusual succession of strata and their mutual relations. This section is found, or rather was found, in the upper, old pit of the now abandoned Green and Ward brickyard in the eastern confines of Denison. The brickyard is on the slope of East Boyer valley which it overlooks from the north. The pit showed the following section, which is also shown diagramatically in figure 61 and photographically in figure 62:

		FEET
1.	Loess, yellow, upper ten feet leached, no fossils or lime concretions; lower part calcareous, abundant fossils, some concretions, finely laminated, gray near base. Rests unconformably on sloping surface of number 2, thickens to south	15 to 25
2.	Silt or fine clay, brownish in upper part, then nearly black for a foot, then brownish in lower part; very few small pebbles, the largest seen being a piece of feldspar an inch in diameter. This member slopes toward the river, of whose valley wall it evidently formed the upper member before the loess was laid above it. Thickens toward the valley	1 to 3
3.	Soil band (?), black; thickens as it rises to north; lies unconformably on eroded slope of number 4	1 to 3
4.	Clay, reddish yellow, finely sandy, streaks of gravel in lower part; cobbles up to three inches in diameter. Clay is hard above and is difficult to pick. Surface slopes toward valley and cuts off gravel layers. Maximum exposed thickness	6
5.	Silt, mixed gray and brown, finely siliceous, somewhat jointed	1 to 2

A newer pit 300 feet south of the old one and at the level of the floor of the old one exposes fifteen feet of bluish or brownish gray loess which is mottled gray-brown and yellow in its upper part. The lower members of the old pit were not reached in this one. A forty foot well between the pits went through the loess and into gravel. At the bottom is a tough dark blue clay, probably till. Since the level of these pits is below the general level of the Nebraskan gumbotil plain this till may be Nebraskan. The "gravel" may represent the sandy layers of the upper pit.

It seems probable that all the members of this section are post-Kansan. If so they show that after the till had been weathered and eroded a soil band was formed over the slopes and that later still the loess was deposited on the now mature topography. A ball and socket joint, probably of an elephant, was found in the soil band, and numerous teeth and bones have been taken from the loess.

ECONOMIC GEOLOGY

Soils

Crawford county is essentially an agricultural district. While there are some industrial plants within the county they are nearly all directly dependent upon the agricultural activities of the surrounding region, and it is highly probable that any further development in the industrial life of the community will be based largely upon the growth and improvement of agriculture.

The soils of the county are an invaluable storehouse and rightly used and cared for will continue to yield their stores abundantly for generations to come. But like all storehouses their supplies are not limitless. ''Mining the soil'' as we mine coal, continually drawing out the richness of the soil as our stores of coal are drawn from the heart of Mother Earth, without returning anything to replace what is withdrawn—this means certain exhaustion and ultimate ruin. While the danger may not be immediate it is none the less real, as the abandoned farms of New England and the fertilized soils of the eastern states bear witness. This simply means that precaution should be exercised against the wasting of the soil by stream and rain wash, that gullies must not be allowed to cut up the fields and pastures. It means that care must be used in proper rotation of crops, that, for example, if timothy has been cropped on a field clover should be sown, as clover is one of the most helpful crops to the soil while timothy drains a soil of its plant food more quickly, almost, than any other crop. This is not a dissertation on farm crops and this is not the place to discuss these matters at length. It is desired simply to point out and emphasize the necessity for the use of care and intelligence in relation to this the most vital of the problems of reasonable conservation of Crawford county's natural wealth.

The soils of the county are of two classes, the loess soils of the uplands and the alluvial soils of the larger stream valleys. Some of the steep hillsides are bare of loess and the drift clays or gravels immediately underlie the black top soil. Also the gravels of the valleys are in many places covered by only a thin veneer of soil or sod. But these constitute only a small percentage of the whole surface and the two first mentioned types are by far the most predominating.

Loess Soils.—On account of its peculiar characteristics the loess makes an admirable soil for many purposes. While it is a very fine-grained material it is at the same time quite porous. It has been determined that 80 per cent of the particles comprising the loess of western Iowa are smaller than grains of fine sand and yet have a diameter not smaller than one sixty-fourth of a millimeter, 0.006 inch.[38] This texture allows an easy and rapid passage of excess water and on the other hand facilitates by capillary action the drawing up of water from below to sustain growing crops in dry seasons. The loess soils as a rule have no true subsoils, as they cover the sheet of drift to such a depth that it has practically no influence on the character of the soil as used by the farmer. The seed bed, then, is merely the loess darkened by humus—the material resulting from growth and decay of vegetation. On steep hillslopes this humus is washed off as fast as it forms, enriching the lowlands at the expense of the uplands. The resulting yellow patches are often conspicuous features of the hillside fields, and are generally distinguished also by the poorer quality of the crops. It should be noted that while the loess is rich in plant food, potash, lime, magnesia, phosphoric and sulphuric acids, it is not until these have been rendered available by solution and a vegetable mould has been mingled with the minerals of the soil that this or any other soil really becomes fertile. Hence the need for vigilance in the prevention of the washing away of the black top soil and hence also the real wastefulness of cultivating the steep slopes where the loss is likely to exceed the reward.

The loess of the Missouri slope forms a splendid corn soil and in some areas, as around Missouri Valley and Council Bluffs, it is being employed increasingly for orchards and vineyards. The Bulletin of the Iowa Experiment Station already quoted calls attention to the additional fact that the porosity of the loess is likely to be a retarding feature as well as an advantage, on ac-

38 Principal Soil Areas of Iowa: Agr. Exp. Sta., Iowa State College, Bull. 82, p. 377.

count of its permitting the rapid decay and leaching of the vegetable content, with a consequent deficiency in humus. Hence the loess soil may be slightly more backward in the spring than are the drift soils of similar productiveness. The case is cited of Carroll county, the eastern part of which has soil of Wisconsin age, the western a loess soil like that of Crawford county. The corn of the drift soil is likely to be eight or ten days in advance of the corn of the loess.

In the face of this condition it remains true that the loess soil raises excellent crops of corn and oats and, especially in the southeastern part of the county, large quantities of potatoes. This is one of the most important potato yielding localities in the state.

Alluvial Soils.—The valley bottoms of the larger streams, notably the Boyer and East Boyer, are filled with alluvium and these make excellent farm lands. The alluvium consists of the wash from higher land, both up the valley and along its sides. Loess silt mingled perhaps with clay from the till, humus from the centuries of vegetable growth, sand washed down by the floods, all combine to make a soil of boundless fertility. Although these regions are subject to floods, these very agents are the means of perpetuating the richness of these soils.

Underlying the true alluvium along these streams are extensive beds of sand and gravel which afford certain drainage to the surface soil.

From the steeper slopes facing the valleys and from a few hilltops over the country the loess blanket has been blown or washed away. Here the pebbly till comes to the surface. Such steep slopes are used for pasture or are covered with timber and brush. Any attempt to cultivate them would be likely to result in worse than failure.

Water Supply

Wells.—In every part of the county an abundance of water is obtained from the various members of the Pleistocene system. There are comparatively few deep wells in the county. Much the larger number are less than fifty feet deep. The wells in and near the county which reach the rock have been mentioned under the head of Stratigraphy (see pages 294 to 302). The artesian well at Dunlap has a very strong flow and the King well in section 9 of Hays township derives an abundant supply from the sandstone in which it ends.

The towns of the county with the exception of Denison derive their municipal water supplies from large shallow wells which have been dug in the valley bottoms for the most part.

Denison.—The Denison water supply was formerly derived from two shallow wells sunk in the East Boyer bottoms. These wells are twenty-two feet in diameter and thirty-two feet deep. The upper six feet of this depth is black soil and below this is twenty-two feet of bowlder-bearing clay. Beneath this is gravel which was penetrated to a depth of four feet. These wells had a capacity of 160,000 gallons per day. In 1916 the city abandoned these wells and began using the water from the new deep well, which was completed March 10, 1916, by W. H. Gray and Brother of Chicago. The record of the strata and other information regarding this well are given on pages 297 to 301. On completion of the well the water stood eighty-eight feet below the surface and the pumping capacity was 200 gallons per minute. The level of the water was constant at a depth of 170 feet and its temperature was 66° F. There are about nineteen miles of mains and seventy hydrants and the water is used by about 750 families. The sanitary analysis is as follows, stated in parts per million:

Date collected, July 26, 1920
Odor-none; color—none; turbidity—none; sediment—trace
Ammonia nitrogen— 0.060
Albumenoid nitrogen—0.008
Nitrite nitrogen— 0.004
Nitrate nitrogen— 2.000
Chlorine— 66.000
Bacteria per c.c. at 37°C. on litmus lactose agar—7
At 20°C. on plain nutrient agar—90.
Acid colonies in 1 c.c. on litmus lactose agar—none.
Gas forming bacteria in lactose broth at 37°C.—none.
Quality—satisfactory.

Jack J. Hinman, Jr.,
Laboratories, State Board of Health, State University of Iowa.

Water from one of the shallow wells east of the present pumping plant was analyzed at Iowa State College in September, 1920, and the following report was made, stated in parts per million:

Total solids	623
Calcium	111
Magnesium	40
Sulphur (SO_4)	137
Chlorine	36

The analyst recommended using 19 ounces soda ash (Na_2SO_4) and 20 ounces lime (CaO) to 1000 gallons of water to precipitate the salts of calcium and magnesium which give the water its hardness and form scale in the boiler.

Partial analyses were made of water from two of the forty-foot wells north of the plant with the following results:

Calcium bicarbonate, 30 grains per gallon.
Magnesium sulphate, 32 grains per gallon.

Analysis of water from the river near by showed:

Calcium bicarbonate, 19 grains per gallon.
Magnesium bicarbonate, 51 grains per gallon.

These data were kindly furnished by the city officials of Denison.

The Chicago and North Western Railway Company has several water stations in Crawford county and of these the two at Denison and at West Side are of especial interest on account of the water softening plants operated in connection. The well at Denison is eighteen feet wide and twenty-five feet deep. As the water from this well contains a good deal of mineral matter which forms hard scale in boilers it is necessary to remove this before the water is used in locomotives. To accomplish this result a relatively simple apparatus is employed to mix with the water a prescribed amount of quick lime and soda ash. About seventy-five pounds of soda ash and ninety pounds of lime are used for treating 50,000 gallons of water. The lime combines with the carbonates of lime and magnesia dissolved in the water and precipitates these as white sludge. The soda ash likewise unites with the sulphates of lime (gypsum) and of magnesia which are present in the untreated water and they are thrown out of solution. In this way nearly all of the scale-forming minerals are removed from the water. Two gallon samples of the untreated water are sent to the company chemist each week. An analysis of the water is as follows, stated in grains per gallon:

	BEFORE TREATMENT	AFTER TREATMENT
Total solid matter	24.19	16.50
This solid matter consists of:		
Carbonate of lime	14.68	2.16
Carbonate of magnesia	2.51	2.05
Sulphate of lime	3.60	---- ----
Sulphate of magnesia	1.20	---- ----
Oxides of iron and aluminum	0.09	0.06
Silica	0.96	0.86
Incrusting solids	23.04	5.13
Alkali chlorides	1.15	2.38
Alkali sulphates	---- ----	7.77
Alkali carbonates	---- ----	1.22
Non-incrusting solids	1.15	11.37
Pounds of scale-forming matter in 1,000 gallons	3.29	0.73

The water used at West Side is one of the hardest of the waters in use along the Iowa division of the Chicago and North Western railway. In amount of solid matter contained it is exceeded only by the water used at Council Bluffs, which carries 53.67 grains per gallon, or 6.69 pounds of scale-forming matter in 1,000 gallons. The result of the treatment of the West Side water may be seen from the following analyses, stated in grains per gallon.[39]

	BEFORE TREATMENT	AFTER TREATMENT
Total solid matter	51.33	28.18
This solid matter consists of:		
Carbonate of lime	17.32	2.67
Carbonate of magnesia	11.70	---- ----
Sulphate of lime	11.55	---- ----
Sulphate of magnesia	1.09	1.54
Oxides of iron and alumium	0.64	trace
Silica	1.55	0.54
Incrusting solids	43.85	4.75
Alkali chlorides	6.32	3.42
Alkali sulphate	1.16	20.01
Non-incrusting solids	7.48	23.43
Pounds of scale-forming matter in 1,000 gallons	6.26	0.68

The well from which the water is derived is thirty feet deep and twelve feet wide. The water comes within six feet of the

39 For the information regarding the treatment of the water at Denison and West Side the Survey is indebted to Mr. G. M. Davidson, chemist for the Chicago and North Western Railway Co., who is also the designer of the apparatus used at Denison. For description and illustrations of this apparatus and method see a paper by Mr. Davidson in Official Proceedings of the Western Railway Club, vol. 15, no. 6, February 17, 1903.

surface. The character of the strata is unknown, but the aquifer is doubtless sand or gravel.

The Nicholson Produce Company of Denison gets the water for its refrigerating plant from a thirty-five foot well twenty feet wide cased with a sixteen inch brick wall. This well was opened in March, 1909, and is sunk through eight feet of black soil, then through blue clay underlain by a thin layer of yellow loam in which was found wood cut by beavers. Beneath the loam is yellow clay, then gravel at the bottom. The air in the well has a fetid odor as if from vegetation, doubtless in one of the water-bearing layers. The well is stated to have a pumping capacity of seventy-five gallons per minute. Mr. Nicholson kindly furnished the writer with the following analysis and notes, made by the Dearborn Drug and Chemical Works, Chicago, August 4, 1910.

	GR. PER GAL.
Silica	.817
Oxides of iron and aluminum	.082
Carbonate of lime	11.481
Nitrate of lime	1.214
Sulphate of lime	8.112
Carbonate of magnesia	6.229
Sodium and potassium sulphates	trace
” ” ” chlorides	2.720
” ” ” nitrates	2.786
Loss &c.	.081
Total mineral solids	33.522
Organic matter	trace
Total incrusting solids	27.935
Total non-incrusting solids	5.587
Pounds incrusting solids per 1,000 U. S. gallons	3.98
Pounds non-incrusting solids per 1,000 U. S. gallons	0.80

"This water will cause the formation of more than twice an average amount of incrustation which will be decidedly hard, impervious, persistent and tenacious. There will also be a tendency to its causing trouble under certain conditions in the way of corrosion and pitting, due to the character of the sodium and potassium salts present and the nitrate of lime."

The water is run through a Stillwell heater to remove hardness.

*West Side.**—The town of West Side is supplied from a well located in the East Boyer bottoms. This well passes through fourteen or fifteen feet of alluvium, one or two feet of yellow

* The water supply data have been recently revised from the bulletins of the Iowa Insurance Service Bureau of Des Moines, which were kindly loaned by Mr. K. L. Walling, the manager.

sandy clay and eight feet of very fine sand, which is almost quicksand. The well will allow the pumping of 20,000 gallons per day and in addition five feet of water is left in the well to avoid drawing out the sand. A pump with capacity of 130,000 gallons per day is used and the water is pumped into a tank with a capacity of 40,000 gallons. The well is bricked up to the surface. Analyses are made twice a year. Consumption is about 30,000 gallons per day. The railway well is described on page 349.

Vail.—Vail gets its water supply from eight two inch sand point wells ranging in depth from eighteen to twenty-two feet. Sand and gravel in the river valley form the aquifer. The pumps used have a capacity of 120 gallons per minute and have never exhausted the wells. There are also two wells twenty-five feet deep and twelve feet in diameter which are pumped by a windmill. These are on the hillside but also penetrate the gravel.

Schleswig.—Schleswig installed a water system in the autumn of 1910. The wells are located in one of the broad shallow sags draining into Beaver creek and are probably one-fourth mile or more beyond the outskirts of the town and seventy-five to one hundred feet below the hilltops. The two original wells were ten and twelve feet in diameter and twenty-five feet deep, were sunk entirely in sand and gravel and were brick lined and covered with wood roofs. They proved inadequate and so ten shallow wells lined with 12 inch tile were installed in 1921. They are connected with each other and with the old wells by an intake pipe and any one can be shut off. The pump has a capacity of 250,000 gallons per day and is worked by a 15 horse power motor. The tank has a capacity of 60,000 gallons. Consumption is about 30,000 gallons daily.

Ricketts.—The village of Ricketts has a water system supplied by six 2½ inch sand points sunk nineteen feet below the bottom of a ten foot well. The points penetrate a sand bed for seven feet. They are sunk in the valley of Middle Soldier river on the south edge of town. The pump has capacity of 50,000 gallons per day. About 8,000 gallons per day is used.

Charter Oak.—The Charter Oak well is on the bottom lands of East Soldier river and is forty-five feet deep and twenty-nine feet wide. It ends in a bed of sand and gravel. A concrete standpipe having a capacity of 80,000 gallons stands 150 feet above the business district.

Arion.—Arion is supplied with water from a six inch well on the edge of the Boyer flats. It is fifty-six feet deep and penetrates a yellow pebbly clay overlying an abundantly water-bearing gravel bed. A thin layer of quicksand separates the two layers. A six horse-power oil engine is used to operate the deep well pump, which has a daily capacity of 40,000 gallons. A 23,000 gallon cistern on the top of the bluff, 155 feet above the well curb, is used for storage and gives a pressure in the town of seventy pounds. The water is very pure, does not scale in boilers and is in general use throughout the village, for both fire protection and domestic purposes.

Manilla.—The public water supply for Manilla is gained from two six-inch wells sixty-four and sixty-eight feet deep, situated in a ravine back from the river valley. Water is pumped by the municipal electric light plant. There are about two miles of mains and 150 users consume 60,000 gallons daily. The well at the electric light plant on the bottoms goes through four feet of black loam, ten feet of yellow clay and nine feet of coarse sand. It yields 10,000 gallons a day.

Mr. H. P. Achey, water supply foreman for the Chicago, Milwaukee and St. Paul Railway at Manilla, has kindly furnished the following information regarding the wells which supply the railway at that town. There are five drilled wells all of which are ten inches in diameter. All are located close to the pumping station.

Well No. 1, no log, tested 115 gallons per minute for three days.

Well No. 2

	DEPTH FEET
Yellow clay	0–25
Blue clay	25–30
Fine sand	30–40
Coarse sand	40–44
Coarse gravel	44–49
Clay	49–49.5

Test, 50 gallons per minute.

Well No. 4

	DEPTH FEET
Yellow clay	0–25
Blue clay	25–30
Sewer mud and fine sand	30–38
Coarse gravel	38–47.5
Clay	47.5–48

Test, 120 gallons per minute for ten days.

The logs of Nos. 3 and 5 are similar to those given.

The well at the old La Turno brickyard in the western part of Manilla, perhaps fifty feet above the bottom lands, was forty-five feet deep and penetrated loess and blue clay to gravel. The house well near by and probably twenty-five feet higher is thirty-six feet deep and is entirely in loess.

Mr. E. H. Woodard drilled a well in Manilla to a depth of 305 feet. Below eleven feet of black soil the entire depth was in blue clay. Four miles north of Manilla in section 2, Nishnabotany township, is the Clayton Baker well, 515 feet deep. The following is the driller's log: Yellow clay, loess in upper 50 feet, 75 feet; sand (water), 2 feet; blue clay and pebbles, 408 feet; "hardpan," 20; sand and gravel (water), 10. This is one of the deepest drift wells in the state. It is situated on a high ridge and shows well the great depth of the Pleistocene deposits in this part of the state.

Country wells.—In the vicinity of Vail country wells are generally from fifteen to forty-five feet deep. They go through a yellow clay into gravel but if a blue clay is struck instead of the gravel there is no water for 120 feet or so, where a lower gravel is reached. If the wells penetrate the gravel under the upper yellow clay they strike another yellow limy pebbly clay. It would seem as if the upper clay is loess, the gravel post-Kansan and the blue clay Kansan drift. The deep-lying gravel may be Aftonian. As an example of these shallow wells one in the northeast quarter of section 10, East Boyer township, may be mentioned. It is twenty-six feet deep and ends in sand. This one is located in a valley but is typical of many shallow wells of the county. Water is pumped into a cistern near the farm buildings, whence it is drawn for use.

Several deep wells in the eastern part of the county have been mentioned on page 294 and may be described in more detail here. The Peter Lorensen well, in section 10, Jackson township, is 500 feet deep. It passes through loess for twenty feet; then through blue and yellow clay with five sandy layers each two to three feet thick, but with no water, for 200 feet; blue clay for 200 feet; quicksand, very fine, for 100 feet.

In the south half of section 27, same township, is the well of McCaffery Brothers, 662 feet deep. The succession of strata is similar in the upper part to that in the Lorensen well, including: loess, twenty feet; blue and yellow clay, 100 feet; blue clay, 180 feet. Below this is a yellow limestone, so hard that the hydraulic churn drill could penetrate it only one and one-half to two feet per day. In spite of this the well is reported to have penetrated the limestone for 357 feet.

The Jonathan Miller well, located in the east half of the southwest quarter of section 16, Milford township, reaches a depth of 492 feet and passes through twenty feet of loess, fifty-five feet of very bowldery till, and then blue clay, bowldery, to rock at 460 feet. This rock is a blue-gray limestone and was penetrated for thirty feet.

A similar succession of Pleistocene deposits was encountered in the Franklin well in the northeast quarter of section 17, East Boyer. This well is located on a hilltop, is 404 feet deep and struck a very coarse sandstone at 390 feet.

The Barnhoff or King well, section 9, Hayes, is similar to the others except for one feature. Fifteen or twenty feet of loess overlies eighty feet of yellow and blue pebbly clay. Then follows 100 feet of blue clay, succeeded by what Mr. Hoffard, the driller, terms "potter's clay," a light blue-gray clay which contains some pebbles and which does not check on drying. It extends to the depth of 550 feet where a gray rather coarse sandstone is entered. This is penetrated for twenty-two and one-half feet and furnishes a strong flow of water. The well is drilled from a hilltop and if the "potter's clay" is all Pleistocene till this well must be the deepest drift well in the region and perhaps in the state.

In the southeastern part of the county the wells are usually sunk in low ground and the water is forced into cisterns to supply the barns and houses. In many instances the cisterns are located on hillsides above the buildings, and distribution is effected by gravity systems. This plan of pumping the water into cisterns and piping it about the homestead is a very common one all over the county and is the means used by about half of the farmers for insuring a supply of water. Not all the wells are in low ground, although even on higher land they are quite shallow, ranging in depth from fifteen to twenty-five, or more rarely to thirty-five feet. They generally pass through yellow clay, in some cases, at least, loess, and enter a layer of gravel and sand. This bed does not seem to be very thick, in some wells not over two feet, but the supply is said to be abundant, even in dry seasons. Some wells are reported to have been dug to a depth of eighty feet without finding water, presumably because of the absence of the gravel bed. One well in the southwest quarter of section 1, Iowa, is twenty-five feet deep, and one in the southwest quarter of section 36, Hays, is fifteen feet deep. Both pass through yellow pebbly (?) clay, perhaps loess bearing kindchen, and reach gravel. Two wells on the upland in the southwest quarter of section 13 and another across the road in the southeast quarter of section 14, Nishnabotany, are thirty-two feet deep and pass through loess to gravel. The water in all these wells is said to be of excellent quality.

Wells in western Crawford are similar to those described above. One on a farm in the southwest quarter of section 23, Hanover, is fifteen feet deep and draws an abundant supply, even in times of such severe testing as the summer of 1910, from a gravel layer underlying a gray pebbleless clay, doubtless loess. Water is forced up into a cistern near the house. Most wells in this vicinity are twenty to twenty-five feet deep.

It seems most reasonable to assume that the aquifer of these shallow wells is the post-Kansan gravel. The water-bearing stratum immediately underlies the loess and therefore there is no basis for placing it any farther down in the geological column than the Yarmouth. The blue or blue and yellow clay which has been found under the gravel in some cases may well be the Kansan as its characters agree better with the known features of this till than with those of the older Nebraskan, although some of the deeper wells doubtless have reached this lower till.

Mr. Henry Rickert of Schleswig, in company with Mr. Henry Hansen, has dug several wells near Schleswig. Mr. Rickert has kindly furnished the following information. The Henry Naeve well, in the northeast quarter of section 19, Otter Creek township, is 390 feet deep. It passed through loess and yellow and blue till to 118 feet where the first water was reached in a seven or eight foot layer of sand and gravel. This was overlain by blue clay and below it also is blue clay to the bottom of the well.

The well on the farm of Mrs. Mary Herring, across the road from Mr. Naeve, in the southeast quarter of section 18, is 410 feet deep. The strata passed through here were the same as those in the Naeve well and in addition the lower twenty feet, from 390 to 410 feet is in "soapstone." Whether this represents the Benton or the Des Moines shale or is a hard layer of Nebraskan or other till is not clear. Both of these wells are on high ground, more than 1,500 feet above sea level.

The Fred Shurkey well, northwest quarter section 12, Otter Creek, is 373 feet deep and pierces the same succession of loess, yellow and blue clay, with a sand layer at 120 feet. There was not much water in the sand as here penetrated.

Along the Boyer the gravels supply an abundance of water. The hill on which Deloit is built is veneered with gravel and nearly all the wells on the hill as well as those in the valley draw their waters from this source. It underlies also the alluvium of the river plain.

Mr. W. A. Davie has drilled several wells in southwestern Crawford and the following records were furnished by him. They are typical of conditions in this area. Mrs. Talcott owns a well in section 12, Union township, which is sunk to the depth of 234 feet, fifty feet of which was in loess, 175 feet in yellow drift, a few feet in blue clay, and the last ten feet in a rather fine sand. There is a "soapstone," so-called, at the base of the yellow clay. It is light-colored, bears lime balls and is in many cases very hard although it is softer as it is found at greater depth. The "soapstone," however, seems to belong to the glacial series, on account of its relations to the other members of the Pleistocene.

In section 5 of Union township Mr. S. J. Woodruff has a well which is 260 feet deep and which penetrates formations similar to those of the Talcott well. The same is true of the well of George Kern in section 31, Union. This is 315 feet deep and encountered the same blue clay above gravel.

Mr. Davie's well at his home on the southwest corner of section 36, Boyer, is 180 feet deep and the strata passed through include: loess, sixty feet; yellow clay, 100 feet; gravel, twenty-four feet. At the bottom is a blue-black clay, probably Nebraskan. The influence of the Missouri loess is plainly evident in all of these wells. The altitudes of these wells are probably not quite so great as are those of the deep wells described heretofore, as those were in the northern part of the county, which is naturally higher than more southern locations, and in addition the wells of the southern area are near the river valley and not quite on the uplands.

Springs.—Many of the minor streams are fed by seepage springs, some of which issue from the till, while others are fed from the gravels. Where these springs are conveniently located they are used for domestic purposes. Thus a small spring in the valley wall in the southeast part of section 26, Goodrich township, supplies the nearby farmhouse with a three-quarter inch stream. Probably it is fed from the gravels which are seen close by. In the southwest quarter of section 2, East Boyer, is another spring which supplies the farmhouse situated near. In the northwest quarter of section 24, Denison, is a large spring which forms the source for a brook two feet wide and eight inches deep.

Streams.—Crawford county is so thoroughly covered by a ramifying network of streams, large and small, that there is no lack of surface water in every township. The larger streams and indeed many of the smaller ones, such as Beaman creek, Paradise creek, Friends creek and numerous others, are perennial and furnish a never failing supply for farm use, unless we except such seasons of severe drought as those of 1910 and 1911.

Rainfall.—Since the determining factor in water supply is rainfall it may not be amiss to include here some statistics with regard to this subject. In order to make these data more general and cover a larger period of time than would be possible otherwise, figures from several stations in counties surrounding Crawford are included. The data are summarized from the published records of the Iowa Section of the United States Weather Bureau.

Precipitation at various stations

Date	Logan	Sac City	Grant City	Onawa	Denison	Carroll	Council Bluffs
1866	13.00[1]						
1867	27.81						
1868	29.85[2]						
1869	44.95		38.95[19]				
1870	25.30[3]		24.05[20]				
1871	28.95[4]		27.53[21]				28.49[30]
1872	32.10		---- ----				32.64
1873	43.20		---- ----				27.78
1874	28.40		---- ----				25.48
1875	42.00		---- ----				38.65
1876	28.20	29.98[10]	40.22				35.05
1877	45.10	30.07	29.10				38.72
1878	46.31[5]	30.00	31.06				34.69
1879	33.10	21.69	20.41	23.33			25.16
1880	27.30	22.83	23.27	23.42			---- ----
1881	56.60	46.55	29.48[22]	49.93			41.42[31]
1882	37.30	25.82	21.03[23]	31.34			30.23[32]
1883	39.90	---- ----	27.14	33.68			45.47
1884	36.60	42.54	---- ----	37.56			46.60
1885	40.20[6]	36.51	33.99	43.21			35.32
1886	23.10[7]	21.68	---- ----	33.01			27.85
1887	23.60	28.55	29.05	27.30			23.35
1888	34.02	30.33	---- ----	37.18			
			Sioux City				
1889	29.87	28.17	9.45[24]	27.42			
1890	34.95[8]	23.53	22.25	35.37		30.34	Omaha
1891	35.39	28.90	33.29	36.61		41.63	34.92
1892	35.25	24.78	26.38	25.76		24.82	29.44
1893	22.40	18.96[11]	23.05	27.27	24.53[25]	29.63	---- ----
1894	16.63	29.81	17.84	16.01	---- ----	20.42	17.82
1895	26.12	31.59	20.29	31.97	18.54[26]	23.32[29]	21.69
1896	43.82	38.92	30.77	42.17	36.40	41.83	35.90
1897	26.00	22.67	20.38	24.37	25.50	28.80	21.30
1898	24.96	27.54	22.91	31.35	---- ----	28.65	27.84
1899	31.95	---- ----	22.67	20.59	26.25	34.90	26.74
1900	31.39	34.21	32.22	42.20	33.90	40.18	31.20
1901	30.56	24.35	26.59	30.07	23.40	29.55	25.08
1902	40.74	42.77	20.34	42.25	33.81	43.94	30.48
1903	30.25	36.24	41.10	50.53	34.55	34.48	33.43
1904	24.14	25.48[12]	21.46	31.30	21.28	26.83	25.48
1905	30.35	31.93[13]	31.66	32.33	25.87	31.56	29.88
1906	38.05	23.49[14]	31.41	40.59	25.44[27]	22.79	27.59
1907	22.73	28.92[15]	19.93	21.55	28.48	29.24	24.60
1908	28.12	---- ----	26.44	31.33	37.24	42.52	27.10
1909	43.39	28.50[16]	---- ----	29.64	37.73	41.62	44.92
1910	19.03	14.75	---- ----	16.85	21.78	23.10	22.21
1911	23.12	33.92	24.02	24.81	22.79	24.18	18.46
1912	29.46	30.33	30.54	32.37	30.68	30.45	26.46
1913	31.59	27.39	30.31	30.32	28.32	29.93	25.03
1914	25.26	30.13	24.77	26.90	30.33	30.92	27.25
1915	38.27	41.27	33.46	46.01	38.05	41.19	31.57
1916	21.66[9]	19.66[17]	24.51	28.37	26.30	26.17	19.46
1917	25.43	18.66[18]	21.32	34.41	---- ----	27.66	22.62
1918	25.84	---- ----	25.41	---- ----	25.17[28]	31.31	21.44
1919	29.19	34.64	29.16	32.31	---- ----	32.48	29.70
1920	30.55	28.48	31.96	---- ----	27.64	33.47	23.01
1921	31.11	23.24	21.61	---- ----	32.57	37.63	25.29
1922	30.80	---- ----	25.94	---- ----	25.26	29.79	22.46
1923	36.65	29.37	34.50	36.09	29.98	33.13	30.95
1924	---- ----	24.92	22.82	31.86	28.45	32.30	26.83
1925	21.42	21.75	18.01	26.99	26.04	24.29	21.12
1926		30.59	24.26		30.75	36.79	25.96

Notes: 1, includes May-Sept.; 2, except Jan., Aug., Oct.; 3, except Feb., Nov.; 4, except Mar.; 5, except Nov.; 6, except Jan.; 7, except Sept.; 8, except Dec.; 9, except Mar.; 10, except Apr., and May; 11, except Sept.-Nov.; 12, except Dec.; 13, except Mar., Nov.; 14, except Dec.; 15, except Jan., Nov., Dec.; 16, except Jan.-Mar.; 17, except Oct.; 18, except Jan.; 19, except Jan. Feb.; 20, except Feb., Mar., Apr.; 21, except Sept.; 22, except Feb., Mar., Oct.; 23, except Mar., Nov.; 24, includes July-Dec.; 25, except Sept., Nov.; 26, except Jan.-Mar.; 27, except Dec.; 28, except Jan.; 29, except Jan.; 30, except Jan., Feb.; 31, except Feb., Mar.; 32, except Oct., Dec.

Average precipitation for Iowa.

1890	31.30	1903	35.39	1916	28.90
1891	32.90	1904	28.51	1917	27.81
1892	36.58	1905	36.56	1918	32.78
1893	27.59	1906	31.60	1919	36.76
1894	21.94	1907	31.61	1920	31.75
1895	26.77	1908	35.26	1921	32.03
1896	37.23	1909	40.01	1922	29.98
1897	26.98	1910	19.87	1923	29.50
1898	31.34	1911	31.37	1924	31.39
1899	28.68	1912	28.89	1925	28.24
1900	35.05	1913	29.95	1926	32.22
1901	24.41	1914	31.93		
1902	43.82	1915	39.53		

Normal precipitation, 31.97 inches.

Sand and Gravel

Sand and gravel are very generally distributed over the county as will have been seen from the descriptions of the gravels and of the wells. Where the overburden is deep sand and gravel are, to be sure, not available for pit work but in a great number of places their presence has been revealed by erosion. This is especially true of the Boyer valley, whose walls and floor are in many localities lined with deposits of sand and gravel. Some of these beds have been opened for commercial use but there are numerous deposits which can and doubtless will be put to use in the future. The most important exposures are indicated on the map which accompanies this report. As these have been discussed under the description of the Pleistocene it will be sufficient here to make brief mention of a few of the observed beds.

The erosive work of Porter and Wheeler creeks above Boyer has uncovered beds of sand at several points along their courses, and the same is true of Beaman and Trinkle creeks. The veneering of the Boyer wall at Deloit by gravel has been mentioned, and the McAhren pit, about one-half mile below the village, at the mouth of Otter creek, has supplied both sand and gravel of fine quality. The valleys of Otter and Buffalo creeks show many gravel beds, as for instance in sections 12, 34, 27, 15, 10 of Goodrich and 36 of Otter Creek townships.

At Denison the Mill sand pit, northwest corner section 14, Denison, and the Mill gravel bank one-half mile farther down the valley and in its floor, are well known for their fossil content as well as for the quality of their economic products. A smaller pit was opened some years ago by Mr. Will Quade near the Illinois Central station on Court street in Denison. Most of the layers here exposed are sand but some gravel bands occur also.

Where Buck creek debouches into the main valley the Chicago, Milwaukee and Saint Paul Railway Company has cut into a bed of fine sand which has, however, a rather heavy overburden of loess. This loess must thin out at the point of the ridge and here the sand should be nearer the surface. There are without doubt large quantities here, and one mile and two miles up Buck creek other masses are shown. At the latter point, southwest quarter of section 8, Washington, the ferruginous sands have been dug for various purposes. They should make excellent road metal.

A number of openings have been made below Arion. A small pit has been opened by Mr. Milo Kelly in the southwest quarter of section 1, Union, on the south side of the valley. It contains only fine sand with few pebbles. About one-half mile down the valley and on the same side, is the Charles Butler pit. This shows a face of thirty feet of sand and gravel, with a ten foot layer of loess above it. This top layer probably will be thicker as the pit face advances into the bluff. Near this pit is the exposure of sand and loess which shows interbanding of the two materials and a curious contortion of the sand pockets and bands. (See figure 58, page 335.) Other pits have been opened immediately below this one thus showing a practically continuous deposit for more than a mile down the valley. Across the valley at the mouth of Paradise creek is the Riddell pit. This is claimed by some users to yield the best gravel to be found in this vicinity. It is not so thick as some others but the contents are clean and the stripping is not so great nor does it thicken so abruptly as is the case where pits are opened in steep slopes. (See figure 57, page 330.)

The western part of the county is so deeply covered with loess that little else is exposed. Only rarely are the underlying beds revealed in the deeper gullies and other cuts. One of the few exposures of gravel is in a valley just south of the road on the north line of section 9, Soldier. Six feet or more is exposed, bearing all the marks of an old deposit, rusty rotten bowlders and yellow stains. Again on the south line of section 29, this township, is exposed eight feet of very rusty red gravel of medium fine size with numerous small bowlders and cobblestones.

Some exposures of sand are found along the East Boyer, as for instance along the road in sections 23 and 10, East Boyer township. These are very fine, are stained yellow and lie at the edge of the flood plain, where they are quite easy of access.

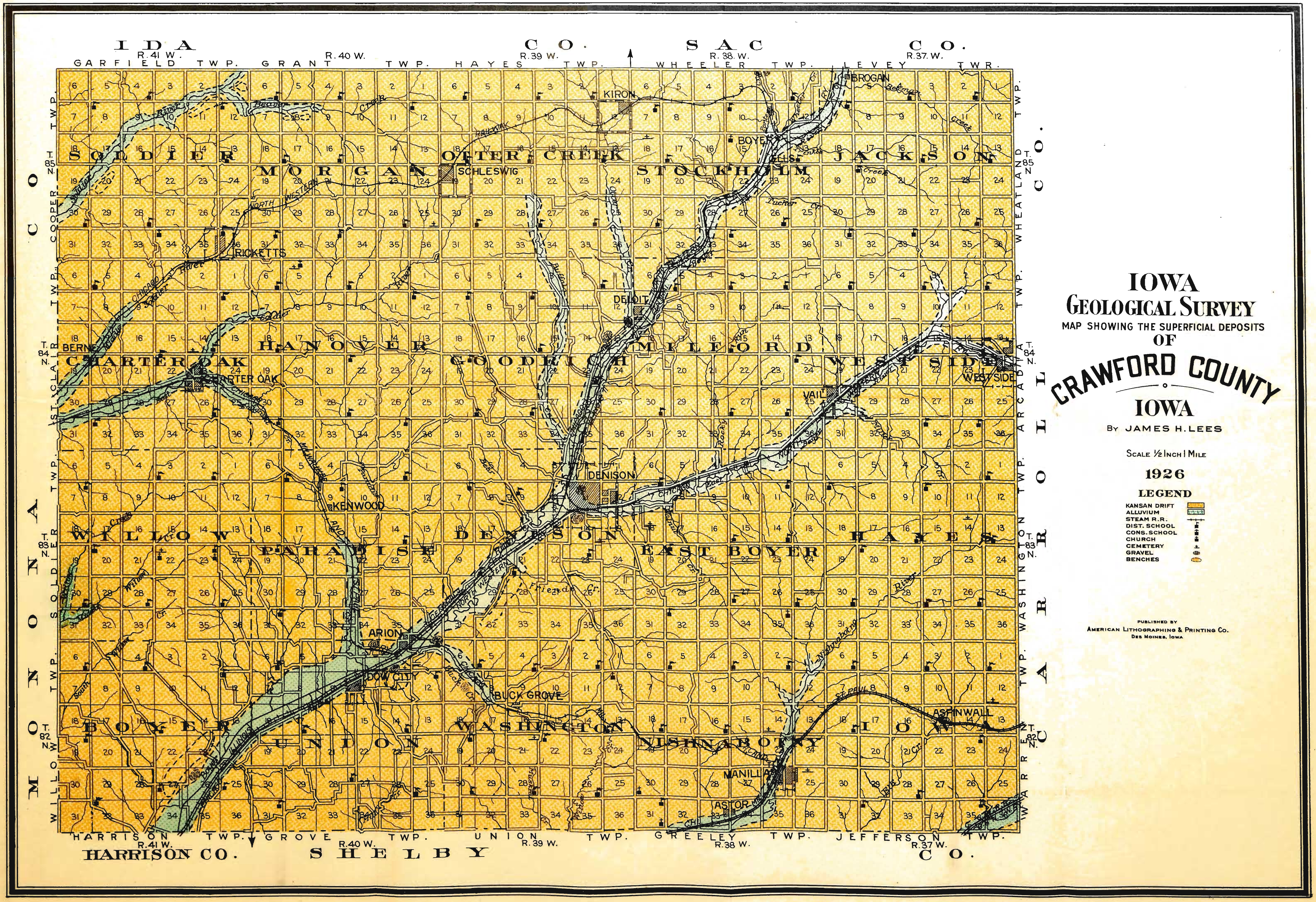
In the railroad cut in the center of section 14, Washington, a thickness of sixteen feet of red, oxidized gravels is exposed. This is near the headwaters of Buck creek and it should certainly be no difficult matter to secure an abundance of this excellent material for use on roads and for other purposes to which it is adapted.

Brick Plants

Two plants producing common brick and similar materials have been operated in the county. Both of these used the loess. One of these was located at Denison and was operated by Messrs. A. C. Green and Son and J. Ward for over twenty years previous to 1910. The other was located at Manilla and was owned by Mr. J. L. La Turno for about ten years. It was abandoned in 1913. At present no plants are in operation.

Coal

Every community is anxious to secure a supply of fuel in its own vicinity and therefore it is not surprising that the citizens of Crawford county should have attempted to find coal in their county. Mr. A. C. Green, who was at that time a county supervisor, informs the writer that in 1875 a hole was bored on the land of Mr. J. H. Maloney, one mile east of Denison, in search of coal, on the recommendation of "Professor" Fox. The work was done under the authority of the Board of Supervisors and the county authorities, among whom was Mr. Maloney as Auditor. Mr. Green directed the work as representative of the county officials although he was not in favor of its being under-taken. In the lower part of the drilling small bits of coal were found but these apparently were from the drift. The hole was sunk to the depth of about 350 feet but no bed of coal was reached. Evidently the drill did not get down to the Coal Measures. Whether any coal would have been found had these been penetrated is a question. It should be noted that the samples of the deep well at Denison showed a few very small fragments of coal at a depth of 360 feet. How much coal there may be at this level, and what its quality, are questions which can not be answered without a large expenditure of time and money in careful prospecting and examinations. Crawford county lies west of the area in which coal is known with certainty to be present in the beds of the Des Moines series. The presence of coal seams in the Coal Measures of western Iowa has always been a matter of doubt and the thickness of the drift and the presence, over much of the area at least, of the overlying Cretaceous, renders the solution of the problem far from easy. It has seemed probable to some of the investigators in this part of Iowa that conditions here were not favorable to the formation of beds of plant remains such as those which now form our coal supplies in eastern and southern Iowa.


IOWA
GEOLOGICAL SURVEY
MAP SHOWING THE SUPERFICIAL DEPOSITS
OF
CRAWFORD COUNTY
IOWA
BY JAMES H. LEES
SCALE ½ INCH 1 MILE
1926
LEGEND
KANSAN DRIFT
ALLUVIUM
STEAM R.R.
DIST. SCHOOL
CONS. SCHOOL
CHURCH
CEMETERY
GRAVEL
BENCHES
PUBLISHED BY
AMERICAN LITHOGRAPHING & PRINTING CO.
DES MOINES, IOWA
IDA CO.
SAC CO.
MONONA CO.
CARROLL CO.
HARRISON CO.
SHELBY CO.
R.41 W.
R.40 W.
R.39 W.
R.38 W.
R.37 W.
T. 85 N.
T. 84 N.
T. 83 N.
T. 82 N.
GARFIELD TWP.
GRANT TWP.
HAYES TWP.
WHEELER TWP.
LEVEY TWR.
HARRISON TWP.
GROVE TWP.
UNION TWP.
GREELEY TWP.
JEFFERSON TWP.
SOLDIER
MORGAN
OTTER CREEK
STOCKHOLM
JACKSON
CHARTER OAK
HANOVER
GOODRICH
MILFORD
WEST SIDE
WILLOW
PARADISE
DENISON
EAST BOYER
HAYES
BOYER
UNION
WASHINGTON
NISHNABOTNY
IOWA
KIRON
BROGAN
BOYER
SCHLESWIG
RICKETTS
DELOIT
BERNE
CHARTER OAK
VAIL
WEST SIDE
DENISON
KENWOOD
ARION
DOW CITY
BUCK GROVE
ASPINWALL
MANILLA
ASTOR

ALTITUDES IN IOWA

by

JAMES H. LEES

ALTITUDES IN IOWA

Introductory

For a number of years the Survey has felt the need of a comprehensive list of elevations in the state, both to facilitate its own work and also to supply information to those who wished to know something about the altitudes of different localities. No such list has been available since 1906, when the United States Geological Survey published as its Bulletin 274 the fourth edition of Gannett's Dictionary of Altitudes in the United States. This volume included a large number of elevations in Iowa, most of them determined from railroad profiles, and it has served a most useful purpose. In the nature of the case, however, its use was restricted to a relatively small number of Iowa people, and besides it has been out of print for a number of years. It has been used by the Iowa Survey for giving the elevations of towns which were published in the various county reports.

The list of altitudes given herewith is the outgrowth of an attempt to determine the elevations of a series of localities in western Iowa, including some others than railroad stations. This necessitated the use of railway profiles of the district and the list thus begun has gradually been extended until now it includes all the stations on every large railway system operating in the state and also practically every smaller one, as well as the electric interurban lines.

Sources.—In the work of accumulating the needful railway profiles and determining the altitudes of the different stations and crossings the railway officials have been most helpful. The chief engineers and their corps have not only furnished the profiles for which they were asked but they also have checked the figures of altitudes as measured from those profiles. As a result of this coöperation the Survey has profiles of nearly every railway line in the state and also has corrected lists giving the elevation of practically every railway station in Iowa. Without the help so freely given by the railroad officials this list of altitudes would have been impossible.

Another important source of information was the Results of Spirit Leveling in Iowa From 1896 to 1913, published by the United States Geological Survey in 1915 as Bulletin 569. The descriptions and elevations of bench marks along Mississippi river from Keokuk to New Albin, those along Missouri river from Hamburg to Akron and those along Des Moines river from Keokuk to Des Moines which with some corrections are copied from Bulletin 569 into the present list are from reports by the United States Coast and Geodetic Survey, the Mississippi and Missouri River Commissions and the United States Corps of Engineers. They are the result of precise leveling and have been corrected to agree with the 1912 adjustment of the Coast and Geodetic Survey. The elevations determined by these organizations may be distinguished in this list by the initials of the bureau, usually U.S.C. & G.S. or U.S.C.E. followed by b.m. or p.b.m., in parentheses. They are identifiable also by "Bull. 569" in the Authority column.

Most of the elevations given in Bulletin 569, however, were determined by the United States Geological Survey as a part of its topographic mapping operations in this state. The elevations along the line of the Chicago, Rock Island and Pacific Railway between Council Bluffs and Des Moines are the results of a line of first order levels run in 1905 from the United States Army Engineers' bench mark 348 at Council Bluffs, the cap on an iron pipe in the southwest corner of the courthouse yard, the elevation of which is accepted as 994.335 feet, to the Federal Building (the old Post Office) at Des Moines. The other elevations given in Bulletin 569 for which the U. S. Geological Survey is responsible were the results of third order leveling. All of the United States Geological Survey's determinations which were published in Bulletin 569 are credited in this list by "Bull. 569" in the Authority column. The figures published in Bulletin 569 and republished here have been brought into agreement with the 1912 adjustment of the Coast and Geodetic Survey and therefore should be used in preference to figures marked on bench marks established by the Geological Survey. The elevations in northeastern Iowa are based on bench mark 279 of the Mississippi River Commission, a copper bolt in the northeast corner of the customhouse at Dubuque, the elevation of which is accepted as

644.838 feet above mean sea level. The elevation at Vincennes determined from Chicago, Rock Island and Pacific Railway and United States Corps of Engineers leveling from Keokuk is checked by a single line by the U. S. Geological Survey at St. Francisville, Mo. The other elevations in southeastern Iowa are based on various bench marks established by the Mississippi River Commission and the elevations in western Iowa were based on bench marks of the Missouri River Commission and the Coast and Geodetic Survey. Elevations determined in central Iowa are based on the line of precise levels run from Council Bluffs to Des Moines and on various other U. S. Geological Survey bench marks established in the localities concerned.

The Iowa State College students ran an additional line in the Ames quadrangle in 1911, starting from T. 83 N., R. 24 W., sec. 30 and connecting with Chicago & North Western Railway level bench marks near Ames.

It seems worth while to include in this list the altitudes given by Gannett and so these are given in the Elevation column and are preceded by the letter G. It will be noticed that many of these figures do not quite agree with those credited to the railroads by the present work. There are several facts to account for this. In the first place Doctor Gannett "adjusted" his elevations. That is he attempted to harmonize the figures given by various roads to overcome the discrepancies shown on the different profiles. In the present work, however, no attempt has been made to do this. The figures given here on the authority of the different railroads are just as checked by the engineers of those roads. In the second place some of the roads have resurveyed their lines since the publication of Bulletin 274 and have corrected what mistakes may have been made in earlier surveys. In the third place some of the roads have changed the location of their lines in greater or lesser degree. These three factors are quite sufficient to account for most of the differences in the figures given. Where the differences are large Gannett's figures are not given, as is true also in the case of a very few quite obvious errors, such for instance as the figure of 1800 feet for the Weather Bureau station at Primghar. On the whole the agreement between Gannett's figures and those given by the roads themselves is quite remarkable.

Figures given on authority of the "U.S.G.S.", with no bulletin number following, were for the most part furnished to the Iowa Geological Survey especially for publication here and have not appeared heretofore. A few were taken from Bulletin 274, as indicated in the list, and a few are gathered from other sources, chiefly topographic maps. Of course those taken from Bulletin 274 are not brought into agreement with the 1912 adjustment.

The courtesy of the U. S. Geological Survey in permitting use of its recently determined data in advance of publication in its own reports and also in permitting republication of the data in Bulletins 274 and 569 is greatly appreciated. The latter bulletin is used almost in its entirety in this report.

Figures credited to the Iowa Geological Survey are barometric and were obtained by the authors of the various county reports from which they were taken for this publication.

At the request of the Iowa Geological Survey the engineers of the Des Moines Department of Streets ran a line of levels between the U. S. Geological Survey bench mark on the old Post Office building and the U. S. Corps of Engineers bench mark on Locust Street bridge in order to determine the relation between the two. The Survey is glad to acknowledge this help in its work.

*Bench marks.**—The standard bench marks of the U. S. Geological Survey are of two forms. The first form is a circular bronze or aluminum tablet, 3½ inches in diameter and one-fourth inch thick, having a 3-inch stem, which is cemented in a drill hole in solid rock in the wall of some public building, a bridge abutment, or other substantial masonry structure. The second form, used where masonry or rock is not available, consists of a hollow wrought-iron post 3½ inches in outer diameter and 4 feet in length, which is set about 3 feet in the ground. It is split at the bottom and expanded to a width of 10 inches in order to give a firm bearing on the earth. A bronze or aluminum-bronze cap is riveted upon the top of the post. A third style of bench mark with abbreviated lettering is used for unimportant points. This consists of a special copper nail, 1½ inches in length, driven through a copper washer seven-eighths of an inch in diameter.

The tablets, as well as the caps on the iron posts, are appropriately lettered, and State coöperation is indicated by the addition of the State name.

The numbers stamped on the bench marks described in the fol-

* U. S. Geol. Survey, Bull. 569, pp. 6, 7, 85, 86.

lowing pages represent the elevations to the nearest foot, as determined by the levelman. These numbers are stamped with $\frac{3}{16}$-inch steel dies on the tablets or post caps, to the left of the word "feet." The office adjustment of the notes and the reduction to mean sea level datum may so change some of the figures that the original markings are 1 or 2 feet in error. It is assumed that engineers and others who have occasion to use the bench-mark elevations will apply to the Director of the United States Geological Survey at Washington, D. C., for the adjusted values, and will use the markings as identification numbers only.

Datum.—All United States Geological Survey elevations are referred to mean sea level, which is the level that the sea would assume if the influence of tides and winds were eliminated. This level is not the elevation determined from the mean of the highest and the lowest tides, nor is it the half sum of the mean of all the high tides and the mean of all the low tides, which is called the half-tide level. *Mean sea level is the average height of the water, all stages of the tide being considered.* It is determined from observations made by means of tidal gages placed at stations where local conditions, such as long narrow bays, rivers, and like features will not affect the height of the water. To obtain even approximately correct results these observations must extend over at least one lunar month, and if accuracy is desired they must extend over several years. At ocean stations the half-tide level and the mean sea level usually differ but little. It is assumed that there is no difference between the mean sea levels determined from observations in the Atlantic Ocean, the Gulf of Mexico, and the Pacific Ocean.

Other bench marks.—Along Mississippi river the lines of bench marks established by the Mississippi River Commission and called stone lines are placed normal to the river at intervals of about 3 miles and are numbered consecutively from Cairo northward. Each stone line generally consists of four bench marks, two on each side of the river, the one farthest from the river on the left (east) bank being No. 1.

The elevations of the stone-line bench marks were determined by the ordinary leveling by the topographic party, running from the adjacent precise-level bench marks. The discrepancies between the precise and ordinary leveling, between successive precise-level bench marks, have averaged about 0.06 foot.

The bench marks above Alton, Ill., consist of a flat tile 4 inches thick and 18 inches square, with a copper bolt leaded vertically into the upper face at the center. The tile is set about 3 feet below the surface of the ground and is surmounted by a 4-inch iron post 4 feet long, upon which an iron cap is bolted. The words

"Mississippi River Commission" and letters "U. S." are printed on both tile and cap.

Where standard bench marks are not used, descriptions of the marks employed are given. The numbers of Mississippi River Commission bench marks are given in parentheses and refer to the surface mark.

In the descriptions of bench marks of the Missouri River Commission along Missouri river the letters "b.m." refer to permanent bench marks which are designated by fractions, the numerator standing for the number of the bench-mark line counting from the mouth of the river up and the denominator for the number in the line counting from the one on the right bank farthest from the river. The bench marks are similar to those along Mississippi river described above.

The elevations and bench marks along Des Moines river from Keokuk to Des Moines and return were established by the U. S. Corps of Engineers in 1910. The work was done pursuant to an act of Congress and the results were published as a part of Document 1063 of the 62d Congress, 3d session, which was a report of the Corps of Engineers to the Secretary of War on a survey of Des Moines river. The elevations there given were referred to Memphis datum, but as republished in Bulletin 569 and again in part in this list they are brought into agreement with the 1912 adjustment of the Coast and Geodetic Survey.

In 1906 the Chicago, Rock Island and Pacific Railway ran a line of levels along its Des Moines Valley division between Keokuk and Des Moines, establishing bench marks at each mile post. "Elevations are based on U.S.C.E. p.b.m. No. 3, Keokuk, a copper bolt in doorway of Patterson Bldg., elevation 509.559 feet. The levels were run to U.S.G.S. B.M. on the old post office at Des Moines (elevation, 807.351 feet), a distance of 165 miles. The mile monuments are pieces of 60 pound rail, four feet long, set about 3 feet in the ground opposite mile posts, five feet east of the east rail of track." The figures obtained from this leveling have recently been adjusted by the U. S. Geological Survey and as so adjusted are published here and credited to the Rock Island Railway. Originally they differed but little from the figures obtained by the U. S. Corps of Engineers and published in Bulletin 569, as described in the preceding paragraph, where the army engineers followed the railroad, as was the case most of the way between Keokuk and Eddyville. As adjusted the railroad figures are identical with the adjusted figures of the Corps of Engineers. Coincidences of location are indicated in the list by the initials U.S.C.E. b.m. and the bench mark number following the description of the bench mark as given by the railway engineers.

The Corps of Engineers has also used Biloxi, Mississippi, on the Gulf of Mexico, as a datum base. This datum differs from mean sea level as determined by adjustment of precise leveling by various amounts. The Corps of Engineers elevation at Keokuk based on Memphis datum is 7.34 feet above its Biloxi datum and 6.81 feet above mean sea level.

Railroads.—The following list gives the names of Iowa railroads and their abbreviations as shown under the head of Authority in the list of altitudes. Other abbreviations are given in a supplementary list.

Atchison, Topeka & Santa Fe Ry.	A., T. & S.F.
Cedar Rapids and Iowa City Ry.	C.R. & I.C.
Charles City Western Ry.	C.C.W.
Chicago and North Western Ry.	C. & N.W.
Chicago, Burlington & Quincy RR.	C., B. & Q.
Chicago Great Western RR.	C.G.W.
*Chicago, Milwaukee and St. Paul Ry.	C., M. & St.P.
Chicago, Rock Island and Pacific Ry.	C., R.I. & P.
Chicago, St. Paul, Minneapolis & Omaha Ry.	C., St.P.,M. & O.
Clinton, Davenport & Muscatine Ry.	C., D. & M.
Davenport, Rock Island & Northwestern Ry.	D., R.I. & N.W.
Des Moines and Central Iowa RR.	D.M. & C.I.
Fort Dodge, Des Moines & Southern RR.	Ft.D., D.M. & S.
Great Northern Ry.	G.N.
Illinois Central RR.	I.C.
Iowa Southern Utilities Co.	I.S.U.
Manchester & Oneida Ry.	M. & O.
Minneaplis and St. Louis RR.	M. & St.L.
Tabor & Northern Ry.	T. & N.
Wabash Ry.	W. R.R.
Waterloo, Cedar Falls & Northern Ry.	W., C.F. & N.

Adj.	Adjusted or Adjustment.
B.M. or b.m.	Bench Mark.
Bull. 569	Bulletin 569, U.S.Geol.Survey, Spirit Leveling in Iowa, 1896 to 1913.
DBQ. or DUBQ.	Dubuque.
G.	Gannett's Dictionary of Altitudes, Bull. 274, U.S. Geol. Survey.
Ia. G.S.	Iowa Geological Survey.
M.P.	Mile post.
M.R.C.	Mississippi River Commission.
P.B.M. or p.b.m.	Permanent bench mark.
Prim.Trav. Sta.	Primary Traverse station.
T.B.M. or t.b.m.	Temporary bench mark.
U.S.C.E.	United States Corps of Engineers.
U.S.C. & G.S.	United States Coast & Geodetic Survey.
U.S.G.S.	United States Geological Survey.
Ynktn.	Yankton.

* On January 15, 1928, this name was changed to Chicago, Milwaukee, St. Paul and Pacific Railway.

Abbreviations for bench marks in some cases are preceded by the initials of the organization doing the work and followed by letters or numbers describing the bench marks.

Some of the locations along the Mississippi at and above Keokuk for which elevations are given are now under water as a result of the building of the Keokuk dam. This also necessitated the raising of the C., B. & Q. RR. track between Keokuk and Montrose.

Some distances are given in the text in terms of meters and kilometers. It will be easy to reduce these to the more familiar units by multiplying meters by 3.28 to reduce them to feet and multiplying kilometers by 0.621 to reduce them to miles. In other words a meter equals 39.37 inches, 3.281 feet, 1.0936 yards; and a kilometer equals 3,281 feet, nearly five-eighths of a mile, or expressed decimally, a little over six-tenths of a mile.

The following railroads, most of which are named in Gannett's Dictionary of Altitudes, have been absorbed by other railroads as indicated or have changed their names. Burlington, Cedar Rapids and Northern Ry. is now part of the Chicago, Rock Island & Pacific Ry. Chicago, Burlington & Kansas City RR., Iowa & St. Louis Ry., Keokuk & Western RR., Kansas City, St. Joseph & Council Bluffs RR., and the St. Louis, Keokuk & Northwestern RR., are now part of the Chicago, Burlington and Quincy RR. Des Moines & Northwestern Ry. is now part of the Chicago, Milwaukee & St. Paul Ry. Iowa Central Ry. is now part of the Minneapolis & St. Louis RR. Sioux City and Northern RR. is now part of the Great Northern Ry. Sioux City & Pacific RR. is now part of the Chicago & North Western Ry. The Interurban Ry. is now the Des Moines & Central Iowa Ry.

The tracks and stations of the Davenport, Rock Island and Northwestern Ry. between Davenport and Clinton are used by the Chicago, Milwaukee & St. Paul Ry. and the Chicago, Burlington & Quincy RR.

The point on the grade of each railway for which elevations of stations and other locations are given is set forth in the list below. Where the orginal datum was stated by the railway officials it is given in the third column.

A., T. & S.F.	base of rail; east end of depot	U.S.C. & G.S. b.m., 1912 adj.
C.R. & I.C.	top of rail	B.m. of C. & N.W. Ry. at Cedar Rapids.
C.C.W.	base of rail	
C. & N.W.	base of rail, center of depot	Mean Gulf tide, Biloxi, Miss.*
C., B. & Q.	base of rail	Biloxi datum.
C.G.W.	base of rail	U.S.G.S. b.m.
C., M. & St.P.	top of rail	Level of Lake Michigan = 582 feet above sea level.
C., R.I. & P.	subgrade; add rail, tie and ballast, 1½ to 2 feet	
C., St.P.,M. & O.	base of rail	
C., D. & M.	base of rail	Davenport to Muscatine—Cairo datum; figures are reduced to Memphis datum. Davenport to Clinton—Memphis datum.*
D.M. & C.I.	top of rail	Bull. 569, U.S.G.S.
Ft.D., D.M. & S.	top of rail	
G.N.	top of rail	
I.C.	top of rail, center of depot	
T. & N.	top of rail	
Wabash	base of rail	St. Louis City datum plane = 413.536 feet above mean Gulf level at Biloxi by U.S. C.E. data or 413.969 feet above mean sea level by adjusted data. St. Louis Union Station is 439.244 feet above mean sea level.
W., C.F. & N.	Waterloo to Cedar Rapids—subgrade Others—top of rail, 1½ feet above subgrade	

Topographic maps.—For a number of years the United States Geological Survey, as a part of its work of mapping the area of the United States, has been making topographic maps of parts of Iowa and since 1907 the Iowa Geological Survey has coöperated in this work of mapping our state. The areas covered by these maps are called quadrangles and are bounded by meridians of longitude and parallels of latitude rather than by political boundary lines. Hence they may include parts of two or three states, as in the case of the Elk Point sheet, which covers parts of Nebraska, South Dakota and Iowa. These maps, in addition to showing natural features, as rivers and lakes, and cultural features, such as towns, public roads and railroads, show by means of contour lines the elevations of the included area. The

* Biloxi datum plane at Keokuk is 0.53 foot above mean sea level, 7.34 feet above Memphis datum plane.
Memphis datum elevations at Keokuk are therefore 6.81 feet greater than mean sea level elevations.
Cairo datum plane at Rock Island is 13.13 feet below Memphis datum plane or 19.94 feet below mean sea level. Elevations above this datum plane are therefore 19.94 feet greater than mean sea level elevations.

contour lines pass through all points having the same altitude, hence their closeness or distance indicates the steepness or flatness of the surface. With the exception of the Fort Dodge, Fort Dodge Special and Lehigh maps all the topographic maps covering parts of Iowa have a contour interval of twenty feet; that is, the interval between contour lines represents a vertical distance of twenty feet on the ground. In the three exceptions the interval is ten feet.

Maps having a scale of 1:62,500 cover an area one-fourth degree or fifteen minutes in length and breadth; that is, one-sixteenth of a square degree. The maps whose scale is 1:125,000 are one-half degree in dimensions and have an area of one-fourth square degree.

With a few exceptions, the maps are published on sheets about 16x20 inches in size. The Omaha and vicinity sheet is 22x32 inches in size and the Camp Dodge sheet is 25x27 inches in size. In many cases an explanation of the map is printed on the back of the sheet.

These maps may be purchased from the Iowa Geological Survey, Des Moines, or from the United States Geological Survey, Washington, D. C.

Name of Map	Counties in Iowa Included	Area in square miles	Scale	Price—cents
Amana[a]	Parts of Linn, Johnson, Iowa, Benton	222.50	1:62,500	10
Ames	Parts of Hamilton, Story, Boone	221.65	1:62,500	10
Anamosa[b]	Parts of Linn, Jones	221.65	1:62,500	10
Baldwin[c]	Parts of Jackson, Clinton, Jones	221.65	1:62,500	10
Boone	Parts of Hamilton, Boone, Webster	221.65	1:62,500	10
Camp Dodge	Parts of Polk, Warren, Dallas	496.02	1:62,500	10
Canton (S. Dak.-Iowa)	Part of Lyon	870.90	1:125,000	10
Cedar Rapids[a]	Parts of Linn, Johnson	222.50	1:62,500	10
Chariton	Parts of Marion, Lucas, Warren	225.06	1:62,500	10
Clinton (Iowa-Ill.)[d]	Part of Clinton	222.50	1:62,500	10
Cordova (Iowa-Ill.)[d]	Parts of Clinton, Scott	891.73	1:125,000	10
Davenport (Iowa-Ill.)[e]	Part of Scott	223.36	1:62,500	10
Decorah	Parts of Allamakee, Clayton, Fayette, Winneshiek	870.90	1:125,000	10
Des Moines	Parts of Polk, Warren	223.33	1:62,500	10
Dewitt[e]	Parts of Clinton, Scott	222.50	1:62,500	10
Durant[e]	Parts of Scott, Muscatine, Cedar	223.36	1:62,500	10
Edgington (Ill.-Iowa)	Parts of Muscatine, Scott	224.21	1:62,500	10
Elk Point (S. Dak.-Neb. Iowa)	Parts of Sioux, Plymouth	877.91	1:125,000	10
Elkader (Iowa-Wis.)	Parts of Dubuque, Delaware, Clayton	877.91	1:125,000	10
Fairfax[a]	Parts of Linn, Johnson, Iowa, Benton	891.73	1:125,000	10
Farley[b]	Parts of Dubuque, Jones, Linn, Delaware	884.85	1:125,000	10

Name of Map	Counties in Iowa Included	Area in square miles	Scale	Price—cents
Fort Dodge	Parts of Humboldt, Webster	219.91	1:62,500	10
Fort Dodge Special	Part of Webster	220.35	1:62,500	10
Galena (Ill.-Iowa)	Part of Jackson	221.65	1:62,500	10
Goose Lake (Iowa-Ill.)[d]	Part of Clinton	222.50	1:62,500	10
Iowa City[a]	Parts of Johnson, Washington	223.36	1:62,500	10
Kahoka (Mo.-Iowa-Ill.)	Part of Lee	911.94	1:125,000	10
Knoxville	Part of Marion	224.21	1:62,500	10
Lancaster (Wis.-Iowa-Ill.)	Parts of Clayton, Dubuque	877.91	1:125,000	10
LeClaire (Iowa-Ill.)[d]	Parts of Clinton, Scott	223.36	1:62,500	10
Lehigh	Part of Webster	220.78	1:62,500	10
Madrid	Parts of Boone, Polk, Dallas	222.50	1:62,500	10
Maquoketa[c]	Parts of Jackson, Clinton	221.65	1:62,500	10
Marion[f]	Part of Linn	221.65	1:62,500	10
Mechanicsville[g]	Parts of Jones, Cedar, Johnson, Linn	222.50	1:62,500	10
Melcher	Parts of Marion, Monroe, Lucas	225.06	1:62,500	10
Milan (Ill.-Iowa)	Part of Scott	224.21	1:62,500	10
Milo	Parts of Marion, Warren, Polk	224.21	1:62,500	10
Monticello[b]	Part of Jones	221.65	1:62,500	10
Nebraska City (Neb.-Ia.-Mo.)	Part of Fremont	226.73	1:62,500	10
Oelwein	Parts of Clayton, Delaware, Buchanan, Fayette	877.91	1:125,000	10
Omaha and vicinity (Neb.-Iowa)	Parts of Pottawattamie, Mills	459.00	1:62,500	20
Oxford[a]	Parts of Johnson, Washington, Keokuk, Iowa	223.36	1:62,500	10
Pella	Parts of Mahaska, Marion	224.21	1:62,500	10
Peosta (Iowa-Ill.)[c]	Parts of Dubuque, Jackson, Clinton, Jones	884.85	1:125,000	10
Rock Island (Iowa-Ill.)[e]	Parts of Clinton, Scott, Muscatine, Cedar, Jones	891.73	1:125,000	10
Savanna (Iowa-Ill.)	Parts of Jackson, Clinton	221.65	1:62,500	10
Shellsburg[f]	Parts of Linn, Benton	221.65	1:62,500	10
Slater	Parts of Story, Polk, Boone	222.50	1:62,500	10
Stanwood[g]	Parts of Jones, Cedar, Muscatine, Johnson, Linn	891.73	1:125,000	10
Tipton[g]	Parts of Jones, Cedar	222.50	1:62,500	10
Waukee	Parts of Polk, Warren, Madison, Dallas	223.36	1:62,500	10
Waukon (Iowa-Wis.)	Parts of Allamakee, Clayton	870.90	1:125,000	10
West Liberty[g]	Parts of Cedar, Muscatine, Johnson	223.36	1:62,500	10
Wheatland[e]	Parts of Clinton, Scott, Cedar, Jones	222.50	1:62,500	10
Wilton Junction[g]	Parts of Cedar, Muscatine	223.36	1:62,500	10
Winthrop[f]	Parts of Delaware, Linn, Benton, Buchanan	884.85	1:125,000	10

LIST OF QUADRANGLES IN IOWA IN WHICH TOPOGRAPHIC MAPPING HAS BEEN WHOLLY OR PARTLY COMPLETED; MAPS NOT YET PUBLISHED

Name of Map	Counties in Iowa Included	Area in square miles	Scale	Price—cents
Albia	Parts of Mahaska, Marion, Monroe	225.06	1:62,500	10
Bondurant	Parts of Jasper, Marion, Polk, Warren	223.33	1:62,500	10
Coalfield	Parts of Mahaska, Monroe, Wapello	225.06	1:62,500	10
Newton	Parts of Jasper, Marion	223.33	1:62,500	10

Total area surveyed and published, 1926	12,420
Total area of state	56,147
Percentage of total area of state surveyed	22

Note 1.—The scale of 1:62,500 equals approximately one mile per inch. The scale of 1:125,000 equals approximately two miles per inch.

Note 2.—Fort Dodge Special map is composed of adjacent halves of Lehigh and Fort Dodge maps. Camp Dodge map is composed of Des Moines and parts of Waukee, Madrid and Slater maps.

Note 3.—Folios have been published by the United States Geological Survey describing the geology of Elk Point, Galena and Lancaster quadrangles.

Note 4.—The United States Geological Survey has published a map of Iowa, without contour lines, on a scale of 8 miles per inch. Size of map, 28½x41 inches. Price 25 cents.

a Amana, Cedar Rapids, Iowa City and Oxford sheets, on scale of 1:62,500, have been reduced and form Fairfax sheet, on scale of 1:125,000.

b Anamosa and Monticello sheets, on scale of 1:62,500, have been reduced and form parts of Farley sheet, on scale of 1:125,000.

c Baldwin and Maquoketa sheets, on scale of 1:62,500, have been reduced and form parts of Peosta sheet, on scale of 1:125,000.

d Clinton, Goose Lake and LeClaire sheets, on scale of 1:62,500, have been reduced and form parts of Cordova sheet, on scale of 1:125,000.

e Davenport, Dewitt, Durant and Wheatland sheets, on scale of 1:62,500, have been reduced and form Rock Island sheet, on scale of 1:125,000.

f Marion and Shellsburg sheets, on scale of 1:62,500, have been reduced and form parts of Winthrop sheet, on scale of 1:125,000.

g Mechanicsville, Tipton, West Liberty and Wilton Junction sheets, on scale of 1:62,500, have been reduced and form Stanwood sheet, on scale of 1:125,000.

A topographic map of Iowa.—The ultimate purpose of the mapping just described, of course, is to make possible an accurate contour map of the entire state. It is evident, however, from the slow progress thus far made, 22 per cent in forty years, that the realization of this purpose is yet a long way in the future. And yet if such a map will ever be serviceable it surely should be as useful now as a hundred and sixty years from now when, presumably, the state will be covered by topographic maps of the present scales. So it seems to be a worthy undertaking to make, with aid of the topographic maps already available and the railway profiles, which cross the state at intervals of a few miles, a preliminary map which will show the topography of Iowa in a general way. Such a map is presented as a part of this report. The contour lines, which show the elevations above sea level, are based, first on the published contour maps, so far as they cover the state, and second on the profiles of the railroad lines. A few lines are drawn from barometric data. There seems reason to believe, therefore, that the map represents a reasonable degree of accuracy and the hope may be expressed that it will prove to be of some value until one more correct in its details becomes possible.

Lowest and Highest Points in Iowa.—Probably no question is ever raised as to the lowest point in Iowa. It is the mouth of Des Moines river at Keokuk, about 477 feet above sea level. But there are several claimants for the highest point. Without discussing the relative merits of these localities it may be said that the highest points, so far as yet determined, are Ocheyedan Mound, near Ocheyedan, Osceola county, which is 1670 feet above sea level, and the prairies northeast of Sibley, which have about the same elevation. A hill near Hesper, Winneshiek county, 1360 feet, probably is the highest point in Iowa east of Pilot Knob, Hancock county, 1450 feet above sea level. The highest lakes are Rush lake, near Ocheyedan, 1550 feet; Iowa lake, near Rush lake, nearly 1600 feet; Silver lake, at Lake Park, 1460 feet; and Spirit, East and West Okoboji lakes, 1400 feet.

List of Elevations

Station	Elevation Feet	Authority
Abbott	1103,G1097	M&StL
Abbott Crossing, crossing CRI&P	1110,G1102	M&StL
Abbott Crossing	1104	CRI&P
Abbott Crossing, crossing M&StL	1104	CRI&P
Ackley	1090,G1092	IC
Ackley, crossing M&StL	1093,G1092	IC
Ackley	1101	M&StL
Ackley, crossing IC	1100	M&StL
Ackworth	863,G857	CB&Q
Ackworth, T. 76 N., R. 23 W., center of NE.¼ sec. 10, west side road, opposite T road to east, limestone rock 5 by 8 by 28 inches, set 27 inches in the ground; aluminum tablet stamped "931 Adj"	930.189	Bull. 569
Ackworth, 0.75 mile west of, at SE. angle forks of road, limestone rock 8 by 8 by 30 inches, set 29 inches in ground; aluminum tablet stamped "943 Adj"	941.264	Bull. 569
Acme	1207.8	CGW
Adair	1398,G1403	CRI&P
Adair	G1415	Weather Bur.
Adair, 2.5 miles west of, in NW. abutment of bridge, near telegraph pole 420-1; aluminum tablet	1,320.798	Bull. 569
Adair, 150 feet south of track, opposite point 375 feet east of station, 300 feet SW. of Davenport Elevator Co.'s elevator; iron post	1,399.355	Bull. 569
Adair, in front of CRI&PRy station; top of rail	1,404.2	Bull. 569
Adair, 3 miles east of, in SW. abutment of bridge 402; aluminum tablet	1,273.002	Bull. 569
Adams	624,G638	CRI&P
Adaza	1125,G1127	CM&StP
Adel	900,G894	CM&StP
Adel, in SE. cor. courthouse yard, 2 feet from either side of angle formed by sidewalks; iron post (Prim. Trav. Sta. No. 11)	891.391	Bull. 569
Adelphi	776	WRR
Adelphi, 4 miles north of, T. 79 N., R. 22 W., near south corner of secs. 32 and 33, 70 feet west and 15 feet south of T-road north, in top of south heading of concrete		

Station	Elevation feet	Authority
culvert under highway No. 2, Federal highway No. 63; chiseled square, marked "899.3"	899.26	USGS
Adelphi, 4 miles north, 1 mile east of, T. 79 N., R. 22 W., near south corner of secs. 33 and 34, 70 feet north and 25 feet west of T-road north, in root on SW. side of 3-foot elm tree; copper nail and washer, marked "847.7"	847.68	USGS
Adelphi, 4 miles north, 2 miles east of, T. 79 N., R. 22 W., near south corner of secs. 34 and 35, 50 feet north and 25 feet east of T-road north, in root on south side of 15-inch maple tree; copper nail and washer, marked "916.2"	916.17	USGS
Adelphi, 3 miles north of, T. 78 N., Rs. 22 and 23 W., near corner of secs. 1, 6, 7 and 12, 40 feet east and 30 feet south of crossroads, in root on SW. side of 16-inch burr oak tree; copper nail and washer, marked "824.8"	824.78	USGS
Adelphi, 2.75 miles north of, T. 78 N., R. 22 W., 0.25 mile west of center of sec. 7, 45 feet south and 25 feet west of T road south, in root on NE. side of 3-foot elm tree; copper nail and washer marked "836.2"	836.19	USGS
Adelphi, 1½ miles north of, T. 78 N., R. 22 W., 0.25 mile west of center of sec. 18, 35 feet south and 15 feet west of road corner, in root on east side of 14-inch elm tree; copper nail and washer, marked "877.1"	877.07	USGS
Adelphi, 1 mile north of, T. 78 N., R. 22 W., 0.25 mile west of quarter corner between secs. 18 and 19, 35 feet south and 35 feet east of T-road south, in root on north side of 1-foot maple tree; copper nail and washer, marked "839.0"	839.02	USGS
Adelphi, 0.7 mile NW. of, T. 78 N., R. 22 W., in NW. ¼ NW. ¼ sec. 30, 52 feet north and 17 feet west of road forks, 1 foot east of wire fence, in top of concrete post; bronze tablet marked "783.4"	783.43	USGS
Adelphi, reference mark, 20.8 feet south of B.M., 1 foot east of corner fence post; top of iron pipe driven in ground	782.73	USGS
Adelphi, T. 78 N., R. 22 W., in NE. ¼ sec. 30, 400 feet NW. of Wabash RR. station, in top of south heading of concrete culvert; chiseled square, marked "778.6"	778.62	USGS
Adelphi, 1700 feet southeast of, T. 78 N., R. 22 W., about 0.2 mile west of quarter corner between secs. 29 and 30, 35 feet east of road forks, top of SE. end of iron culvert; chiseled square, marked "789.5"	789.45	USGS
Adelphi, T. 78 N., R. 22 W., near center of NW. ¼ sec. 32, 30 feet south of road forks, in root on north side of 20-inch elm tree; copper nail and washer, marked "762.4"	762.39	USGS
Aetna	1076	CB&Q
Afton	1195,G1198	CB&Q
Afton	G1212	Weather Bur.
Afton Junction	1097	CB&Q
Afton Junction, crossing over CGW	1096.5,G1099	CB&Q
Afton Junction	1077.3	CGW
Afton Junction, Grand river at	1040	IaGS
Agency	798,G798	CB&Q
Ainsworth	690,G700	CRI&P
Akron	1151,G1147	CM&StP
Akron, 1.4 kilometers north of, 13 meters south of railway bridge, 6 meters south of road, 15 meters west of railway, 0.5 meter east of pasture fence, 1.6 meters below rails; copper bolt in top of stone post lettered "U. S. B. M." (U. S. C. & G. S. b. m. Q)	1,138.640	Bull. 569

STATION	ELEVATION FEET	AUTHORITY
Akron, in front doorsill (jasper) of Akron Savings Bank, 0.47 meter NW. of SE. side of doorway, 0.12 meter SW. of front edge, 0.45 meter above sidewalks; bottom of square hole (U.S.C. & G. S. b.m. R.)	1,146.283	Bull. 569
Akron, at NE. cor. Reed and Second sts. at north sidewalk line, 0.13 meter west of SW. cor. of building, north side of top edge of 1-inch galvanized-iron pipe set solidly in cement flush with sidewalk. (U. S. C. & G. S. b. m. city)	1,145.135	Bull. 569
Akron, 1.5 kilometers south of, 15 meters west of railway, 40 feet west of road along track, 6 meters north of road, 2 meters north and 0.5 meter east of SE. cor. cultivated field, 0.4 meter below rails; copper bolt in top of stone post lettered "U. S. B. M." (U. S. C. & G. S. b. m. S)	1,136.343	Bull. 569
Akron, 4 kilometers south of, 13 meters west of railway, 7 meters north of road, 1 meter east of fence, 0.3 meter above rails; iron pipe (U. S. C. & G. S. b. m. T)	1,134.841	Bull. 569
Akron, T. 92 N., R. 48 W., sec. 6, NW. cor.; iron post stamped "Ynktn 1140"	1,139.544	Bull. 569
Albany, sec. 14, T. 93 N., R. 8 W., 1,100 feet north of school building; iron post stamped "930 DBQ"	931.737	Bull. 569
Albert City	1322,G1325	CM&StP
Albia	957,G959	CB&Q
Albia	965	M&StL
Albia	960	WRR
Albia, junction with M&StL	958	WRR
Albia, crossing CB&Q	948	WRR
Albia, cross-over with M&StL	965	ISU
Albia, T. 72 N., R. 18 W., near center of NE. ¼ NE. ¼ sec. 26, 300 feet west of CB&Q RR crossing 150 feet west of crossroads, in NE. root of 30-inch white oak tree; copper nail and washer, painted "798.0"	797.94	USGS
Albia, CB&Q RR crossing at location given above, west rail	803.6	USGS
Albia, Cedar creek, center of floor of steel bridge over, NW. ¼ sec. 25	803.2	USGS
Albia, T. 72 N., R. 17 W., near center of NW. ¼ sec. 25, 75 feet west of T-road south at west end of gate, on south side of road, on south root of 10-inch oak tree; copper nail and washer, painted "812.5"	812.40	USGS
Albia, T-road south, painted "946.8"	946.7	USGS
Albia, T. 72 N., Rs. 17 and 18 W., just south of quarter corner between secs. 25 and 30, at SW. cor. crossroads, 6 inches NW. of corner fence post; 1-inch gas pipe projecting 2 inches, painted "959.8"	959.67	USGS
Albia, T. 72 N., R. 17 W., quarter corner between secs. 19 and 30, 250 feet west of T-road north, 60 feet SW. of house, 1 foot west of corner fence post, 1-inch gas pipe projecting 3 inches above ground, painted "930.2"	930.07	USGS
Albia, T. 72 N., R. 17 W., quarter corner between secs. 19 and 30, NE. cor. intersection at T-road north, 3 feet NE. corner fence post, in top of cement post projecting 8 inches; bronze tablet stamped "E.B. No. 3 1924 Iowa"	926.862	USGS
Albia, T. 72 N., R. 17 W., near south sixteenth corner between secs. 19 and 20, on SE. concrete wingwall of steel bridge, at base of center guard rail post; painted square	803.90	USGS
Albia, T. 72 N., R. 17 W., about 0.25 mile east of center of sec. 20, north side of road, on west end of cement culvert across drive leading in to residence of Ira Van Dalen; chiseled square, painted "922.6"	922.46	USGS

Station	Elevation feet	Authority
Albia, T. 72 N., R. 17 W., about 0.25 mile SW. center sec. 21, 250 feet east of T-road south, 1 foot east of corner fence post on north side of road: 1-inch gas pipe projecting 3 inches, painted ''942.7''	942.53	USGS
Albia, CB&Q RR crossing at above location, above grade of road, base of rail	891.8	USGS
Albia, on west end of third step of north entrance to Monroe county courthouse; bronze tablet stamped ''E.B. No. 4 1924 Iowa''	968.790	USGS
Albia, reference mark, 25 feet east of P.B.M., on east end of lowest step to north entrance to courthouse; chiseled square	967.75	USGS
Albia, about 1 block west of CB&Q RR depot at highway crossing railroad tracks; top of south rail of south switch	960.0	USGS
Albia, 1 mile NW. of, near center of sec. 16, T. 72 N., R. 17 W., 120 feet west of road crossing CB&Q RR tracks, on south side of road, in root on west side of a 2.5-foot tree at east end of row of maples; copper nail and washer, painted ''U.S.B.M. 959.1''	959.01	USGS
Albia, T. 71 N., R. 17 W., about 0.38 mile east of center of sec. 8, in NW. angle of crossroads, on north end of concrete culvert under road to west; chiseled square, painted ''U.S.B.M. 952.6''	952.52	USGS
Albia, at NE. cor. town, in N.W. angle of T-road north at jog, 1 foot south by 3 feet west of corner fence post, driven in ground; top of 0.75-inch gas pipe, painted ''U.S.B.M. 954.4''	954.34	USGS
Albia, road crossing M&SL RR near above location; top of west rail	937.2	USGS
Albion	937,G929	M&StL
Albion, Iowa river south of	894	M&StL
Alburnette	889,G891	IC
Alden	1116	C&NW
Alden	1169,G1168	IC
Alexander	1261,G1253	M&StL
Alger	831	CM&StP
Algona	1188,G1193	CM&StP
Algona, crossing under C&NW	1183	CM&StP
Algona	G1213	Weather Bur.
Algona	1204,G1209	C&NW
Algona, crossing over CM&StP	1210	C&NW
Algona	1200	M&StL
Alleman	1013	FtDDM&S
Alleman, T. 82 N., R. 24 W., cor. secs. 2, 3, 34, and 35	1,017	Bull. 569
Alleman, T. 81 N., R. 24 W., SW. cor. sec. 2; iron post stamped ''1010''	1,008.810	Bull. 569
Alleman, T. 81 N., R. 24 W., SE. cor. sec. 10; spike in telephone pole, marked ''U.S.B.M. 1009''	1,007.38	Bull. 569
Alleman, T. 81 N., R. 24 W., SE. cor. sec. 9; spike in telephone pole, marked ''U.S.B.M. 985''	983.97	Bull. 569
Alleman, T. 81 N., R. 24 W., NE. cor. sec. 21; iron post stamped ''1007''	1,005.593	Bull. 569
Alleman, T. 81 N., R. 24 W., NE. cor. sec. 28; spike in telephone pole, marked ''U.S.B.M. 989''	987.64	Bull. 569
Alleman, T. 81 N., R. 24 W., corner between secs. 35 and 36; spike in telephone pole, marked ''U.S.B.M. 943''	942.12	Bull. 569
Alleman, T. 81 N., R. 24 W., center of sec. 35, road south	946	Bull. 569
Allendorf	1598	CRI&P
Allerton	1092,G1103	CRI&P
Allison	1045.0,G1044	CGW
Almont	662,G661	C&NW

Station	Elevation feet	Authority
Almoral	974.8,G977	CGW
Alta	1514,G1509	IC
Alta	G1513	Weather Bur.
Alta Vista	1163.5	CGW
Alton, crossing CStPM&O, union station	1303,G1299	C&NW
Alton, union station with C&NW	1303.6	CSTPM&O
Altoona, T. 79 N., R. 23 W., 127 feet north and 74 feet west of crossroads at corner of secs. 1, 2, 11 and 12, in top of south side of concrete porch of schoolhouse; bronze tablet marked "965.9"	965.88	USGS
Altoona, reference mark, 38.5 feet south and 19.5 feet west of b. m., in top of SE. cor. concrete foundation for flag pole; chiseled square	962.97	USGS
Altoona, T. 79 N., Rs. 22 and 23 W., near corner of secs. 1, 6, 7 and 12, 30 feet south and 15 feet west of crossroads, in top of west heading of concrete culvert; chiseled square, marked "950.8"	950.80	USGS
Altoona, T. 79 N., Rs. 22 and 23 W., corner of secs. 7, 12, 13 and 18 at crossroads, 420 feet north and 20 feet west of, in root on south side of 20-inch maple tree; copper nail and washer, marked "957.6"	957.59	USGS
Altoona, CRI&P Ry, south track of main street crossing; top of south rail	956.7	USGS
Altoona, 0.47 mile south of, T. 79 N., Rs. 22 and 23 W., near corner of secs. 13, 18, 19 and 24, 54 feet south and 24 feet west of cross-roads, in top of concrete post; bronze tablet marked "952.3"	952.264	USGS
Altoona, reference mark, 43 feet east and 83 feet north of bench mark, in NE. angle of crossroads, top of east heading of culvert; chiseled square	953.97	USGS
Altoona, T. 79 N., R. 22 W., near corner of secs. 17, 18, 19 and 20, 30 feet south and 23 feet east of crossroads, in top of third step leading to school yard; chiseled square, marked "930.4"	930.43	USGS
Altoona, T. 79 N., R. 22 W., near corner of secs. 19, 20, 29 and 30, 26 feet east and 30 feet north of crossroads, in root on west side of 2-foot elm tree; copper nail and washer, marked "951.8"	951.76	USGS
Altoona, T. 79 N., R. 22 W., 0.25 mile north of corner of secs. 29, 30, 31 and 32, 20 feet south and 20 feet east of crossroads, in top of concrete foundation of corner fence post; chiseled square, marked "941.0"	940.97	USGS
Altoona, 2 miles east of Rising Sun, T. 78 N., Rs. 22 and 23 W., corner of secs. 1 and 6, 27 feet south and 30 feet east of T-road south, 100 feet north and 75 feet west of D. W. Darr's house, on concrete post; bronze tablet stamped "Prim. Trav. Sta. No. 27-L-S,-1924-Iowa-", marked "924.6"	924.583	USGS
Altoona, reference mark, 117 feet S. 10° E of "L.S. No. 27", top of southwest corner of well platform; chiseled square	925.50	USGS
Altoona, Keokuk line, B.M. top of monument M.P. 351	969.94	CRI&P
Altoona, B.M. top of monument M.P. 353	916.77	CRI&P
Altoona, top of rail, center of depot	956.7	CRI&P
Altoona, B.M. top of monument Ia. Div. M.P. 348	920.35	CRI&P
Altoona, B.M. top of monument M.P. 356	873.29	CRI&P
Altoona, B.M. top of monument M.P. 357	869.18	CRI&P
Altoona, B.M. top of monument M.P. 358	872.86	CRI&P
Altoona, B.M. top of monument M.P. 359	816.79	CRI&P
Altoona, main line	955,G958	CRI&P
Altoona	955	DM&CI
Alvord	1321	GN

Station	Elevation feet	Authority
Amana	716,G721	CM&StP
Amber	1009	C&NW
Amboy	964,G967	CRI&P
Ames, main line	917,G922	C&NW
Ames	G926	Weather Bur.
Ames	911	FtDDM&S
Ames, Campus station	912	FtDDM&S
Ames, T. 83 N., R. 23 W., NE. cor. sec. 8, SW. cor. crossroads, just inside of fence corner; copper nail in root on north side of box-elder tree, marked "973.8"	972.82	Bull. 569
Ames, 2 miles east of, T. 83 N., R. 23 W., NW. cor. NE. ¼ sec. 7, NW. cor. schoolhouse yard, SE. cor. road forks south; copper nail in root on west side of 2½-foot maple tree, marked "944.6"	943.62	Bull. 569
Ames, 1.5 miles east of, T. 83 N., R. 24 W., SE. cor. sec. 1, north-south township line between Grant and Washington townships, NW. cor. crossroads, at fence corner; iron post stamped "940"	939.336	Bull. 569
Ames, 1 mile east of, T. 83 N., R. 24 W., near north center of NW. ¼ sec. 12, SW. cor. steel highway bridge over Skunk river; painted bolthead on top of steel foundation pillar, marked "890.1"	889.13	Bull. 569
Ames, T. 83 N., R. 24 W., near SW. cor. sec. 1, NW. cor. small bridge just east of second-class road forks south; copper nail in top of piling, marked "889.7"	888.69	Bull. 569
Ames, C&NW Ry crossing on Duff Ave.; top of north rail of north main track, marked "917.8"	916.82	Bull. 569
Ames, SW ¼ sec. 2, T. 83 N., R. 24 W., SW. cor. intersection of Story and Kellogg St., NE. cor. post-office building, in ground; iron post stamped "922"	920.608	Bull. 569
Ames, T. 83 N., R. 24 W., just west of north center of sec. 10, SW. cor. concrete bridge at base of concrete railing at stream crossing; chiseled square, marked "899.9"	898.95	Bull. 569
Ames, T. 83 N., R. 24 W., corner of secs. 3, 4, 9, and 10, center of T road south, on top of star in cover of manhole of water system; marked "908.2"	907.22	Bull. 569
Ames, T. 83 N., R. 24 W., near SE. cor. sec. 4, on south side of street at T road north leading to College; 10 feet south of manhole; chiseled square on top of west end of concrete curbing, marked "937.65"	936.67	Bull. 569
Ames, at FtDDM&S electric line crossing highway just west of College station; top of south rail	913.2	Bull. 569
Ames, T. 83 N., R. 24 W., near center of sec. 4, center of Iowa State College campus, 250 feet south of flagpole, 550 feet west of west entrance to Agriculture Building, 300 feet NW. of Stanton Memorial Chimes tower; iron post stamped "952"	950.977	Bull. 569
Ames, Iowa State College, 8.5 feet east of SE. cor. Engineering Building, just inside of stone walk; brass plug cemented in tile (engineering students' bench-mark elevation brought north from near Kelly)	960.019	Bull. 569
Ames, T. 83 N., R. 24 W., near center of NW. ¼ sec. 4, NW. cor. concrete bridge over stream, top of base of concrete guard rail; chiseled square, marked "915.1"	914.11	Bull. 569
[Bench marks established by Iowa State College students.]		
Ames, Dairy Farm station, south side of east-west highway, square cut on NW. cor. west head wall of 14-inch vitrified pipe, 19 feet north of pole A183	975.28	Bull. 569
Ames, spike in track side of pole A177, 1.1 feet above ground	974.13	Bull. 569
Ames, square cut on NW. cor. west head wall of 2-foot vitrified pipe, 11 feet south of pole A173	967.45	Bull. 569

Station	Elevation feet	Authority
Ames, at SE. cor. Knapp St. and Welch Ave., on letters "St" of the word "St. Paul" on projecting base of cap of fire hydrant	963.60	Bull. 569
Ames, spike in track side of electric-light pole 9 feet south by 24 feet east of pole A156, north side of Knapp St., east of track	964.33	Bull. 569
Ames, spike in pole A145, on side away from the track, 4 feet above ground, east side of Ridge Ave.	946.54	Bull. 569
Ames, square cut on corner of the retaining wall on SE. cor. Boone and Ridge Sts., about 1.5 feet above sidewalk	945.34	Bull. 569
Ames, 1.7 feet west of east end of north railing of Boone St. concrete bridge, about 100 feet west of Welch St.	932.48	Bull. 569
Ames, brass plug in concrete marked "B.M.1," 38.5 feet west by 2.8 feet north of NW. cor. chemistry building, 18.4 feet east of 6-foot concrete walk running north-south in front of engineering laboratory, 45.2 feet SE. of SE. cor. engine room, 42.2 feet east by 4 feet south of NE. cor. engineering laboratory; at Iowa State College	955.99	Bull. 569
Ames, SE. cor. concrete platform of FtDDM&S RR station, 500 feet north of central building of Iowa State College	952.34	Bull. 569
Ames, top of track bolt cemented into north end of east back wall of C&NW Ry bridge 566A (railroad elevation 939.33)	936.87	Bull. 569
Ames, SW. cor. south coping of bridge 566; square cut (railroad elevation 929.09)	926.63	Bull. 569
Ames, top of track bolt cemented into north end of east back wall of bridge 565 (railroad elevation 926.99)	924.523	Bull. 569
Ames, b. m. 2, Iowa State College	913.44	Bull. 569
Ames, cross on concrete monument	944.56	Bull. 569
Anamosa	828,G829	CM&StP
Anamosa, crossing C&NW	832	CM&StP
Anamosa, crossing CM&StP	831	C&NW
Anamosa	825	C&NW
Anderson	958,G956	CB&Q
Anderson	966	IaGS
Andover	731	C&NW
Andover, Mo.	1094	CB&Q
Andrew, Jackson Co.	870	USGS
Andrew, middle Perry Tp.	870	USGS
Andrews Road station	853.41	DM&CI
Angus	1026,G1028	M&StL
Anita	1253,G1256	CRI&P
Anita, 3 miles west of, in north abutment of concrete culvert, 50 feet south of wagon road near telegraph pole 428-14; aluminum tablet	1,232.213	Bull. 569
Anita, 1 mile west of, in NE. cor. concrete culvert A2; aluminum tablet	1,243.318	Bull. 569
Anita, in front of CRI&P Ry station; top of rail	1,256.9	Bull. 569
Anita, 20 feet west of entrance to Keystone Park, 150 feet south of track, opposite point 300 feet west of station; iron post	1,252.360	Bull. 569
Anita, bed of Turkey creek at	1236	IaGS
Anita, NE. ¼ NW. ¼ sec. 4, T. 76 N., R. 33 W., base of Missouri limestone in Eureka shaft	1198	IaGS
Ankeny	998,G1001	C&NW
Ankeny	996	FtDDM&S
Ankeny, 2.5 miles east by 1 mile south of, T. 80 N., R. 23 W., SE. cor. sec. 19, 40 feet NW. of center crossroads; iron post stamped "938 Adj. 1903"	936.837	Bull. 569

Station	Elevation feet	Authority
Ankeny, Methodist Episcopal Church, in foundation stone facing east and 2 feet south of north main-entrance door; aluminum tablet stamped "997 Adj. 1903"	995.799	Bull. 569
Ankeny, 1 mile north by 1.5 miles west of, 100 feet west of SE. cor. of field, in SE. cor. sec. 9; iron post stamped "Prim. Trav. Sta. No. 4"	962.546	Bull. 569
Anthon	1120,G1119	IC
Appanoose, Mississippi river, low water	G502	Miss. Riv. Com.
Appanoose, Mississippi river, high water	G518	Miss. Riv. Com.
Aplington	967,G958	IC
Arbor Hill, Adair Co., W. line SE.¼ sec. 18, T. 76 N., R. 30 W.	1068	IaGS
Arbor Hill, SE. ¼ sec. 20, T. 76 N., R. 30 W.	1060	IaGS
Arbor Hill, SE.¼ sec. 21, T. 76 N., R. 30 W.	1038	IaGS
Arbor Hill, SE. ¼ sec. 27, T. 76 N., R. 30 W.	988	IaGS
Arbor Hill, SE. ¼ sec. 26, T. 76 N., R. 30 W.	943	IaGS
Arbor Hill, NE. ¼ sec. 36, T. 76 N., R. 30 W.	940	IaGS
Arcadia	1386,G1425	C&NW
Arcadia, divide 1 mile east	1402	C&NW
Arcadia, uplands just north of	1430	IaGS
Arcadia, uplands about 6 miles north of	1476	IaGS
Archer	1475,G1468	IC
Ardon	747,G749	CM&StP
Aredale	1023	C&NW
Argand, Jones Co., south line of sec., SE. ¼ SE. ¼ sec. 4, T. 86 N., R. 4 W., corner of yard at schoolhouse; iron post stamped "977"	967.778	Bull. 569
Argyle	669.4,G668	AT&SF
Argyle, 4 miles west, east end bridge over CRI&P, base of rail	566.0	AT&SF
Argyle, 4 miles west, east end bridge over Des Moines river	560.9	AT&SF
Argyle, 4 miles west, bottom Des Moines river	500.	AT&SF
Arion	1138	C&NW
Arion, crossing CM&StP	1138	C&NW
Arion	1143,G1140	IC
Arion, crossing CM&StP	1143,G1140	IC
Arion	1138	CM&StP
Arion, crossing C&NW and IC	1138	CM&StP
Arispe	1270.5,G1267	CGW
Arlington	1112,G1112	CM&StP
Arlington, NE. cor. sec. 28, T. 92 N., R. 7 W.; iron post stamped "1080 DBQ"	1,081.171	Bull. 569
Arlington, 4 miles south of, center Putnam Tp.	1113	IaGS
Armstrong	1249,G1237	CRI&P
Arnold	1132,G1135	M&StL
Arnolds Park	1429,G1432	CM&StP
Arsenal station, Camp Dodge, at pole 540	854.29	DM&CI
Arthur	1287,G1287	C&NW
Ascalon	904	CRI&P
Ascot, MP 501	996,G993	IC
Ascot, T. 76 N., R. 44 W., 352 feet S. 79° 55′ E. (mag.) from center of sec. 9, on south side of road, on land owned by Mr. Corby; copper bolt in tile surmounted by iron pipe (U.S.C.E. b. m. 124/2):		
Copper bolt	983.15	Bull. 569
Cap on pipe	987.24	
Ashawa	888,G883	M&StL
Ashawa, T. 78 N., R. 25 W., 40 feet NW. of NW. cor. sec. 8, in corner of school yard; iron post stamped "950"	948.675	Bull. 569
Ashton	1448.9,G1449	CStPM&O

Station	Elevation feet	Authority
Aspinwall	1380	CM&StP
Aspinwall, divide 2 miles west of	1428	CM&StP
Astor	1301,G1304	CM&StP
Atalissa	655,G658	CRI&P
Athelstan	1069.8,G1069	CGW
Atkins	838,G833	CM&StP
Atlantic	1155,G1158	CRI&P
Atlantic	G1164	Weather Bur.
Atlantic, in grass plat of CRI&P Ry station, 200 feet east of station, 20 feet west of standpipe, 30 feet south of main track; iron post	1,159.311	Bull. 569
Atlantic, on east side of south wing of county courthouse, 4 feet above ground; aluminum tablet	1,215.088	Bull. 569
Atlantic, 0.5 mile east of, in SW. abutment of bridge 440, 375 feet east of road crossing; aluminum tablet	1,154.720	Bull. 569
Atlantic, bed of river west of	1124	IaGS
Atlantic, bed of Turkey creek, SE. ¼ sec. 28, T. 76 N., R. 36 W.	1136	IaGS
Atlantic, Vista Place	1292	IaGS
Attica, Marion Co., 1.25 miles north of, Tps. 74 and 75 N., R. 19 W., 20 feet west by 10 feet north of corner of secs. 2, 3, 34, and 35, east of T road west; iron post stamped "Prim. Trav. Sta. No. 2, 1908, 908, Iowa"	906.387	Bull. 569
Attica, T. 75 N., R. 19 W., SE. cor. sec. 32, west and 50 feet south of center of crossroads, 2 feet east of fence; iron post stamped "824 Iowa"	823.044	Bull. 569
Attica, Tps. 74 and 75 N., R. 20 W., 20 feet south and 25 feet west of corner of sec. 1, 2, 35, and 36; iron post stamped "Prim. Trav. Sta. No. 1, 1908, 916, Iowa"	914.247	Bull. 569
Attica, one-fourth mile north of, at T road west, NW. angle of road junction, in root of 20-inch oak; nail	915.34	Bull. 569
Attica, at center of town, in NE. cor. crossroads; iron post stamped "Iowa 923, 1913"	922.823	Bull. 569
Attica, 1 mile south of, at Gullion Cemetery, at base of north gatepost, in concrete base; bottom of square cut	925.88	Bull. 569
Attica, 1.9 miles south of, at road forks, 50 feet NE. of mile board "Knoxville 12, Attica 2 miles," 250 feet west of Indiana Chapel, in top of osage stump at head of drain; copper nail	905.69	Bull. 569
Attica, T. 74 N., R. 19 W., at corner of secs. 22, 23, 26, and 27; top of section stone	901.02	Bull. 569
Attica, T. 74 N., R. 19 W., 0.25 mile south of NE. cor. sec. 27, at NW. angle T road north, 7.1 feet NW. of corner post, in field; iron post stamped "Iowa 868, 1913" Prim. Trav. Sta. 11, 1914	867.862	Bull. 569
Attica, T. 74 N., R. 19 W., near center of sec. 26, at highway (covered) bridge over North Cedar creek, in SW. cor. bridge floor; top of bolt painted white	746.29	Bull. 569
Attica, T. 74 N., R. 19 W., 0.25 mile south of center of sec. 35, on east side of north-south road, on line with east-west fence, 10 inches north of telephone pole, in hickory peg; copper nail	855.25	Bull. 569
Attica, T. 73 N., R. 19 W., at center of sec. 2, at T road north, 15 feet south by 15 feet east of center of road intersection, 110 feet S.W. of Eldorado Church; iron post stamped "Iowa 915, 1913" Prim. Trav. Sta. 10	914.797	Bull. 569
Attica, 4 miles south of, T. 73 N., R. 19 W., at corner of secs. 2, 3, 10, and 11, at T road north, in section stone; bottom of square	915.25	Bull. 569
Atwood	703,G717	CRI&P
Atwood, crossing C&NW	703,G717	CRI&P

Station	Elevation feet	Authority
Atwood, crossing CRI&P	711	C&NW
Atwood, North Skunk river at	695	IaGS
Auburn	1232,G1240	C&NW
Audubon	1322,G1297	C&NW
Audubon	1295,G1299	CRI&P
Audubon	G1301	Weather Bur.
Aurelia	1387,G1387	IC
Aurora	1134.5,G1135	CGW
Aurora, T. 90 N., R. 8 W., NE. cor. sec. 21, at side of wagon road; iron post stamped "1063 DBQ"	1,063.969	Bull. 569
Austin	1210,G1205	CM&StP
Austin, 1.2 kilometers south of, 1.6 kilometers south of railway bridge over Big Sioux River, 13 meters west of railway, 6 meters north of road, 1 meter west of fence, 0.8 meter below rails; copper bolt in top of stone post lettered "U.S.B.M." (U.S.C.&G.S.b.m.E.)	1,200.313	Bull. 569
Austinville	1003,G1006	IC
Avery	894.14,G903	CB&Q
Avery, T. 72 N., R. 17 W., at SE. cor. SW. ¼ SW. ¼ sec. 1, 4 feet north by 1 foot east of fence corner, in top of concrete post; bronze tablet stamped "E.B. No. 10 1924 Iowa", painted "U.S.B.M. 917.7"	917.523	USGS
Avery, reference mark, 21 feet west by 5 feet south of tablet, in root on east side of 6-inch box-elder tree; copper nail and washer	918.32	USGS
Avoca	1134,G1137	CRI&P
Avoca, 3 miles NW. of, in SE. wing wall of stone culvert, third step from top; aluminum tablet	1,192.860	Bull. 569
Avoca, in stone water table of Avoca bank, on south side, 10 feet from SW. cor.; aluminum tablet	1,158.769	Bull. 569
Avoca, near SW. cor. Avoca Hotel, between building and sidewalk; iron post	1,155.38	Bull. 569
Avoca, near SW. cor. city hall lot, town bench mark, a 6-inch iron pipe open at top and filled with concrete, in which is embedded a ¾-inch brass pipe	1,165.147	Bull. 569
Avoca, 2 miles east of, in NW. abutment of bridge 459; aluminum tablet	1,171.039	Bull. 569
Avon	780,G783	CRI&P
Ayrshire	1315,G1293	M&StL
Babcock, south end switch	1001	IC
Badger	1154,G1156	M&StL
Badger, 5.5 miles west of, T. 90 N., R. 29 W., quarter corner, S. side of sec. 10, 40 ft. N. of section line crossing road, on east side of road, in base of telephone pole, marked "1,127.2"; spike	1,127.07	USGS
Badger, T. 90 N., R. 29 W., center of sec. 10, 20 feet NE. of crossroads; iron post stamped "IOWA 1919 Prim. Trav. Sta. No. 9 1,134"	1,133.441	USGS
Badger, T. 90 N., R. 29 W., 0.25 mile west of center of sec. 11, at second class road N., 50 ft. NE. of road fork, in base of telephone pole, marked "1,127.2"; spike	1,127.09	USGS
Badger, T. 90 N., R. 29 W., quarter corner, E. side of sec. 11, at T road W., 40 ft. SE. of road fork, in base of telephone pole, marked "1,120.8"; spike	1,120.64	USGS
Badger, 4 miles west of, T. 90 N., R. 29 W., corner of secs. 11, 12, 13 and 14, 50 ft. SE. of crossroads, in base of corner fence post, marked "1,112.2"; spike	1,112.05	USGS
Badger, bridge floor over Des Moines river, 3.33 miles W. of Badger	1,043.74	USGS
Badger, T. 90 N., R. 28 W., quarter corner, N. side of		

Station	Elevation feet	Authority
sec. 18, at T road S., 50 ft. SE. of road fork, in base of telephone pole, marked "1,131.6"; spike	1,131.43	USGS
Badger, T. 90 N., R. 28 W., corner of secs. 7, 8, 17 and 18, T road north, 35 ft. NW. of road fork; iron post stamped "IOWA 1919 1,136"	1,136.183	USGS
Badger, T. 90 N., R. 28 W., quarter corner, S. side of sec. 8, T road S., 60 ft. NE. of road fork, in base of telephone pole marked "1,131.6"; spike	1,131.45	USGS
Badger, T. 90 N., R. 28 W., corner of secs. 8, 9, 16 and 17, crossroads, 375 ft. E. of road fork, at base of bridge floor and at extreme NW. corner of steel bridge over Badger creek; top of bolt in steel girder, marked "1,117.8"	1,117.62	USGS
Badger, T. 90 N., R. 28 W., corner of secs. 9, 10, 15 and 16, 100 ft. E. of road leading N. at road leading S., 300 ft. W. of railway crossing, 30 ft. SW. of road fork, in base of telephone pole, marked "1,143.4"; spike	1,143.30	USGS
Badger, 1 mile east of, T. 90 N., R. 28 W., corner of secs. 10, 11, 14 and 15, 35 ft. SW. of crossroads, iron post stamped "Prim. Trav. Sta. No. 14 1,132 IOWA 1919"	1,131.608	USGS
Badger, T. 90 N., R. 28 W., corner of secs. 11, 12, 13 and 14, 40 ft. NE. of crossroads, in base of corner fence post, marked "1,151.8"; spike	1,151.64	USGS
Badger, T. 90 N., Rs. 27 and 28 W., corner of secs. 7, 12, 13 and 18, 35 ft. NW. of crossroads, in fence corner, in root of large willow tree, marked "1,131.7"; copper bolt	1,131.54	USGS
Badger, T. 90 N., R. 27 W., corner of secs. 7, 8, 17 and 18, 30 ft. NW. of crossroads, in top of concrete culvert, marked "1,125.7"; chiseled square	1,125.50	USGS
Badger, T. 90 N., R. 28 W., quarter corner, N. side of sec. 29, at T road E., 75 ft. N. of road fork, E. side, N. end and top of concrete culvert railing over Badger creek; chiseled square, marked "1,088.3"	1,088.18	USGS
Badger, T. 90 N., R. 28 W., quarter corner, N. side of sec. 20, 40 ft. SW. of crossroads, in base of corner fence post, marked "1,131.7"; spike	1,131.62	USGS
Bagley, Clayton Co., 1 mile below, on right of way of CM&StP Ry, 500 meters above milepost 76-85, opposite upper end of small curve which is second one above a perpendicular rock cut, and curves toward bluffs, 37 meters above Government light, 3 meters from center of track toward bluffs, rock is 0.6 meter higher than track and is marked "U.S." in large letters on side facing track; copper bolt in rock (U.S.C.E.b.m. 193/3)	630.90	Bull. 569
Bagley, Guthrie Co	1098,G1100	CM&StP
Bailey	1284.8,G1283	CGW
Baird, MP 470	1076,G1070	IC
Baldwin	714,G712	C&NW
Balfour	1146.8,G1148	CB&Q
Ballinger, MP 184	530	CB&Q
Balltown, Dubuque Co., T. 90 N., R. 1 E., south side sec. 4, in ledge of rock; bronze tablet stamped "1049 DBQ"	1,049.855	Bull. 569
Bancroft	1174,G1189	C&NW
Bankston, Dubuque Co., 0.8 mile south of, T. 89 N., R. 1 W., NE. ¼ sec. 16, SW. cor. O'Connor's orchard; iron post stamped "1193 DBQ"	1,194.293	Bull.. 569
Bard	593,G599	CRI&P
Barnes City	901,G910	CRI&P
Barney	1051.7,G1047	CGW
Barney, Clanton creek west of	1066	IaGS
Barnum	1177,G1174	IC

Station	Elevation feet	Authority
Bartlett	954,G951	CB&Q
Bartlett, T. 70 N., R. 43 W., 45 feet east of NW. cor. NE. ¼ of sec. 17, on east side of north-south road; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 115/2)		
Copper bolt	939.57	Bull. 569
Cap on pipe	943.64	
Bartlett, T. 71 N., R. 43 W., not far from center of NE. ¼ NE.¼ sec. 30, on west side of road running along an old river bank; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 116/2):		
Copper bolt	944.99	Bull. 569
Cap on pipe (approximate)	948.98	
Bartlett, 6,522 feet south of station, 1,214 feet south of L. M. Gannon's house, 82 feet east of center of public road, 45 feet west of railroad; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 332):		
Copper bolt	938.289	Bull. 569
Cap on pipe	942.305	
Bartlett, 6,486 feet north of station, 46 feet east of tracks; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 333):		
Copper bolt	941.553	Bull. 569
Cap on pipe	945.572	
Bartlett, bluffs east of	1190	IaGS
Bassett	1026,G1029	CM&StP
Batavia	729,G731	CB&Q
Batavia, junction with old main line CB&Q	706	CB&Q
Battle Creek	1196,G1195	C&NW
Baxter, Jasper Co.	1004,G1000	CGW
Baxter, MP 199, Lee Co	531	CB&Q
Bayard	1133,G1134	CM&StP
Bayfield	682,G684	CRI&P
Beacon	761,G752	M&StL
Beacon, subgrade of track opposite center of depot	723.2,G735	CRI&P
Beacon, B.M. top of SE. cor. north pedestal of west pier of CB&Q RR bridge	734.70	CRI&P
Beaconsfield	1212,G1209	CB&Q
Beals, M.P. 408	1200,G1202	IC
Beaman	983,G984	C&NW
Bear Creek	690	CM&StP
Beaver	1024,G1027	C&NW
Beaver Avenue station	808.03	DM&CI
Beaver Park station on electric railroad, at crossing; top of rail	909.86	Bull. 569
Beaver Park	911.54	DM&CI
Beaver Valley Junction, Des Moines	808.57	DM&CI
Beck	560,G559	CB&Q
Beck, crossing under Santa Fe	556,G559	CB&Q
Beckwith	777,G777	CB&Q
Bedford	1099.59,G1098	CB&Q
Bedford, state line	1054	CB&Q
Beech	878	CRI&P
Belfast, 1 mile south of, B.M. top of monument M.P. 19 (U.S.C.E.b.m. 5)	532.10	CRI&P
Belfast, 100 feet east of, B.M. top of monument M.P. 20 (U.S.C.E.b.m. 6)	526.79	CRI&P
Belfast, top of rail, center of depot	527.0	CRI&P
Belfast, 1 mile NW. of, B.M. top of monument M.P. 21 (U.S.C.E.b.m. 7)	530.57	CRI&P

STATION	ELEVATION FEET	AUTHORITY
Belfast, 2 miles NW. of, B.M. top of monument M.P. 22 (U.S.C.E.b.m. 8)	549.35	CRI&P
Belfast, 3 miles NW. of, B.M. top of monument M.P. 23 (U.S.C.E.b.m. 9)	558.43	CRI&P
Belfast, see also Hinsdale		
Belinda, Lucas Co., T. 73 N., R. 20 W., 0.25 mile north of quarter corner on west side of sec. 20, in NE. angle crossroads, in SW. cor. school yard; iron post stamped "Iowa 1,000, 1913"	1,000.408	Bull. 569
Belinda, T. 73 N., R. 20 W., 0.25 mile south of the NW. cor. sec. 17, opposite T road west, 25 feet east of section corner, 1.5 feet north of telephone pole, in top of wooden peg; copper nail	991.11	Bull. 569
Belinda, 0.5 mile NE. of, at NW. cor. crossroads, at SE. cor. churchyard; iron post stamped "Iowa, 982, 1913"	982.198	Bull. 569
Belinda, 0.5 mile north by 0.5 mile west of, opposite center of T road north, 6 feet west of gate, in root of twin-maple tree; copper nail	986.00	Bull. 569
Belinda, T. 73 N., R. 20 W., 0.25 mile east of quarter corner on north side of sec. 6, at county line between Marion and Lucas counties, in SW. angle T road west, 1 foot SE. of corner post, in top of wooden peg; copper nail	973.66	Bull. 569
Belinda, T. 73 N., R. 20 W., at quarter corner on north side of sec. 19, in SW. angle of T road west, 1.5 feet west of corner post, in top of wooden peg; copper nail	999.66	Bull. 569
Belinda, T. 73 N., R. 21 W., just west of quarter corner on south side of sec. 13, at NE. cor. wooden bridge over English creek, in plank; copper nail	892.13	Bull. 569
Belknap	859,G847	CRI&P
Belknap, crossing Wabash	859,G847	CRI&P
Belknap	868	WRR
Belknap, crossing CRI&P	868	WRR
Belknap	G877	Weather Bur.
Bell	1155,G1158	CM&StP
Belle Plaine	821,G824	C&NW
Belle Plaine	G828	Weather Bur.
Bellevue	617,G617	CM&StP
Bellevue, junction with Cascade line	616	CM&StP
Bellevue, Mississippi river, low water	G578	Miss. Riv. Com.
Bellevue, Mississippi river, high water	G598	Miss. Riv. Com.
Bellevue, B.M. at head of slough	G622	Miss. Riv. Com.
Bellevue, North	631,G631	CM&StP
Bellevue, Golden's wood yard, 0.3 mile below log house at, opposite Island 253, 56 feet from top of bank, 2 feet below fence on lower side of clearing and upper side of woods, which runs at about right angles to river bank, 8 feet from 10-inch ash tree, blazed facing bench; copper bolt set in tile surmounted by iron pipe (U.S.C.E.p.b.m. 315):		
Copper bolt	587.722	Bull. 569
Cap on pipe	591.685	
Bellevue, 5.5 miles below, at third tree from river of same row of trees where t. b. m. 333 is located, on south side of slough at foot of Island 250, 88 feet from NW. cor. Mr. Golden's log house; copper bolt set in tile and surmounted by iron pipe (U.S.C.E.p.b.m. 313):		
Copper bolt	589.002	Bull. 569
Cap on pipe	592.972	
Bellevue, 3.5 miles below, on line of CM&StP Ry, 705 feet below stone culvert on which t. b. m. 331 is located, 177 feet below lower side of C. A. Harrington's stone barn,		

Station	Elevation feet	Authority
40 feet above wooden drain under track, at lower end of small cut, 33 feet east from center of track, 1.5 feet west of east right-of-way fence; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 311):		
Copper bolt	595.636	Bull. 569
Cap on pipe	599.628	
Bellevue, 3.5 miles below, on line of CM&StP Ry track, 250 feet above C. A. Harrington's house, on SW. cor. stone culvert, 3 feet above south side and 3 inches back from west end, marked "U□S"; highest point in square (U.S.C.E.p.b.m. 331)	600.412	Bull. 569
Bellevue, 2.5 miles below, 0.2 mile below bridge 42K, 0.3 mile below milepost 142-19, on line of CM&StP Ry, 279 feet above sluiceway under track, 12 feet west of center of track, on west side of ditch, on natural outcropping of ledge of rock, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 329)	605.721	Bull. 569
Bellevue, 2 miles below, 558 feet above center of CM&StP Ry bridge 42K over Duck creek, 148 feet above milepost 142-19, at upper side of highway crossing, at south side of fence running to cattle guard, 20 feet east of center of track; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 309):		
Copper bolt	605.166	Bull. 569
Cap on pipe	609.146	
Bellevue, in lower end of, on river bank, in first building above sawmill, a two-story stone store, owned by M. G. Heiler, at its west front, second door from north end, marked "U□S"; copper bolt (U.S.C.E.p.b.m. 308)	610.858	Bull. 569
Bellevue, in south end of, on line of CM&StP Ry, on bridge 44K over Mill creek, between flour mill and sawmill, on north pier at its east end, marked "U□S"; highest point in square (U.S.C.E.p.b.m. 326)	608.355	Bull. 569
Bellevue, at river shore, on Kilburn & Co.'s warehouse, on projecting stone at east end of south wall, just below iron-bolt plate; highest point in circle cut in stone (U. S.C.E. old U.S. b.m.)	597.033	Bull. 569
Bellevue, on southeast corner of Court and Second Sts., on front of stone store owned by John Baumann, on lower end of water table, 2½ feet above south corner; copper bolt marked "U.S.⊙P.B.M." (U.S.C.E.p.b.m. 307)	619.297	Bull. 569
Bellevue, in upper part of, on west line of Front St. in NE. cor. lot owned by Mrs. Booth, 2 feet south from north side of lot and south side of street; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 305):		
Copper bolt	618.900	Bull. 569
Cap on pipe	622.899	
Bellevue, North, 1 mile above, 40 feet back from high-water line on river bank, 45 feet north of bank of creek which is crossed by CM&StP Ry bridge 48K where p.b.m. 302 is located, about 984 feet from said railroad, 410 feet below large stone arch culvert under wagon road, 36 feet south from another wagon road winding around south point of bluff; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m 303 and 304):		
Copper bolt	591.761	Bull. 569
Cap on pipe	595.734	
Bellevue, North, 1 mile above, on line of CM&StP Ry, 1,279 feet below milepost 138-23, in north abutment, east end of bridge 48K, on third course of stone from		

STATION	ELEVATION FEET	AUTHORITY
top; copper bolt marked "U.S.⨀P.B.M." (U.S.C.E. p.b.m. 302)	626.521	Bull. 569
Bellevue slough, behind, 262 feet from low-water edge, 1.2 miles below Smiths, 3 miles above North Bellevue, 1,900 feet above bridge 50K, 150 feet below stone culvert on right of way at east fence, but a few feet below t.b.m. 323; copper bolt in tile surmounted by iron pipe (U.S. C.E.p.b.m. 300 and 301):		
Copper bolt	606.203	Bull. 569
Cap on pipe	610.176	
Bellevue, 6 miles below, 50 meters from shore, in wagon road along river, 0.5 meter from east fence and 6 meters south of south fence along east-west wagon road, 100 meters below Mr. Degear's house; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 171/2):		
Copper bolt	616.01	Bull. 569
Cap on pipe	620.02	
Bellevue, Island 253, 0.25 mile above small island and opposite point just below, on sandy ridge in maple timber 20 meters NE. of slough 40 meters wide, 15 meters from river bank; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 171/3):		
Copper bolt	587.76	Bull. 569
Cap on pipe	591.76	
Bellevue, 6 miles below, 480 meters from river, 32 meters west of slough and 25 meters east of another slough, on narrow neck of land between two sloughs; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 171/4):		
Copper bolt	583.96	Bull. 569
Cap on pipe	587.96	
Bellevue, 0.25 mile below head of Island 249, in timber 15 meters west of large slough, 595.7 meters back of following-described bench mark; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 172/1):		
Copper bolt	583.08	Bull. 569
Cap on pipe	587.10	
Bellevue, 0.25 mile below point opposite head of Island 249, 40 meters from bank of slough, in bunch of elms; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 172/2):		
Copper bolt	586.00	Bull. 569
Cap on pipe	590.03	
Bellevue, bridge 40K, 55 meters above, 1 meter west of west right of way fence of CM&StP Ry, 60 meters above wagon bridge which is at foot of bluffs where wagon road turns from river and appears to go up bluffs; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 172/3):		
Copper bolt	604.80	Bull. 569
Cap on pipe	608.88	
Bellevue, upper end of, on east line of north and south alley running between Front and Second Sts., inside of fence on property of Mose Bean (Mr. Bean's house is a large yellow frame building facing Front St. and one block south of Harmony Park); copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 173/3):		
Copper bolt	626.34	Bull. 569
Cap on pipe	630.36	
Bellevue, 3 miles above, 863.5 meters back of following-described bench mark, 15 meters from bank and at intersection of slough with Yonkers Lake, at large bend in		

Station	Elevation feet	Authority
slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 174/1):		
Copper bolt	587.93	Bull. 569
Cap on pipe	591.95	
Bellevue, 0.25 mile above foot of Island 243, 30 meters from shore, in timber, 300 meters from head of Crooked slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 174/2):		
Copper bolt	588.79	Bull. 569
Cap on pipe	592.79	
Bellevue, 0.5 mile above foot of Island 243, 0.5 meter west of west right of way fence of CM&StP Ry, on property belonging to Mr. Efferding, on top of 25-foot railroad cut; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 174/3):		
Copper bolt	637.98	Bull. 569
Cap on pipe	642.02	
Bellevue, 3 miles above, 0.25 meter north of east-west wire fence, on very high ridge, 0.8 mile from river, a rocky point stands about 0.25 mile north of bench mark on property of John Weinert, 20 meters west of a gate, 100 meters west of jog in wire fence; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 174/4):		
Copper bolt	746.96	Bull. 569
Cap on pipe	750.99	
Belmond	1190,G1181	M&StL
Belmond, crossing CRI&P	1190,G1181	M&StL
Belmond, crossing CGW	1184,G1178	M&StL
Belmond	1191,G1184	CRI&P
Belmond, crossing CGW	1194	CRI&P
Belmond, crossing M&StL	1186	CRI&P
Belmond	1181.4,G1180	CGW
Belmond, crossing M&StL	1177.1	CGW
Beloit	1253,G1242	CM&StP
Beloit, 420 meters north of station, 13 meters west of track, 4 meters south of private road to orphan asylum, 1 meter east and 2 meters south of NE. cor. garden plot owned by J. Widdy, 1 meter below rails; copper bolt in top of stone post lettered "U.S.B.M." (U.S.C.&G.S.b.m. A)	1,244.177	Bull. 569
Beloit, 170 meters south of station, 31 meters east of track, 14 meters south of roadway, on a jasper rock, in garden plot, 2 meters south and 1 meter east of NW. cor., 0.4 meter below rails; bottom of square hole (U.S.C.&G.S. b.m. B)	1,246.911	Bull. 569
Beloit, 3 kilometers south of, 13 meters west of railway track, 4 meters north of private road, 110 meters north of trestle over ravine, 1 meter east of fence, 0.3 meter below rails; copper bolt in top of stone post lettered "U.S.B.M." (U.S.C.&G.S.b.m. C)	1,236.435	Bull. 569
Ben Clare, S. Dakota	1494	IC
Bennett	741,G742	CRI&P
Bennington, top of rim of upstream edge of iron casing tube of second pier from north end of highway bridge near Morgan Valley on Wabash RR (U.S.C.E.b.m. 59)	752.28	USGS
Bennington, T. 78 N., R. 21 W., at corner of secs. 26, 27, 34 and 35, 80 feet north and 20 feet east of T-road west, in root on west side of 18-inch elm tree; copper nail and washer, marked "791.8"	791.92	USGS
Bennington, T. 78 N., R. 21 W., at corner of secs. 27, 28, 33 and 34, 30 feet south and 25 feet west of T-road		

Station	Elevation feet	Authority
south, in root on south side of 30-inch elm tree; copper nail and washer, marked "827.1"	827.18	USGS
Bennington, Tps. 77 and 78 N., R. 21 W., at corner of secs. 3, 4, 33 and 34, 35 feet south and 20 feet east of crossroads, in root on north side of 30-inch boxelder tree; copper nail and washer, marked erroneously "888.3"	885.34	USGS
Bennington, T. 77 N., R. 21 W., at corner of secs. 3, 4, 9 and 10, 30 feet north and 20 feet west of T-road east, in root on NE. side of 16-inch elm tree; copper nail and washer, marked "791.6"	791.72	USGS
Bennington, 1.5 miles west of Percy, in south part of W. C. Wilson's yard, 1 foot north of Wabash RR. fence at road crossing south to wagon bridge over Des Moines river, in top of concrete post; bronze tablet stamped "Prim. Trav. Sta. No. 24-L.S.-1904 reset 1924-Ia." (B569. Elev. and descrip. obsolete)	772.989	USGS
Bennington, reference mark, 135 feet S. 20° E. of, at west side of north end of river bridge; top of retaining wall; chiseled square	753.66	USGS
Benson	894,G904	IC
Bentley	1261.1,G1266	CGW
Benton	1058.8,G1059	CGW
Bentonsport, B.M. top of monument M.P. 38 (U.S.C.E. b.m. 22)	568.72	CRI&P
Bentonsport, B.M. top of monument M.P. 39 (U.S.C.E. b.m. 23)	574.51	CRI&P
Bentonsport, top of rail, center of depot; (U.S.C.E. b.m. 24)	574.59	CRI&P
Bentonsport, B.M. top of monument M.P. 40 (U.S.C.E. b.m. 25)	569.65	CRI&P
Bentonsport, B.M. top of monument M.P. 41 (U.S.C.E. b.m. 26)	577.61	CRI&P
Bentonsport, B.M. top of monument M.P. 42 (U.S.C.E. b.m. 27)	584.84	CRI&P
Bentonsport, B.M. top of monument M.P. 43 (U.S.C.E. b.m. 28)	578.22	CRI&P
Bentonsport, top of upstream end of first pier from north end of highway bridge (U.S.C.E.b.m 92)	569.88	Bull. 569
Bentonsville	1086	CB&Q
Berkeley	994,G995	M&StL
Berlin, changed to Lincoln		
Bernard	920,G911	CM&StP
Berne	1213	C&NW
Bernhart	735,G737	CB&Q
Bertram	717,G716	C&NW
Bertram, top of rail on east line of sec. 29, Tp. 83, R. 6, 90 feet south of NE. cor. NE. ¼ SE. ¼ sec. 29	772.81	CR&IC
Bertram, top of rail on south line sec. 28, Tp. 83, R. 6, 600 feet west of SE. cor. sec. 28	792.11	CR&IC
Bertram, top of rail on east line sec. 34, Tp. 83, R. 6, 650 feet north of SE. cor. sec. 34	741.31	CR&IC
Berwick	851.9,G846	CGW
Berwick, 200 feet north of station, east of road, 20 feet north of elm; iron post stamped "841 Adj. 1903"	839.931	Bull. 569
Berwick, 1.6 miles north of, 150 feet SW. of brick house, 100 feet NE. of fork of road; iron post stamped "942 Adj. 1903"	940.889	Bull. 569
Berwick, T. 79 N., R. 23 W., about 0.2 mile west of corner of secs. 4, 5, 8 and 9, 140 feet east and 20 feet south of T-road south, in root on NE. side of 30-inch forked elm tree; copper nail and washer, marked "858.4"	858.35	USGS

Station	Elevation feet	Authority
Berwick, CGW RR at road crossing between secs. 4 and 9, T. 79 N., R. 23 W.; top of rail	898.8	USGS
Berwick, T. 79 N., R. 23 W., near corner of secs. 3, 4, 9 and 10, 150 feet east and 10 feet south of crossroads, near Hammer schoolhouse, on top of south heading of concrete culvert; chiseled square, marked "920.0"	920.04	USGS
Berwick, T. 79 N., R. 23 W., near corner of secs. 2, 3, 10 and 11, 35 feet east and 20 feet south of crossroads, 13 feet east and 4 feet south of fence corner, in root on SW. side of 16-inch walnut tree; copper nail and washer, marked "960.3"	960.35	USGS
Bethany Junction	1104,G1106	CB&Q
Bettendorf	575	CM&StP
Bettendorf	572.00	CD&M
Bettendorf, DRI&NW station	572.5	CB&Q
Bettendorf, Union Station	G565	DRI&NW
Bettendorf, crossing CM&StP	G568	DRI&NW
Beverly	736	C&NW
Beverly, crossing CM&StP	737	C&NW
Beverly, crossing C&NW	736,G738	CM&StP
Bevington	840,G847	CRI&P
Bevington, Middle river at	833	IaGS
Beulah	938,G943	CM&StP
Bidwell	718,G720	CM&StP
Big Mound, Lee Co.	748	IaGS
Big Rock	710,G696	CM&StP
Bigelow, Minn.	1637.3	CStPM&O
Bingham	1073	WRR
Birmingham	751	CB&Q
Blairsburg	1229,G1224	IC
Blairstown	838,G839	C&NW
Blakesburg	908,G912	CM&StP
Blanchard	985	WRR
Blanden	1234,G1232	CRI&P
Blencoe	1042,G1043	C&NW
Blencoe, T. 82 N., R. 45 W., at NW. cor. NE. ¼ SE. ¼ sec. 7, in SE. angle formed by crossroads, on land owned by Thorley heirs, 1.5 miles from river bank; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 133/3):		
Copper bolt	1,038.19	Bull. 569
Cap on pipe	1,042.26	
Blencoe, 4.5 miles south of, 165 feet south by 92 feet east of p.b.m. 372, 1,345 feet south of milepost 28, 46 feet east of tracks; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 371):		
Copper bolt	1,031.133	Bull. 569
Cap on pipe	1,035.136	
Blencoe, 4.5 miles south of, 1,148 feet south of milepost 28, 46 feet west of tracks; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m 372 equals 132/4): Cap on pipe	1,031.930	Bull. 569
Blencoe, 1.8 miles south of, 1,483 feet north of milepost 30, 1,305 feet south of railway bridge 25, 46 feet east of tracks; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 373):		
Copper bolt	1,034.132	Bull. 569
Cap on pipe	1,038.134	
Blencoe, 623 feet north of station, 525 feet west of tracks, 25 feet north by 58 feet east of NE. cor. Isaac Fleener's house; copper bolt in bench-mark stone surmounted by		

Station	Elevation feet	Authority
iron pipe (U.S.C.E.p.b.m. 374 equals 133/4):		
Copper bolt	1,037.229	Bull. 569
Cap on pipe	1,041.218	
Blencoe, copper bolt in stone north of C&NW station	G1038	Mo. Riv. Com.
Blockley	958	CB&Q
Blockton	1080.1,G1081	CGW
Bloomfield	844,G832	CB&Q
Bloomfield, junction with Wabash	881	CB&Q
Bloomfield	857,G845	WRR
Bloomfield, junction with CB&Q	881	WRR
Bloomington, Story Co	1041	IAGS
Blue Grass	796	CRI&P
Blue Grass	803.87	CD&M
Bluffton, Winneshiek Co., T. 99 N., R. 9 W., SE. cor. sec. 16, in NE. cor. school yard; iron post stamped "1139 DBQ"	1,139.16	Bull. 569
Bode	1155,G1150	CRI&P
Bolan	1228.7,G1222	CGW
Bonair	1309,G1308	CM&StP
Bonaparte, B.M. top of monument M.P. 34 (U.S.C.E. b.m. 18)	561.88	CRI&P
Bonaparte, B.M. top of monument M.P. 35 (U.S.C.E. b.m. 19)	560.71	CRI&P
Bonaparte, top of rail, center of depot (U.S.C.E.b.m. 20)	564.00	CRI&P
Bonaparte, B.M. top of monument M.P. 36	564.11	CRI&P
Bonaparte, B.M. top of monument M.P. 37 (U.S.C.E. b.m. 21)	574.37	CRI&P
Bonaparte, high-water mark of 1903, on north end of retaining wall of approach to highway bridge; chisel mark (U.S.C.E.b.m. 93)	557.93	Bull. 569
Bondurant	968.0,G964	CGW
Boone	1138	C&NW
Boone, B.M. on station doorsill	1138.40	FtDDM&S
Boone, crossing over C&NW	1177	FtDDM&S
Boone	1120,G1122	CM&StP
Boone, crossing over C&NW	1130,G1112	CM&StP
Boone, T. 83 N., R. 26 W., south center of SE. 1/4 sec. 2, east-west crossing CM&StP Ry, on north side of road, east side of railroad; spike in base of telephone pole, marked "1140.0"	1,139.10	Bull. 569
Boone, Tps. 83 and 84 N., R. 26 W., CM&StP Ry, crossing township-line road between sec. 2, T. 83 N., and sec. 35, T. 84 N., top of rail	1,138.5	Bull. 569
Boone, 1 mile east by 2.5 miles south of, T. 84 N., R. 26 W., SE. cor. sec. 34, just north of township line between Des Moines and Worth townships, SW. cor. crossroads, just west of fence corner; iron post stamped "1119"	1,117.929	Bull. 569
Boone, 1.5 miles SE. of, T. 84 N., R. 26 W., east center of sec. 27, SW. cor. crossroads, west end of drain under road to south; chiseled square on top of stone, marked "1141.7"	1,140.73	Bull. 569
Boone, T. 84 N., R. 26 W., just north of SE. cor. sec. 21, C&NW Ry overhead-crossing road to north on north-south section line, north entrance of subway, west side of, at base of abutment, in top of concrete curbing running north; chiseled square, marked "1116.6"	1,115.63	Bull. 569
Boone, in grass plot on north side of east entrance to post-office building; iron post stamped "1134"	1,133.406	Bull. 569
Boone, 1 mile north of, NW. cor. sec. 22, T. 84 N., R. 26 W., at fair grounds, SE. cor. crossroads; chiseled square		

Station	Elevation feet	Authority
on top of concrete foundation of manhole of storm sewer, marked "1140.0"	1,139.08	Bull. 569
Boone, 2 miles north of, T. 84 N., R. 26 W., cor. secs. 9, 10, 15, and 16, in center of road forks at T road west; chiseled square on top of corner stone, marked "1141.85"	1,140.89	Bull. 569
Boone, 3 miles north of, T. 84 N., R. 26 W., NE. cor. sec. 9, SW. cor. crossroads, at fence corner; iron post stamped "1135"	1,133.829	Bull. 569
Boone, 4 miles north of, T. 84 N., R. 26 W., NW. cor. sec. 3, SE. cor. crossroads, 20 feet SE. of center of roads, 17 feet NW. of SE. fence corner; chiseled square on top of stone, marked "1131.8"	1,130.78	Bull. 569
Boone, 4.5 miles north of, T. 85 N., R. 26 W., west center of sec. 34, SE. cor. crossroads; chiseled square on top of stone at fence corner, marked "1138.7"	1,137.75	Bull. 569
Boone, 5.2 miles north of, T. 85 N., R. 26 W., west center of SW. ¼ sec. 27, houses on both east and west sides of road, in front of house on east side of road, on fence line east of road, 20 feet south of gate to house; copper nail in root of 1½-foot maple tree, marked "1176.8"	1,175.80	Bull. 569
Boone, 6.1 miles north of, T. 85 N., R. 26 W., east center of SE. ¼ sec. 21, 0.1 mile north of crossroads, SE. cor. schoolhouse yard, west side of road; iron post stamped "1177"	1,176.455	Bull. 569
Boone, 7 miles north of, T. 85 N., R. 26 W., SE. cor. sec. 16, NW. cor. crossroads; copper nail in top of north end of plank drain under road to west, marked "1137.0"	1,136.01	Bull. 569
Booneville	853,G858	CRI&P
Booneville, 50 feet south of track, in NW. cor. of field, opposite point 450 feet west of station; iron post stamped "Prim. Trav. Sta. No. 9"	857.618	Bull. 569
Booneville, in front of CRI&P Ry station; top of rail	856.3	Bull. 569
Booneville, 2 miles east of, in SW. abutment of bridge 353; aluminum tablet	845.155	Bull. 569
Border Plains	1090	FtDDM&S
Botna	1292	C&NW
Botna	1290.10,G1298	CGW
Bouton	957,G958	CM&StP
Bowsher station, 0.8 mile south of, bridge over Four Mile creek, in south side of east abutment; aluminum tablet stamped "821 Adj. 1903"	819.296	Bull. 569
Boxholm, B.M. pole No. 908	1145.55	FtDDM&S
Boyd, Butler county	899	IC
Boyd, Chickasaw county	1132.2	CGW
Boyden	1418,G1424	CM&StP
Boyer	1217	C&NW
Braddyville	963.8,G953	CB&Q
Braddyville, Iowa-Mo. state line	964	CB&Q
Bradford	1243	CRI&P
Bradgate	1122,G1123	C&NW
Brady	977.41	DM&CI
Brainard	909,G919	CRI&P
Brandon, switch at Line St. crossing, subgrade	819.10	WCF&N
Brayton	1207,G1209	CRI&P
Brazil	906,G933	CB&Q
Brazil, crossing CM&StP	G955	CB&Q
Breda	1366,G1365	C&NW
Bremer	1032.9	CGW
Bricker, base of rail opposite E. end depot	567.4	AT&SF

Station	Elevation feet	Authority
Bricker, 1 mile east of, east end of bridge over CB&Q. base of rail	576.6	AT&SF
Bricker, square cut in north concrete bridge seat, east abutment, bridge over CB&Q	573.54	AT&SF
Bridgeport, Jackson Co	640	USGS
Bridgewater	1189.88,G1188	CB&Q
Bridgewater, SE. ¼ sec. 34, T. 75 N., R. 33 W	1198	IaGS
Bridgewater, SE. ¼ sec. 16, T. 74 N., R. 33 W	1155	IaGS
Brighton	750,G743	M&StL
Brighton, crossing over CRI&P	755,G747	M&StL
Brighton, crossing, CRI&P track	729,G722	M&StL
Brighton, crossing CB&Q	751	M&StL
Brighton	722	CRI&P
Brighton, crossing M&StL and CB&Q	722	CRI&P
Brighton	740	CB&Q
Brighton, crossing CRI&P	744	CB&Q
Brighton, crossing, CRI&P track	722	CB&Q
Brighton, Skunk river north of	613	IaGS
Briscoe, Adams Co., top of mine shaft at	1135	IaGS
Briscoe, Nodaway river bed at Fox quarries, SW. ¼ sec. 31, T. 74 N., R. 35 W	1102	IaGS
Bristow	1031.4,G1030	CGW
Britt	1229,G1234	CM&StP
Britt, crossing M&StL	1207	CM&StP
Britt	1224,G1229	M&StL
Britt, crossing CM&StP	1207	M&StL
Brogan	1232	IC
Bromley	941,G932	M&StL
Brompton	944,G950	CM&StP
Bronson	1103	C&NW
Brooklyn	845,G848	CRI&P
Brooks	1095.3,G1096	CB&Q
Browns, main line	685,G685	CM&StP
Browns, Elk River Junction line	676	CM&StP
Bruce, Minn.	1491	IC
Brunsville	1263.4	C&NW
Brushy	1096	FtDDM&S
Brushy, T. 88 N., R. 27 W., cor. secs. 8, 9, 16 and 17, 120 feet north of sec. cor. and directly in front of dwelling, on west edge of road, on steel base of mail box post, marked "1,103.5"; chiseled notch	1,103.36	USGS
Brushy, interurban railway and highway crossing at, 100 feet north of crossing, on east side of highway, in front end of and south side of church, 2 feet west of and 0.5 foot lower than front door, 1.5 feet above ground; bronze tablet set in concrete, stamped "Iowa 1919 1,106"	1,106.388	USGS
Brushy, railroad crossing, 0.45 mile south of, 280 feet south of T road west, on east side of road, in front end of concrete walk to house, marked "1,095.4"; chiseled square	1,095.23	USGS
Brushy, T. 88 N., R. 27 W., cor. secs. 20, 21, 28 and 29, 90 feet south of center of crossroads, on west side of north and south road, in base of telephone pole, marked "1,100.3"; spike	1,100.16	USGS
Brushy, T. 88 N., R. 27 W., cor. secs. 28, 29, 32 and 33, 115 feet south of crossroads, on west side of road, on fence line, in root of large lone willow tree, marked "1,095.2"; copper nail and washer	1,095.04	USGS
Bryant, Clinton Co	771	C&NW
Bryant, Polk Co	800	WRR
Bryantsburg	977	CRI&P

Station	Elevation feet	Authority
Buchanan	749,G750	CRI&P
Buck Grove	1233,G1233	CM&StP
Buckeye	1154	CRI&P
Buckingham	906	C&NW
Bucknell, T. 72 N., R. 19 W., about 0.35 mile east of quarter corner on south side of sec. 16, in NW. angle of T road north, 4 feet west of corner post; iron post stamped "Iowa 983, 1913"	983.039	Bull. 569
Bucknell, T. 72 N., R. 19 W., about 0.25 mile west by 0.10 mile south of NE. cor. sec. 16, on east side of road, 10 feet north of wire gate opening into cornfield, lone red-oak tree 2.5 feet in diameter, in top of stump at base of tree; copper nail	964.10	Bull. 569
Bucknell, T. 72 N., R. 19 W., 0.25 mile east of quarter corner on north side of sec. 9, opposite secondary T road west, 50 feet NE. of John F. Foley's mail box, 1 foot south of telephone pole, in top of peg; copper nail	839.41	Bull. 569
Bucknell, at village, T. 72 N., R. 19 W., at center of sec. 3, in NW. angle of road forks, 150 feet NW. of wooden bridge over White creek, 6 feet west of corner post; iron post stamped "Iowa 811, 1913"	811.399	Bull. 569
Bucknell, T. 73 N., R. 19 W., at center of sec. 34, in SE. angle of T road east, concrete foundation to corner post; center of letter A in "A.B. May 22, 1913"	966.47	Bull. 569
Bucknell, T. 73 N., R. 19 W., at quarter corner on south side of sec. 27, in NW. angle of crossroads, 3 feet NE. of corner post, in osage peg; copper nail	964.01	Bull. 569
Bucknell, T. 73 N., R. 19 W., at quarter corner between secs. 22 and 27, at T road west, on section stone; chiseled square	936.90	Bull. 569
Bucknell, 4.5 miles north of, T. 73 N., R. 19 W., sec. 10, at quarter corner on south side of, in NW. angle T road, 1.5 feet NE. of corner post, in top of peg; copper nail	863.39	Bull. 569
Bucknell, T. 73 N., R. 19 W., sec. 22, at NW. cor., at T road north, 200 feet SW. of Cedar Center schoolhouse, 27 feet east by 30 feet south of section corner; iron post stamped "Iowa 943, 1913"	942.694	Bull. 569
Bucknell, T. 73 N., R. 19 W., sec. 21, at NW. cor., opposite T road north, 18 feet south by 9 feet east of section corner, in top of wooden peg; copper nail	921.97	Bull. 569
Bucknell, T. 73 N., R. 19 W., sec. 17, near SW. cor., 47.2 feet due south of center of south wall of schoolhouse, in stump of twin-oak tree 7 inches in diameter; copper nail	909.43	Bull. 569
Bucknell, T. 73 N., R. 19 W., at quarter corner between secs. 18 and 19, top of hill; top of quarter corner stone	884.13	Bull. 569
Budd	700.4	CGW
Buena Vista, Clayton Co., see North Buena Vista	626,G626	CM&StP
Buena Vista, Lee Co., M.P. 175.7	496,G502	CB&Q
Buena Vista, bridge over Des Moines river, M.P. 175	502	CB&Q
Buena Vista, on NW. cor. east abutment CB&Q RR bridge near mouth of Des Moines river, 2.7 miles from Keokuk. Cross mark 1 foot in from face of abutment (U.S.C.E. b.m. 1)	496.63	USCE
Buffalo, union station with CRI&P	558	CM&StP
Buffalo	556,G559	CRI&P
Buffalo, 0.8 mile below, on property of W. L. Clark, 1 meter south and 2 meters east of center of SE. ¼ sec. 21, 400 meters from river; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 146/3):		
Copper bolt	613.63	Bull. 569
Cap on pipe	617.63	

Station	Elevation feet	Authority
Buffalo, on William Karge's brick store and post-office building, in east side near SE. cor., 3 feet above foundation, at NW. cor. Hecker and Second Sts.; brass bolt (U.S.C.E.p.b.m. 36)	565.438	Bull. 569
Buffalo, 0.5 mile east of, on foundation of brick house of Eliza M. Dodge, in upper foundation stone on west side, near SW. cor., 1 meter from ground, 100 meters north of CRI&P RR; brass bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 37)	568.936	Bull. 569
Buffalo Center	1196,G1183	CRI&P
Bullard, M.P. 197	559,G559	CB&Q
Burch	819	CGW
Burch	828	CB&Q
Burchinal	1229.7,G1230	CGW
Burdette	1176	CRI&P
Burlington	532.3	CB&Q
Burlington, Union Station	G533	Miss. R. Com.
Burlington, City datum	G435	Miss. R. Com.
Burlington, Mississippi R., low water	G511	Miss. R. Com.
Burlington, Mississippi R., extreme high water, 1851	G531	Miss. R. Com.
Burlington	530	CRI&P
Burlington, 3.5 miles south of, on south side of CB&Q RR, on north side of stone building known as Patterson's grocery near NE. cor., 2½ feet from ground; copper bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 11)	540.156	Bull. 569
Burlington Island, 15 meters from east shore opposite foot of Two Mile Island, 18.3 meters 165° from 15-inch ash tree, 9.2 meters 253° 30′ from 30-inch elm tree, 10 meters 70° from 22-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 122/1):		
Copper bolt	515.13	Bull. 569
Cap on pipe	519.13	
Burlington, Island 380, 60 meters from head, 17 meters from top of bank, 7.4 meters 148° to 41-inch elm tree, 4.5 meters 235° to 9-inch ash tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 122/2):		
Copper bolt	516.56	Bull. 569
Cap on pipe	520.57	
Burlington Island, at foot of, in field 2 meters north of hedge fence on hill near top, abreast the 4-mile post on CB&Q RR, a two-story stone house with red roof is on slope of hill about 100 meters from stone; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. "Pat"):		
Copper bolt	638.71	Bull. 569
Cap on pipe	642.68	
Burlington Island, in interior of, 560 meters back of following-described bench mark, on east side of an old wagon road, 13 meters 184° to 25-inch elm tree, 10 meters 248° to 18-inch white oak; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 123/1):		
Copper bolt	516.72	Bull. 569
Cap on pipe	520.73	
Burlington Island, on west shore of, on narrow ridge 5 meters from shore, 3 meters 336° to 12-inch willow tree, 3 meters 29° 30′ to 15-inch willow, 0.7 meter 121° 30′ to 15-inch willow; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 123/2):		
Copper bolt	516.02	Bull. 569
Cap on pipe	520.96	
Burlington, three-mile post on CB&Q RR, on brow of bluff above, in front of dwelling house, 4.5 meters 308° to 6-		

Station	Elevation feet	Authority
inch hickory, 4.8 meters 128° to 7-inch hickory, 2.5 meters 186° 30′ to 8-inch oak; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 123/3):		
Copper bolt	646.99	Bull. 569
Cap on pipe	651.01	
Burlington, in SE. cor. west abutment of bridge, on stone used as bridge seat and in same course of masonry as those upon which plate girder rests; square cut (U.S.C.E. b.m. 13 R.B.)	535.90	Bull. 569
Burlington, on NW. cor. Front and Valley sts.; top of water table (U.S.C.E. city b.m. 1)	537.66	Bull. 569
Burlington, on NE. cor. Main and Valley Sts.; top of stone door sill (U.S.C.E. city b.m. 2)	538.22	Bull. 569
Burlington, on lower side of round pier to draw span by bridge; high-water mark of 1851	530.28	Bull. 569
Burlington, inside of upper stone of mouth of sewer emptying just below elevator; cut (U.S.C.E. high-water mark of 1888)	529.59	Bull. 569
Burlington, private marks in Diamond Jo warehouse (U. S.C.E. high-water marks, 1880, 1881, 1888, 1892, 1892):		
1880	527.60	Bull. 569
1881	528.49	
1888	529.17	
1892	529.50	
1892	528.40	
Burlington, in upper part of, nearly on line with bench marks 124/2 and 124/3, 4.7 meters 314° to 30-inch cottonwood, 7.8 meters 148° 30′ to 8-inch locust, 3.2 meters 48° 30′ to 18-inch elm, in woods on ridge; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 124/1):		
Copper bolt	520.16	Bull. 569
Cap on pipe	524.16	
Burlington, in upper part of, on sandy ridge, 25 meters from water's edge at old warehouse levee, 60 meters below ferry landing and about 120 meters from old sawmill; copper bolt in tile surmounted by iron pipe (U.S. C.E.b.m. 124/2):		
Copper bolt	521.34	Bull. 569
Cap on pipe	525.33	
Burlington, in upper part of, on brow of bluff at corner of lots of Mr. Churchall and Mrs. Foote, 50 meters north of tall chimney of waterworks engine house; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 124/3):		
Copper bolt	633.64	Bull. 569
Cap on pipe	637.66	
Burlington, Otter Island, at foot of, near large swamp, 626 meters back of following-described bench mark, 1.3 meters 46° to 15-inch cottonwood, 8 meters 136° 30′ to 18-inch elm tree, 10.2 meters 292° to 30-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 125/1):		
Copper bolt	519.79	Bull. 569
Cap on pipe	523.80	
Burlington, Otter Island, at foot of, at head of riprap, 14 meters from water's edge, 6.5 meters 303° to 15-inch black oak, 11.5 meters 12° to 24-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 125/2):		
Copper bolt	520.49	Bull. 569
Cap on pipe	524.50	
Burlington, Otter Island, 13 meters west of small slough		

Station	Elevation feet	Authority
on, 400 meters above foot of island, 100 meters from east side of island, 7.4 meters 65° to 18-inch cottonwood tree, 6 meters 176° 30′ to 15-inch cottonwood; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 125/3):		
Copper bolt	519.06	Bull. 569
Cap on pipe	523.04	
Burlington, O'Connell Island, 8 meters from east shore, 250 meters above point opposite head of Rush Island, 5.6 meters 149° to 28-inch maple tree, 8.9 meters 232° 30′ to 9-inch maple tree, 7.2 meters 301° to 15-inch maple tree; copper bolt in tile surmounted by iron pipe (U.S. C.E.b.m. 125/4):		
Copper bolt	519.58	Bull. 569
Cap on pipe	523.58	
Burlington, top of water table, NW. cor. Front and Valley Sts., marked "537.48"	537.66	Bull. 569
Burlington, CB&Q RR bridge over Mississippi river; chiseled square on top of north wing wall of west abutment; marked "U.S.B.M. 542.2"	542.37	Bull. 569
Burlington, CB&Q RR bridge over Mississippi river, on south end of bridge seat of west abutment; chiseled square cut in top, marked "535.7" (U. S. Corps of Engineers bench mark)	535.902	Bull. 569
Burlington, West	688.5,G690	CB&Q
Burlington Crossing, under CGW	824	CRI&P
Burnside	1145,G1147	M&StL
Burnside, T. 87 N., R. 28 W., cor. secs. 3, 4, 9 and 10, at road crossing over Crooked creek, on N. edge of road and E. end of bridge, 2.5 ft. above bridge floor, in top of concrete railing, marked "1,100.1"; chiseled square	1,100.21	USGS
Burnside, T. 87 N., R. 28 W., cor. secs. 2, 3, 10 and 11, 35 ft. NW. of center of crossroads, at fence corner, in base of telephone pole, marked "1,118.9"; spike	1,119.02	USGS
Burnside, T. 87 N., R. 28 W., near cor. secs. 27, 28, 33 and 34, 550 feet west of center of crossroads, in north side of road, at gate entrance to Mr. L. E. Ruper's barn lot, in root of large cottonwood tree (36 inches in diameter); copper nail and washer, marked "U.S.G.S. B.M."	1,154.76	USGS
Burnside, T. 87 N., R. 28 W., at cor. secs. 28, 29, 32 and 33, 30 feet NE. of center of crossroads, in north end of concrete culvert; chiseled square "T.B.M. 1,149.8"	1,149.72	USGS
Burr Oak, Winneshiek Co., T 100 N., R. 9 W., quarter corner on east side of sec. 21, in SW. corner of Ward schoolhouse yard; iron post stamped "1213 DBQ"	1,212.773	Bull. 569
Burt	1177,G1169	C&NW
Bussey	873	WRR
Bussey	871.32,G873	CB&Q
Bussey, T. 74 N., R. 17 W., near quarter corner between secs. 19 and 30, 120 feet north of bridge over small creek, on west side of road, 10 feet east of right-of-way fence, in root on east side of a 2-foot birch tree; copper nail and washer painted "U.S.B.M. 772.7"	772.64	USGS
Bussey, T. 74 N., R. 17 W., near quarter corner between secs. 18 and 19, 100 feet east of T-road south, on south side of road, 10 feet north of fence line, in root on east side of a 1-foot elm tree; copper nail and washer, painted "U.S.B.M. 812.4"	812.31	USGS
Bussey, T. 74 N., R. 17 W., cor. secs. 17 and 18, 19 and 20, in NE. angle of roads at T-road north, 6 feet north by 0.5 foot west of corner fence post, in top of concrete		

Station	Elevation feet	Authority
post; bronze tablet stamped ''E.B. No. 8 1924 Iowa'', painted ''U.S.P.B.M. 835.1''	835.042	USGS
Bussey, reference mark, 17 feet south by 5 feet east of tablet, in top of a 6-inch hedge stump 2 feet above ground; copper nail and washer	836.68	USGS
Bussey, T. 74 N., R. 17 W., cor. secs. 7, 8, 17 and 18 in NW. angle of roads at T-road west, in top on east side of concrete base to corner fence post; chiseled square, painted ''U.S.B.M. 786.3''	786.22	USGS
Bussey, T. 74 N., R. 17 W., quarter corner between secs. 7 and 8, in NW. angle of crossroads, in top on east side of concrete base to corner fence post; chiseled square, painted ''U.S.B.M. 844.6''	844.53	USGS
Bussey, T. 74 N., R. 17 W., quarter corner between secs. 5 and 6, in NE. angle of crossroads, 70 feet north by 1 foot east of corner of right-of-way fence, in top of a 6-inch hedge stump; copper nail and washer, painted ''U. S.B.M. 847.2''	847.15	USGS
Butler	845,G838	M&StL
Butler, crossing CB&Q	840,G833	M&StL
Butler	831	CB&Q
Buxton	769	C&NW
Buxton, T. 73 N., R. 17 W., cor. secs. 1, 2, 11 and 12, in N.W. angle of crossroads, 10 feet west by 1 foot south of fence corner, in top of 6-inch osage orange stump; copper nail and washer, painted ''U.S.B.M. 843.8''	843.49	USGS
Buxton, Tps. 73 and 74 N., R. 17 W., near cor. secs. 1, 2, 35 and 36, on county line, in SE. angle of roads at T-road south, 4 feet south of corner fence post, in top of concrete post; bronze tablet stamped ''E.B. No. 13 1924 Iowa'', painted ''U.S.B.M. 849.8''	849.539	USGS
Buxton, reference mark, 60 feet north by 10 feet west of tablet, south (5 feet) of fence line, on north side of east and west road, in top of 6-inch elm stump; copper nail and washer	849.47	USGS
Buxton, T. 74 N., R. 17 W., near SE. cor. sec. 35, at road crossing C&NW Ry; top of east rail	755.5	USGS
Calamus	703,G706	C&NW
Caldwells	1071,G1075	CM&StP
California Junction	1009,G1011	C&NW
California Junction, low water in Missouri river near Blair, Nebr.	G986	USGS
California Junction, high water in Missouri river	G1007	USGS
California Junction, 758 feet east of station, NW. cor. A. W. Smith's orchard, 3 feet from each fence, 56 feet south of C&NW track; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m 360 equals 127/3):		
Copper bolt	1,002.475	Bull. 569
Cap on pipe	1,006.481	
California Junction, 1.8 miles north of station, 70 feet south of public-road crossing, 44 feet east of tracks; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 361):		
Copper bolt	1,005.293	Bull. 569
Cap on pipe	1,009.306	
California Junction, on left bank of Missouri river, 1.25 miles from river bank, in SW. cor. sec. 25, T. 78 N., R. 45 W., opposite side of road from H. B. Hendrick's house, from which it is distant about 200 feet; copper		

STATION	ELEVATION FEET	AUTHORITY
bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 126/2):		
. Copper bolt	998.47	Bull. 569
Cap on pipe	1,002.53	
Callender	1156,G1151	M&StL
Callender, T. 87 N., R. 29 W., cor. secs. 19, 20, 29 and 30, 50 feet NE. of center of crossroads, in concrete base of fence post, marked "1,157.4"	1,157.44	USGS
Callender, T. 87 N., R. 29 W., cor. secs. 17, 18, 19 and 20, 60 feet SW. of road forks, in base of telephone pole, marked "1,159.4"; spike	1,159.45	USGS
Callender, T. 87 N., R. 29 W., cor. secs. 7, 8, 17 and 18, 50 feet NE. of center of crossroads, 2.5 feet south of fence corner; iron post stamped "IOWA 1919 1,155"	1,154.994	USGS
Callender, T. 87 N., R. 29 W., quarter corner south side of sec. 8 at T road north, 40 feet NE. of road fork, in base of corner fence post, marked "1,155.8"; spike	1,155.82	USGS
Callender, T. 87 N., R. 29 W., quarter corner, north side of sec. 8, 50 feet SE. of center of crossroads, in base of corner fence post, marked "1,158.5"; spike	1,158.49	USGS
Callender, T. 87 N., R. 29 W., quarter corner, north side of sec. 5, 50 feet SE. of center of crossroads, in concrete base of corner fence post, marked "1,155.2"; chiseled point	1,155.27	USGS
Callender, T. 87 N., R. 29 W., cor. secs. 4, 5, 32 and 33, T road north, 50 feet south of road fork, in root of 8-inch cottonwood tree, marked "1,152.5"; copper nail and washer	1,152.52	USGS
Callender, T. 88 N., R. 29 W., cor. secs. 28, 29, 32 and 33, at T road east, 35 feet west of road fork, 2 feet east of fence line; iron post stamped "Iowa 1919 1,153"	1,153.406	USGS
Calliope	1191,G1185	CM&StP
Calliope, 5.9 meters south of cor. McCaull-Webster elevator, 18 meters west of railway and 55 meters south of station, 0.4 meter above ground, 0.25 meter north of south end of foundation wall (pink jasper), at east edge; square hole (U.S.C.&G.S.b.m.H.)	1,181.566	Bull. 569
Calmar	1258,G1262	CM&StP
Calmar, junction with Iowa and Dakota division	1265	CM&StP
Caloma, Marion Co., 2 miles west of, T. 75 N., R. 22 W., NE. cor. sec. 26, in SW. angle of crossroads, 50 feet west by 30 feet south of corner; in limestone rock 6 by 10 by 30 inches, set 28 inches in ground; aluminum tablet stamped "966 Adj."	965.179	Bull. 569
Caloma, 1 mile north of, T. 75 N., R. 21 W., NW. cor. sec. 20, at SE. angle of crossroads, limestone rock 8 by 10 by 24 inches, set 22 inches in ground; aluminum tablet stamped "936 Adj."	934.698	Bull. 569
Calumet	1434,G1430	IC
Calumet, crossing under C&NW	1454	IC
Camanche	598	CRI&P
Camanche	599.00	CD&M
Camanche, crossing over C&NW	628	CD&M
Camanche	G596	DRI&NW
Camanche	606	CM&StP
Camanche	598,G599	C&NW
Camanche distillery building, top of upper foundation stone on SE. cor., 2 feet above ground; cross cut in boards above (U.S.C.E.t.b.m. 16 R.B.)	584.99	Bull. 569
Camanche, cut in foundation on east side of warehouse (U.S.C.E. high-water mark, June 25, 1880)	584.53	Bull. 569

Station	Elevation feet	Authority
Camanche, in root of first large birch tree 100 meters above old sawmill piling at upper end of; nail (U.S.C.E. t.b.m. 17 R.B.)	576.77	Bull. 569
Camanche, in front of station on branch of CB&Q RR, base of rail (U.S.C.E.b.m.)	597.28	Bull. 569
Camanche, 1 mile north of, 0.5 mile from river, on north-south wagon road, 80 meters north of north fence of cemetery, on ridge 0.5 meter west of east fence; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 159/4):		
Copper bolt	607.19	Bull. 569
Cap on pipe	611.21	
Cambria	1089,G1100	CB&Q
Cambridge	881,G861	CM&StP
Cambridge, crossing over CRI&P	880	CM&StP
Cambridge	853	CRI&P
Cambridge, crossing under CM&StP	854	CRI&P
Cambridge, T. 82 N., R. 23 W., NE. cor. NW. ¼ sec. 10; iron post stamped "942"	940.907	Bull. 569
Cambridge, T. 82 N., R. 23 W., SE. cor. SW. ¼ sec. 10; spike in corner post, marked "U.S.B.M. 918"	916.56	Bull. 569
Cambridge, 1 mile NE. of, iron bridge over county ditch, top of east abutment of north wing wall; marked □ U.S. B.M. 855"	853.32	Bull. 569
Cambridge, in front face of Citizens State Bank; aluminum tablet stamped "872"	870.442	Bull. 569
Cambridge, in front of CRI&P Ry; top of rail	861.6	Bull. 569
Cambridge, T. 82 N., R. 23 W., SW. cor. SE. ¼ sec. 28; spike in telephone pole, marked "U.S.B.M. 884"	882.93	Bull. 569
Cambridge, T. 81 N., R. 23 W., NW. cor. NE. ¼ sec. 4, line between Story and Polk counties; spike in telephone pole, marked "U.S.B.M. 906"	904.51	Bull. 569
Cambridge, T. 81 N., R. 23 W., NW. cor. NE. ¼ sec. 9; iron post stamped "910"	908.698	Bull. 569
Cameron, Cerro Gordo Co.	1228,G1220	M&StL
Cameron, Dubuque Co.	621,G623	CM&StP
Camp Dodge	846.07	DM&CI
Camp Douglas	806.81	DM&CI
Campbell	876,G879	CM&StP
Canton, Jackson Co.	730	USGS
Canton, S. Dakota, SC&D line	1253	CM&StP
Canton, S. Dakota, Ia. & Dak. line	1244,G1246	CM&StP
Cantril	773,G773	CB&Q
Capron	1061	M&StL
Capron, crossing CM&StP	1061	M&StL
Capron, crossing CGW	1059	M&StL
Capron	1052,G1050	CM&StP
Capron, crossing M&StL	1052,G1049	CM&StP
Carbon, Adams Co.	1100	IaGS
Carbon, Middle Nodaway river at	1060	IaGS
Carbon, Davis county	699	WRR
Carl, Adams Co.	1280	IaGS
Carlisle	780,G784	CRI&P
Carlisle, in front of CRI&P Ry station; top of rail	784.2	Bull. 569
Carlisle station, at side of road 200 feet east of tracks, limestone rock 8 by 8 by 30 inches, set 28 inches in ground; aluminum tablet stamped "782 Adj."	781.564	Bull. 569
Carlisle, T. 77 N., R. 23 W., sec. 23, SW. cor. at NE. cor. of crossing, limestone rock 8 by 9 by 32 inches, set 30 inches in ground; aluminum tablet stamped "914 Adj."	912.891	Bull. 569
Carlson	644	CRI&P

STATION	ELEVATION FEET	AUTHORITY
Carnarvon	1252	C&NW
Carnes	1274.6,G1273	CStPM&O
Carney's Sdg., M.P. 449	1215	IC
Carnforth	806,G808	CRI&P
Carnforth, crossing C&NW	806,G808	CRI&P
Carnforth	811	C&NW
Carnforth, crossing CRI&P	810,G832	C&NW
Carpenter	1190,G1192	CM&StP
Carroll	1257,G1261	C&NW
Carroll, under crossing CGW	1244	C&NW
Carroll	1259.7,G1266	CGW
Carroll, crossing over C&NW	G1274	CGW
Carroll, crossing, C&NW tracks	G1251	
Carroll	G1265	Weather Bur.
Carrville	1003	IC
Carson, union station with CRI&P	1066	CB&Q
Carson	1064,G1066	CRI&P
Cartersville	1182	C&NW
Cascade, Des Moines Co	535	CB&Q
Cascade, Dubuque Co	831,G832	CM&StP
Cascade, T. 86 N., R. 1 W., NW. ¼ sec. 7, junction of road going south; iron post stamped "961"	951.797	Bul. 569
Cascade, T. 86 N., R. 2 W., NW. ¼ NW. ¼ sec. 1, on line between secs. 1 and 2, at junction of roads going north and west; iron post stamped "957"	947.900	Bul. 569
Cascade, hydrant at base of water tower	G865	USGS
Cascade, top course of bridge over North Fork of Maquoketa river	G839	USGS
Case Drive station	826.95	DM&CI
Casey	1225,G1228	CRI&P
Casey, 2.8 miles west of, in SW. stone abutment of bridge 397; aluminum tablet	1,253.485	Bull. 569
Casey, in front of CRI&P Ry station; top of rail	1,228.9	Bull. 569
Casey, in stone foundation of T. J. Burns's store, in south wall, halfway between Main St. and alley; aluminum tablet	1,248.979	Bull. 569
Casey, 100 feet south of track, opposite point 300 feet east of station, 200 feet northwest of Lutheran Church, 3 feet east of sidewalk leading to station; iron post	1,223.927	Bull. 569
Casey, SE. ¼ sec. 31, T. 77 N., R. 31 W.	1361	IaGS
Castalia	1240,G1240	CRI&P
Castalia	1238,G1243	CM&StP
Castalia, in SW. cor. school yard; iron post stamped "1251 DBQ"	1,251.144	Bull. 569
Castana	1072	C&NW
Cattese	616,G616	CM&StP
Cattese, 5 miles below Dubuque, 0.5 mile above Ninemile Island, near south abutment of bridge 86, where t.b.m. 304 is located, on river end of abutment, lowest course of stone, on northeast corner of step, now marked "□"; highest point in square (U.S.C.E. old U.S.b.m. 24)	591.042	Bull. 569
Cattese siding, near, 5 miles below Dubuque and 0.5 mile above head of Ninemile Island, on south abutment of bridge 86, river end, on second course of stone below bridge seat, on NE. cor., marked "U□S"; highest point in square (U.S.C.E.t.b.m. 304)	607.315	Bull. 569
Cattese siding, 1 mile below, 1.3 miles above head of Ninemile Island, on line of CM&StP Ry, directly opposite milepost 122-39, on bluff side, 9 feet from center, on natural ledge of rock, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 303)	615.054	Bull. 569

Station	Elevation feet	Authority
Cattese siding, 72 feet above lower headblock of switch at, 15 feet west from center of side track, in natural ledge of rock marked "U□S," opposite foot of Island 228; highest point in square (U.S.C.E.t.b.m. 302)	617.226	Bull. 569
Cattese siding, 669 feet above upper headblock of switch to, on upper side of coulee, where t.b.m. 301 is located, 344 feet below milepost 121-40, 43 feet from center of track, on bluff side, in fence corner by gate; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 284-285):		
Copper bolt	613.031	Bull. 569
Cap on pipe	617.030	
Cedar	810	CB&Q
Cedar Falls, CGW crossing at 13th St., top of rail	858.9	WCF&N
Cedar Falls, Main Street station, top of rail	854	WCF&N
Cedar Falls, Normal Hill, top of rail	926.0	WCF&N
Cedar Falls, city datum plane	760.48	
Cedar Falls	860,G854	CRI&P
Cedar Falls	864,G868	IC
Cedar Falls, crossing CRI&P	874,G868	IC
Cedar Falls, Normal Hill, cor. Normal and 24th Sts	937	T. R. Warriner
Cedar Falls	G854	Weather Bur.
Cedar Falls Junction	871.4	CGW
Cedar Heights, at Waterloo Ave., top of rail	956.3	WCF&N
Cedar Rapids, Interurban station	820	WCF&N
Cedar Rapids, M.P. 59, subgrade	821.40	WCF&N
Cedar Rapids	731	C&NW
Cedar Rapids, crossing CM&StP	727	C&NW
Cedar Rapids, crossing CRI&P	725	C&NW
Cedar Rapids	729	IC
Cedar Rapids	729,G732	CRI&P
Cedar Rapids	734,G737	CM&StP
Cedar Rapids, crossing C&NW	730,G733	CM&StP
Cedar Rapids	G733	Weather Bur.
Cedar Rapids, NE. cor. top step, east waiting room door, C&NW Railway station	733.25	CR&IC
Cedar Rapids, 292 feet north of SE. cor. sec. 14, Tp. 83, R. 7, top of rail at center line of road on east line sec. 14	779.81	CR&IC
Cedar Rapids, top of rail on east line sec. 24, Tp. 83, R. 7, 212 feet north of SE. cor. of SE. ¼ of NW. ¼ sec. 24	764.21	CR&IC
Cedar Rapids, top of rail on west line of Fourth Ave. and Third St. east	732.87	CR&IC
Cedar Rapids, top of rail, crossing of CM&StP and CR&IC main lines	754.40	CR&IC
Cedar Rapids, top of rail on south line sec. 32, Tp. 83, R. 7, 1625 feet east of SW. cor. sec. 32	782.70	IC
Center Grove, east end side track	730	CR&IC
Center Grove, IC, nail in floor of highway bridge over Catfish creek	G731	USGS
Center Grove, guard rail of bridge over N. Fork Catfish creek on Delhi road	G735	USGS
Center Junction	907	C&NW
Center Junction, crossing under CM&StP	895	C&NW
Center Junction	926,G926	CM&StP
Center Junction, crossing over C&NW	915	CM&StP
Center Point, crossing State St., subgrade	806.41	WCF&N
Center Point, crossing CRI&P, top of rail	813.38	WCF&N
Center Point	811,G819	CRI&P
Centerdale	720,G725	CRI&P

STATION	ELEVATION FEET	AUTHORITY
Centerville	1002	CRI&P
Centerville, crossing CB&Q	1000	CRI&P
Centerville	999,G1014	CB&Q
Centerville, crossing CRI&P	1007,G1013	CB&Q
Centerville, east side courthouse square at interurban stop	1014	ISU
Centerville, CB&Q transfer	931	ISU
Centerville, junction Albia and Mystic lines	933	ISU
Centerville	G1013	Weather Bur.
Central City	835,G837	IC
Chamberlin	893.43	DM&CI
Chancy	595	CM&StP
Chancy	588	CRI&P
Chancy	G586	DRI&NW
Chapin	1165,G1157	M&StL
Chapin	1128	CRI&P
Chariton	1014	CRI&P
Chariton, CB&Q overhead crossing	1036	CRI&P
Chariton, crossing under CB&Q	1009	CRI&P
Chariton	1041,G1042	CB&Q
Chariton	G1042	Weather Bur.
Chariton, CRI&P Ry, in front of station; top of rail	1,015.9	Bull. 569
Chariton, 0.96 mile SE. of, T. 72 N., R. 21 W., at center of sec. 29, in SE. angle of crossroads, in root of 14-inch maple tree; copper nail	1,027.12	Bull. 569
Chariton, 2.3 miles SE. of, near SE. cor. sec. 28, T. 72 N., R. 21 W., on north side of road, 80 feet east of new concrete bridge, in root of 28-inch maple tree; copper nail	960.64	Bull. 569
Chariton, 3.4 miles SE. of, about 0.2 mile west of the NE. cor. sec. 34, T. 72 N., R. 21 W., on south side of road, 120 feet SW. of farmhouse, in top of 10-inch osage stump; copper nail	1,025.08	Bull. 569
Chariton, 4.2 miles SE. of, T. 72 N., R. 21 W., at quarter corner on south side of sec. 26, 80 feet west of T road north, steel highway bridge over creek, in plank in NE. cor. bridge floor; copper nail	930.90	Bull. 569
Chariton, T. 72 N., R. 21 W., near SE. cor. sec. 13, on west side of road, opposite gate to P. D. Schreck's farmyard, 2 feet south of pasture gate, in top of peg; copper nail	1,015.89	Bull. 569
Chariton, 4.5 miles east of, T. 72 N., R. 21 W., 0.25 mile east by 0.25 mile south of center of sec. 24, in NW. angle of T road west, 4 feet south of telephone pole, in top of peg; copper nail	1,007.97	Bull. 569
Chariton, T. 72 N., Rs. 20 and 21 W., 0.25 mile north of quarter corner between secs. 25 and 30, at elbow of road east to south, in front yard of John Collinson, in root of 18-inch maple tree on west side of gate; copper nail	1,031.17	Bull. 569
Chariton, T. 72 N., R. 22 W., at SE. cor. sec. 21, in NE. angle of crossroads, 1 foot south of corner post, in top of wooden peg; copper nail	924.16	Bull. 569
Chariton, T. 72 N., R. 22 W., at NE. cor. sec. 27, at SW. cor. crossroads, 2 feet NE. of corner post; iron post stamped "Iowa, 1046, 1913"	1,046.474	Bull. 569
Chariton, T. 72 N., R. 22 W., at NW. cor. sec. 25, in SE. angle of T road south, 1 foot east of corner post, in top of osage peg; copper nail	1,027.54	Bull. 569
Chariton, Crystal Lake; water elevation	975.16	Bull. 569
Chariton, T. 72 N., Rs. 21 and 22 W., between secs. 19 and 24, respectively, on north side of road, at corporation limits, west side, 6 inches south of east-west fence, in top of wooden peg; copper nail	958.60	Bull. 569

Station	Elevation feet	Authority
Chariton, in SW. cor. courthouse yard; iron post stamped "Iowa, 1041, 1913"	1,040.984	Bull. 569
Chariton, 1.2 miles north of, in SW. cor. T road west, about 0.2 mile east of greenhouse, on west side of 16-inch maple tree, in root of tree; iron wire nail with copper washer	1,037.32	Bull. 569
Chariton, 2 miles north of, T. 72 N., R. 21 W., NW. of center of sec. 17, at SE. angle of T road east, south end of plank drain, in top of; copper nail	1,005.42	Bull. 569
Chariton, 3.2 miles north of, in NW. angle of crossroads, 3.5 feet north of corner post; iron post stamped "Iowa, 991, 1913"	991.101	Bull. 569
Charles City	1017.40	CCW
Charles City	1012	IC
Charles City, crossing CM&StP	1011	IC
Charles City	1011,G1013	CM&StP
Charles City, crossing IC	1007,G1023	CM&StP
Charles City	G1005	Weather Bur.
Charleston	700,G701	CB&Q
Charlotte	681,G681	C&NW
Charter Oak	1230,G1232	CM&StP
Chatsworth	1169,G1164	CM&StP
Chatsworth, 1 kilometer north of, 20 meters east of railway, 13 meters north of road, 2 meters east and 1 meter north of SW. cor. pasture, 1.7 meters below rails; copper bolt in top of stone post lettered "U.S.B.M." (U.S.C.&G.S.b.m.M)	1,155.405	Bull. 569
Chatsworth, 25 meters north of station, 29 meters east of railway, 12 meters south of road, on jasper rock 1 meter south and 0.5 meter west of NW. cor. meadow; bottom of square hole (U.S.C.&G.S.b.m.N)	1,159.833	Bull. 569
Chatsworth, on east pier of north pair, under railway water tank, 36 meters south of station, 5.5 meters west of track, in top bevel, 0.19 meter above ground, at east edge and 0.24 meter south of north edge; bottom of square hole (U.S.C.&G.S.b.m.O)	1,161.753	Bull. 569
Chatsworth, 2.3 kilometers south of, 330 meters north of railway bridge, 3 meters north of road, 13 meters west of railway, 1 meter east of fence, 0.5 meter below rails; copper bolt in top of stone post lettered "U.S.B.M." (U.S.C.&G.S.b.m.P)	1,154.348	Bull. 569
Chatsworth, 2 miles NE. of	1252	IaGS
Chautauqua	1009	CRI&P
Chautauqua, west end switch	1009,G1011	CM&StP
Chelsea	788,G789	C&NW
Cherokee	1199,G1201	IC
Chester	1230,G1230	CM&StP
Chesterfield	792	WRR
Chillicothe	662,G660	CB&Q
Chillicothe, southeast corner of SE. wing of west abutment of highway bridge over Des Moines river, (U.S.C.E. b.m. 49)	659.73	Bull. 569
Chillicothe, top of extreme south point of abutment at west end of highway bridge over Des Moines river (U.S.C.E. b.m. 78)	659.73	Bull. 569
Chisholm	859.9	CB&Q
Churchville	953.1,G949	CGW
Churdan	1121,G1123	CM&StP
Cincinnati	1034,G1034	CB&Q
Cisco	818	CRI&P
Clara, M.P. 505	994,G991	IC

Station	Elevation feet	Authority
Clara, at intersection of north-south and east-west roads, in NW. cor. C. E. Osborn's yard near NW. cor. SW. ¼ NW. ¼ sec. 34, T. 76 N., R. 44 W.; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 123/2):		
Copper bolt	984.00	Bull. 569
Cap on pipe	988.08	
Clare	1216,G1194	M&StL
Clare, T. 90 N., R. 29 W., quarter corner, N. side of sec. 34, 40 ft. SW. of crossroads, 2 ft. N. of fence corner; iron post stamped "IOWA 1919 1,141"	1,141.307	USGS
Clare, T. 90 N., R. 28 W., at center of sec. 27, at T road W., 50 ft. NE. of road fork, inside church inclosure, in root of 18-inch elm tree, marked "1,177.7"; copper nail and washer	1,177.55	USGS
Clare, 4.5 miles east of, T. 90 N., R. 29 W., quarter corner, S. side of sec. 22, 35 ft. NW. of crossroad, in base of corner fence post, marked "1,152.6"; spike	1,152.49	USGS
Clare, T. 90 N., R. 29 W., quarter corner, S. side of sec. 15, 30 ft. NW. of crossroads, in base of corner fence post, marked "1,146"; spike	1,145.87	USGS
Clarence	827,G825	C&NW
Clarinda	1012,G1009	CB&Q
Clarinda, crossing Villisca and Shenandoah lines	1006.36	CB&Q
Clarinda	G1009	Weather Bur.
Clarion	1166.8,G1170	CGW
Clarion, crossing CRI&P	1165.4,G1168	CGW
Clarion	1174,G1168	CRI&P
Clarion, crossing CGW	1170	CRI&P
Clark	1000.7,G999	CB&Q
Clark	1000	IaGS
Clarkson	770,G772	CB&Q
Clarksville	931,G924	CRI&P
Clarksville	933.8,G933	CGW
Clarksville, crossing CRI&P	G932	CGW
Clay	759,G751	M&StL
Clayton	624,G624	CM&StP
Clayton, 400 meters above foot of Island 181, 20 meters back from bank of river, just above head of Island 182; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 193/2):		
Copper bolt	609.87	Bull. 569
Cap on pipe	613.82	
Clayton, opposite CM&StP Ry station; base of rail (U.S. C.E.b.m.)	623.46	Bull. 569
Clayton, Island 181, 20 meters back from river bank, 600 meters above small slough which empties into river opposite Clayton, 100 meters below upper end of high timber (bank in front of bench mark is steep, but becomes sloping 100 meters below); copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 194/2):		
Copper bolt	613.24	Bull. 569
Cap on pipe	617.19	
Clayton, 0.25 mile above station, on right of way of CM&StP Ry, 1.5 meters from fence, on slope of bluff, 5 meters above railroad bridge 352; 10 meters above a Government light; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 194/3):		
Copper bolt	644.26	Bull. 569
Cap on pipe	648.20	
Clayton, nearly 3 miles below, 4 feet farther down the river than p.b.m. 242, 2 feet above grade of track,		

Station	Elevation feet	Authority
marked "U□S" on face of ledge; highest point in square (U.S.C.E.t.b.m. 241)	628.306	Bull. 569
Clayton, nearly 3 miles below, opposite lower part of Island 182, 141 feet below milepost 76, on line of CM&StP Ry, 45 feet above highest point of heavy rock-cut waste, about in center of long sidehill rock cut, at prominent point of bluff in steeply inclined face of rock, 4½ feet above grade, marked "U.S.⊙P.B.M."; copper bolt (U.S.C.E.p.b.m. 242)	630.674	Bull. 569
Clayton, 1 mile below, 866 feet below milepost 74, 230 feet above wooden sand hopper, on more northerly one of two large bowlders, 19 feet west of center of track; highest point in square cut on top face, 1 foot from edge, marked "U□S" (U.S.C.E.t.b.m. 239)	632.053	Bull. 569
Clayton, on south side of Main St., 656 feet back from river bank, on southwest corner of Main and Douglas Sts., on brick building occupied by Frank Lier & Co., on east end of doorstep, marked "U.S.⊙P.B.M."; copper bolt (U.S.C.E.p.b.m. 241)	650.304	Bull. 569
Clayton, at CM&StP Ry station, on top stone of foundation pier, at northeast corner of platform, behind center of circle "⊙" (U.S.C.E.t.b.m. "Old U.S.b.m."; also called "Old p.b.m. 27")	626.137	Bull. 569
Clayton, in upper end of, on large stone mill at west side of CM&StP Ry track, on river front of building at lower window and lower end of window sill; top of ring bolt, 1 inch above surface (U.S.C.E. old U.S.b.m.b.)	622.541	Bull. 569
Clayton, Mississippi river, low water	G601	Miss. Riv. Com.
Clayton, Mississippi river, high water	G631	Miss. Riv. Com.
Clayton Center, Clayton Co., sec. 9, T. 93 N., R. 4 W., SE. cor. school yard; iron post stamped "1038 DBQ"	1,038.838	Bull. 569
Clear Lake	1236,G1240	CM&StP
Clear Lake Junction	1164.7	CGW
Clear Lake Junction, crossing CM&StP	1144.1	CGW
Clear Lake Junction	1160	CRI&P
Clearfield	1253,G1250	CB&Q
Cleghorn	1459,G1458	IC
Clemons Grove	960,G953	M&StL
Clermont, in front of CRI&P Ry station; top of rail (on spur line)	854.6	Bull. 569
Clermont, in sec. 34, T. 95 N., R. 7 W., in NE. cor. school yard; iron post stamped "861 DBQ"; as reset in 1924	861.836	Bull. 569
Clermont	859	CRI&P
Cleveland	899	CB&Q
Cleves	1075,G1070	CRI&P
Cliffland, B.M. top of monument M.P. 69	628.44	CRI&P
Cliffland, B.M. top of monument M.P. 70	632.92	CRI&P
Cliffland, B.M. top of monument M.P. 71 (U.S.C.E.b.m. 40)	631.19	CRI&P
Cliffland, top of rail, center section house (U.S.C.E.b.m. 45)	630.50	CRI&P
Cliffland, B.M. top of monument M.P. 72	641.05	CRI&P
Cliffland, B.M. top of monument M.P. 73	638.71	CRI&P
Cliffland, top of SE. cor. downstream end of first concrete pier from north end of highway bridge (U.S.C.E.b.m. 86)	636.00	Bull. 569
Clinton	598	C&NW
Clinton, crossing CM&StP	598	C&NW
Clinton	593	CM&StP
Clinton, crossing C&NW	594	CM&StP
Clinton, CB&Q depot	595	CM&StP
Clinton, DRI&NW station	601	CB&Q
Clinton, junction with City Railway lines	595.18	CD&M
Clinton	591	CRI&P

Station	Elevation feet	Authority
Clinton, in extreme southern part of, opposite stock yards, 1 meter east of fence on west side of street forming west line of Chancy Park addition, 131 meters north of north line of Liberty St.; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 160/4):		
Copper bolt	633.80	Bull. 569
Cap on pipe	637.83	
Clinton, in front of CB&Q RR passenger station, base of rail (U.S.C.E.)	590.19	Bull. 569
Clinton, in front of C&NW Ry passenger station; base of rail (U.S.C.E.)	590.83	Bull. 569
Clinton, cut on third capstone of west abutment of C&NW Ry bridge (U.S.C.E. railroad b.m.)	592.42	Bull. 569
Clinton, at waterworks, cut on top of square stone 1 foot above ground on building line on north side of Sixth Ave. at waterworks (U.S.C.E.t.b.m. 20 r.b. equals city b.m.)	587.25	Bull. 569
Clinton, on NW. cor. Oliver Messer's warehouse; high-water mark of 1880	587.10	Bull. 569
Clinton, on iron safe inside of Smith & Oak's warehouse on river bank; high-water mark of 1892	584.30	Bull. 569
Clinton, at east end of C &NW Ry bridge; base of rail over east abutment (U.S.C.E.b.m.)	593.08	Bull. 569
Clinton, at Chandler St., 648.6 meters back of following-described bench mark, on wagon road running parallel to CB&Q RR tracks, 0.5 meter west of fence on east side of road, 225 meters south of north line of property of C&NW Ry, 14.5 meters 209° 30′ to SW. cor. white house owned by C&NW Ry; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 161/1):		
Copper bolt	591.59	Bull. 569
Cap on pipe	595.60	
Clinton, at Chandler St., 1.5 miles below Lyons wagon bridge across river, on prominent point, 25 meters from shore; copper bolt in top of tile surmounted by iron pipe (U.S.C.E.b.m. 161/2):		
Copper bolt	584.77	Bull. 569
Cap on pipe	588.72	
Clinton, 1 meter south by 0.5 meter east of SW. cor. Chandler and North First St., one block south of Joyce's saw-mill; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 161/3):		
Copper bolt	593.34	Bull. 569
Cap on pipe	597.35	
Clinton, C&NW	G589	USGS
Clinton, Mississippi river, low water	G566	Miss. Riv. Com.
Clinton, Mississippi river, high water	G586	Miss. Riv. Com.
Clinton	G593	Weather Bur.
Clio	1107,G1117	CRI&P
Clive	846,G848	CM&StP
Clive, Motts schoolhouse, 1.1 miles north of, 20 feet north of center of forks of roads, 400 feet west of road north, 400 feet west of SE. corner of sec. 26, T. 79 N., R. 25 W.; iron post stamped "869 Adj 1903"	868.097	Bul. 569
Cloverdale	1522,G1518	CRI&P
Clucas	955	CRI&P
Clutier	856	C&NW
Coalfield, T. 73 N., R. 16 W., near NW. cor. NE. ¼ NE. ¼ sec. 19, in NW. angle of roads at T road north of fence corner, on fence line to north, driven in ground; 0.75-inch gas pipe, painted "U.S.B.M. 871.7"	871.49	USGS

Station	Elevation feet	Authority
Coalfield, T. 73 N., R. 16 W., NW. cor. NE. ¼ NE. ¼ sec. 18, 10 feet east of right-of-way fence, on fence line east, at angle in road, in root on east side of a 3-foot willow tree; copper nail and washer, painted "U.S.B.M. 855.2"	854.91	USGS
Coalfield, T. 73 N., R. 16 W., near quarter corner between secs. 7 and 8, in NE. angle of roads at T road north, 10 feet east by 1 foot south of corner of right-of-way fence, in top of concrete post; bronze tablet stamped "E.B. No. 12 1924 Iowa", painted "U.S.B.M. 826.3"	826.041	USGS
Coalfield, reference mark, 15 feet west by 3 feet north of tablet, in root on west side of a 3-foot black oak tree; copper nail and washer	823.66	USGS
Coalfield, T. 73 N., R. 16 W., at NW. cor. NE. ¼ NE. ¼ sec. 7, in SE. angle of crossroads, 1 foot east of corner fence post, in top of large bowlder; chiseled square, painted "U.S.B.M. 738.0"	737.78	USGS
Coalfield, T. 73 N., Rs. 16 and 17 W., cor. secs. 1, 6, 7 and 12, in SW. angle of roads at T-road south, 35 feet west by 3 feet south of fence corner, in top of a 1-foot oak stump; copper nail and washer, painted "U.S.B.M. 812.9"	812.57	USGS
Coalfield	723,G719	M&StL
Coatesville	992	WRR
Coburg	1008.6	CB&Q
Coggon	916	IC
Coggon, crossing CA&N	908	IC
Coin	995	WRR
Coin, crossing CB&Q	1015	WRR
Coin	1039.9,G1031	CB&Q
Coin, crossing Wabash	1039	CB&Q
Cole Junction	711	CB&Q
Colfax, T. 79 N., R. 21 W., at corner of secs. 13, 14, 23 and 24, in NW. cor. crossroads, top of north end of iron culvert; chiseled square, marked "867.5"	867.58	USGS
Colfax, T. 79 N., R. 21 W., near corner of secs. 11, 12, 14 and 13, 175 feet east and 15 feet north of crossroads, top of second concrete step leading to farmhouse yard; chiseled square, marked "881.3"	881.39	USGS
Colfax, 0.25 mile south of, 30 feet north of elbow in road, at quarter corner between secs. 11 and 12, on concrete post; bronze tablet stamped "Prim. Trav. Sta. No. 20-L.S.-1924-Ia.", marked "915.1"	915.220	USGS
Colfax, reference mark is 5 feet east of "L.S. 20"; top of gas pipe	915.11	USGS
Colfax, on south Locust St. between West Broadway and West Washington Sts., on west side of public grade school building, on south side north door, in top of foot stone; chiseled square, marked "813.0"	813.096	USGS
Colfax, CRI&P Ry in, at crossing of Walnut St.; top of south rail	791.54	USGS
Colfax, on north side of, top of NE. end of railing of concrete bridge on Highway No. 64 over Skunk river drainage ditch; chiseled square, marked "794.6"	794.71	USGS
Colfax, Skunk river drainage ditch near, surface of water underneath bridge on May 22, 1926, 2.30 p.m.	775.78	USGS
Colfax, T. 80 N., R. 21 W., in NW. ¼ NW. ¼ sec. 36, near road junctions, 85 feet west of line of highway south and 45 feet south of line of highway west and road east, in root on south side of 30-inch maple tree; copper nail and washer, marked "808.0"	808.06	USGS
Colfax, T. 80 N., R. 21 W., in NE. ¼ NW. ¼ sec. 35, 160		

Station	Elevation feet	Authority
feet north and 25 feet west of T-road west, top of west heading of concrete culvert; chiseled square, marked "857.6"	857.73	USGS
Colfax, T. 80 N., R. 21 W., near quarter corner between secs. 23 and 26, 30 feet south and 30 feet east of cross-roads, top of concrete post (witness mark of corner); iron rod, marked "927.3"	927.38	USGS
Colfax	786.71	DM&CI
Colfax	788,G791	CRI&P
Collett	752	CB&Q
Collins	1007,G1005	CM&StP
Collins, Altamont moraine east of	1022	IaGS
Colo	1043,G1043	C&NW
Colo, Altamont moraine east of	1016	IaGS
Columbia Siding	816	C&NW
Columbus Junction	586,G595	CRI&P
Columbus Junction, crossing CRI&P, Burlington line	586	CRI&P
Commerce	833,G836	CRI&P
Commerce, 2.5 miles west of, in NW. cor. concrete culvert; aluminum tablet	834.843	Bull. 569
Commerce, 50 feet south of track, 75 feet SW. of first stone culvert west of station, 2 feet west of gate, in right of way fence, near section tool house; iron post	836.074	Bull. 569
Commerce, in front of CRI&P Ry station; top of rail	836.5	Bull. 569
Cone	615,G618	CRI&P
Cone, crossing CM&StP	614	CRI&P
Cone	612,G615	CM&StP
Cone, crossing CRI&P	613,G615	CM&StP
Conger	921.41	DM&CI
Connables—Subgrade of track opposite shelter	528.3	CRI&P
Connables, 1.8 miles SE. of, top of monument M.P. 10 (U.S.C.E.b.m. 2)	512.56	CRI&P
Connables, 0.8 mile SE. of, top of monument M.P. 11 (U.S.C.E.b.m. 3)	515.24	CRI&P
Connables, top of monument M.P. 12	533.79	CRI&P
Connables, top of monument M.P. 13	542.27	CRI&P
Connor, Allamakee Co., T. 98 N., R. 6 W., SE. cor. sec. 9, in SW. cor. West Ridge school yard; iron post stamped "1254 DBQ"	1,253.487	Bull. 569
Conover, in front of CM&StP Ry station; top of rail	1,235.2	Bull. 569
Conover, sec. 15, T. 97 N., R. 9 W., north of front entrance to village hall; iron post stamped "1233 DBQ"	1,233.449	Bull. 569
Conover	1235.6	USGS
Conover	1236	CM&StP
Conover, junction with Decorah branch	1239	CM&StP
Conrad	992	C&NW
Conroy	878,G883	CM&StP
Consol	793.99	C&NW
Conway	1141.5,G1140	CB&Q
Conway Crossing (changed to Merle Junction) Creston branch	1154.6,G1158	CB&Q
Conway Crossing, crossing CB&Q	G1156	CB&Q
Coon Rapids	1170,G1174	CM&StP
Coon Valley	779	CRI&P
Cooper	1079,G1081	CM&StP
Coppock	617	CB&Q
Coppock	623,G620	M&StL
Cora	1258	IC
Coralville, top of rail on south line sec. 31, Tp. 80, R. 6, 240 feet west of SE. cor. sec. 31	730.40	CR&IC

Station	Elevation feet	Authority
Coralville, top of rail at center line of CRI&P and CR&IC crossing	663.30	CR&IC
Coralville, bench mark, top of water table on SW. cor. substation	664.78	CR&IC
Coralville, top of rail on south line sec. 5, Tp. 79, R. 6, 1025 feet east of S. ¼ cor. sec. 5	662.80	CR&IC
Cordova	738	WRR
Cordova, T. 77 N., R. 20 W., 0.5 mile east of SW. cor. sec. 12, 30 feet south and 85 feet west of center of crossroads, 4 feet north of fence; iron post stamped "837 Iowa"	835.423	Bull. 569
Corley	1176,G1180	CRI&P
Cornelia	1223.0,G1223	CGW
Cornell	1396	M&StL
Corning	1117,G1117	CB&Q
Corning, E. line sec. 4, Mercer Tp.	1280	IaGS
Corning	G1117	Weather Bur.
Correctionville	1128	C&NW
Correctionville, crossing IC	1126	C&NW
Correctionville	1127,G1129	IC
Correctionville, crossing C&NW	1130,G1129	IC
Corwith	1174,G1177	M&StL
Corwith, crossing M&StL	1178,G1178	M&StL
Corydon	1083	CRI&P
Corydon, crossing under CB&Q	1078	CRI&P
Corydon	1089,G1105	CB&Q
Cotter	694	CRI&P
Cottonville, Jackson Co.	990	USGS
Cottonville, Middle Richland Tp.	840	USGS
Cottonwood	708	CB&Q
Cou Falls, top of rail on south line sec. 16, Tp. 81, R. 7, 550 feet east of SW. cor. sec. 16	743.60	CR&IC
Cou Falls, bench mark, top of east end of middle concrete pier on north side of elevator	743.15	CR&IC
Cou Falls, top of rail on east line sec. 21, Tp. 81, R. 7, 1350 feet north of SE. cor. sec. 21	700.50	CR&IC
Cou Falls, top of rail on north end of Iowa river bridge	700.70	CR&IC
Cou Falls, top of rail on south end of Iowa river bridge	700.60	CR&IC
Coulter	1239.4	CGW
Council Bluffs	983.1,G984	CGW
Council Bluffs, crossing C&NW	980.30,G984	CGW
Council Bluffs, crossing CB&Q	983.0,G988	CGW
Council Bluffs	989,G984	IC
Council Bluffs, Levee Jct.	991	IC
Council Bluffs, North Jct.	990	IC
Council Bluffs	986	C&NW
Council Bluffs, east switch	981	WRR
Council Bluffs, west end Wabash yards	983	WRR
Council Bluffs	977,G983	CRI&P
Council Bluffs, crossing CGW	989	CRI&P
Council Bluffs, crossing Wabash and CB&Q	976	CRI&P
Council Bluffs, crossing CM&StP	977	CRI&P
Council Bluffs, crossing C&NW	977	CRI&P
Council Bluffs, U.P. transfer	978	CRI&P
Council Bluffs, in front of CRI&P station; top of rail	981.9	Bull. 569
Council Bluffs, in south wall of post office, near SW. cor.; aluminum tablet	1,000.654	Bull. 569
Council Bluffs, 2.5 miles east of, in west pier of CGW Ry bridge crossing CRI&P Ry and CM&StP Ry tracks, 5 feet from ground; aluminum tablet	994.520	Bull. 569
Council Bluffs, 6 miles east of, halfway between CRI&P		

Station	Elevation feet	Authority
Ry and CM&StP Ry tracks, 6 feet north of wagon road at crossing SE. of John Slightam's house; iron post	1,019.720	Bull. 569
Council Bluffs	988,G984	CB&Q
Council Bluffs, crossing Wabash & CRI&P	988	CB&Q
Council Bluffs	976,G979	CM&StP
Council Bluffs, U.P. transfer station	981,G984	CM&StP
Council Bluffs, crossing CB&Q and Wabash	976	CM&StP
Council Bluffs, 4 miles SE. of CB&Q station, 615 feet south of railway bridge over Mosquito creek, 49 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 342):		
Copper bolt	970.461	Bull. 569
Cap on pipe	974.473	
Council Bluffs, in stone doorsill of CM&StP roundhouse, 0.3 foot from east side of door frame and same from front face of sill, 8 feet from SW. cor. building; top of copper bolt in stone (U.S.C.E.p.b.m. 343)	981.002	Bull. 569
Council Bluffs Union Station, in window sill of second window west of NE. cor. station, 0.4 foot from east jamb and 0.3 foot from face of sill; copper bolt in stone (U.S.C.E.p.b.m. 347)	986.570	Bull. 569
Council Bluffs, in SW. cor. courthouse yard, 3 feet from west fence and 3 feet from south fence; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E. p.b.m. 348 equals 121/2):		
Copper bolt	990.339	Bull. 569
Cap on pipe	994.355	
Council Bluffs, 197 feet above upper end of ways of United States boat yard, 112 feet from river bank, 3 feet from NW. cor. boat-yard storehouse; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E. p.b.m. 349 equals 122/2):		
Copper bolt	975.362	Bull. 569
Cap on pipe	979.378	
Council Bluffs, 4 miles above, 62 feet south of south end of bridge 1066, 404 feet north of milepost 4, 28 feet east of C&NW Ry track; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 350):		
Copper bolt	995.615	Bull. 569
Cap on pipe	999.621	
Council Bluffs, 6 miles north of Union Station, 630 feet north of shore end of upper Government dike, 367 feet north of south end of bridge 1043, 16 feet west of C&NW Ry track; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 351)		
Copper bolt	986.740	Bull. 569
Cap on pipe	990.756	
Council Bluffs, Missouri river, low water	G962	Mo. River Com.
Council Bluffs, Missouri river, high water	G981	Mo. River Com.
Council Bluffs	G990	Weather Bur.
County Line	776	CRI&P
Covington	762,G762	CM&StP
Covington, south crossing under CRI&P	791	CM&StP
Covington, north crossing under CRI&P	812	CM&StP
Crabb Hill, Jackson Co.	700	USGS
Craig, Plymouth Co.	1406.49	C&NW
Craig, divide 1 mile west of, surface	1441	C&NW
Craig, 1 mile west of, track	1433	C&NW
Craig, Polk Co.	962.63	DM&CI
Cranston	660,G663	CM&StP
Cranston, crossing Cedar river	604,G607	CM&StP

Station	Elevation feet	Authority
Crawfordsville	731	CB&Q
Crescent	992,G995	C&NW
Crescent, 183 feet south of station, 15 feet east of railroad, in small park belonging to railway company; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 352):		
Copper bolt	988.440	Bull. 569
Cap on pipe	992.459	
Cresco	1300,G1298	CM&StP
Cresco	G1300	Weather Bur.
Creston	1314,G1312	CB&Q
Crippen	1260,G1265	CM&StP
Crocker	981,G985	C&NW
Crocker, T. 81 N., R. 24 W., NW. cor. sec. 34; spike in telephone pole, marked "U.S.B.M. 995"	993.58	Bull. 569
Crocker, T. 81 N., R. 24 W., SW. cor. sec. 35; iron post stamped "979"	977.418	Bull. 569
Crocker, T. 80 N., R. 24 W., NE. cor. sec. 4; spike in telephone pole, marked "U.S.B.M. 981"	980.08	Bull. 569
Crocker, T. 81 N., R. 24 W., SW. cor. sec. 33; spike in telephone pole, marked "U.S.B.M. 975"	974.22	Bull. 569
Crocker, T. 80 N., R. 24 W., NE. cor. sec. 6; iron post stamped "977"	975.742	Bull. 569
Cromwell	1253,G1255	CB&Q
Crooks	1162	FtDDM&S
Crooks, T. 87 N., R. 28 W., near cor. secs. 29, 30, 31 and 32, about 600 feet east of crossroads, in concrete walk at SE. corner of west porch on Mr. Grant Spangler's residence, bronze tablet stamped "Iowa 1921"	1,165.353	USGS
Crooks, T. 87 N., R. 28 W., near cor. secs. 29, 30, 31 and 32, about 600 feet east of crossroads, in Mr. Grant Spangler's yard, near front gate, in root of maple tree (10 inches in diameter); copper nail and washer marked "U.S.G.S.B.M." S 10° E. 93.1 ft. from bronze tablet desc. above	1,162.24	USGS
Crooks, T. 87 N., Rs. 28 and 29 W., at cor. secs. 25, 30, 31 and 36, about 280 feet west of junction of T road north, in south side of road, in foot of willow stump; copper nail and washer marked "U.S.G.S.B.M."	1,153.90	USGS
Crooks, T. 87 N., R. 29 W., at cor. secs. 25, 26, 35 and 36 in schoolyard at NE. cor. crossroads, 40 feet SW. of schoolhouse, in root of maple tree (15 inches in diameter); copper nail and washer marked "U.S.G.S. B.M."	1,158.85	USGS
Crooks, 0.5 mile west of, T. 87 N., R. 29 W., at cor. secs. 23, 24, 25 and 26, in SW. cor. crossroads, inside field fence and 6 feet south of fence corner; iron post stamped "Iowa 1921"	1,158.061	USGS
Crooks, 0.5 mile west of, T. 87 N., R. 29 W., cor. secs. 23, 24, 25 and 26, in south end of concrete culvert, at SE. cor. crossroads; chiseled square N. 65° E. 66.1 ft. from iron post desc. above	1,158.06	USGS
Crooks, T. 87 N., R. 29 W., at cor. secs. 13, 14, 23 and 24, in schoolyard at SE. cor. crossroads, 40 feet west of schoolhouse, in root of soft maple tree (14 inches in diameter): copper nail and washer marked "U.S.G.S. B.M." T.B.M. 1,157.4	1,157.27	USGS
Croton, B.M. top of monument M.P. 24 (U.S.C.E.b.m. 10)	544.32	CRI&P
Croton, B.M. top of monument M.P. 25 (U.S.C.E.b.m. 11)	548.21	CRI&P
Croton, top of rail, center of depot	543.4	CRI&P
Croton, B.M. top of monument M.P. 26 (U.S.C.E.b.m. 12)	542.72	CRI&P

Station	Elevation feet	Authority
Croton, B.M. top of monument M.P. 27 (U.S.C.E.b.m. 13)	560.61	CRI&P
Croton, B.M. top of monument M.P. 28 (U.S.C.E.b.m. 14)	553.40	CRI&P
Crown	1143	CB&Q
Crystal Lake	1258	CRI&P
Cuba	739,G744	CM&StP
Cuba, English river near	725	IaGS
Culver	543	CRI&P
Culver, junction with CRI&P	545	CM&StP
Cumberland	1224.64,G1223	CB&Q
Cumberland, level of Seven Mile creek, 1½ miles north of	1105	IaGS
Cumberland, first hilltop south of	1317	IaGS
Cummings	972.7,G971	CGW
Cummins	917.87	DM&CI
Curlew	1243	M&StL
Cushing	1275,G1275	C&NW
Cylinder	1188,G1194	CM&StP
Daileys	966.40	DM&CI
Daileys Park	807.76	DM&CI
Dakota City	1124,G1125	C&NW
Dakota City, crossing over M & StL	1135	C&NW
Dakota City, T. 92 N., R. 28 W., near NW. cor. sec. 26, 1,551 feet (by traverse) south of T road east, in south corner of right angle bend in road to north and west; iron post stamped "Iowa 1921" Note: Set in place of Prim. Trav. Sta. No. 11 which had been removed, and in the hole where traverse post had been, as pointed out by nearby resident.	1,127.149	USGS
Dakota City, T. 92 N., R. 28 W., near NW. cor. sec. 26, bearing N. 50° W., distant 67.5 feet from above post, 1,524 feet south of T road east, at north cor. of right angle bend in road, in root of oak tree (12 inches in diameter); copper nail and washer marked "U.S.G.S.B. M."	1,127.60	USGS
Dale	560	CRI&P
Dallas, Dallas Co.	944.27	DM&CI
Dallas, Marion Co., see Melcher.		
Dallas Center	1073,G1068	M&StL
Dallas Center, T. 79 N., R. 27 W., NE. cor. NW. ¼ sec. 14, in corner of lot at SW. cor. junction of crossroads, 10 feet from either road; iron post stamped "1049"	1,047.306	Bull. 569
Dallas Center, T. 79 N., R. 27 W., sec. 2, in east face of Citizen's Bank, 27 feet from south edge; aluminum tablet stamped "1073"	1,071.985	Bull. 569
Dallas Center, T. 80 N., R. 27 W., NW. cor. SW. ¼ sec. 23, in corner of field at SE. cor. crossroads, 15 feet from either road and 3 feet from side of fence around field; iron post stamped "1024"	1,022.376	Bull. 569
Dallas Center, T. 80 N., R. 26 W., SE. cor. NE. ¼ sec. 19, in corner of field at NW. cor. T road, 10 feet from either road, 3 feet from either side of fence around field; iron post stamped "1029"	1,027.993	Bull. 569
Dalton	1203	GN
Dana	1123,G1118	M&StL
Danbury	1157	C&NW
Danville	723,G726	CB&Q
Darby (abandoned, 1908)	867,G871	CM&StP
Davenport	569,G559	CM&StP
Davenport, crossing CRI&P	575	CM&StP
Davenport	606,G591	CRI&P
Davenport, crossing Telegraph Road and Indian Road	592.07	CD&M
Davenport, crossing over CRI&P	727.96	CD&M

Station	Elevation feet	Authority
Davenport, crossing, top of CRI&P rail	703.20	CD&M
Davenport, DRI&NW station	566	CB&Q
Davenport, 3 miles below, 0.5 meter west of fence on Davenport wagon road along bluffs, 1,569.5 meters back from bench mark 148/3, 35.5 meters 229° to NW. cor. Fairview schoolhouse; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 148/4):		
Copper bolt	616.22	Bull. 569
Cap on pipe	620.12	
Davenport, in top of corner of foundation of glucose works in southern part of, on SW. cor. east wing of building; copper bolt marked "M.R.C.⊙B.M.U.S." (U.S.C.E. b.m. 149/3):	563.63	Bull. 569
Davenport, top of top bolt in fire plug at west end of retaining wall, Davenport end of Government bridge (U.S. C.E.t.b.m. 3 r.b.)	566.05	Bull. 569
Davenport, top of water table SW. cor. Davenport waterworks (U.S.C.E.t.b.m. r.b.)	564.94	Bull. 569
Davenport, in front of CM&StP Ry station; base of rail (U.S.C.E.b.m.)	560.17	Bull. 569
Davenport, in front of passenger station of CRI&P Ry; base of rail	592.12	Bull. 569
Davenport, top of stone doorsill west end of stone of Masonic Temple entrance on Third St. (U.S.C.E. city b.m.)	583.33	Bull. 569
Davenport, top of water table NW. cor. CRI&P Ry passenger station (U.S.C.E. city b.m.)	593.38	Bull. 569
Davenport and Rock Island bridge, on draw pier; Government gage; elevation of zero	542.52	Bull. 569
Davenport, 500 meters above last lumber yard above, 30 meters from bank of river, 0.5 meter north of fence, in oak grove, 115 meters above culvert across creek, 11.5 meters 334° 30′ to 10-inch hickory tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 150/3):		
Copper bolt	585.77	Bull. 569
Cap on pipe	589.82	
Davenport, Rock Island rapids, opposite guide pier 22; on top of solid ledge of rock at extreme point of rock at bend (U.S.C.E.b.m. 22 R.B.) (Col. King)	560.58	Bull. 569
Moline, Ill., just below iron post opposite upper end of, on solid ledge of rock (U.S.C.E.b.m. 21 R.B.)	559.82	Bull. 569
Davenport, Rock Island, 1.5 miles above head of, on property of George Walker, 60 meters east of east line of club grounds belonging to M. Y. Cady, 0.5 meter east of wire fence between properties of George Walker and Lawrence Rassmusson, 25 meters south of river, 125 meters north of CB&Q RR; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 151/2):		
Copper bolt	564.04	Bull. 569
Cap on pipe	568.06	
Davenport, Rock Island, 1.5 miles above head of, on property of Young Stokes, 0.5 meter west of line between properties of Stokes and Hartman, 400 meters south of Pleasant Valley wagon road, 300 meters north of river bank on high ridge; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 151/3):		
Copper bolt	568.31	Bull. 569
Cap on pipe	572.33	
Davenport, Rock Island, 1.5 miles above head of, cut on top of solid ledge of rock opposite and below guide pier 16,		

Station	Elevation feet	Authority
marked "B.M. 15" black on white (U.S.C.E.b.m. 15 R.B.)	557.90	Bull. 569
Davenport, West, at lower end of, near river bank, in west side near SW. cor. foundation of vinegar works, 0.4 meter from ground; brass bolt, marked "U.S.P.B.M." (U.S. C.E.p.b.m. 38)	567.505	Bull. 569
Davenport, in north abutment of Rock Island and Davenport railway bridge over main channel of Mississippi river, in coping of east or upper side of abutment, on plane with sidewalk, 4.1 meters from river face of abutment and 0.1 meter inside of railing; copper bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 39)	573.562	Bull. 569
Davenport, Arsenal Island, at lower end of, on base of stone tower of United States arsenal stone building A1865, in east side NE. cor., 4 feet from ground; copper bolt marked "U.S.P.B.M." (U.S.C.E.p.b.m. 40)	577.627	Bull. 569
Davenport, new city datum	G529	Weather Bur.
Davenport	G606	Weather Bur.
Davenport, West, yard	G568	CM&StP
Davenport, West, crossing CRI&P	G568	CM&StP
Davenport, West	583	CRI&P
David	1265.9,G1265	CGW
Davis City	913,G914	CB&Q
Dawson	1036,G1039	CM&StP
Dayton, Washington Co	823	IaGS
Dayton, Webster Co.	1083,G1089	C&NW
Dayton	1139,G1131	M&StL
Dayton, crossing over C&NW	1139,G1139	M&StL
Dayton, crossing, C&NW track	1116,G1116	M&StL
Dayton, T. 86 N., R. 27 W., near center of sec. 20, bend in road to west, east side of road at bend; copper nail in base of telephone pole, marked "1122.3"	1,121.33	Bull. 569
Dayton, T. 86 N., R. 27 W., west center of sec. 20, NE. cor. crossroads, at fence corner; iron post stamped "Prim. Trav. Sta. No. 6, 1912, 1130"	1,128.531	Bull. 569
Dayton, T. 86 N., R. 27 W., SE. cor. sec. 19, NW. cor. forks at T road west; copper nail in base of corner fence post, marked "1132.6"	1,131.66	Bull. 569
Dayton, T. 86 N., R. 27 W., NE. cor. sec. 31, SW. cor. crossroads, in corner of fence post; copper nail marked "1129.5"	1,128.55	Bull. 569
Dayton, T. 86 N., R. 28 W., 0.25 mile south of NE. cor. sec. 24 at crossroads, 40 feet SW. of center of crossroads, in base of corner fence post, marked "1,130.6"; spike	1,130.58	USGS
Dayton, 0.6 mile SE. of, near south quarter corner of sec. 13, at bend in road to east, on north side of road, on fence line; copper nail and washer, in root of 12-inch oak tree, marked "1,126.1"	1,126.15	USGS
Dayton, C&NW Ry crossing at station; top of south rail, marked "1,082.5"	1,082.5	USGS
Dayton, C&NW Ry station, 58 feet west of, at C&NW and M&StL railways crossing, 50 feet east of crossing, on south edge of C&NW roadbed, in center of concrete culvert, marked "1,109.4"; chiseled square	1,109.38	USGS
Dayton, T. 86 N., R. 28 W., corner of secs. 14, 15, 22 and 23, at T road west, 130 feet west of road fork, on south edge of road, in top of concrete culvert; bronze tablet stamped "Iowa 1919 1,124"	1,123.970	USGS
Dayton, T. 86 N., R. 28 W., cor. secs. 15, 16, 21 and 22, 50 feet SW. of center of crossroads, in fence corner, in		

Station	Elevation feet	Authority
root of 12-inch maple stump marked ''1,153''; copper nail and washer	1,153.05	USGS
Dayton, T. 86 N., R. 28 W., cor. secs. 16, 17, 20 and 21, 35 feet NW. of center of crossroads, in concrete base of fence post, marked ''1,173.2''; chiseled square	1,173.24	USGS
Dayton, Tps. 86 and 87 N., R. 27 W., cor. secs. 4, 5, 32 and 33, T road north, 30 feet south of road fork, 3 feet north of fence line, in root of 12-inch oak tree, marked ''1,107.6''; copper nail and washer	1,107.44	USGS
Dayton, Tps. 86 and 87 N., R. 27 W., quarter cor., south side of sec. 32 at T road south, 60 feet SW. of road fork, 6 feet south of fence corner; iron post stamped ''Iowa 1919 1,116''	1,115.720	USGS
Dayton, T. 86 N., R. 27 W., 0.25 mile south of center of sec. 5; T road east, 25 feet SE. of road fork, in base of corner fence post, marked ''1,119''; spike	1,118.86	USGS
Dayton, T. 86 N., R. 27 W., quarter corner, south side of sec. 5, T road west, 25 feet northwest of road fork, in base of corner fence post, marked ''1,118.6''; spike	1,118.43	USGS
Dayton, T. 86 N., R. 27 W., quarter corner, north side of sec. 17, T road north, 25 feet south of road fork, in corner fence post, marked ''1,117.8''; spike	1,117.62	USGS
Dayton, about 3 miles east of, at C&NW Ry. bridge over Skillet creek, on west end and north side of bridge, in wooden top sill over ties, marked ''963.8''; iron bolt	963.63	USGS
Dayton, T. 86 N., R. 27 W., one-sixteenth corner, south side of SW. ¼ sec. 17, 50 ft. west of old abandoned road entering timber, 12 ft. north of fence line, in root of 10-inch oak tree; marked ''1,111.5''; copper nail and washer	1,111.35	USGS
Dayton, T. 86 N., R. 27 W., quarter cor., west side sec. 19, T road east, 100 feet north of road cor., on east side of north and south road, in base of telephone pole, marked ''1,136.9''; spike	1,136.91	USGS
Dayton, T. 86 N., R. 28 W., 0.25 mile south of NE. cor. sec. 24, at crossroads, 40 feet SW. of center of crossroads, in base of cor. fence post, marked ''1,130.6''; spike	1,130.58	USGS
Dayton, T. 86 N., R. 28 W., at cor. secs. 9, 10, 15 and 16, 30 feet SE. of center of crossroads, in east end of iron culvert under road; painted square ''T.B.M. 1,153.2''	1,153.24	USGS
Dayton, T. 86 N., R. 28 W., about 500 feet south of cor. secs. 3, 4, 9 and 10, in driveway to Aivie Larson's residence just opposite house, in root of boxelder; copper nail and washer marked ''U.S.G.S.B.M.'' 65.2 feet due west of iron post desc. below	1,149.43	USGS
Dayton, T. 86 N., R. 28 W., about 500 feet south of cor. secs. 3, 4, 9 and 10, just inside gate and on south side of driveway to Aivie Larson's residence; iron post stamped ''Iowa 1921''	1,150.198	USGS
Dayton, T. 87 N., R. 28 W., 1,280 feet north of south corner of secs. 33 and 34, on north side of driveway to David A. Miller's residence, 100 feet N.W. of house in root of maple tree (15 inches in diameter); copper nail and washer marked ''U.S.G.S.B.M.'' T.B.M. 1,146.9	1,146.86	USGS
Dean	828.5,G834	CB&Q
Decatur City	1137	CB&Q
Decorah	859	CRI&P
Decorah, in front of CRI&P Ry station; top of rail	861.2	Bull. 569
Decorah, in front of CM&StP Ry station; top of rail	863.1	Bull. 569
Decorah, SE. ¼ sec. 16, T. 98 N., R. 8 W., in foundation		

Station	Elevation feet	Authority
of jail at NE. cor., 3 feet above ground; bronze tablet stamped ''904 DBQ''	904.152	Bull. 569
Decorah, T. 99 N., R. 8 W., 0.25 mile east of SW. cor. sec. 21, NW. of road intersection; iron post marked ''1148 DBQ''	1,148.355	Bull. 569
Decorah	875	CM&StP
Decorah	G875	Weather Bur.
Dedham	1262	CM&StP
Deep River	839	C&NW
Defiance	1280,G1275	CM&StP
De Kalb	963,G960	CB&Q
Delaware	1063,G1065	IC
Delaware, crossing under CM&StP	1071	IC
Delaware	1078,G1080	CM&StP
Delaware, crossing over IC	1088,G1089	CM&StP
Delaware, crossing, IC track	G1068	CM&StP
Delaware, SW. ¼ sec. 32, T. 88 N., R. 4 W., NW. cor. street opposite post office and Knowles Hotel; iron post stamped ''1089''	1,079.668	Bull. 569
Delaware, in front of IC RR station; top of rail	1,065.4	Bull. 569
Delaware	G1083	Weather Bur.
Delhi	997,G998	CM&StP
Delhi, near north line of sec. 20, T. 88 N., R. 4 W., on east side of road, about 100 feet east of CM&StP Ry station; iron post stamped ''1016''	1,007.208	Bull. 569
Delmar	807,G807	C&NW
Delmar, crossing CM&StP	819	C&NW
Delmar	821,G820	CM&StP
Delmar, crossing C&NW	820	CM&StP
Deloit	1185	C&NW
Deloit	1190,G1191	IC
Delphos	1133,G1140	CB&Q
Delray	1147	CB&Q
Delta	787	CRI&P
Delta, North Skunk river at mill	682	IaGS
Delta, Cedar creek east of	693	IaGS
Delvida	844	CRI&P
Denison	1169,G1170	IC
Denison, crossing C&NW	1169,G1170	IC
Denison	1171,G1176	C&NW
Denison, crossing IC	1170	C&NW
Denison	G1180	Weather Bur.
Dennis	896	ISU
Dennis, crossing Chariton river	884	ISU
Denova	720,G720	CB&Q
Denver, depot, top of rail	940.1,G943	WCF&N
Denver Junction	1008.5,G1007	CGW
Derby	1093,G1094	CB&Q
Des Moines, Keokuk line, B.M. top of monument M.P. 360	797.17	CRI&P
Des Moines, B.M., top of monument M.P. 361	796.61	CRI&P
Des Moines, B.M. top of monument M.P. 362	800.31	CRI&P
Des Moines, B.M. top of monument M.P. 363	792.47	CRI&P
Des Moines, B.M. west anchor bolt on north side of cylinder pier, west end of Des Moines river bridge	795.14	CRI&P
Des Moines, top of rail, center of depot	799.14	CRI&P
Des Moines, main line	796,G799	CRI&P
Des Moines, East	790,G793	CRI&P
Des Moines, East, crossing main line and Short Line	797	CRI&P
Des Moines, East, crossing CB&Q	793	CRI&P
Des Moines, East, crossing CGW	793	CRI&P
Des Moines, East, crossing Wabash	793	CRI&P

Station	Elevation feet	Authority
Des Moines, Union Station	802,G805	CM&StP
Des Moines, crossing Valley Junction interurban line	816	CM&StP
Des Moines, East, crossing CRI&P	796.1,G789	CGW
Des Moines, East, crossing CB&Q	794.2,G791	CGW
Des Moines, East, Des Moines river bridge	G796	CGW
Des Moines, South	800.8	CGW
Des Moines, South, crossing CB&Q	799.9	CGW
Des Moines, Union Station, not now used by M&StL	801	M&StL
Des Moines, East	794.9,G792	CB&Q
Des Moines, West, old depot	801.4	CB&Q
Des Moines, West, crossing CGW	803	CB&Q
Des Moines, East	795	WRR
Des Moines, Union Station	800±	WRR
Des Moines, West, 2d & Grand	802	FtDDM&S
Des Moines, W. 2d and Grand Ave., top of rail	800.25	DM&CI
Des Moines, East	797,G803	C&NW
Des Moines, SE. cor. sec. 19, T. 79 N., R. 24 W., 50 feet N.W. center of crossroads, 2 miles north of University Ave.; iron post stamped ''935 Adj. 1903''	933.983	Bull. 569
Des Moines, Youngstown, center of south side of sec. 5, T. 78 N., R. 23 W., CRI&P Ry bridge over Four Mile creek, west face of coping stone above east pier; aluminum tablet stamped ''796 Adj. 1903''	794.172	Bull. 569
Des Moines, 1 mile west of station, in SE. cor. park adjoining old pumping station of Des Moines Water Works Co., 100 feet north of CM&StP Ry tracks; iron post stamped ''797''	795.560	Bull. 569
Des Moines, in foundation stone 1 foot east of SW. cor. old post office, now Federal Bldg.; aluminum tablet stamped ''809''	807.351	Bull. 569
Des Moines, in NE. cor. yard adjoining city hall, 60 feet north of Locust St.; iron post stamped ''804'' (now city market site, post removed)	802.510	Bull. 569
Des Moines, in front of CRI&P Ry station; top of rail	799.2	Bull. 569
Des Moines, CRI&P Ry bridge over Des Moines river, north face of coping, 2 feet west of east end of pier on south bank, SE. cor. sec. 11, T. 78 N., R. 24 W.; aluminum tablet stamped ''797 Adj 1903''	795.206	Bull. 569
Des Moines, Twenty-eighth St. crossing of CRI&P Ry, SW. ¼ NW. ¼ sec. 8, T. 78 N., R. 24 W., 30 feet north of cottonwood tree; iron post stamped ''804 Adj 1903''	802.978	Bull. 569
Des Moines	G861	Weather Bur.
Des Moines, Locust St. bridge, on 2d pier from west end; zero of gage	773.695	City Engineer*
Des Moines Junction	1163	CB&Q
De Soto	888,G892	CRI&P
De Soto, 1.5 miles SW. of, in SW. stone abutment of bridge 368; aluminum tablet	920.595	Bull. 569
De Soto, 150 feet south of track, opposite west end of station, 2 feet north of wire fence; iron post	888.266	Bull. 569
De Soto, in front of CRI&P Ry station; top of rail	891.8	Bull. 569
Devon	1196.5,G1195	CGW
Dewar	891.1,G891	CGW
Dewitt	719,G710	CM&StP
Dewitt, crossing C&NW	701,G687	CM&StP
De Witt	683,G683	C&NW
De Witt, crossing CM&StP	684	C&NW
Dexter, in front of CRI&P Ry station; top of rail	1,148.3	Bull. 569
Dexter, in stone water table of National Bank of Dexter,		

* By checked levels, Jan., 1925. This gage zero is believed to be zero of City datum and 0.88 foot higher than zero of gage tied to by U. S. Corps of Engineers in 1910.

STATION	ELEVATION FEET	AUTHORITY
on north side of building, 1 foot from NW. cor.: aluminum tablet	1,152.335	Bull. 569
Dexter, 150 feet south of track, opposite point 300 feet east of station, 50 feet north of wagon road, opposite S. C. Paton & Co.'s elevator; iron post	1,144.048	Bull. 569
Dexter	1144,G1148	CRI&P
Diagonal	1094,G1087	CB&Q
Diagonal, crossing over CGW	1099	CB&Q
Diagonal, CGW track	1079	CB&Q
Diagonal	1087.3,G1089	CGW
Diagonal, crossing CB&Q	G1088	CGW
Dickens	1324,G1330	CM&StP
Digby	825	CRI&P
Dike	943	C&NW
Dillon	983,G977	M&StL
Dinsdale	934	CRI&P
Dion	1385	CM&StP
Divide Spur	1548	CRI&P
Dixon	675,G663	CM&StP
Dixon, crossing CRI&P	664,G652	CM&StP
Dixon	674,G676	CRI&P
Dixon, crossing CM&StP	655	CRI&P
Dolliver	1287	C&NW
Donohue	713,G700	CM&StP
Donnan, crossing CRI&P, union station	1150,G1150	CM&StP
Donnan	1153	CRI&P
Donnelley	756,G760	CB&Q
Donnelley, RR bridge over White Breast creek near	753.22	CB&Q
Donnelley, bed of White Breast creek at RR bridge, near	723	IaGS
Donnelley, T. 76 N., R. 20 W., SW. cor. sec. 15, 28 feet north and east of center of crossroads, 3 feet west of fence, 10 feet north of corner fence post; iron post stamped "781 Iowa"	779.879	Bull. 569
Donnellson, Fort Madison line	703,G704	CB&Q
Donnellson, crossing Keokuk-Mt. Pleasant line	703,G703	CB&Q
Donnellson, Keokuk line	702	CB&Q
Doon	1302.1	CStPM&O
Doon	1276	GN
Dorchester, Allamakee Co., T. 100 N., R. 5 W., north of quarter corner east side sec. 16, 60 feet south of SE. cor. schoolhouse, north side of road; iron post stamped "842 DUBQ"	843.468	Bull. 569
Dorchester, 1 mile west of, T. 100 N., R. 6 W., NW. ¼ sec. 23, NW. of road intersection by cemetery; iron post stamped "1087 DBQ"	1,086.825	Bull. 569
Doris	1012	IC
Dotson	847.71	DM&CI
Doubleday	1133,G1136	CM&StP
Douds, B.M. top of monument M.P. 52 (U.S.C.E.b.m. 36)	603.38	CRI&P
Douds, B.M. top of monument M.P. 53 (U.S.C.E.b.m. 37)	606.18	CRI&P
Douds, B.M. top of monument M.P. 54 (U.S.C.E.b.m. 38)	609.05	CRI&P
Douds, top of rail, center of depot	608.9	CRI&P
Douds, B.M. top of monument M.P. 55 (U.S.C.E.b.m. 39)	610.11	CRI&P
Douds, B.M. top of monument M.P. 56 (U.S.C.E.b.m. 40)	605.65	CRI&P
Douds and Leando, top of upstream end of north abutment of highway bridge between (U.S.C.E.b.m. 90)	612.20	Bull. 569
Dougherty	1099	C&NW
Douglass, Fayette Co., T. 95 N., R. 9 W., 0.4 mile north by 0.1 mile west of SE. cor. sec. 22, opposite road intersection by east-west road, east side; iron post stamped "1151 DBQ"	1,152.424	Bull. 569

Station	Elevation feet	Authority
Dover Mills, Fayette Co., level of flood plain	863	IaGS
Dow City	1136,G1132	IC
Dow City	1131,G1132	C&NW
Dow City	G1142	Weather Bur.
Downey	678,G681	CRI&P
Dows	1150,G1142	CRI&P
Drake Siding, M.P. 106	861	CB&Q
Drakeville	878,G891	CRI&P
Dubuque	608.1,G611	CGW
Dubuque, crossing IC	G616	CGW
Dubuque, Fairground	629.4	CGW
Dubuque, crossing CM&StP	608.2	CGW
Dubuque	606,G610	CM&StP
Dubuque, crossing I.C.	607	CM&StP
Dubuque, North Junction switch	606	CM&StP
Dubuque, crossing CGW	608,G611	CM&StP
Dubuque Shops	611,G614	CM&StP
Dubuque	607,G616	IC
Dubuque, crossing CB&Q	610,G616	IC
Dubuque, crossing CM&StP	607,G616	IC
Dubuque	G612	CB&Q
Dubuque, curbstone near lamp-post at junction of Dodge street with North Cascade road	G841	USGS
Dubuque, city B.M. on doorstep of building, First and Main streets	G629	Miss. River Com.
Dubuque, Mississippi river, zero of U.S. gage	G605	Miss. River Com.
Dubuque, Mississippi river, high water	G607	Miss. River Com.
Dubuque	G698	Weather Bur.
Dubuque, NE. cor. customhouse, copper bolt marked U.S. P.B.M.b.m. 279	644.838	Bull. 569
Dubuque, 3 miles below, on property of Joe Herod, 15 meters back from river bank, 0.5 meter from right of way fence of railroad, 15 meters north of perpendicular rock cliff, 100 meters below railroad bridge 92K; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 179/3):		
Copper bolt	608.53	Bull. 569
Cap on pipe	612.49	
Dubuque, 0.8 mile above railroad bridge over river at, on right bank below shops of CM&StP Ry, 0.5 meter north of SW. cor. small stockyards which are just south of roundhouse of that RR. and 50 meters SE. of roundhouse and 25 meters back from bank of slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 180/3):		
Copper bolt	607.48	Bull. 569
Cap on pipe	611.48	
Dubuque, 3 miles above, at foot of bluffs, 8 meters toward bluffs from center of CM&StP Ry track, 125 meters above signboard reading "Slow, 6 miles per hour," 100 meters below a point opposite ferry landing on left bank; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 181/3):		
Copper bolt	614.35	Bull. 569
Cap on pipe	618.30	
Dubuque, NE. cor. Grandview and Dodge Sts.; iron post stamped "875"	874.486	Bull. 569
Dubuque, T. 88 N., R. 2 E., SW. ¼ sec. 15, south side of road, 60 feet from center of porch; iron post stamped "1071"	1,070.924	Bull. 569
Dubuque, 3.2 miles below, 660 feet below milepost 121-40, 370 feet above upper headblock of siding at Cattese and		

STATION	ELEVATION FEET	AUTHORITY
295 feet below Creston Crossing, on lower side of coulee, 25 feet west of center of track, on natural ledge of rock, marked "U□S"; highest point in square (U.S. C.E.t.b.m. 301)	616.807	Bull. 569
Dubuque, 1 mile below, at point of bluff on south side of Rugdale hollow, through which IC RR passes from river, 36 feet from t.b.m. 299, 623 feet from CM&StP Ry bridge, 180 feet above house owned by R. Smith, 131 feet west from center of track, 43 feet NW. from blazed elm on upper side of large flat rock; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 282 and 283):		
Copper bolt	610.038	Bull. 569
Cap on pipe	614.037	
Dubuque, 1 mile below, at point of bluff on lower side of ravine through which the IC Ry passes from river, 623 feet below bridge on CM&StP Ry track, 164 feet above house owned by R. Smith, 98 feet west of center of CM&StP Ry track, on top of large flat rock, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 299)	610.779	Bull. 569
Dubuque, in southern extremity of, at bluff, 0.1 mile below sawmill, directly opposite end of runway to mill, 305 feet above headblock of sawmill siding, 26 feet west from center of siding, in recess in face of rock bluff; copper bolt (U.S.C.E.p.b.m. 281)	612.463	Bull. 569
Dubuque, at river front below harbor, on SW. cor. Houser & Linnehan's boat store, 1½ feet above corner, on water table, in center of buttress, marked "⨀"; highest point of circle in circle (U.S.C.E. old U.S.b.m. b)	606.311	Bull. 569
Dubuque, at river front below harbor, on Diamond Joe store, on upstream end of upstream stone doorsill, marked "□"; highest point of circle in square (U.S. C.E. old U.S.b.m. a)	607.450	Bull. 569
Dubuque, on IC station, at north end, about in center of east side of tower, in water table; highest point in square (U.S.C.E.t.b.m. 297)	608.309	Bull. 569
Dubuque, on west end and first pier of IC RR bridge across Mississippi river, at upper end of pier, near its west edge, about in center of bridge-seat stone; copper bolt marked "U.S.⨀P.B.M." (U.S.C.E.p.b.m. 280)	618.106	Bull. 569
Dubuque, north side of Fourth St., opposite CM&StP Ry station, on Page House, on water table 6 inches in front of west window, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 296)	608.391	Bull. 569
Dubuque, SW. cor. First and Main Sts., near SE. cor. Jess's store, on north end of doorstep; highest point in square (U.S.C.E. city b.m.)	608.976	Bull. 569
Dubuque, on north side of Second St., at east door of older part of Julien House, on east end of doorstep, which is about 32 feet west of Iowa St.; highest point in square (U.S.C.E. city b.m)	612.626	Bull. 569
Dubuque, at NE. cor. U. S. post-office building, 10 inches south of north corner and 3 feet above stone pavement; copper bolt marked "U.S.⨀P.B.M." (U.S.C.E.p.b.m. 279)	644.838	Bull. 569
Dubuque, on SW. cor. Elm and Ninth Sts., on end of curb abutting against NE. cor. CM&StP freight house, marked "U□S"; highest point in square (U.S.C.E. t.b.m. 295)	607.548	Bull. 569
Dubuque, at NW. cor. Fifteenth and Pine Sts., on south side of Iowa Coffin Co.'s warehouse, on west end of first		

Station	Elevation Feet	Authority
doorstep from Pine St.; copper bolt marked "U.S.⊙ P.B.M." (U.S.C.E.p.b.m. 278)	609.624	Bull. 569
Dubuque, 0.5 mile below CM&StP Ry shops, at SE. cor. Iowa Coffin Co.'s warehouse, on top of foundation stone; highest point in square (U.S.C.E.t.b.m. 294)	609.500	Bull. 569
Dubuque, in upper part of, on line of CM&StP Ry, at NW. cor. of their freight-car repair shop, on SW. cor. of foundation stone, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 293)	611.085	Bull. 569
Dubuque, Eagle Point, 0.2 mile below Dubuque Woodenware Co.'s works, on line of CM&StP Ry, 2,181 feet above milepost 115-46, 394 feet above bridge 114, 267 feet below bridge 114½, over sewer, on upper end of mound built up from earth excavation from opposite side of track, 1½ feet west from east fence and 13.6 feet from center of track; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 276 and 277):		
Copper bolt	608.017	Bull. 569
Cap on pipe	612.010	
Dubuque, Eagle Point, in main building of Dubuque Woodenware Co., on river bank, in foundation on south side, 1.8 feet from west corner and 2.1 feet above ground; copper bolt, marked "U.S.⊙P.B.M." (U.S. C.E.t.b.m. 275)	605.875	Bull. 569
Dubuque, Eagle Point, on Dubuque Woodenware Co.'s drying house, east of railroad tracks, on top of stone foundation, 10 feet from west side, on lower side of building, marked "U□S"; highest point in square (U.S.C.E. t.b.m. 291)	608.864	Bull. 569
Dubuque, Eagle Point, at prominent point of river bank covered with large rock, above ferry landing, on SW. part of very large triangular-shaped rock lying at water's edge; highest point in bottom part of letter "B" cut on rock (U.S.C.E. old U.S.b.m. 23)	594.527	Bull. 569
Dubuque, 1.25 miles above Eagle Point, 0.2 mile below milepost 113-48, midway between two small wooden-box culverts, 20 feet west of center of track, on natural ledge, marked "U□S"; highest point in square (U.S.C.E. t.b.m. 289)	618.348	Bull. 569
Dubuque, 2.3 miles above Eagle Point, 58 feet south of small stone culvert on which t.b.m. 287 is located, 436 feet below bridge 122K, 896 feet below railroad platform in front of Mr. James Cushing's house, 23.3 feet east of center of track, on right of way; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 273 and 274):		
Copper bolt	608.283	Bull. 569
Cap on pipe	612.279	
Dubuque, 2.3 miles above Eagle Point, 1,569 feet below milepost 112-49, 1,161 feet above bridge 120K, 377 feet below bridge 122K, 836 feet below small railroad platform in front of Mr. Cushing's house, 6 feet west from center of track, on upper end of capstone of small stone culvert, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 287)	611.406	Bull. 569
Dudley	675.18,G678	CB&Q
Duggan, Jackson Co.	830	USGS
Duggan, center Butler Tp.	1010	USGS
Dumas, Mo., base of rail opposite E. end depot	556.6,G559	AT&SF
Dumfries	1241	WRR
Dumont	978.3,G977	CGW

Station	Elevation feet	Authority
Dumont, crossing C&NW	978.40,G978	CGW
Dumont	975	C&NW
Dumont, crossing CGW	978	C&NW
Dunbar	914	CM&StP
Duncan	1248	CM&StP
Duncombe	1110,G1108	IC
Duncombe, T. 88 N., R. 27 W., at west quarter cor. of NW. quarter of sec. 4, at T road south, 90 feet SE. of road corners, just inside fence line, in root of large maple tree, marked ''1,105.4''; copper nail and washer	1,105.31	USGS
Duncombe, T. 88 N., R. 27 W., cor. secs. 4, 5, 8 and 9, 50 feet SW. of center of crossroads, just inside fence corner, in root of elm tree, marked ''1,103.8''; copper nail and washer	1,103.71	USGS
Dundee, at CGW Ry station; iron post stamped ''997 DBQ''	997.847	Bull. 569
Dundee, in front of CGW Ry station; top of rail	998.0	Bull. 569
Dundee	998.6,G998	CGW
Dunkerton	947.7,G947	CGW
Dunlap	1094,G1097	C&NW
Dunlap	1095,G1091	IC
Dunreath	739	WRR
Dunreath, in front of Wabash RR station; top of rail (U.S.C.E.b.m. 55)	740.0	Bull. 569
Dunreath, near, in ground on south side of Wabash RR, at milepost ''Des Moines 27''; top of rail set vertically (U.S.C.E.b.m. 56) not found in 1926	757.63	Bull. 569
Dunreath, T. 77 N., R. 20 W., 0.5 mile east of SW. cor. sec. 9, 15 feet west and 50 feet north of center of crossroads, 3 feet east of fence; iron post stamped ''824 Iowa''	822.294	Bull. 569
Durango	641.8,G644	CGW
Durango, T. 89 N., R. 1 E., near SE. cor. sec. 16, east end of south abutment of wagon bridge over south fork of Maquoketa river; bronze tablet stamped ''732 DBQ''	733.564	Bull. 569
Durant	713,G717	CRI&P
Durham	743,G745	CB&Q
Dyersville	943,G944	CGW
Dyersville	941,G941	IC
Dyersville, about 100 feet north of east end of IC RR station; iron post stamped ''952''	942.308	Bull. 569
Dysart	973,G968	CRI&P
Eagle Grove	1114,G1115	C&NW
Eagle Grove, crossing CGW	1107	C&NW
Eagle Grove	1109.2,G1112	CGW
Eagle Grove, crossing C&NW	1105.4,G1109	CGW
Eagle Point, see Dubuque, Eagle Point		
Earlham, 100 feet south of track, opposite point 560 feet east of station, 150 feet south of derailing switch, 2 feet north of fence; iron post	1,104.188	Bull. 569
Earlham, in front of CRI&P Ry station; top of rail	1,106.1	Bull. 569
Earlham, 1.5 miles east of, in south side of a concrete culvert, near telegraph pole 485-30; aluminum tablet	1,065.576	Bull. 569
Earlham	1102,G1105	CRI&P
Earling	1307,G1309	CM&StP
Earlville	994	IC
Earlville, bottom step of station platform	G1005	USGS
Earlville, B.M. in east end stock yard	G999	USGS
Earlville, T. 89 N., R. 3 W., NW. ¼ sec. 33, near north line, where highway goes south from IC RR; iron post stamped ''1022''	1,011.966	Bull. 569

Station	Elevation feet	Authority
Early	1332,G1331	C&NW
Easley	1152	FtDDM&S
East Clayton	G625	CM&StP
East Pleasant Plain	735,G749	CRI&P
Eckard, in front of CM&StP Ry station; base of rail (U.S.C.E.b.m.)	622.93	Bull. 569
Eckard, 1 mile below, opposite head of McMillan Island, on line of CM&StP Ry, 1,722 feet above milepost 79 from La Crosse, 722 feet above first road crossing below Eckard, 27 feet west of center of track, on an embedded rock, marked "U□S"; highest point in square (U.S. C.E.t.b.m. 245)	623.014	Bull. 569
Eckard, 0.2 mile below, where CM&StP Ry comes to bluff, 215 feet above mile post 78-83, opposite upper end of curve, 96½ feet west of center of track, 4½ feet from corner of fence, between this fence and highway which runs parallel with railroad, 82 feet above cluster of butternut trees; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 243 and 244):		
Copper bolt	620.008	Bull. 569
Cap on pipe	624.015	
Eckard	623,G623	CM&StP
Eddyville	675,G676	M&StL
Eddyville, crossing CRI&P	702	M&StL
Eddyville, crossing under C&NW	682	M&StL
Eddyville, low water in Des Moines river at	677	M&StL
Eddyville, B.M. top of monument M.P. 88 (U.S.C.E.b.m. 51)	686.76	CRI&P
Eddyville, B.M. top of monument M.P. 89 (Last tie to U.S.C.E.b.m. 52)	670.33	CRI&P
Eddyville, B.M. top of monument M.P. 90	671.02	CRI&P
Eddyville, top of rail, center depot	671.7	CRI&P
Eddyville, B.M. top of monument M.P. 92	674.92	CRI&P
Eddyville, B.M. top of monument M.P. 93	673.84	CRI&P
Eddyville, B.M. top of monument M.P. 94	685.38	CRI&P
Eddyville, in front of M&StL station; top of rail (U.S.C. E.b.m. 53)	669.79	Bull. 569
Eddyville, in north end of timber cap on bank bent of piling at east end of C&NW Ry bridge over Des Moines river; top of railroad spike (U.S.C.E.b.m. 74)	685.44	Bull. 569
Eddyville, top of downstream end of third pier from east end of M&StL RR bridge over Des Moines river (U.S. C.E.b.m. 75)	671.30	Bull. 569
Eddyville, top of downstream end of first pier from left bank or Eddyville side of highway bridge over Des Moines river (U.S.C.E.b.m. 76)	671.00	Bull. 569
Eddyville, on south end of water table of post-office building (De Long Building), at connection of cement blocks and brick wall, first and second building north side of Main St. (U.S.C.E.b.m. 77)	671.61	Bull. 569
Eddyville, upstream edge of north pier tube at east end of Gately highway bridge (U.S.C.E.b.m. 73)	682.98	Bull. 569
Edgewood	1165,G1165	CM&StP
Edgewood, T. 91 N., R. 4 W., NW. cor. sec. 22, at NW. cor. schoolhouse; iron post stamped "1168"	1,168.870	Bull. 569
Edgewood, T. 91 N., R. 5 W., quarter corner south side sec. 16; iron post stamped "1240 DBQ"	1,241.790	Bull. 569
Edmore	613	CM&StP
Edmore, in front of CM&StP Ry station; base of rail (U.S.C.E.)	614.74	Bull. 569
Edmore, Island 217, on left bank of, 10 meters from river		

Station	Elevation feet	Authority
bank, 0.25 mile below head of island; copper bolt in tile surmounted by iron pipe (U.S.C.E. 182/2):		
Copper bolt	600.02	Bull. 569
Cap on pipe	603.99	
Edmore, 0.8 mile above, on right of way CM&StP Ry track, 531 feet below south end of bridge 124K over Little Maquoketa river, 6.8 miles above Dubuque, on west side of track, 2 feet from fence, opposite center of curve in railroad line; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 271 and 272):		
Copper bolt	612.309	Bull. 569
Cap on pipe	616.308	
Edmore, 1.5 miles above Little Maquoketa river bridge, on line of CM&StP Ry, 0.7 mile above Zollicoffer lake, 1,076 feet above milepost 109-52, 12 feet west of track, on large flat rock inside of bank, inclining perhaps 30° to horizon, marked "U□S"; highest point in square (U. S.C.E.t.b.m. 283)	616.590	Bull. 569
Edna	1417	IC
Egan, Allamakee Co., T. 96 N., R. 4 W., 1,000 feet west of SE. cor. sec. 2, in NE. cor. schoolhouse No. 1; iron post stamped "1137 DBQ"	1,137.865	Bull. 569
Ehler	970	IC
Elberon	840,G836	CM&StP
Elberon, crossing C&NW	823	CM&StP
Elberon	821	C&NW
Elberon, crossing CM&StP	822	C&NW
Eldon, Keokuk line, B.M. top of monument M.P. 62	622.07	CRI&P
Eldon, B.M. top of monument M.P. 63	621.86	CRI&P
Eldon, top of rail, center of depot	628.24	CRI&P
Eldon, on south side street crossing highway bridge, B.M. top of monument M.P. 64 (U.S.C.E.b.m. 42)	625.86	CRI&P
Eldon, 1 mile NW. of, B.M. top of monument M.P. 65 (U.S.C.E.b.m. 43)	619.80	CRI&P
Eldon, B.M. top of monument M.P. 66	630.35	CRI&P
Eldon, B.M. top of monument M.P. 67	638.16	CRI&P
Eldon, 4 miles NW. of, B.M. top of monument M.P. 68 (U.S.C.E.b.m. 44)	632.22	CRI&P
Eldon, Kansas City line	619,G630	CRI&P
Eldon, on top of and at NW. cor. first stone pier from north end of CRI&P Ry bridge (U.S.C.E.b.m. 88)	623.68	Bull. 569
Eldon, on top of and at NW. cor. first stone pier from north end of highway bridge (U.S.C.E.b.m. 87)	622.23	Bull. 569
Eldora	1071,G1064	M&StL
Eldora, crossing C&NW	1067,G1059	M&StL
Eldora	1051.91	C&NW
Eldora, crossing M&StL	1061	C&NW
Eldora	G1070	Weather Bur.
Eldora, Court House hill	1110	IaGS
Eldora mill, low water below dam	955	IaGS
Eldora Junction	956	C&NW
Eldorado, Fayette Co.	924	IaGS
Eldorado, T. 95 N., R. 8 W., 0.5 mile north of center of sec. 21, in schoolyard; iron post stamped "983 DBQ"	983.688	Bull. 569
Eldridge Junction	804,G794	CM&StP
Eldridge Junction, junction with Maquoketa line	802	CM&StP
Eleanor	966	C&NW
Elgin	834	CRI&P
Elgin, floor of Turkey river bridge	G807	USGS
Elgin, T. 94 N., R. 6 W., NE.¼ sec. 33, NE. cor. school yard; iron post stamped "876 DBQ"	877.585	Bull. 569

Station	Elevation feet	Authority
Elgin, in front of CRI&P Ry station, top of rail	835.1	Bull. 569
Elgin, T. 94 N., R. 7 W., SE. ¼ sec. 16, in school yard; iron post stamped "989 DBQ"	989.926	Bull. 569
Elkader, in front of CM&StP Ry station; top of rail	724.5	Bull. 569
Elkader, sec. 23, T. 93 N., R. 5 W., NE. cor. courthouse yard; in concrete foundation of flagpole; iron post stamped "759 DBQ" as reset in 1919	761.610	Bull. 569
Elkader	722,726	CM&StP
Elkhart	975	CRI&P
Elkhart, T. 81 N., R. 23 W., about 0.4 mile east of NW. cor. sec. 16, SE. cor. crossroads; spike in telephone pole, marked "U.S.B.M. 898"	896.96	Bull. 569
Elkhart, T. 81 N., R. 23 W., SE. cor. sec. 17; spike in telephone pole, marked "U.S.B.M. 981"	979.38	Bull. 569
Elkhart, T. 81 N., R. 23 W., NW. cor. sec. 28; iron post stamped "986"	984.513	Bull. 569
Elkhart, T. 81 N., R. 23 W., SW. cor. sec. 28; spike in telephone pole, marked "U.S.B.M. 985"	983.84	Bull. 569
Elkhart, T. 81 N., R. 23 W., SE. cor. sec. 32; spike in telephone pole, marked "U.S.B.M. 982"	981.26	Bull. 569
Elkhart, T. 80 N., R. 23 W., NE. cor. sec. 6; iron post stamped "959"	958.215	Bull. 569
Elkhart, T. 81 N., R. 23 W., SW. cor. sec. 31; spike in telephone pole, marked "U.S.B.M. 974"	972.56	Bull. 569
Elk Point, S. Dakota	1130	CM&StP
Elkport, changed to Garber	G655	CM&StP
Elk River, 0.25 mile below mouth of, 200 meters from river bank, opposite head of Island 281, on small ridge 10 meters east of slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 164/3):		
Copper bolt	576.83	Bull. 569
Cap on pipe	580.86	
Elk River Junction, opposite north end of station at, 0.5 meter east of west right-of-way fence of CM&StP Ry; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 164/4):		
Copper bolt	589.21	Bull. 569
Cap on pipe	593.23	
Elk River Junction, 0.25 mile above Island 276, 0.25 mile below head of slough, 30 meters from shore, in bunch of tall cottonwood trees; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 165/2):		
Copper bolt	577.59	Bull. 569
Cap on pipe	581.60	
Elk River Junction, Island 276, 0.25 mile above head of, 14 meters from top of bank and on south bank of small slough below mouth of Dark Slough, 10 meters west is 12-inch hickory; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 165/3):		
Copper bolt	582.31	Bull. 569
Cap on pipe	586.32	
Elk River Junction, 3 miles above, in maple timber on high ground, 4 meters west of large slough, 742 meters from river bank, 4 meters north to 6-inch burr oak; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 165/4):		
Copper bolt	579.22	Bull. 569
Cap on pipe	583.24	
Elk River Junction	595.G594	CM&StP
Elliott	1083.G1075	CB&Q
Ellmaker	741.5	CB&Q

Station	Elevation feet	Authority
Ells	1221	IC
Ellston	1214,G1214	CB&Q
Ellsworth	1082,G1084	C&NW
Ellsworth, Minn.	1455	CRI&P
Ellsworth Spur	1199	CRI&P
Elma	1189,G1188	CGW
Elmira	753,G751	CRI&P
Elmore, Minn.	1129	C&NW
Elm Springs	1221	CM&StP
Elm Springs, 5 kilometers northwest of, 13 meters west of railway, 8 meters north of road, on south line of sec. 5, T. 97, R. 48, 2 meters north and 1 meter east of fences, 0.2 meter below rails; top of iron pipe (U.S.C.&G.S.b.m. D)	1,280.109	Bull. 569
Elon, Allamakee Co., 2,500 feet east of, ¼ mile east of center sec. 33, T. 98 N., R. 4 W., NE. of fence post NE. of schoolhouse; iron post stamped "1238 DBQ"	1,238.726	Bull. 569
Elon, T. 98 N., R. 4 W., sec. 16, 200 feet east of bridge over small tributary of Village creek, on north side of road and south side of fence; iron post stamped "834 DBQ	835.510	Bull. 569
Elrick Junction	567,G560	M&StL
Elwell	970	CM&StP
Elwood	733,G735	CM&StP
Ely	734,G741	CRI&P
Emeline, Jackson Co.	963	USGS
Emeline, Center Brandon Tp.	955	USGS
Emerson	1056.34,G1057	CB&Q
Emmetsburg	1232,G1237	CM&StP
Emmetsburg, crossing CRI&P	1229,G1234	CM&StP
Emmetsburg	1238,G1234	CRI&P
Emmetsburg, crossing CM&StP	1237	CRI&P
Enterprise	992	CRI&P
Enterprise, 4 miles east, 1 mile north of, T. 80 N., R. 22 W., at cor. secs. 7, 8, 17 and 18, 25 feet east and 20 feet north of crossroads, 0.7 foot south of corner fence post, top of 0.5-inch gas pipe, marked "977.4"	977.63	USGS
Enterprise, 3 miles east, 1 mile north of, T. 80 N., Rs. 22 and 23 W., at cor. secs. 7, 12, 13 and 18, 25 feet south and 20 feet west of crossroads, on concrete post; bronze tablet stamped "Prim. Trav. Sta. No. 15-L.-S.-1924-Ia." marked "984.1"	984.313	USGS
Enterprise, reference mark is 39.4 feet N.80° E. of "L. S. No. 16", in SE. angle of crossroads, top of east heading of concrete culvert; chiseled square	984.38	USGS
Enterprise, 2 miles east, 1 mile north of, T. 80 N., R. 23 W., at cor. secs. 11, 12, 13 and 14, 26 feet south and 17 feet east of crossroads, in top of east heading of concrete culvert; chiseled square, marked "986.8"	987.11	USGS
Enterprise, 1 mile north, 1 mile east of, T. 80 N., R. 23 W., at cor. secs. 10, 11, 14 and 15, in NW. angle of crossroads, top of concrete corner fence post; chiseled square, marked "999.1"	999.40	USGS
Enterprise, 1 mile north of, in SE. cor. J. Wohlwind's farm, on north side of east and west road, 2.5 feet NW. corner post of field; iron post stamped "Prim. Trav. Sta. No. 5", marked "980.7"	981.023	USGS
Enterprise, reference mark is 57.5 feet S.45°E. of P.T. Sta. No. 5, 12 feet west of railroad, 16 feet south of road, top of south end of tile; chiseled square	978.15	USGS
Enterprise, 260 feet south and 150 feet west of station,		

Station	Elevation feet	Authority
220 feet north of road junction, on east side of road, in root on west side of 2-foot maple tree; copper nail and washer, marked "1001.1"	1,001.40	USGS
Enterprise, 0.5 mile west of, T. 80 N., R. 23 W., at cor. secs. 16, 17, 20 and 21, in SE. angle of crossroads, top of east end of tile, painted square, marked "987.9"	988.18	USGS
Enterprise, 1 mile south, ½ mile west of, T. 80 N., R. 23 W., at cor. of secs. 20, 21, 28 and 29, 25 feet east of T-road west, 1 foot west of corner of fence post; top of iron rod, marked "963.4"	963.70	USGS
Enterprise, 1 mile south, 1½ miles west of, T. 80 N., R. 23 W., SE. cor. sec. 19, 40 feet NW. center of crossroads; iron post stamped "938 ADJ. 1903 936.537"	936.837	USGS
Epworth, I. C. road crossing at stock yards	G1048	USGS
Epworth	1034	IC
Ericson	1127	FtDDM&S
Ericson, T. 83 N., Rs. 25 and 26 W., cor. secs. 1, 6, 7, and 12, center of road forks at T road south; chiseled square on top of corner stone, marked "1144.1"	1,143.18	Bull. 569
Ericson, T. 83 N., R. 25 W., SW. cor. sec. 7, on north-south township line between Colfax and Worth townships, NE. cor. crossroads, at fence corner, top of large rock; chiseled square, marked "1121.96"	1,121.06	Bull. 569
Ericson, T. 83 N., R. 25 W., NW. cor. sec. 17, SE. cor. crossroads, at NW. cor. grove; copper nail in root on north side of soft-maple tree, marked "1106.95"	1,106.04	Bull. 569
Ericson, T. 83 N., R. 25 W., cor. secs. 8, 9, 16, and 17, in center of crossroads; chiseled square on top of corner stone, marked "1082.4"	1,081.47	Bull. 569
Essex	999.8,G992	CB&Q
Estherville	1292,G1287	CRI&P
Estherville, crossing M&StL	1290	CRI&P
Estherville	1295,G1298	M&StL
Estherville, crossing CRI&P	1277,G1287	M&StL
Estherville	G1298	Weather Bur.
Euclid	1010	IC
Evans	727,G733	CRI&P
Evans, Keokuk line, B.M. top of monument M.P. 101	720.29	CRI&P
Evans, B.M. top of monument M.P. 102	724.12	CRI&P
Evans, top of rail, center of depot	732.6	CRI&P
Evans, B.M. top of monument M.P. 103	731.73	CRI&P
Evans, B.M. top of monument MP. 307	747.66	CRI&P
Evanston, T. 88 N., R. 28 W., near quarter corner, S. side sec. 2, at road crossing, 40 ft. SW. of road crossing, in base of railroad signpost, marked "1,112.6"; spike	1,112.45	USGS
Evanston, T. 88 N., R. 28 W., quarter corner, W. side of sec. 12, in base of railway signpost, marked "1,104.9"; spike	1,104.74	USGS
Evanston, 150 ft. SE. of CGW RR station, 90 ft. S. of schoolhouse, 45 ft. NE. of crossroads; iron post stamped "Iowa 1919 1,109"	1,108.421	USGS
Evanston, 0.74 mile east of, at road crossing, 20 ft. N. of crossing, in base of railway signpost, marked "1,105.3"; spike	1,105.15	USGS
Evanston, 1.48 miles E. of, at road crossing, 15 ft. NE. of crossing, in base of railway signpost, marked "1,101.3"; spike	1,101.14	USGS
Evanston Junction	1105	FtDDM&S
Eveland, see Givin		
Everly	1360,G1365	CM&StP
Ewart	985	M&StL

Station	Elevation feet	Authority
Excelsior	713,G702	M&StL
Exira	1224,G1227	CRI&P
Exline	1014,G1013	CB&Q
Fairbank	996.4,G996	CGW
Fairfax	766,G769	C&NW
Fairfax	790,G795	CM&StP
Fairfield	766,G780	CRI&P
Fairfield, crossing CRI&P	771,G780	CRI&P
Fairfield	772.26,G780	CB&Q
Fairfield, crossing CRI&P	774,G780	CB&Q
Fairfield	G780	Weather Bur.
Fairmount, B.M. top of monument M.P. 334	918.82	CRI&P
Fairmount, B.M. top of monument M.P. 335	913.05	CRI&P
Fairmount, top of rail, center of depot	923.3,G921	CRI&P
Fairmount, B.M. top of monument M.P. 336	923.88	CRI&P
Fairmount, B.M. top of monument M.P. 337	924.15	CRI&P
Fairmount, B.M. top of monument M.P. 338	926.28	CRI&P
Fairport	557,G567	CRI&P
Fairport, union station with CRI&P	558	CM&StP
Fairport, on foundation of pottery owned by John Feustel, in west side near SW. cor. stone foundation, 350 meters above railroad station and near river bank; copper bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 33)	555.550	Bull. 569
Fairport, 0.25 mile above, 1 meter north of south fence of Muscatine-Davenport wagon road, 295 meters east of east line of street which is eastern boundary of Fairport; copper bolt in tile surmounted by iron pipe (U.S. C.E.b.m. 143/3):		
Copper bolt	592.38	Bull. 569
Cap on pipe	596.40	
Fairport, Island 325, on north side of, opposite a point about 400 meters below foot of Island 326, 25 meters from bank of river; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 144/2):		
Copper bolt	545.49	Bull. 569
Cap on pipe	549.44	
Fairport, 3.5 miles above, on property of J. B. Bar, 0.5 meter west of line between secs. 21 and 22, 150 meters from railroad track, on side of hill at edge of timber, 10.7 meters south of intersection of north-south section line, south line of J. C. Fitchner; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 144/3):		
Copper bolt	630.89	Bull. 569
Cap on pipe	634.90	
Fairport, T. 77 N., R. 1 E., near NE. cor. sec. 8, 100 feet west of crest of hill, 70 feet south of roadway, opposite barn, on top of stump in field; copper nail, marked "710.63"	710.70	Bull. 569
Fairport, T. 77 N., R. 1 E., NW. cor. NE. ¼ sec. 8, SE. cor. crossroads, in NW. cor. Patterson schoolhouse lot; iron post stamped "Prim. Trav. Sta. No. 2 Iowa 1910, 728"	728.044	Bull. 569
Fairport, T. 77 N., R. 1 E., NW. cor. sec. 8, 150 feet east of crossroads, near middle of south side of bridge, in floor; copper nail, marked "654.50"	654.58	Bull. 569
Fairport, T. 77 N., R. 1 E., NW. cor. sec. 7, SE. cor. T road east, east end of wooden drainpipe; copper nail, marked "715.36"	715.45	Bull. 569
Fairport, T. 77 N., meridian line SE. ¼ sec. 1, R. 1 W., middle of east line; T road west, marked "724.9"	725	Bull. 569
Fairport, T. 77 N., R. 1 W., near SW. cor. sec. 1, north		

Station	Elevation feet	Authority
side of road, on east side of Pine creek, 20 feet NE. of NE. cor. bridge over Pine creek, 15 feet NW. of 6-inch boxelder, 10 feet east of 4-foot boxelder, 13 feet east of 6-inch boxelder; iron post stamped "623"	622.864	Bull. 569
Fairport, T. 77 N., R. 1 W., near west line of sec. 28, NE. cor. road forks, northeast from river road, 1.5 feet west of fence, 20 feet north of fence; iron post stamped "558.8"	559.054	Bull. 569
Fairport, T. 77 N., R. 1 W., NW. ¼ sec. 29, near middle of south line, at road forks, SE. cor. bridge on river road; top of plank backing for steel abutment marked "558.70"	558.90	Bull. 569
Fairview, S. Dakota	1220	CM&StP
Farley	1061,G1064	CGW
Farley	1104	IC
Farley, junction CM&StP	1107	IC
Farley	1113	CM&StP
Farley, crossing IC	G1115	CM&StP
Farley, SW. ¼ sec. 13, T. 88 N., R. 1 W., west side of Wood St., where street crosses IC RR; iron post stamped "1117"	1,108.148	Bull. 569
Farley, T. 88 N., R. 1 W., middle north line of sec. 6, at road junction; iron post stamped "1139"	1,130.066	Bull. 569
Farlin	1072	CM&StP
Farmersburg	907,G909	CM&StP
Farmersburg, crossing south of CM&StP Ry station; top of rail	905.4	Bull. 569
Farmersburg, T. 94 N., R. 5 W., SW. cor. sec. 15, SW. cor. schoolhouse yard; iron post stamped "1077 DBQ"	1,078.516	Bull. 569
Farmington	571,G567	CB&Q
Farmington, B.M. top of monument M.P. 29	562.76	CRI&P
Farmington, B.M. top of monument M.P. 30 (U.S.C.E. b.m. 15)	570.17	CRI&P
Farmington, top of rail, center of depot	566.5	CRI&P
Farmington, 1 mile NW. of, B.M. top of monument M.P. 31 (U.S.C.E.b.m. 16)	561.27	CRI&P
Farmington, 2 miles NW. of, B.M. top of monument M.P. 32 (unadjusted)	553.67	CRI&P
Farmington, 3 miles NW. of, B.M. top of monument M.P. 33 (U.S.C.E.b.m. 17)	574.33?	CRI&P
Farnam	670,G677	CRI&P
Farnhamville	1142	C&NW
Farragut	963.4,G959	CB&Q
Farson	799,G801	CM&StP
Faulkner	1113,G1105	M&StL
Fayette	1002	CM&StP
Fenton	1241	C&NW
Ferguson	911,G908	CM&StP
Fernald	1037	CRI&P
Fifield	724	WRR
Fifield, T. 76 N., R. 19 W., SE. cor. sec. 2, west and 85 feet north of center of crossroads, 18 feet west of center of roadway, 30 feet east of bank of small creek; iron post stamped "749 Iowa"	747.844	Bull. 569
Fifield, above; top of west side of north shore pier of highway bridge (U.S.C.E.b.m. 65) (Pier pushed 1 foot down stream by ice and lowered)	725.03	Bull. 569
Fillmore	831,G830	CM&StP
Fillmore, T. 87 N., R. 1 W., at quarter-section line of sec. 25, Whitewater Tp., road crossing CM&StP Ry, near		

Station	Elevation feet	Authority
north end of second tie from east cattle guard; iron post stamped "889"	879.594	Bull. 569
Findley, M.P. 494	1023,G1020	IC
Findley, crossing over C&NW	1028	IC
Finley Landing, on line of CM&StP Ry, 649 feet below milepost 101-60, 180 feet above bridge 162, on right of way, 2 feet from south fence and 38 feet from center of track; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 260 and 261):		
Copper bolt	618.870	Bull. 569
Cap on pipe	622.873	
Flagler	746,G746	CB&Q
Flagler, crossing CRI&P	726.5	CB&Q
Flagler, T. 76 N., R. 19 W., 0.25 mile north of SE. cor. sec. 27, in pasture of P. Augustine, 290 feet north of T road, near fence west of road, in fork of boxelder tree; 40-penny nail	797.028	Bull. 569
Flagler, T. 75 N., R. 19 W., center of sec. 15, north and 55 feet east of center of crossroads, 2 feet south of fence; iron post stamped "854 Iowa"	852.285	Bull. 569
Flagler, T. 75 N., R. 19 W., 0.5 mile north of SE. cor. sec. 27, south and 55 feet west of center of crossroads, 3 feet north of fence; iron post stamped "888 Iowa"	886.459	Bull. 569
Flagler, T. 75 N., R. 19 W., SE. cor. sec. 27, at center of crossroads; section corner stone	909.96	Bull. 569
Flagler, RR bridge over English creek, 1 mile east of	727.4	CB&Q
Flagler, bed of English creek at RR bridge, 1 mile east of	704	IaGS
Flanders	1081,G1085	CM&StP
Flint	1169	CRI&P
Florence	1126.60,G1130	CGW
Floris	708,G706	CRI&P
Floyd	1104,G1099	IC
Floyd crossing	1072	CM&StP
Flugstad	1116	FtDDM&S
Flynns	870,G865	CM&StP
Foley Switch	536	CB&Q
Follets	606	CRI&P
Folsom	974.5	CB&Q
Folsom, T. 73 N., R. 44 W., 0.25 mile east by 430 feet south of NW. cor. sec. 12, on east side of old stage road, 300 feet north of house of J. C. Cole; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 119/2):		
Copper bolt	961.34	Bull 569
Cap on pipe	965.40	
Fonda	1231,G1234	CM&StP
Fonda, crossing IC	1231,G1235	CM&StP
Fonda	1230	IC
Fonda, crossing CM&StP	1230	IC
Fontanelle	1334.84	CB&Q
Fontanelle (old station)	1247	CB&Q
Fontanelle, E. line SE. ¼ sec. 18, T. 75 N., R. 32 W.	1282	IaGS
Forbush	979	ISU
Ford	760,G760	CB&Q
Ford, 0.75 mile NE. of, in top of SE. pier of south span of highway bridge over Des Moines river; aluminum tablet stamped "Prim. Trav. Sta. No. 1, 763 Adj" (see also Runnels)	761.635	Bull. 569
Forest City	1265,G1251	CRI&P
Forest City, crossing M&StL	1249	CRI&P
Forest City	1221,G1220	M&StL
Forest City	G1226	Weather Bur.

Station	Elevation feet	Authority
Forest City, Pilot Knob	1450	IaGS
Fort Atkinson	1016,G1021	CM&StP
Fort Atkinson, sec. 7, T. 96 N., R. 9 W., west side of town, in NW. cor. church yard; iron post stamped ''1019 DBQ''	1,019.721	Bull 569
Fort Dodge	1111.1,G1115	CGW
Fort Dodge, crossing FtDDM&S	1108.8	CGW
Fort Dodge, crossing over IC, CGW track	G1101	CGW
Fort Dodge, CGW crossing, IC track	G1061	CGW
Fort Dodge	1025	IC
Fort Dodge, M&StL Jct.	1008	IC
Fort Dodge, crossing over M&StL	1016	IC
Fort Dodge, crossing over FtDDM&S	1100	IC
Fort Dodge, crossing under CGW	1059	IC
Fort Dodge	1009,G1011	M&StL
Fort Dodge, crossing under IC, IC track	1017,G1017	M&StL
Fort Dodge, crossing under IC, M&StL track	994,G994	M&StL
Fort Dodge	1111	FtDDM&S
Fort Dodge, East	1107	FtDDM&S
Fort Dodge, T. 88 N., R. 29 W., quarter corner, west side of sec. 3, at right angle in road, second class road leading north, 50 feet SE. of road fork, in fence corner, in root of 12-inch maple tree, marked ''1,128.8''; copper nail and washer	1,128.70	USGS
Fort Dodge, T. 88 N., R. 29 W., 0.25 mile west of quarter cor., east side of sec. 3, at T road north, 75 feet NW. of road fork, 25 feet north of fence corner, 1.5 feet east of fence line; iron post stamped ''Iowa 1919 1,125'' (said to have been moved)	1,125.423	USGS
Fort Dodge, T. 88 N., R. 29 W., 0.25 mile west of NE. cor. sec. 3, at T road south, 250 feet west of T road north, 40 feet SE. road fork, in base of corner fence post, marked ''1,123.1''; spike	1,123.03	USGS
Fort Dodge, T. 89 N., R. 29 W., near NE. cor. sec. 36, CGW RR crossing range line, 75 feet SW. railway crossing, in base of telephone pole, marked ''1,124.1'': spike	1,124.03	USGS
Fort Dodge, T. 89 N., Rs. 28 and 29 W., cor. secs. 31, 36, 25 and 30, 50 feet SW. of center of crossroads at fence corner, in base of telephone pole marked ''1,112''; spike	1,111.94	USGS
Fort Dodge, top of south rail of CGW RR, marked ''1,125.8''	1,125.7	USGS
Fort Dodge, 1.5 miles SW. of, CGW RR bridge over Des Moines river, at western end of bridge and south side of track, about 1.5 feet lower than the track; point in concrete abutment marked ''1,197.1''	1,096.99	USGS
Fort Dodge, T. 89 N., R. 29 W., near center of sec. 26, 450 feet SW. of top of slope leading down to Lizard creek, at bend in road to west, just inside of fence on south side of road, in root of 2.5 foot maple tree, marked ''1,113.1''; copper nail and washer	1,113.04	USGS
Fort Dodge, T. 89 N., R. 29 W., quarter corner, S. side of sec. 3, 60 ft. NE. of center of crossroads, in root of large maple tree, marked ''1,126.1''; copper nail and washer	1,125.98	USGS
Fort Dodge, Tps. 89 and 90 N., R. 29 W., quarter corner, S. side of sec. 34, at T road W., 35 ft. NW. of road fork, in fence corner, in root of large willow tree, marked ''1,124.4''; copper nail and washer	1,124.24	USGS
Fort Dodge, Tps. 89 and 90 N., R. 28 W., cor. secs. 4, 5, 32 and 33, T road N., 35 ft. S. of road fork, in concrete		

Station	Elevation feet	Authority
base of corner fence post, marked "1,131.1"; chiseled mark	1,130.99	USGS
Fort Dodge, Tps. 89 and 90 N., R. 28 W., quarter corner, S. side of sec. 32, 40 ft. NW. of crossroads, in root of 5-inch catalpa tree, marked "1,146.2"; copper nail and washer	1,146.08	USGS
Fort Dodge, T. 90 N., R. 28 W., quarter corner, N. side of sec. 32, T road W., 38 ft. SW. of road fork; iron post stamped "IOWA 1919 1,121"	1,121.258	USGS
Fort Dodge, intersection of 5th Ave. S. and interurban railway, top of west rail, marked "1,110.5"	1,110.6	USGS
Fort Dodge, 15th St. crossing of CGW RR; top of south rail, marked "1,098.7"	1,098.6	USGS
Fort Dodge, 15th St. and 5th Ave. S., crossing, 25 ft. NE. of center of street crossing, 2 ft. SW. of telephone pole; chiseled square, in concrete curbing, marked "1,107.4"	1,107.30	USGS
Fort Dodge, 5th St. and 1st Ave. N., crossing, 50 ft. NE. of center of street crossing, on edge of sidewalk; copper nail and washer, in root of 18-inch maple tree	1,122.13	USGS
Fort Dodge, P. O., rear end, NW. corner, 20 inches above sidewalk and 12 inches from north edge of building; bronze tablet stamped "IOWA 1,099"	1,098.500	USGS
Fort Dodge, 2nd Ave N. and CGW RR crossing, 50 ft. E. of railway and 15 ft. south of highway; chiseled point on top of large terra cotta pipe marked "1,108.9"	1,108.80	USGS
Fort Dodge, 10th Ave. N. and CGW RR crossing, 25 ft. SE. of crossing, in base of telephone pole, spike, marked "1,109.1"	1,109.07	USGS
Fort Dodge, at CGW RR crossing, 10th Ave. N., top of east rail	1,112.5	USGS
Fort Dodge, T. 89 N., R. 28 W., cor. secs. 15, 16, 21 and 22, at T road N., 40 ft. S. of center of road fork, 3 ft. N. of fence line and 2 ft. N. of telephone pole; iron post stamped "IOWA 1919 1,109"	1,108.794	USGS
Fort Dodge, T. 89 N., R. 28 W., cor. secs. 14, 15, 22 and 23, 145 ft. E. of section corner and 60 ft. S. of front of dwelling, on N. side of road, in base of telephone pole; spike, marked "1,115.6"	1,115.49	USGS
Fort Dodge, T. 89 N., R. 28 W., cor. secs. 13, 14, 23 and 24, 300 ft. W. of second class road to north, on N. side of road, in base of telephone pole; spike, marked "1,109.2"	1,109.14	USGS
Fort Dodge, T. 89 N., Rs. 27 and 28 W., cor. secs. 13, 18, 19 and 24, 50 ft. SE. of center of crossroads; iron post stamped "Prim. Trav. Sta. No. 5 1919 IOWA 1,113"	1,112.589	USGS
Fort Dodge, T. 89 N., R. 27 W., cor. secs. 17, 18, 19 and 20, 50 ft. NW. of center of crossroads, in fence corner; copper nail and washer in root of large willow tree, marked "1,117.8"	1,117.66	USGS
Fort Dodge, T. 89 N., R. 27 W., 1/16 corner, N. side of NE. quarter cor. sec. 20, at second class road crossing, 40 ft. NW. of center of crossroads, in concrete base of corner fence post, marked "1,113.9"; chiseled square	1,113.77	USGS
Fort Dodge, T. 89 N., R. 27 W., quarter corner, N. side of sec. 21, at T road S., 75 ft. SW. of road fork, 4 ft. N. of fence line, 3 ft. W. of telephone pole; iron post stamped "IOWA 1919 1,120"	1,119.661	USGS
Fort Dodge, T. 89 N., R. 27 W., quarter corner S. side of sec. 15, at T road N., 25 ft. NW. of center of road fork; chiseled square, in concrete base of fence post, marked "1,110.9"	1,110.82	USGS

Station	Elevation feet	Authority
Fort Dodge, T. 89 N., Rs. 27 and 28 W., cor. secs. 19, 24, 25 and 30, 30 ft. SE. of center of crossroads, in concrete base of corner fence post, marked "1,110.6"; chiseled square	1,110.50	USGS
Fort Dodge, T. 89 N., Rs. 28 and 29 W., cor. secs. 24, 25, 19 and 30, T road S., 75 ft. SW. of road fork, on fence line, in base of telephone pole, marked "1,118"; spike	1,117.97	USGS
Fort Dodge, T. 89 N., R. 29 W., cor. secs. 23, 24, 25 and 26, at right angle of road, in front of Oakdale dairy farm, 40 ft. N. of second class road fork, 6 ft. E. of fence corner; iron post stamped "IOWA 1919 1,120"	1,120.222	USGS
Fort Madison, Ottumwa line	522	CB&Q
Fort Madison, Keokuk line	520,G523	CB&Q
Fort Madison, Mississippi river, low water	G502	Miss. R. Com.
Fort Madison, Mississippi river, high water	G518	Miss. R. Com.
Fort Madison	G522	Weather Bur.
Fort Madison, base of rail opposite east end depot	522.9,G522	AT&SF
Fort Madison, in middle of west side of brick chimney of woodenware factory on NE. cor. Front St. and Broadway, 3 feet above base of chimney in building owned by W. H. Cretzinger; copper bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 8)	539.671	Bull. 569
Fort Madison, 4 miles above, on brick house of James Gibbs, in top foundation stone on south side, 3 feet from SE. corner, house stands about 150 meters west of CB&Q RR track; copper bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 9)	545.996	Bull. 569
Fort Madison, 9 miles north of, on east abutment of CB&Q RR bridge over Skunk river, in north end of abutment; copper bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 10)	548.076	Bull. 569
Fort Madison, 450 meters below station at, in top of north corner of stone pier of railroad water tank, on second pier NW. of spout to tank; top of stone (U.S.C.E. b.m. 4 R.B.)	522.54	Bull. 569
Fort Madison, in water table of Hotel Anthes, on Front St. near AT&SF station, near center of building on south side; copper bolt marked "U.S.P.B.M." (U.S. C.E.p.b.m. 7)	534.513	Bull. 569
Fort Madison, lower part of, on hillside, 12 meters SE. center of public road, 80 meters from river bank, at point where bluffs turn back from river; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 117/1):		
Copper bolt	575.56	Bull. 569
Cap on pipe	579.56	
Fort Madison, Niota Island, on sandy ridge which extends along west bank of, 69 meters 68° to north corner of little frame house, 25 meters north of water's edge; copper bolt in tile surmounted by iron pipe (U.S.C.E.b. m. 117/2):		
Copper bolt	513.29	Bull. 569
Cap on pipe	517.31	
Fort Madison, in vacant lot belonging to Mr. Wilson, in SW. quarter of block inclosed by Spruce St. on west, Division St. on south, Locust St. on east, and Des Moines St. on north, 1.5 meters from line of lot west belonging to J. C. Atlee, 46.5 meters east of Spruce St., 11 meters south of alley running east and west through block; copper bolt in tile surmounted by iron pipe (U. S.C.E.b.m. 117/3):		
Copper bolt	524.07	Bull. 569
Cap on pipe	528.08	

Station	Elevation feet	Authority
Fort Madison Bridge, in south side of second stone pier from Iowa end of; cut in stone (U.S.C.E. zero of gage)	502.53	Bull. 569
Fort Madison, cut in stone on west end of north abutment of Fort Madison Bridge (U.S.C.E. high-water marks 1880, 1888, 1851):		
1880	518.66	Bull. 569
1888	519.26	
1851	524.13	
Fort Madison, on shore opposite to Pontoosuc, Ill., in cluster of large soft maple trees, west of large patch of willows, 45 meters from bank, between two long dikes, 500 meters above lower and 200 meters below upper dike; copper bolt in tile surmounted by iron pipe (U.S. C.E.b.m. 119/3):		
Copper bolt	511.39	Bull. 569
Cap on pipe	515.37	
Fort Madison, Green Lake, 150 meters south of outlet of, 807 meters back of above-described bench mark, by side of wagon road, in heavy timber, 7.5 meters 320° to 30-inch elm tree, 13.2 meters 58° to 36-inch elm tree, 8 meters 158° to 11-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 119/4):		
Copper bolt	512.79	Bull. 569
Cap on pipe	516.80	
Fort Madison, U.S.P.B.M., square cut in SE. cor. top step of west wing wall north side Mississippi river bridge	535.25	USC&GS and AT&SF
Foster	900,G904	CM&StP
Fosterdale, T. 75 N., R. 17 W., 0.25 mile west of quarter corner on east side of sec. 27, on east side of road, 84 feet north of CB&Q RR track, 3 feet west of fence, 0.8 foot underground; iron post stamped "700 Iowa"	698.736	Bull. 569
Fosterdale, reference mark, 25 feet west and 7 feet north of b.m., in root 0.5 foot underground, on south side of 2.5-foot locust tree; copper nail and washer	700.77	USGS
Fosterdale, T. 75 N., R. 17 W., near center of sec. 28, 140 feet west and 15 feet south of T road north, top of east end of south heading of concrete culvert under road; chiseled square, marked "709.7"	709.74	USGS
Fosterdale, T. 75 N., R. 17 W., near SE. cor. NE. ¼ NE. ¼ sec. 35, 15 feet west of center of road forks, in root on east side of 3-foot elm tree; copper nail and washer, tree is painted "U.S.B.M. 689.7"	689.30	USGS
Fosterdale, at road crossing CB&Q RR; top of south rail	701.8	USGS
Fosterdale, T. 75 N., R. 17 W., near center of sec. 25, 13 feet east by 13 feet north of SE. cor. Jack Oak School yard fence, in NW. angle of roads at T-road north, in root on east side of 2-foot black oak tree; copper nail and washer, painted "U.S.B.M. 763.7"	763.33	USGS
Fosterdale, T. 75 N., R. 17, at quarter corner between secs. 24 and 25, in NE. angle of roads at T road north, 4 feet north of corner fence post, driven in ground; 0.75 inch gas pipe painted "U.S.B.M. 739.9"	739.55	USGS
Fosterdale, opposite CB&Q RR station, top of rail	701.45	Bull.569
Fosterdale, T. 75 N., R. 17 W., quarter corner on north side of sec. 25, T corner, on rock; painted square	729.29	Bull.569
Fosterdale, T. 75 N., R. 17 W., quarter corner on north side of sec. 24, 30 feet west and 30 feet north of center road, SE. cor. Charles Oswandel's place, crossroads; iron post stamped "772 Iowa" (Junction point)	771.045	Bull.569
Fosterdale	693	CB&Q

Station	Elevation feet	Authority
Fosterdale, 0.5 mile south of, in east side of burr-oak tree on bank of river, about 200 feet upstream from residence of A. B. Henry; twentypenny nail, which is also high-water mark of 1903 (U.S.C.E.b.m. 71)	688.62	Bull. 569
Fostoria	1447,G1449	CM&StP
Franklin, Lee Co.	700,G699	CB&Q
Franklin, Jasper Co.	762	CRI&P
Frankville, T. 97 N., R. 6 W., center, 20 feet west of road intersection on north side of, at Center schoolhouse, Allamakee Co.; iron post stamped "1169 DBQ"	1,168.880	Bull. 569
Frankville, T. 97 N., R. 7 W., near center of sec. 15, NW. of road junction, in SE. cor. McKay school yard; iron post stamped "1144 DBQ"	1,144.127	Bull. 569
Fraser, bench mark	896.44	FtDDM&S
Fraser, crossing Des Moines river	910	FtDDM&S
Frederic	747.47,G752	CB&Q
Fredericksburg	1076.2,G1076	CGW
Fredonia	593,G602	CRI&P
Freeman	1157,G1150	M&StL
Freeman	1146.6,G1140	CGW
Freeport, Winneshiek Co., T. 98 N., R. 7 W., 0.4 mile west of southeast cor. sec. 16, 2 rods north of northwest cor. of road intersection; iron post stamped "845 DBQ"	844.805	Bull. 569
Fremont	827	CB&Q
Fremont	850,G842	M&StL
French Creek, Allamakee Co., T. 99 N., R. 5 W., near quarter corner on north side sec. 21, NW. of schoolhouse, 25 feet south of fence-corner post; iron post stamped "1060 DUBQ" (map shows B.M. in sec. 15)	1,060.838	Bull. 569
Frenchtown landing, Dubuque Co., on right of way of CM&StP Ry, at fence, at upper end of small picnic grounds, 25 meters below end of bridge 148K; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 184/3 equals U.S.P.B.M. 263):		
Copper bolt	610.88	Bull. 569
Cap on pipe	614.88	
Frenchtown Landing, 35 feet above t.b.m. 277, 1,335 feet above milepost 104-57, 80 feet below bridge 148, 60 feet above platform on side of railroad and at entrance to picnic grounds, on east side of coulee, 38 feet south from center of track, on right of way, 1½ feet from south limit, under extreme northwest point of table-land forming picnic ground; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 263 and 264):		
Copper bolt	610.878	Bull. 569
Cap on pipe	614.877	
Frenchtown Landing, 0.2 mile above milepost 104-57, 115 feet below bridge 148, 25 feet above end of platform at entrance to picnic grounds, 20 feet south from center of track, on flat rock, embedded, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 277)	614.002	Bull. 569
Frenchtown Landing, in front of Island 207, 919 feet above milepost 102-59, 79 feet above section post 10-11, on west abutment of bridge 156, at its north end, on fourth stone step from top, 3 inches from end face of third step, 9 inches back from east face; copper bolt marked "U.S.⊙P.B.M." (U.S.C.E.p.b.m. 262)	615.622	Bull. 569
Froelich	1017	CM&StP
Fruitland, Muscatine Co.	544,G552	CRI&P
Fruitland, Polk Co.	830.56	DM&CI
Fulton, Jackson Co.,	785	USGS

Station	Elevation feet	Authority
Fulton, center Farmers Creek Tp.	700	USGS
Galbraith	1162.0	C&NW
Galland	532	CB&Q
Galland, in top of coping of west wall near SW. tower of guard lock; top of brass bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 2)	507.922	Bull. 569
Galland, on east side of guard lock, just above upper gate of Des Moines Rapids canal; gage cut in stone masonry (U.S.C.E. "gage at guard lock")	496.94	Bull. 569
Galland, Des Moines Rapids canal, 580 meters above a point on railroad opposite upper gate of guard lock of, 3 meters east of track, 4 meters from south end of culvert, at upper end of large gravel bar, nearly opposite U. S. light on large stone pier; stone post (U.S.C.E. "channel survey b.m.")	517.66	Bull. 569
Galland, Des Moines Rapids canal, 1,250 meters above point on railroad opposite upper gate of guard lock of, 250 meters above U. S. light on upper end of long narrow towhead, at top edge of right bank of river, on north side of mouth of ravine, 20 meters east of railroad, opposite north end of culvert; stone post (U.S.C.E. "channel survey b.m.")	518.28	Bull. 569
Galland and Montrose, about halfway between, between river bank and public road, directly in front of residence of Charles Hummel, between an old stone culvert and west corner of hedge inclosing an orchard on hillside, 14 meters from river bank, 8 meters from wagon track of public road at point 13 meters south of where small ravine crosses road, 27.5 meters from corner of hedge and 18.7 meters from 8-inch hickory tree; copper bolt in tile surmounted by iron post (U.S.C.E.b.m. 114/2):		
Copper bolt	519.43	Bull. 569
Cap on pipe	523.46	
Galland and Montrose, about halfway between, on little hillock between public road and railroad, on section line running west from river on south line of Solferino farm, 61 meters from river bank, 56.5 meters from center of road, 43.7 meters from center line of railroad, 37 meters from large arched stone culvert on railroad; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 114/3):		
Copper bolt	523.59	Bull. 569
Cap on pipe	527.60	
Galt	1204,G1198	CRI&P
Galva	1287,G1286	C&NW
Galva	G1290	Weather Bur.
Garber, formerly Elkport	656,G655	CM&StP
Garden City	1196	CRI&P
Garden Grove	1114,G1115	CB&Q
Gardiner	953.53	DM&CI
Garfield	1011	CB&Q
Garland	767	CRI&P
Garnavillo, SE. ¼ sec. 18, T. 93 N., R. 3 W., SE. cor. park; iron post stamped "1065 DBQ"	1,066.760	Bull. 569
Garner	1216,G1209	CRI&P
Garner, crossing CM&StP	1218,G1209	CRI&P
Garner	1212	CM&StP
Garner, crossing CRI&P	1217,G1212	CM&StP
Garrison	863,G859	CRI&P
Garry Owen, Jackson Co.	975	USGS
Garwin	895	C&NW

Station	Elevation feet	Authority
Gaza	1508,G1508	IC
Geneva	1100,G1092	M&StL
George	1374,G1377	IC
Georgetown, Dubuque Co., T. 90 N., R. 1 W., north line sec. 17, corner of O. W. Burns's field, iron post stamped ''1159 DBQ''	1,159.854	Bull. 569
Gerled	1152	C&NW
Gerled, crossing CRI&P	1153	C&NW
Gerled	1180	CRI&P
Gerled, crossing over C&NW	1180	CRI&P
Giard	800	CM&StP
Gibson	886	CRI&P
Gibson, crossing C&NW	882	CRI&P
Gifford	956	M&StL
Gifford, crossing C&NW	956	M&StL
Gifford	951,G953	C&NW
Gifford, crossing M&StL	951	C&NW
Gilbert	994	C&NW
Gilbert, T. 84 N., R. 24 W., 300 feet east of SW. cor. sec. 17, NW. cor. forks at T road north, in SW. foundation of small shed at windmill; square cut in top of stone, marked ''954.5''	953.48	Bull. 569
Gilbert, 1.5 miles west by 1 mile south of, T. 84 N., R. 24 W., NW. cor. sec. 17, SE. cor. crossroads, 5 feet south of fence corner; iron post stamped ''965''	964.255	Bull. 569
Gilbert, 1.5 miles west of, T. 84 N., R. 24 W., cor. secs. 5, 6, 7, and 8, center of crossroads; chiseled square cut on top of stone, marked ''960.1''	959.12	Bull. 569
Gilbert, 1.5 miles west by 1 mile north of, T. 85 N., R. 24 W., SW. cor. sec. 32, on east-west township line between La Fayette and Franklin townships, NE. cor. of crossroads; copper nail in base of telephone pole, marked ''993.2''	992.15	Bull. 569
Gilbert, 1.5 miles west by 2 miles north of, T. 85 N., R. 24 W., SW. cor. sec. 29, NE. cor. crossroads, SW. cor. schoolhouse yard; iron post stamped ''1048''	1,047.281	Bull. 569
Gilbert, 0.5 mile west by 2 miles north of, T. 85 N., R. 24 W., NW. cor. sec. 33, SE. cor. crossroads; chiseled square on top of large stone, marked ''1024.2''	1,023.23	Bull. 569
Gilbert station, 2 miles north of, on railroad, just south of road crossing, north end of east guardrail of small railroad bridge; top of painted bolt-head, marked ''1036.2''	1,035.22	Bull. 569
Gilbert, 0.5 mile east by 2 miles north of, T. 85 N., R. 24 W., SW. cor. sec. 27, NE. cor. crossroads; copper nail in top of post at east end of drain under road north, marked ''1037.7''	1,036.73	Bull. 569
Gilbert, 1.5 miles east by 2 miles north of, T. 85 N., R. 24 W., SW. cor. sec. 26, NE. cor. crossroads, 10 feet north of fence corner; iron post stamped ''1013''	1,012.349	Bull. 569
Gilbert, 5.5 miles west of, T. 84 N., R. 25 W., SE. cor. sec. 4, north side of road opposite T road south, just west of section line at foot of telephone pole; iron post stamped ''Prim. Trav. Sta. No. 3, 1912, 1034''	1,032.988	Bull. 569
Gilbert, T. 84 N., R. 25 W., NW. cor. sec. 3, 45 feet NE. of north end bridge over branch of Squaw creek, just south of township line between Jackson and Harrison townships, east side of road at fence line; copper nail in root on west side of red-oak tree, marked ''972.2''	971.19	Bull. 569
Gilbert, T. 85 N., R. 24 W., SW. cor. sec. 20, N.E. cor.		

STATION	ELEVATION FEET	AUTHORITY
crossroads; top of north end of tile drain under road to east; painted square, marked "1032.8"	1,031.82	Bull. 569
Gilbertville, road intersection, subgrade	822.09	WCF&N
Gillett Grove	1297,G1300	CM&StP
Gilliat	1033.3	CGW
Gilman	1037,G1031	M&StL
Gilmore City	1228	M&StL
Givin, B.M. top of monument M.P. 95	687.49	CRI&P
Givin, B.M. top of monument M.P. 96	688.65	CRI&P
Givin, B.M. top of monument M.P. 97	696.66	CRI&P
Givin, top of rail, center depot	696.9	CRI&P
Givin, B.M. top of monument M.P. 99	707.80	CRI&P
Givin	703,G697	M&StL
Givin, at NE. cor. Eveland Church; iron post (U.S.C.E.b.m. 54 equals U. S. Geological Survey primary traverse station mark No. 9)	680.422	Bull. 569
Givin, top of upstream end of second pier from north or left bank of Eveland highway bridge (U.S.C.E.b.m. 72)	687.087	Bull. 569
Gladbrook	949.5,G949	CGW
Gladbrook, crossing C&NW	949.7,G949	CGW
Gladbrook	953,G950	C&NW
Gladbrook, crossing CGW	951	C&NW
Gladstone	835,G827	CM&StP
Gladwin	597,G600	CM&StP
Gladwin, crossing Iowa river	600,G603	CM&StP
Glendale	754.9,G758	CB&Q
Glendon	1032,G1038	CRI&P
Glen Ellen	1095,G1097	CM&StP
Glen Ellen, crossing C&NW	1089	CM&StP
Glenwood	1031,G1037	CB&Q
Glenwood Junction, Mo.	964.8	CB&Q
Glidden	1226,G1226	C&NW
Golden	1048,G1053	IC
Golden, middle sec. 31, T. 88 N., R. 5 W., highway crossing 150 feet west of IC RR, north side of road and south of station; iron post stamped "1055"	1,046.158	Bull. 569
Goldfield	1115,G1108	CRI&P
Goldfield, crossing C&NW	1120	CRI&P
Goldfield	1133	C&NW
Goldfield, crossing CRI&P	1119	C&NW
Goldfield, 4 miles west of, Tps 91 and 92 N., R. 27 W., at south cor. secs. 1, 2, 35 and 36, 120 feet west by 40 feet south of junction, on T road north, in northwest cor. of small maple grove, in root of small maple tree; copper nail and washer "U.S.G.S.B.M."	1,145.28	USGS
Goldfield, T. 92 N., R. 27 W., near cor. secs. 25, 26, 35 and 36, north side of road, about 50 feet west of drain ditch; iron post stamped "Prim. Trav. Sta. No. 12, 1919"	1,123.684	USGS
Goldfield, T. 92 N., R. 27 W., near cor. secs. 25, 26, 35 and 36, in root of soft maple tree, 50 feet west of schoolhouse and 400 feet due west of above iron post, in root of soft maple tree (24 inches in diameter); copper nail and washer marked "U.S.G.S.B.M."	1,128.02	USGS
Goodell	1242,G1236	CRI&P
Goodwin	790	CRI&P
Goose Lake	695,G694	C&NW
Gordons Ferry	609,G609	CM&StP
Gordons Ferry, 20 meters from river bank on Island 237, in open ground, 200 meters above head of Harris slough;		

Station	Elevation feet	Authority
copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 176/2):		
Copper bolt	588.06	Bull. 569
Cap on pipe	592.09	
Gordons Ferry, 0.5 mile above, 0.5 meter west of right of way fence of CM&StP Ry, on bench above railroad track, 10 meters from perpendicular rock bluff and about 150 meters below large bridge 66K across creek; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 176/3):		
Copper bolt	614.26	Bull. 569
Cap on pipe	618.26	
Gordons Ferry, 1.5 miles below, 0.3 mile below milepost 132-29, on low ridge at upper side of coulee, 49 feet west from center of CM&StP Ry track, on right of way, at west fence; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 296 and 297):		
Copper bolt	607.203	Bull. 569
Cap on pipe	611.216	
Gordons Ferry, 1.2 miles below, on line of CM&StP Ry, 396 feet below milepost 132-29, 18 feet west of center of track, 0.5 foot above surface of ground, on flat rock, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 318)	611.180	Bull. 569
Gordons Ferry, 250 feet below bridge 64, 215 feet below station, 125 feet above lower headblock of siding, 45 feet below lower side of stockyard, 34 feet from center of main track on bluff side; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 294 and 295):		
Copper bolt	614.320	Bull. 569
Cap on pipe	618.303	
Gordons Ferry, 0.5 mile above, 1,876 feet below bridge 66, 1,213 feet above water tank, midway between two projecting points of bluff 12 feet west from center of track, 1½ feet above grade on natural ledge of rock, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 315)	612.082	Bull. 569
Gordons Ferry, 1 mile above, 345 feet above Tete des Mort Creek, 215 feet below bridge 68, on which t.b.m. 314 is located, 75 feet below old stone building, 27 feet west of center of CM&StP Ry track; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 292 and 293):		
Copper bolt	600.707	Bull. 569
Cap on pipe	604.710	
Gordons Ferry, 1 mile above, on line of CM&StP Ry, 52 feet below sign "Gordon's Ferry one mile," on south abutment, river end of bridge 68K, just above ruins of large stone house, on fourth course of stone from top, on center of north end of inner stone, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 314)	599.185	Bull. 569
Gordons Ferry, 3 miles above, 285 feet above t.b.m. 312, 125 feet below center of bridge 72K, opposite head of Island 235, 43 feet west of center of CM&StP Ry track, on right of way, at railroad fence; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 290 and 291):		
Copper bolt	604.415	Bull. 569
Cap on pipe	608.417	
Gordons Ferry, Snyder's wood yard, opposite head of Island 235, 1,270 feet above milepost 128-33, 410 feet below bridge 72K, 12 feet west of center of track, on lower end of very large inclined rock at rocky point, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 312)	611.489	Bull. 569

Station	Elevation feet	Authority
Goshen	1182,G1180	CB&Q
Gowrie	1145	FtDDM&S
Gowrie	1137,G1139	C&NW
Gowrie, crossing FtDDM&S and CRI&P	1135	C&NW
Gowrie	1142,G1138	M&StL
Gowrie, T. 86 N., R. 29 W., cor. secs. 7, 8, 17 and 18, 50 feet NW. of center of crossroads at fence corner; iron post stamped "Iowa 1919 1,146"	1,146.277	USGS
Gowrie, 2 miles east of, railway crossing; top of south rail, marked "1,148.8"	1,148.9	USGS
Gowrie, T. 86 N., R. 29 W., cor. sec. 5, 6, 7 and 8, 50 feet N.E. of center of crossroads, in base of sign post marked "1,151"; spike	1,151.01	USGS
Gowrie, Tps. 86 and 87 N., on line between, R. 29 W., cor. secs. 5, 6, 31 and 32, T road west, 60 feet east of road fork, on east side of north and south road, in base of telephone pole, marked "1,148.4"; spike	1,148.45	USGS
Gowrie, T. 87 N., R. 29 W., cor. secs. 29, 30, 31 and 32, 25 feet SW. of center of crossroads, 20 feet south of fence corner and 2 feet east of fence line; iron post stamped "IOWA 1919, 1,157"	1,157.219	USGS
Grable	1002,G999	IC
Graettinger	1252	CRI&P
Graf	766.2,G767	CGW
Grafton	1225	CM&StP
Grand Junction, union station with M&StL	1039,G1041	C&NW
Grand Junction, union station with C&NW	1040	M&StL
Grand Mound	720,G721	C&NW
Grand River	982.5	CB&Q
Granger	888.95	DM&CI
Granger, crossing CM&StP	877.85	DM&CI
Granger	889,G887	CM&StP
Granger, T. 80 N., R. 26 W., NE. cor. NE. ¼ sec. 16, in corner of lot at SW. cor. crossroads; iron post stamped "970"	968.443	Bull. 569
Granger, T. 80 N., R. 26 W., 200 feet east of SW. cor. sec. 4; spike head in NE. cor. wooden bridge over small creek	917.50	Bull. 569
Granger, 1.5 miles north by 1.5 miles east of, at T road in front of schoolhouse, east center SE. ¼ sec. 31, Madison township; iron post stamped "974"	972.673	Bull. 569
Granger, 2 miles north of, at T road, center of sec. 36, Des Moines township; spike in base of fence post	982.99	Bull. 569
Granger, 1.5 miles north of, at T road; spike in base of fence post	952.48	Bull. 569
Granger, 1.5 miles north by 1 mile west of, at road crossing; spike in base of telephone pole	902.89	Bull. 569
Granger, 1.5 miles north by 2 miles west of, at Nixon, Electric RR station; spike in base of trestle post at overhead crossing	877.05	Bull. 569
Granger, 1.5 miles north by 2.5 miles west of, at T road; copper nail in SW. cor. bridge floor over Beaver creek	868.79	Bull. 569
Granite	1313	CRI&P
Granite, T. 99 N., R. 48 W., NW. cor. sec. 6; iron post stamped "Ynktn 1420"	1,419.700	Bull. 569
Granite, T. 100 N., R. 48 W., NW. cor. sec. 19; iron post stamped "Ynktn 1343"	1,343.277	Bull. 569
Granite, 1 mile south of	1440	IaGS
Grant Center	1067,G1070	CM&StP
Granville	1447,G1445	C&NW
Graveldale	999	CM&StP

Station	Elevation feet	Authority
Gravity	1151,G1149	CB&Q
Gray	1352,G1350	C&NW
Grayson	1149,G1145	CM&StP
Greasers Siding	851	CRI&P
Great Western Crossing	1093	CB&Q
Greeley	1139	CM&StP
Greeley, ½ mile north of, sec. 20, T. 90 N., R. 4 W., at road corner; iron post stamped "1142 DBQ"	1,143.753	Bull. 569
Greendale, stock yard	996	CM&StP
Greene	961,G955	CRI&P
Greenfield	1370.45,G1368	CB&Q
Greenfield	1368	IaGS
Greenfield, SE. ¼ sec. 19, T. 76 N., R. 31 W.	1360	IaGS
Greenfield, SE. ¼ sec. 14, T. 75 N., R. 32 W.	1278	IaGS
Greenfield, W. line NW. ¼ sec. 13, T. 75 N., R. 32 W.	1388	IaGS
Greenfield, NW. cor. sec. 13, T. 75 N., R. 32 W.	1298	IaGS
Green Island	600,G601	CM&StP
Green Island, 0.8 mile above Island 256, 0.5 meter south of fence on north side of wagon road on line of division fence of Warner and A. O. Hunt, on sand prairie, 1,356.8 meters back of following-described bench mark; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 170/1):		
Copper bolt	631.60	Bull. 569
Cap on pipe	635.63	
Green Island, 1.25 miles below mouth of Maquoketa river, 30 meters from river bank, in thick timber 0.25 mile above Island 256, on south bank of small slough leading back from river; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 170/3):		
Copper bolt	584.82	Bull. 569
Cap on pipe	588.80	
Green Island, 0.8 mile above Island 256, 20 meters from west bank of small dry slough, in open bottom land, 746 meters from river bank, in open pocket in timber extending to bluffs on west, 60 meters west of edge of timber; copper bolt in tile surmounted by iron pipe (U. S.C.E.b.m. 170/4):		
Copper bolt	585.33	Bull. 569
Cap on pipe	589.34	
Green Island, in front of CM&StP Ry station; base of rail	597.80	Bull. 569
Green Mountain	997.2,G995	CGW
Greenville	1395,G1397	M&StL
Greenville, crossing CRI&P	1348	M&StL
Gridley	1274	C&NW
Gridley, crossing CRI&P	1275	C&NW
Grimes	964,G967	CM&StP
Grimes, T. 80 N., R. 25 W., NW. cor. NW. ¼ sec. 34, in field opposite junction of T roads; iron post stamped "885"	883.280	Bull. 569
Grimes. T. 79 N., R. 25 W., 150 yards west of SE. cor. sec. 4, in brick foundation on west side of schoolhouse; aluminum tablet stamped "976"	974.226	Bull. 569
Grimes Road station	841.09	DM&CI
Grinnell, union station with M&StL	1007	CRI&P
Grinnell, crossing M&StL	1007	CRI&P
Grinnell	1016,G1011	M&StL
Grinnell, crossing CRI&P	1016,G1011	M&StL
Grinnell	G1023	Weather Bur.
Grinnell and Montezuma Junction	1005	M&StL
Griswold	1106,G1098	CB&Q

STATION	ELEVATION FEET	AUTHORITY
Griswold	1100	CRI&P
Griswold, bed of river west of	1076	IaGS
Groveland	1162	CB&Q
Grundy Center	983,G976	CRI&P
Grundy Center	G976	Weather Bur.
Gruver	1311,G1300	CRI&P
Guernsey	810	C&NW
Guinn	894	CB&Q
Guthrie Center	1070,G1077	CRI&P
Guthrie Center	G1077	Weather Bur.
Guttenberg	622,G620	CM&StP
Guttenberg, NE. cor. Herder and First Sts., T. 92 N., R. 2 W.; aluminum tablet stamped ''630 DBQ''	631.603	Bull. 569
Guttenberg, T. 93 N., R. 2 W., near north line of sec. 31, in school grounds; iron post stamped ''681 DBQ''	682.054	Bull. 569
Guttenberg, T. 92 N., R. 3 W., SW. ¼ sec. 9, in schoolhouse grounds; iron post stamped ''959 DBQ''	960.200	Bull. 569
Guttenberg, 3 miles below, on right bank on right of way of CM&StP Ry, 1 meter from fence, 5 meters west of small ravine, 10 meters above bridge 238; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 190/4):		
Copper bolt	635.30	Bull. 569
Cap on pipe	639.20	
Guttenberg, in front of CM&StP Ry station; base of rail (U.S.C.E.b.m.)	620.61	Bull. 569
Guttenberg, at upper end of, on island in front of Swift slough, 20 meters from left bank of Guttenberg channel, 400 meters from head of island; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 191/3):		
Copper bolt	609.03	Bull. 569
Cap on pipe	612.98	
Guttenberg, on property of John Hirschbueller, corner of Second St. and Washington Ave., at his north line, 10 meters east of east line of Second St.; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 191/4):		
Copper bolt	621.54	Bull. 569
Cap on pipe	625.49	
Guttenberg, 400 meters above head of McMillan Island, on right bank, 15 meters back from river bank, 100 meters below bench mark the bank is very steep; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 192/3):		
Copper bolt	609.59	Bull. 569
Cap on pipe	613.53	
Guttenberg, 3 miles below, 3.2 miles above point of bluff at railroad on north side of Turkey river, on bridge 236, north abutment, east end, 1 foot west from end of abutment and 6 inches north of its south face, marked ''U□S''; highest point in square (U.S.C.E.t.b.m. 253)	622.220	Bull. 569
Guttenberg, 2.2 miles below, 63 feet below t.b.m. 252, on opposite side of track, 1.5 feet east of west right-of-way fence and 18 feet from center, 0.5 mile below where track comes to bluff, 150 feet above bridge 258, at place where wagon road turns up into coulee and 24½ feet east of center of road; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 249 and 250):		
Copper bolt	616.842	Bull. 569
Cap on pipe	620.839	
Guttenberg, 2.2 miles below station, on line of CM&StP Ry, 213 feet above bridge 258, at lower end of cut, 17 feet east of center of track, on an embedded bowlder, marked ''U□S''; highest point in square (U.S.C.E.t.b.m. 252)	622.988	Bull. 569

STATION	ELEVATION FEET	AUTHORITY
Guttenberg, on CM&StP Ry, 2,254 feet below station, on upper abutment of bridge 274, on river side of track, on fourth course of stone from top, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 50)	616.301	Bull. 569
Guttenberg, on west side of Front St., 72.7 feet above NW. cor. Front and Goethe Sts., in Clayton County Bank building, 8.5 feet upstream from south side of entrance way and 3.7 feet above bottom step, marked "U.S.⊙ P.B.M."; copper bolt (U.S.C.E.p.b.m. 248)	638.200	Bull. 569
Guttenberg, on NE. cor. Herder and First Sts., on front of Joseph Huene's general store, in doorstep, 5.8 feet from SW. cor. of building, 4.5 inches from angle of casing, and 3½ inches back from face of stone; copper bolt, marked "U.S.⊙P.B.M." (U.S.C.E.p.b.m. 247)	631.593	Bull. 569
Guttenberg, 2.3 miles above, on line of CM&StP Ry, midway between bridges 284 and 286, 2,001 feet below milepost 80, at light cut, 28.5 feet east of center of track and 2 feet west of right-of-way fence, 30 feet west of blazed 14-inch hickory tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 245 and 246):		
Copper bolt	617.535	Bull. 569
Cap on pipe	621.528	
Gypsum	1108	FtDDM&S
Gypsum, crossing IC, union station	1116.8	CGW
Gypsum	1118	IC
Gypsum, crossing CGW	1118	IC
Gypsum, T. 89 N., Rs. 27 and 28 W., cor. secs. 25, 36, 30 and 31, 40 ft. NW. of road fork at fence corner, in base of telephone pole, marked "1,109"; spike	1,108.93	USGS
Gypsum, Tps. 88 and 89 N., Rs. 27 and 28 W., cor. secs. 2, 3, 31 and 36, at railway crossing, 50 ft. NW. of railway crossing on W. side of highway, in line with railway right-of-way fence; iron post stamped "Iowa 1919 1,110"	1,109.400	USGS
Gypsum, T. 88 N., R. 28 W., quarter corner, west side of sec. 2, at right angle in road, on NW. corner of road, in base of corner fence post, marked "1,111.5"; spike	1,111.36	USGS
Hadden Hill	1014,G1014	CM&StP
Hagerty	946,G946	CB&Q
Hagerty, T. 72 N., R. 17 W., at north sixteenth corner between secs. 5 and 6, in NE. angle of crossroads, 5 feet west by 3 feet north of corner fence post, in concrete post; bronze tablet stamped "E.B. No. 5 1924 Iowa", painted "U.S.P.B.M. 956.3"	956.234	USGS
Hagerty, reference mark, 100 feet north by 100 feet west of tablet, in top at west end of concrete tube culvert under CB&Q RR; chiseled square	957.57	USGS
Hagerty, T. 73 N., Rs. 17 and 18 W., at quarter corner between secs. 31 and 36, 150 feet NW. of crossroads in top of center of concrete headwall at east end of bridge under road; chiseled square, painted "U.S.B.M. 947.4"	947.25	USGS
Hagerty, T. 73 N., R. 18 W., near east sixteenth corner between secs. 25 and 36, in NE. angle of crossroads, 5 feet north of corner fence post, on fence line; top of 0.75-inch gas pipe driven in ground, painted "U.S.B.M. 958.2"	958.09	USGS
Hagerty, T. 73 N., R. 18 W., near center of sec. 25, in NW. angle of roads at T road east in root on east side of a 3-foot black oak tree; railroad spike, painted "U.S.B.M. 951.8"	951.72	USGS
Halbur	1335	C&NW

Station	Elevation feet	Authority
Halbur	1377.1,G1384	CGW
Hale	780,G783	CM&StP
Haley, M.P. 462	1122,G1120	IC
Halfa	1269	C&NW
Hamburg	911,G913	CB&Q
Hamburg, 1.5 miles south of station, in pedestal block forming bridge seat at west end of south pier of bridge over Nishnabotna river, 0.67 foot south of south edge of bedplate under inclined end post, 10 feet west of track center; copper bolt in stone (U.S.C.E.p.b.m. 323)	908.328	Bull. 569
Hamburg, 1,998 feet north of station, 43 feet east of railway; in bench-mark stone; copper bolt in stone surmounted by iron pipe (U.S.C.E.p.b.m. 324):		
Copper bolt	903.017	Bull. 569
Cap on pipe	907.045	
Hamburg, 3.8 miles north of, in SE. cor. W. H. Frake's dooryard, 46 feet SE. of SE. cor. Frake's dwelling, 52 feet SW. of SW. cor. schoolhouse, 328 feet west of track; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 110/2):		
Copper bolt	905.530	Bull. 569
Cap on pipe	909.519	
Hamburg, T. 67 N., R. 43 W., 1,200 feet west of east line of sec. 34, SE. cor. orchard belonging to Oliver Taylor, on left bank, on north side of Stateline road between Missouri and Iowa; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 109/2):		
Copper bolt	911.36	Bull. 569
Cap on pipe	915.41	
Hamburg, T. 67 N., R. 43 W., 5,180 feet east of east line of sec. 34, on south side of State-line road, in SE. angle of fence formed by intersection of north-south and east-west roads, on premises owned by Joseph Payne; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 109/3):		
Copper bolt	905.27	Bull. 569
Cap on pipe	909.34	
Hamill	719,G721	CB&Q
Hamilton	904,G906	CB&Q
Hamilton	904	WRR
Hamilton, T. 74 N., R. 17 W., at quarter corner between secs. 30 and 31, in NW. angle of crossroads, in top center of concrete headwall to culvert under road; chiseled square, painted "U.S.B.M. 845.3"	845.24	USGS
Hamilton, T. 74 N., R. 17 W., center of sec. 30, in NE. angle of crossroads, in top on SW. cor. concrete base to corner fence post; chiseled square, painted "U.S.B.M. 872.7"	872.60	USGS
Hamilton, Ill., 350 meters SW. of station, 1 meter north of south right-of-way fence of TP&W RR, 18 meters north of east of sycamore tree, 25 meters NW. of black oak, 16 meters SW. of black oak, all blazed facing pipe; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 111/1):		
Copper bolt	504.62	Bull. 569
Cap on pipe	508.57	
Hamlin	1255,G1257	CRI&P
Hampton	1145	CRI&P
Hampton, crossing CGW	1140	CRI&P
Hampton, crossing M&StL	1135	CRI&P
Hampton	1151,G1143	M&StL

Station	Elevation feet	Authority
Hampton, CGW transfer	1146	M&StL
Hampton, Belmond branch	1146	M&StL
Hampton	1140.0,G1140	CGW
Hampton, crossing M&StL	1141.3,G1142	CGW
Hampton, crossing CRI&P	1145.2	CGW
Hancock	1109,G1113	CRI&P
Hanford	1188	C&NW
Hanley	887,G882	CGW
Hanley, Clanton creek north of	849	IaGS
Hanlontown	1202	C&NW
Hanna	1177,G1179	M&StL
Hansell	1031.4,G1031	CGW
Hansell, 4 miles east of, Franklin Co. line	991	CGW
Harcourt, B.M. on concrete foundation N. of station, E. of track	1173.69	FtDDM&S
Harcourt	1169	C&NW
Harcourt, T. 86 N., R. 28 W., cor. secs. 17, 18, 19 and 20, 50 feet SW. of center of crossroads, 3 feet north of fence and 7 feet NE. of fence corner; iron post stamped "Iowa 1919, 1,170"	1,170.245	USGS
Harcourt, T. 86 N., R. 28 W., cor. secs. 13, 18, 19 and 24, T road east, 35 feet SE. of road fork, in base of corner fence post, marked "1,167.4"; spike	1,167.42	USGS
Harcourt, T. 86 N., R. 28 W., quarter corner, west side of sec. 18, at right angle in road, on north side of, in line with east edge of road, in base of telephone pole, marked "1,169.4"; spike	1,169.38	USGS
Harcourt, 700 feet south of FtDDM&S Ry station, at road crossing; top of east rail, marked "1,172.2"	1,172.2	USGS
Harcourt, T. 86 N., R. 29 W., quarter corner, east side of sec. 14, at T road east, 30 feet NW. of center of T road, in base of telephone pole, marked "1,159.7"; spike	1,159.73	USGS
Harcourt, 0.6 mile NW. of, at C&NW railway crossing, top of south rail, marked "1,156.4"	1,156.4	USGS
Harcourt, T. 86 N., R. 29 W., cor. secs. 10, 11, 14 and 15, railroad crossing at, 60 feet south of crossing, on east side of road, in line with railway right-of-way fence; iron post stamped "Iowa 1919 1,162"	1,162.464	USGS
Harcourt, T. 86 N., R. 29 W., cor. secs. 9, 10, 15 and 16, 50 feet SW. of center of crossroads; in top of 2 foot locust stump, marked "1,161.4"; copper nail	1,161.46	USGS
Harcourt, T. 86 N., R. 29 W., cor. secs. 8, 9, 16 and 17, 50 feet SW. of center of crossroads, in root of 2-foot cottonwood tree, marked "1,148.7"; copper bolt	1,148.76	USGS
Hardy	1135,G1129	CRI&P
Harl, M.P. 421	1248	IC
Harl, crossing over C&NW	1273	IC
Harlan	1208.7	CGW
Harlan	1190,G1194	CRI&P
Harlan	1195	C&NW
Harlan Junction	1135,G1138	CRI&P
Harper	796,G810	CRI&P
Harper, Clear creek east of	743	IaGS
Harpers Ferry	647,G645	CM&StP
Harpers Ferry, T. 97 N., R. 3 W., ¼ mile south of center sec. 16, NE. of junction of roads; iron post stamped "1061D"	1,061.974	Bull. 569
Harpers Ferry, 1.5 miles below, on NE. cor. downstream stone abutment of CM&StP Ry bridge 462K, at lower end of bottom land where Harpers slough strikes bluffs,		

STATION	ELEVATION FEET	AUTHORITY
2.5 feet below track, on first course of stone, 9 feet east of center; square cut (U.S.C.E. t.b.m. 20, R.B.)	630.25	Bull. 569
Harpers Ferry, opposite head of Island 162, on irregular-shaped island just below Island 161, in small clump of heavy timber 15 meters from shore; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 201/3):		
Copper bolt	615.65	Bull. 569
Cap on pipe	619.62	
Harpers Ferry, 1.5 miles above, on main bank, 600 meters from foot of bluffs, 0.5 meter east of fence along wagon road, 500 meters below two-story frame house standing opposite triangulation station "Oil Spring;" 150 meters below land line between John Martell on north and Petér Joice on south, 150 meters below upper end of row of cottonwood trees standing along bank of slough; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 201/4):		
Copper bolt	638.14	Bull. 569
Cap on pipe	642.07	
Harpers Ferry, Island 158, planted on, 150 meters below head of island, on high ground in bunch of elms, 50 meters back from shore; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 202/3):		
Copper bolt	614.62	Bull. 569
Cap on pipe	618.58	
Harpers Ferry, opposite Lynxville, Wis.; at side of old wagon road, 0.5 meter west of right-of-way fence of CM&StP Ry, nearly opposite upper end of railroad curve, on side of bald, grassy, round-topped bluff, 200 meters below where Harpers Slough turns away from bluffs toward Lynxville; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 202/4):		
Copper bolt	649.93	Bull. 569
Cap on pipe	653.86	
Harris, Osceola Co.	1551	CRI&P
Harris, Polk Co.	938.09	DM&CI
Hartford	813	CRI&P
Hartford, T. 76 N., R. 22 W., center of SW. ¼ sec. 4, west of road opposite T road east, limestone rock 6 by 8 by 33 inches, set 32 inches in ground; aluminum tablet stamped "773 Adj"	772.575	Bull. 569
Hartford, at south edge of town, SE. angle of T road east, sandstone rock 8 by 10 by 20 inches, set 19 inches in ground; aluminum tablet stamped "888"	887.171	Bull. 569
Hartley	1456,G1462	CM&StP
Hartley	1465,G1462	CRI&P
Hartley, crossing CM&StP	1469,G1462	CRI&P
Hartwick	934	C&NW
Harvard	1071	CRI&P
Harvey	733	CB&Q
Harvey, union station with CRI&P	710	WRR
Harvey, union station with Wabash	704,G718	CRI&P
Harvey, crossing Wabash	704,G718	CRI&P
Harvey, opposite; top of nut on west side of north tube pier of highway bridge across cut-off (U.S.C.E.b.m. 67)	703.70	Bull. 569
Harvey, near, on top of south or downstream side of west shore pier of CRI&P Ry bridge over Des Moines river; cross mark (U.S.C.E.b.m. No. 68)	703.80	Bull. 569
Haskell	893.48	DM&CI
Haskins	753,G756	CM&StP
Hastie	780	WRR

Station	Elevation feet	Authority
Hastings	999,G999	CB&Q
Hastings	999	IaGS
Havelock	1231,G1232	C&NW
Haverhill	1025,G1022	CM&StP
Havre	747	CB&Q
Hawarden	1180,G1181	C&NW
Hawarden, crossing CM&StP	1178	C&NW
Hawarden	1186,G1182	CM&StP
Hawarden, crossing to C&NW	1184,G1181	CM&StP
Hawarden, 5 kilometers north of, on south sandstone pier of railway bridge over Big Sioux river, 0.4 meter north of south edge and 2 meters west of east end of capstone, 2 meters east of center of track, 1.7 meters below rails; bottom of square hole (U.S.C.&G.S.b.m. F)	1,182.593	Bull. 569
Hawarden, 3 kilometers north of, 13 meters west of railway, 9 meters west of road, opposite crossing, 3 meters south and 1 meter east of NE. cor. field owned by M. Austin; copper bolt in top of stone post lettered "U.S.B.M." (U.S.C.&G.S.b.m. G)	1,177.488	Bull. 569
Hawarden, in doorway of Wood & Fleshman (1902) block, 1.8 meters south of center and 2.2 meters east of front edge of front step; a yellow circle in blue square tiling, 5 centimeters on each edge, the most southeasterly blue square in the design (U.S.C.&G.S.b.m. I)	1,180.650	Bull. 569
Hawarden, on north side of Dakota St., 20 meters west of west line of Kansas St., at SW. cor. lot 14, block 5, on south sidewalk line; center of cap upon upper end of piece of heavily galvanized 3-inch iron pipe, 8 feet long, resting on rock 6 feet underground (U.S.C.&G.S.b.m. City)	1,177.347	Bull. 569
Hawarden, 1 kilometer south of, 13 meters east of railway, 10 meters north of road, 1 meter west and 2 meters north of SW. cor. field owned by John Abbey, at level of rails; copper bolt in top of stone post lettered "U.S.B.M." (U.S.C.&G.S.b.m. J)	1,172.675	Bull. 569
Hawarden, 3 kilometers south of, 14 meters west of railway, 6 meters west of road, opposite crossing, 1 meter east of west road fence, at level of rails; iron pipe (U.S.C.&G.S.b.m. K)	1,171.267	Bull. 569
Hawarden, 4.5 kilometers south of, 500 meters north of railway cut, 240 meters by rail south of section line, 13 meters northwest of railway and 5 meters south of road, 0.4 meter below rails, marked by bowlder; iron pipe (U.S.C.&G.S.b.m. L)	1,165.361	Bull. 569
Hawarden, 2.5 miles SE., junction with Northern Iowa division	1239.31	C&NW
Hawkeye	1174	CM&StP
Hawkeye, T. 94 N., R. 9 W., NE. cor. sec. 16; iron post stamped "1194 DBQ"	1,195.442	Bull. 569
Hawkeye, in front of CM&StP Ry station, top of rail	1,176.5	Bull. 569
Hawkeye, NW. ¼ sec. 14, Windsor Tp.	1285	IaGS
Hawley	1213,G1214	M&StL
Hawley, crossing CRI&P	G1214	M&StL
Hayes, Adams Co.	1160	IaGS
Hayesville	795,G800	CM&StP
Hayfield	1243	CRI&P
Hayfield, crossing M&StL	1221	CRI&P
Hayfield	1214	M&StL
Hayfield Junction	1221	CRI&P
Haynies, opposite switch	960,G956	CB&Q
Haynies, 2.5 miles south of, on east side of public road, on		

STATION	ELEVATION FEET	AUTHORITY
land of Bruce Collier, 984 feet south of Thomas Collier's house, 1,099 feet west of track; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 334 equals 116/3):		
Copper bolt	944.545	Bull. 569
Cap on pipe	948.551	
Haynies, 174 feet NW. of south headblock, 43 feet south of fence corner of west right-of-way fence, 45 feet west of track; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.b.m. 335):		
Copper bolt	947.702	Bull. 569
Cap on pipe	951.714	
Hazelton, at CRI&P station; iron post stamped "995 DBQ"	996.674	Bull. 569
Hazleton	996,G998	CRI&P
Hedrick, union station with CM&StP	829	M&StL
Hedrick, crossing CB&Q	814	M&StL
Hedrick, crossing CM&StP	830	M&StL
Hedrick	803	CB&Q
Hedrick, crossing CM&StP	806	CB&Q
Hedrick	823	CM&StP
Hedrick, over crossing M&StL	G827	CM&StP
CM&StP track	G794	CM&StP
Henderson	1034,G1031	CB&Q
Henderson	1031	IaGS
Hentons	967	CB&Q
Hentons, 2.5 miles south of, on line between secs. 5 and 8, T. 72 N., R. 43 W., 308 feet east of quarter-section cor. and 46 feet east of railway, land on east side belongs to J. Martin; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 338):		
Copper bolt	957.997	Bull. 569
Cap on pipe	962.022	
Hentons, in NE. cor. James Meisner's dooryard, 3 feet from each fence and 259 feet northeast of station; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 339):		
Copper bolt	962.219	Bull. 569
Cap on pipe	966.228	
Hentons, 2.5 miles north of station, 741 feet south of bridge 11, section 38, 427 feet west of Hans Schroeder's house, 43 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 340):		
Copper bolt	969.017	Bull. 569
Cap on pipe	973.030	
Hepburn	1023,G1016	CB&Q
Herndon, main line	1061,G1062	CM&StP
Herndon, Des Moines line	1060	CM&StP
Herring	1227	C&NW
Herrold	850.42	DM&CI
Hesper, Winneshiek Co., T. 100 N., R. 8 W., SE. cor. sec. 16, 10 feet north of NW. cor. road crossing; iron post stamped "1264 DBQ"	1,263.835	Bull. 569
Hesper, west of	1360	IaGS
Heytmans	636,G632	CM&StP
Heytmans, Island 151, on, 50 meters back from shore, opposite center of small island, a little below a point opposite a Government light, two large elms stand close to bench mark, one of which appears to be tallest tree in vicinity; copper bolt in tile surmounted by iron pipe		

Station	Elevation feet	Authority
(U.S.C.E.b.m. 203/2):		
Copper bolt	615.59	Bull. 569
Cap on pipe	619.65	
Heytmans, opposite head of Crooked Slough, at foot of bluffs, along wagon road, 1 meter west of right-of-way fence of CM&StP Ry, 175 meters below a sign "1500 Feet to Sta." (Heytmans), 15 meters above whistling post and 25 meters above lower end of small curve; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 203/3):		
Copper bolt	647.28	Bull. 569
Cap on pipe	651.24	
Heytmans, 6.5 miles below Lansing, 1 mile above Heytmans, on downstream side and river end of upstream stone abutment of CM&StP Ry. bridge 504K, 2.7 feet below top of rail and 12 feet toward river from center track, 300 meters below signboard "Station 1 mile," 70 feet above whistling post; square cut (U.S.C.E.t.b.m. 23 R. B)	633.86	Bull. 569
Hiattsville	1001	WRR
Hickory	805,G799	M&StL
Hickory, T. 72 N., R. 17 W., NW. cor. NE. ¼ NW. ¼ sec. 1, 6 feet east by 6 feet south of fence corner, in NW. cor. timber, in root on east side of 6-inch hickory tree; copper nail and washer, painted "U.S.B.M. 826.7"	826.47	USGS
Hickory, T. 73 N., R. 17 W., NW. cor. SE. ¼ SW. ¼ sec. 25, in SE. angle of roads at T road south, in NW. cor. yard to farmhouse, in root on west side of a 2-foot maple tree; copper nail and washer, painted "U.S.B.M. 897.7"	897.50	USGS
Hickory, T. 73 N., R. 16 W., near NE. cor. SW. ¼ sec. 30, in NE. angle of roads at T road north, 160 feet west of angle in road to south, 40 feet east by 25 feet north of center of road junction, in top of concrete post; bronze tablet stamped "E.B. No. 11 1924 Iowa", painted "U.S.B.M. 856.0"	855.809	USGS
Hickory, reference mark, 12 feet east by 12 feet north of tablet, in root on NW. side of 2-foot white oak tree; copper nail and washer	853.90	USGS
Hickory, T. 73 N., R. 16 W., near SE. cor. SW. ¼ sec. 19, 10 feet north by 35 feet east of bridge over creek, on east side of road, 3 feet east of fence, in top of a 4-inch walnut stump; copper nail and washer, painted "U.S.B.M. 761.1"	760.85	USGS
Hicks, crossing C&NW, union station	907.1,G906	CGW
Hicks	908.81	C&NW
High Bridge	931	CM&StP
High Bridge, over Des Moines river	923,G925	CM&StP
High Bridge, 2 miles east of, at crossroads, west side of sec. 21, Madison Tp.; iron post stamped "951"	949.429	Bull. 569
High Bridge, 1.5 miles east by 0.5 mile north of, at T road, NW. cor. sec. 20, Madison Tp.; spike in base of telephone pole (map says 930)	914.62	Bull. 569
High Bridge, 1.5 miles by 0.5 mile south of, at T road, SW. cor. sec. 20, Madison Tp.; spike in base of fence post	929.03	Bull. 569
Highland	776,G780	CM&StP
Highlandville, Winneshiek Co., 2 miles north of, T. 100 N., R. 7 W., SE. cor. sec. 16, NW. cor. road crossing; iron post stamped "1136 DBQ"	1,135.833	Bull. 569
Highview	1133,G1137	IC
Hills, Johnson Co.	637	CRI&P

STATION	ELEVATION FEET	AUTHORITY
Hills, Minn., center line passing track	1454	IC
Hills, Minn., crossing GN	1450	IC
Hills, Minn.	1448	GN
Hills, crossing IC	1445	GN
Hillsboro	732	CB&Q
Hillside	874.55	DM&CI
Hilton	993	ISU
Hilton	964	WRR
Hill Top	951	CM&StP
Hinsdale—Subgrade of track opposite center of cinder platform	549.8	CRI&P
Hinsdale, B.M. top of monument M.P. 16	558.70	CRI&P
Hinsdale, B.M. top of monument M.P. 17	539.99	CRI&P
Hinsdale, B.M. top of monument MP. 18	532.10	CRI&P
Hinsdale and Belfast, top and extreme southwest corner of east abutment of Santa Fe RR bridge crossing Des Moines river between; top of abutment (U.S.C.E.b.m. 4)	560.68	Bull. 569
Hinton, union station with CStPM&O	1146	GN
Hinton	1150,G1144	IC
Hinton, crossing GN	G1144	IC
Hinton	1148	CStPM&O
Hiteman, T. 72 N., R. 18 W., near center of sec. 22, on north side of road, 400 feet west of crossroads in SE. base of 36-inch cottonwood tree; railroad spike, painted "970.7" (County Engineer's B.M.)	970.76	USGS
Hiteman, T. 72 N., R. 18 W., at NE. cor. SE. ¼ SW. ¼ sec. 22, in SW. angle of roads at T road west, 5 feet west by 1 foot north of corner fence post, in top of concrete post; bronze tablet stamped "E.B. No. 2 1924 Iowa"	962.928	USGS
Hobarton	1213,G1211	CM&StP
Holland	1001,G995	CRI&P
Holmes	1152	CRI&P
Holstein	1445,G1443	C&NW
Homestead	861,G864	CRI&P
Homestead, crossing CM&StP	764	CRI&P
Honey Creek	1009,G1008	C&NW
Honey Creek, 1.8 miles south of station, 112 feet north of north end of railway bridge 1007, 1,936 feet south of milepost 12, 49 feet east of C&NW Ry track; copper bolt in bench-mark stone surmounted by iron pipe (U. S.C.E.p.b.m. 353):		
Copper bolt	996.097	Bull. 569
Cap on pipe	1,000.106	
Honey Creek, near station, in west end of south bridge seat of plate-girder bridge 998 over Honey creek, 4 feet west of south end of west girder; copper bolt (U.S.C.E. p.b.m. 354)	1,004.808	Bull. 569
Honey Creek, 2 miles north of station, 2,730 feet south of milepost 16 and 46 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E. p.b.m. 355):		
Copper bolt	1,000.641	Bull. 569
Cap on pipe	1,004.660	
Hope, B.M. spike in pole west of station	1158.59	FtDDM&S
Hopkinton	866,G866	CM&StP
Hopkinton, SW. ¼ sec. 13, T. 87 N., R. 4 W., NW. cor. Main and Locust Sts., near Central drug store; iron post stamped "872"	862.706	Bull. 569
Hopley	1137	CRI&P
Hornick	1067,G1070	CM&StP

Station	Elevation feet	Authority
Horrabin	641	CRI&P
Hospers	1344.6,G1343	CStPM&O
Hotchkiss	873.55	DM&CI
Houghton, Mount Pleasant line	719,G721	CB&Q
Houghton, crossing over CB&Q, Ft. Madison line	696	CB&Q
Houghton, Ft. Madison line track	680.9	CB&Q
Howell	711	WRR
Howell, near, sec. 20, T. 76 N., R. 18 W., 525 feet north of Wabash crossing, 40 feet west of road, 60 feet north and 35 feet west of road junction, 0.5 foot north of wire fence; iron post (Bul. 569, p. 38)	711.960	USGS
Howell, reference mark, 450 feet south of b.m., in top of south end of concrete porch, in front of Pella Pumping station No. 1 building; chiseled square	712.37	USGS
Howell, 800 feet east of station, in ground on south side of Wabash RR track, top of rail set vertically (U.S.C.E.B.M. 63) (U.S.C.E. elev. from B569, p. 118=712.780 ft.)	711.36	USGS
Howell, at north end of highway bridge; top of east tube pier (U.S.C.E.B.M. 64) (Bul. 569, p. 118=714.030 ft.)	712.49	USGS
Howell, 0.7 mile west of, railroad crossing; north rail	717.7	Bull. 569
Howell, 2 miles NW. of, railroad crossing; south rail	724.3	Bull. 569
Howell, 3 miles west by 0.33 mile north of, T. 76 N., R. 19 W., in NW. cor. sec. 23, in Coalridge Church yard, 25 feet east and 25 feet south of center of crossroads; iron post stamped "Prim. Trav. Sta. No. 3, 1908, Iowa"	822.831	Bull. 569
Hubbard	1097,G1099	C&NW
Hudson	888.6,G888	CGW
Hudson, S. Dakota	1228,G1224	CM&StP
Hudson, S. Dakota, junction with Rock Valley line	1223	CM&StP
Hudson, S. Dak., Rock Valley line	1232,G1224	CM&StP
Hudson, S. Dak., junction with SC&D line	1223	CM&StP
Hughes	1105	C&NW
Hugo, Jackson Co., middle south side sec. 18, Butler Tp.	1085	USGS
Hull	1429,G1435	CM&StP
Humboldt	1087,G1088	M&StL
Humboldt	G1095	Weather Bur.
Humeston	1105,G1104	CB&Q
Humeston, Shenandoah line	1099	CB&Q
Huntington	1345,G1346	M&StL
Hunt's Siding, stock pen	1339	IC
Hurley	1170	CRI&P
Huron, 400 meters below foot of Johnson Island, 8 meters from water's edge, 5.7 meters 194° to 12-inch ash, 3.6 meters 72° to 7-inch maple, 10.2 meters 293° to 18-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 129/3):		
Copper bolt	525.96	Bull. 569
Cap on pipe	529.98	
Hurstville, Jackson Co.	664	USGS
Hurstville	670,G663	CM&StP
Hutchins	1202,G1208	CM&StP
Huxley	1021,G1035	CM&StP
Huxley, crossing under FtDDM&S	1024	CM&StP
Huxley	1046	FtDDM&S
Huxley, T. 82 N., R. 24 W., SW. cor. SE. 1/4 sec. 14; spike in telephone pole, marked "U.S.B.M. 1003"	1,001.99	Bull. 569
Huxley, near center of north side of sec. 26, T. 82 N., R. 24 W., 50 feet west of electric-railway station; iron post stamped "1040"	1,038.481	Bull. 569
Huxley, T. 82 N., R. 24 W., NW. cor. NE. 1/4 sec. 27; spike in telephone pole, marked "U.S.B.M. 1048"	1,046.79	Bull. 569

Station	Elevation feet	Authority
Huxley, T. 82 N., R. 24 W., NW. cor. NE. ¼ sec. 34; spike in telephone pole, marked "U.S.B.M. 1037"	1,035.94	Bull. 569
Huxley, T. 82 N., R. 24 W., SW. cor. SE. ¼ sec. 34; spike in telephone pole, marked "U.S.B.M. 1021"	1,019.49	Bull. 569
Hyperion Club station	858.15	DM&CI
Ida Grove	1225,G1225	C&NW
Imogene	1044	WRR
Independence	917,G923	IC
Independence, crossing CRI&P	912,G921	IC
Independence	914,G921	CRI&P
Independence, crossing IC	912	CRI&P
Indian Creek, top of rail, center line of overhead bridge on east line sec. 19, Tp. 83, R. 6, 140 feet north of SE. cor. sec. 19	724.31	CR&IC
Indianola	961,G966	CRI&P
Indianola, crossing CB&Q	962	CRI&P
Indianola	972	CB&Q
Indianola, T. 76 N., R. 23 W., SW. cor. sec. 16, NE. angle of crossroads, limestone rock; aluminum tablet stamped "948 Adj"	946.812	Bull. 569
Indianola	G969	Weather Bur.
Indianola Junction	1040,G1040	CB&Q
Industry	1124.3,G1129	CGW
Industry, 2 miles south by 1 mile east of, T. 89 N., R. 27 W., cor. secs. 7, 8, 17 and 18, 30 ft. NW. of crossroads, in base of corner fence post, marked "1,117.8"; spike	1,117.74	USGS
Industry, 1 mile south by 1 mile east of, T. 89 N., R. 27 W., cor. secs. 5, 6, 7 and 8, 55 ft. NW. of crossroads, in root of 15-inch boxelder tree, marked "1,124.8"; copper nail and washer	1,124.65	USGS
Industry, 1 mile east of, Tps. 89 and 90 N., R. 27 W., cor. secs. 5, 6, 31 and 32, 35 ft. NE. of crossroads; iron post stamped "IOWA 1919 1,130"	1,129.600	USGS
Industry, Tps. 89 and 90 N., Rs. 27 and 28 W., cor. secs. 1, 6, 31 and 36, 40 ft. SW. of crossroads, in root of large willow tree, marked "1,121.6"; copper nail	1,121.49	USGS
Industry, 1 mile west of, Tps. 89 and 90 N., R. 28 W., cor. secs. 1, 2, 35 and 36, T road N., 35 ft. NE. of road fork; at fence corner, in top of stump standing 6 inches above ground, marked "1,124.5"; copper nail and washer	1,124.44	USGS
Industry, Tps. 89 and 90 N., R. 28 W., cor. secs. 2, 3, 34 and 35, 40 ft. SE. of crossroads; iron post stamped "IOWA 1919 1,136"	1,135.573	USGS
Industry, 3 miles west of, Tps. 89 and 90 N., R. 28 W., cor. secs. 3, 4, 33 and 34, 30 ft. NE. of crossroads, in root of large willow tree, marked "1,128.2"; copper nail and washer	1,128.12	USGS
Ingersoll	882,G885	CM&StP
Ingersoll, T. 80 N., R. 26 W., SE. cor. SE. ¼ sec. 12, in corner of field, 2.5 feet west of Dallas county line, on C. E. Waters's place, 200 yards east of house; iron post stamped "867"	866.142	Bull. 569
Ingersoll, T. 80 N., R. 25 W., SW. cor. NE. ¼ sec. 20, NE. cor. schoolhouse yard; iron post stamped "881"	879.221	Bull. 569
Inwood	1466,G1473	CM&StP
Ionia	1144,G1149	CM&StP
Iowa City, top of rail, north end of Iowa river bridge, Iowa City	668.00	CR&IC
Iowa City, bench mark, SE. cor. of step of east door of Engineering Building, State University of Iowa	699.71	CR&IC
Iowa City, Burlington St. Sta	654,G654	CRI&P

Station	Elevation feet	Authority
Iowa City, Wright St. Sta.	671	CRI&P
Iowa City	G685	Weather Bur.
Iowa Falls, St. Paul-Kansas City line	1098	CRI&P
Iowa Falls, crossing over C&NW	1096	CRI&P
Iowa Falls, crossing Sioux Falls line CRI&P	1107	CRI&P
Iowa Falls, Sioux Falls line	1112,G1107	CRI&P
Iowa Falls, crossing IC	1109	CRI&P
Iowa Falls	1090	C&NW
Iowa Falls	1104,G1103	IC
Iowa Falls, crossing St. Paul Div. CRI&P	1110	IC
Iowa Falls, crossing Sioux Falls line CRI&P	1106,G1105	IC
Iowa Falls, crossing over C&NW	1099	IC
Iowa Falls	G1107	Weather Bur.
Iowa Falls and Alden, morainal hill between, on north side river	1225	IaGS
Iowa Junction	627,G628	CRI&P
Iowana	580.40	CD&M
Ira	831.7,G829	CGW
Ireton	1368,G1373	C&NW
Irma	927	IC
Iron Hill, Allamakee Co.	1320	USGS
Iron Hill, Jackson Co.	940	USGS
Irving	798	C&NW
Irvington	1151,G1155	C&NW
Irwin	1265.2	CGW
Irwin	1263,G1262	C&NW
Island City	622.50	CD&M
Island Park	982.5,G980	CB&Q
Island Park, 1,148 feet south of station, 164 feet south of public-road crossing, 46 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U. S.C.E.p.b.m. 341):		
Copper bolt	967.718	Bull. 569
Cap on pipe	971.737	
Island Park, T. 73 N., R 43 W., on south line of sec. 6, 603 feet east of SW. cor. of SE. ¼ SE. ¼ sec. 6, in dooryard of C. H. W. Busse; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 119/3):		
Copper bolt	968.92	Bull. 569
Cap on pipe	973.00	
Jackson Junction, Ia. & Dak. line	1163,G1169	CM&StP
Jackson Junction, Davenport line	1161,G1169	CM&StP
Jacobs Switch	990,G971	M&StL
Jamaica	1043,G1042	CM&StP
James	1130	IC
James, Platform (abandoned)	1122	GN
James	1125	CStPM&O
Jamison	973	CB&Q
Janesville	893,G891	IC
Jefferson	1056,G1057	C&NW
Jefferson, CM&StP crossing	1053	C&NW
Jefferson	1059,G1062	CM&StP
Jefferson, crossing C&NW	1054,G1056	CM&StP
Jefferson, S. Dakota	1117,G1102	CM&StP
Jerome	1038,G1042	CM&StP
Jesup	979,G980	IC
Jewell, Des Moines line	1054,G1059	C&NW
Jewell, Eagle Grove line	1056	C&NW
Johnson	832.19	DM&CI
Johnson, NE. ¼ sec. 7, T. 79 N., R. 24 W., northeast		

Station	Elevation feet	Authority
corner Lawson schoolhouse; iron post stamped "833 Adj 1903"	831.943	Bull. 569
Johnson, Ridgedale schoolhouse, near center sec. 36, T. 80 N., R. 25 W., SE. cor. school yard, opposite road south; iron post stamped "959 Adj. 1903"	957.965	Bull. 569
Johnsonport, Allamakee Co., 200 meters above last house in upper end of, 2 meters west of west right-of-way fence of CM&StP Ry, 150 meters above mouth of Paint creek, 143 meters above bridge 438K; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 199/3):		
Copper bolt	637.25	Bull. 569
Cap on pipe	641.21	
Joice	1262	C&NW
Jolley	1230,G1232	CM&StP
Jordan	1110	C&NW
Jordan, 4.5 miles east of, T. 84 N., R. 25 W., SE. cor. sec. 25, at county line between Boone and Story counties, NW. cor. forks at T road west, at fence corner; iron post stamped "1016"	1,014.972	Bull. 569
Jordan, 3.5 miles east of, T. 84 N., R. 25 W., cor. secs. 25, 26, 35 and 36, in center of crossroads; chiseled square cut in top of corner stone, marked "1011.5"	1,010.524	Bull. 569
Jordan, T. 84 N., R. 25 W., NW. cor. sec. 35, north-south section line crossing east-west road, south side of road about 20 feet east of section line, inside of fence; copper nail in top of willow stump, marked "1042.9"	1,041.93	Bull. 569
Jordan, 1.5 miles east by 3 miles south of, T. 83 N., R. 25 W., SE. cor. sec. 9, NW. cor. crossroads, 7 feet north of fence corner; iron post stamped "1095"	1,093.738	Bull. 569
Jordan, 1.5 miles east by 2 miles south of, T. 83 N., R. 25 W., NE. cor. sec. 9, SW. cor. crossroads, inside of fence corner; copper nail in root of forked soft-maple tree, marked "1071.1"	1,070.21	Bull. 569
Jordan, 1.5 miles east by 1 mile south of, Tps. 83 and 84 N., R. 25 W., cor. secs. 33, 34, 3, and 4, in center of crossroads; chiseled square in top of corner stone, marked "1070.8"	1,069.88	Bull. 569
Jordan, 1.5 miles east of, T. 84 N., R. 25 W., SW. cor. sec. 27, NE. cor. crossroads; iron post stamped "1040"	1,039.379	Bull. 569
Jordan, T. 84 N., R. 25 W., SW. cor. sec. 22, NE. cor. road forks at T road east, top south end of east side of concrete drain under road north; chiseled square, marked "1045.8"	1,044.81	Bull. 569
Jordan, 1.5 miles east by 1.5 miles north of, T. 84 N., R. 25 W., west center of sec. 22, NE. cor. crossroads, in corner fence post; copper nail in post about 1½ feet above ground, marked "1061.3"	1,060.36	Bull. 569
Jordan, T. 84 N., R. 25 W., SW. cor. sec. 15, NE. cor. crossroads, inside of fence corner, just north of corner fence post; copper nail in base of willow tree, marked "1064.5"	1,063.50	Bull. 569
Jordan, T. 84 N., R. 25 W., SW. cor. sec. 10, NE. cor. crossroads, 65 ft. NE. of center of crossroads; copper nail in base of telephone pole, marked "1045.9"	1,044.91	Bull. 569
Judd	1112,G1111	IC
Judith	818	CRI&P
Julien	846,G842	IC
Julien, T. 89 N., R. 1 E., sec. 36, east-west road crossing IC RR near railroad fence, north side of wagon road, 50 feet west of railroad track; iron post stamped "869"	860.048	Bull. 569
Juniata	1384,1380	CM&StP

Station	Elevation feet	Authority
Junction Switch	842	CM&StP
Kains	638,G632	CM&StP
Kains, in front of CM&StP Ry station; base of rail (U. S.C.E.b.m.)	634.52	Bull. 569
Kains, Battle Island (137), on high sand ridge, 0.5 mile above foot of island, 75 meters from edge of sand bar, 20 meters from main bank, 100 meters below lower end of small willows on bar; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 208/2):		
Copper bolt	622.11	Bull. 569
Cap on pipe	626.06	
Kains, Island 139, about opposite center of Battle Island, 100 meters back from bank of river, 25 meters below south end of dam across slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 208/3):		
Copper bolt	619.93	Bull. 569
Cap on pipe	623.87	
Kains, Island 139, in timber on west bank of small dry slough, in bend of large slough, 50 meters east and 50 meters south from bank of slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 208/4):		
Copper bolt	621.53	Bull. 569
Cap on pipe	625.47	
Kains, 1 mile above, 5 miles below New Albin, on upstream side and river end of downstream abutment of CM&StP Ry bridge 560K, 125 meters above milepost 29-132, 3 feet below track, 10 feet toward river from center; square cut (U.S.C.E.t.b.m. 28, R. B)	636.18	Bull. 569
Kalo	1016	M&StL
Kalona	651,G661	CRI&P
Kamrar	1115	C&NW
Kanawha	1191,G1183	M&StL
Kellerton	1193,G1197	CB&Q
Kelley	1029,G1033	C&NW
Kelley	1027	FtDDM&S
Kelley, T. 82 N., R. 25 W., NW. cor. sec. 1; iron post stamped "1046"	1,044.226	Bull. 569
Kelley, T. 83 N., R. 24 W., SW. cor. sec. 30; iron post stamped "1032"	1,030.455	Bull. 569
Kelley, T. 83 N., R. 24 W., SW. cor. sec. 28; spike in telephone pole, marked "U.S.B.M. 1003"	1,001.60	Bull. 569
Kelley, T. 83 N., R. 24 W., SE. cor. sec. 28, spike in base of telephone pole, marked "U.S.B.M. 1017"	1,015.64	Bull. 569
Kelley, T. 83 N., R. 24 W., center of sec. 27, at NW. cor. crossroads; iron post stamped "987"	986.151	Bull. 569
Kelley, T. 83 N., R. 24 W., center of sec. 26, SE. cor. crossroads; spike in telephone pole, marked "U.S.B.M. 943"	941.79	Bull. 569
Kelley, T. 83 N., R. 24 W., center of line between secs. 25 and 26, SW. cor. of crossroads; top of large rock, marked "□U.S.B.M. 930" [Established by Iowa State College students.]	928.30	Bull. 569
Kelley, on west side of equalizer foundation in south pipe line (of 2), 33 feet west of pole 770 of FtDDM&S Ry, 21 feet east of similar equalizer in north pipe line; square cut	1,027.23	Bull. 569
Kelley, square-cut on track side of concrete base of eastbound home signal, 10.5 feet east of point of switch, 30 feet east of pole 766	1,027.14	Bull. 569
Kelley, square cut on east end of baggage-door lintel of station of FtDDM&S Ry, opposite pole 763	1,029.29	Bull. 569

STATION	ELEVATION FEET	AUTHORITY
Kelley, spike in track of pole 757, 1 foot above ground	1,030.69	Bull. 569
Kelley, spike in track side of pole A414, 1 foot above ground	1,029.73	Bull. 569
Kelley, T. 83 N., R. 24 W., spike in track side of pole A386, south side of east-west road along north line of sec. 32	1,013.03	Bull. 569
Kelley, Pole A360, 1 foot above ground, in track side of; spike	1,015.89	Bull. 569
Kelley, T. 83 N., R. 24 W., spike in track side of pole A332, 1 foot above ground, first pole north of east-west road along north line of sec. 29	1,023.31	Bull. 569
Kellogg	842,G844	CRI&P
Kemper	528,G529	CB&Q
Kennebec	1056,G1061	IC
Kennedy	954,G957	CM&StP
Kensett	1220	CRI&P
Kensett	1218,G1212	M&StL
Kent	1191,G1189	CB&Q
Kenwood	1241,G1245	CM&StP
Kenwood, divide in SE. ¼ sec. 32, Hanover Tp., Crawford Co.	1355	CM&StP
Keokuk, union station	504,G505	CB&Q
Keokuk, center Union Depot, top of rail	506.0	CRI&P
Keokuk, B.M. cross on top of foundation wall, NW. cor. CRI&P Ry engine house	496.23	CRI&P
Keokuk, top of monument M.P.2	497.69	CRI&P
Keokuk, top of monument M.P. 3	499.25	CRI&P
Keokuk, top of monument M.P. 4	506.42	CRI&P
Keokuk, in coping of shore side of lower lock of Des Moines Rapids canal, in recess between stone steps and stone pier of lower hydraulic tower, on south side of pier; copper bolt (U.S.C.E.p.b.m. 1)	493.641	Bull. 569
Keokuk, in south face of Iowa shore pier of railroad bridge, 8 inches above bench in pier, in tenth stone from west end; copper bolt (U.S.C.E.p.b.m. 2)	494.346	Bull. 569
Keokuk, Des Moines river bridge, at intersection of cross cut in upper surface of stone buttress; small conical hole (U.S.C.E.p.b.m. 4)	499.828	Bull. 569
Keokuk, 2 miles above, in coping of west wall of sluiceway at south end of middle canal lock; copper bolt (U.S. C.E.p.b.m 1)	501.571	Bull. 569
Keokuk, below, on south side of right of way fence on south side of CB&Q RR, 150 meters from right bank, 400 meters below or west of lower one of sawmills on right bank, 500 meters above head of Island 405, which is at upper mouth of Des Moines river; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 110/3):		
Copper bolt	487.20	Bull. 569
Cap on pipe	491.17	
Keokuk, second door from corner of Johnson St., in SW. cor. three-story stone building, owned by Mr. Patterson, facing on Water St., 8 inches above west doorsill, on inner side of outer wall, 15 meters from corner of Water and Johnson Sts.; copper bolt (U.S.C.E.p.b.m. 3)	509.559	Bull. 569
Keokuk, in wall at upper end of front of Brown's warehouse; spike (U.S.C.E.p.b.m. 52 Mackenzie equals high-water mark of 1851)	498.58	Bull. 569
Keokuk, at NW. cor. Union Station building on Water St., near foot of Exchange St., top of wagon-guard stone (U.S.C.E. city b.m.)	506.74	Bull. 569
City datum	483.24	
Keokuk, in south face of Iowa shore abutment of railroad		

Station	Elevation feet	Authority
bridge, 8 inches above bench of abutment, in tenth stone from west end; copper bolt (U.S.C.E.p.b.m. 2)	494.346	Bull. 569
Keokuk, in stone masonry at extreme lower end of east wall or pier of lower lock of Des Moines Rapids canal; cut in stone (U.S.C.E. zero, U. S. Engineer gage, lower lock) elevation of zero	477.84	Bull. 569
Keokuk, at side of U. S. Engineers' gage on extreme lower end of east wall or pier of lower lock of Des Moines Rapids canal; marks cut in stone masonry and figures by them (U.S.C.E. high-water marks of 1851, 1888, 1881):		
1851	498.80	Bull. 569
1888	497.48	
1881	496.78	
Keokuk and Hamilton bridge, 270 meters east of east end of, 45 meters north of railroad track, in woods 13 meters SE. of road, 75 meters east of where road joins railroad before crossing bridge; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 111/2):		
Copper bolt	487.45	Bull. 569
Cap on pipe	491.41	
Keokuk, on top of coping on outer corner of apex of lower gate recess on shore side of lower lock of Des Moines Rapids canal (U.S.C.E. canal b.m. Stickney)	493.60	Bull. 569
Keokuk, Des Moines Rapids canal, 920 meters below lower end of sluiceway of middle lock of, in yard about 30 meters west of railroad, 30 meters above house, 70 meters above an old ice house, the road from top of bluff at Rand Park passes about 15 meters west of stone and joins road up west side of railroad at point about 50 meters north of stone; stone post (U.S.C.E. △ lower base)	513.55	Bull. 569
Keokuk, 2 miles above, in coping of west wall of sluiceway at south end of middle canal lock; copper bolt (U.S.C.E.p.b.m. 1)	501.571	Bull. 569
Keokuk, Des Moines Rapids canal, in stone masonry on east side of middle lock of, just below lower gate; gage is cut in stone (U.S.C.E.b.m. lower gage, middle lock)	484.04	Bull. 569
Keokuk, Des Moines Rapids canal, just below lower gate, on east side of middle lock, marks and figures cut in masonry by gage (U.S.C.E. high-water marks of 1891, 1888, 1881):		
1891	498.84	Bull. 569
1888	497.54	
1881	496.84	
Keokuk, Des Moines Rapids canal, in stone masonry on east side of middle lock of, just above upper gate; cut in stone (U.S.C.E. upper gage, middle lock)	492.00	Bull. 569
Keokuk, Des Moines Rapids canal, on north side of sluiceway from dry dock of middle lock of, cut in stone (U.S.C.E. rapids gage, middle lock)	485.98	Bull. 569
Keokuk, Des Moines Rapids canal, on north side of sluiceway from dry dock of middle lock of; mark and figures cut in stone masonry by gage (U.S.C.E. high-water mark 1888, rapids, middle lock)	499.85	Bull. 569
Keokuk, Des Moines Rapids canal, 30 meters north of switch at upper end of middle lock, 3 meters west of railroad, immediately opposite entrance to dry dock from canal; stone post (U.S.C.E. △ upper base)	502.01	Bull. 569
Keokuk, Des Moines Rapids canal, 1 mile above middle lock of, in timber on left bank, about 20 meters from left		

STATION	ELEVATION FEET	AUTHORITY
bank, 11½ meters east of center of road up river bank, 15 meters west of center of old road up river, but farther up on hillside, 130 meters north of half-section line, which is a lane on bluff, on north side of small cemetery, 40 meters north of wash or small ravine on hillside, on land of Martha Parsons, 400 meters above some exposed rocks near left bank at low water; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 112/2):		
Copper bolt	549.30	Bull. 569
Cap on pipe	553.32	
Keokuk, on NW. cor. east abutment of CB&Q RR bridge near mouth of Des Moines river, 1 foot from face of abutment; cross mark (U.S.C.E.b.m. 1)	496.63	Bull. 569
Keokuk, Mississippi river, low water	G477	Miss. Riv. Com.
Keokuk, Mississippi river, high water	G494	Miss. Riv. Com.
Keokuk, city base	G482	Weather Bur.
Keokuk	G614	Weather Bur.
Keosauqua, B.M. top of monument M.P. 3	667.53	CRI&P
Keosauqua, B.M. top of monument M.P. 4	636.51	CRI&P
Keosauqua, top of rail, center of depot	635.08	CRI&P
Keosauqua, B.M. cross on top of bench of pier under SE. cor. of depot	636.98	CRI&P
Keosauqua, at SW. cor. concrete porch floor of Manning Hotel (U.S.C.E.b.m. 29)	579.14	Bull. 569
Keosauqua, on top of east end of south abutment of highway bridge; cross mark (U.S.C.E.b.m. 30)	588.41	Bull. 569
Keosauqua	G664	Weather Bur.
Keota	787,G800	CRI&P
Kesley	995	C&NW
Keswick	863,G872	CRI&P
Ketcham	691,G694	CB&Q
Kew	1110.4,G1109	CB&Q
Keystone	881,G875	CM&StP
Keywest, junction of road south to cemetery gate	G841	USGS
Kidder	847.6,G849	CGW
Kilbourne—Subgrade of track opposite center of depot	596.5	CRI&P
Kilbourne, B.M. top of monument M.P. 48 (U.S.C.E.b.m. 32)	596.96	CRI&P
Kilbourne, 1 mile NW. of, B.M. top of monument M.P. 49 (U.S.C.E.b.m. 33)	601.41	CRI&P
Kilbourne, 2 miles NW. of, B.M. top of monument M.P. 50 (U.S.C.E.b.m. 34)	603.95	CRI&P
Kilbourne, 3 miles NW. of, B.M. top of monument M.P. 51 (U.S.C.E.b.m. 35)	598.71	CRI&P
Kilbourne, top of SW. cor. north abutment of highway bridge (U.S.C.E.b.m. 91)	599.86	Bull. 569
Kilduff	932	M&StL
Kimball	814	CRI&P
Kimball, T. 75 N., R. 21 W., west of SE. cor. sec. 5, NW. angle of crossroads, in limestone rock 6 by 8 by 28 inches, set 27 inches in ground; aluminum tablet stamped "869 Adj"	867.704	Bull. 569
Kimball, T. 76 N., R. 21 W., NE. cor. sec. 33, 2.5 miles south of Pleasantville, in SW. angle of crossroads, at NE. cor. schoolhouse, sandstone rock 8 by 10 by 22 inches, set 21 inches in ground; aluminum tablet stamped "894 Adj"	893.119	Bull. 569
King, Dubuque Co., T. 88 N., R. 3 E., near center NE. ¼ sec. 27, St. Katherine's Church, NW. cor. yard of priest's house; iron post stamped "1123"	1,114.552	Bull. 569

Station	Elevation feet	Authority
Kingsley	1236,G1237	C&NW
Kingston, 0.5 mile above Oquawka, on Iowa shore, 10 meters from river bank, 140 meters below Government light opposite upper end of Oquawka, Ill.; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 128/3):		
Copper bolt	525.15	Bull. 569
Cap on pipe	529.14	
Kingston, on small ridge 674 meters back of preceding bench mark, 4.3 meters 222° to 18-inch hickory tree, 6.8 meters 15° to 12-inch ash tree, 6.6 meters 125° to 20-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 128/4):		
Copper bolt	525.35	Bull. 569
Cap on pipe	529.36	
Kinross	758,G767	CRI&P
Kinsey	882.28	DM&CI
Kirgis	989.73	DM&CI
Kirkman	1233	C&NW
Kirkman	1233.5,G1235	CGW
Kirkville, B.M. top of monument M.P. 81	662.65	CRI&P
Kirkville, B.M. top of monument M.P. 82	658.83	CRI&P
Kirkville, B.M. top of monument M.P. 83	666.78	CRI&P
Kirkville, B.M. top of monument M.P. 84	670.70	CRI&P
Kirkville, top of rail, center depot	697.5	CRI&P
Kirkville, B.M. top of monument M.P. 85	688.71	CRI&P
Kirkville, B.M. top of monument M.P. 86	687.33	CRI&P
Kirkville, B.M. top of monument M.P. 87 (U.S.C.E.b.m. 50)	704.93	CRI&P
Kiron	1307	C&NW
Kiron, divide in NW. ¼ sec. 9, Stockholm Tp.,Crawford Co.	1419	C&NW
Kiron, crossing Otter creek	1287	C&NW
Kiron, divide in SW. ¼ sec. 10, Otter Creek Tp., Crawford Co.	1455	C&NW
Klemme	1227	CRI&P
Klondike Junction, Des Moines	826.71	DM&CI
Knierim	1178,G1178	IC
Knierim, crossing over CRI&P	1205	IC
Kniffin	1075,G1086	CRI&P
Knoke	1243,G1240	CM&StP
Knowlton	1102.2,G1102	CGW
Knoxville	904	CB&Q
Knoxville	G910	Weather Bur.
Knoxville, T. 76 N., R. 20 W., 0.25 mile west of NE. cor. sec. 24, west and 130 feet south of center of crossroads, 40 feet south of small wooden culvert, in angle of rail fence; iron post stamped "819 Iowa"	817.718	Bull. 569
Knoxville, T. 76 N., R. 19 W., SE. cor. sec. 20, near Mount Vernon Chapel, in front yard of J. J. Woody, SE. of house and just inside fence along north side of road; iron post stamped "864 Iowa"	862.777	Bull. 569
Knoxville, T. 76 N., R. 19 W., SE. cor. sec. 29, near Washington Church, in line with east and west road, in NE. root of maple tree 30 inches in diameter; 40-penny nail	876.718	Bull. 569
Knoxville	895,G909	CRI&P
Koenigsmark (Lefebure), top of rail on south line sec. 17, Tp. 82, R. 7, 1150 feet east of SW. cor. sec. 17	810.60	CR&IC
Koenigsmark, top of rail on south line sec. 20, Tp. 82, R. 7, 340 feet east of SW. cor. sec. 20	852.90	CR&IC
Koenigsmark, top of rail on south line sec. 29, Tp. 82, R. 7, 100 feet east of SW. cor. sec. 29	853.60	CR&IC
Koyle	979	CB&Q
Koyle, Des Moines line	983	CB&Q

STATION	ELEVATION FEET	AUTHORITY
Lacey	812,G805	M&StL
Lacona	824,G822	CB&Q
Lacona, T. 74 N., R. 22 W., NW. cor. sec. 9, in SE. cor. crossroads, at south end of tile drain, on 4 by 2 by 2.5 foot bowlder; highest point of chiseled circle	901.37	Bull. 569
Lacona, T. 74 N., R. 22 W., SW. cor. sec. 3, in NE. cor. crossroads, at SW. cor. school yard; iron post stamped "Iowa, 865, 1913"	864.605	Bull. 569
Lacona, T. 74 N., R. 22 W., SE. cor. sec. 3, at crossroads, center of jog in east-west road, at SW. cor. wooden bridge over Flank creek, in bridge floor; copper nail	813.85	Bull. 569
Lacona, high-water mark June 24, 1913, wooden bridge over Flank creek, west side of bridge, on east side of center rail post; pencil mark "815.8"	815.8	Bull. 569
Lacona, T. 75 N., R. 22 W., SW. cor. sec. 35, at St. Mary's Catholic Church, 6 feet east of stump of cottonwood tree, at N.E. angle of crossroads, in sandstone post; aluminum tablet stamped "Prim. Trav. Sta. No. 5, 926." (An old tablet reset in new stone same location but 0.265 foot lower. Old stone had split)	924.436	Bull. 569
Lacona, T. 74 N., R. 22 W., SW. cor. sec. 1, at NE. cor. crossroads, 25 feet east of corner post, in root of 10-inch elm tree; copper nail	885.27	Bull. 569
Lacona, T. 74 N., R. 22 W., sec. 12, at NE. cor. at SW. cor. private T road south, 10 feet west of fence corner; iron post stamped "Iowa, 909, 1913"	909.171	Bull. 569
La Crew	715,G717	CB&Q
Laddsdale	625	CRI&P
Ladoga	1224	CB&Q
Ladora	780,G783	CRI&P
Lafayette, crossing under road, subgrade	883.09	WCF&N
Lafayette, overhead highway bridge	897.53	WCF&N
Lainsville	599,G599	CM&StP
Lainsville, 250 meters below, 0.5 meter from fence on right of way of CM&StP Ry, 25 meters above small bridge; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 168/3):		
Copper bolt	606.50	Bull.569
Cap on pipe	610.52	
Lainsville, on right bank opposite Arnolds landing, at head of Island 259, 25 meters from river bank, in open timber partly cleared; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 169/3):		
Copper bolt	584.07	Bull.569
Cap on pipe	588.06	
Lainsville, on right bank opposite Arnolds landing, 696 meters from river bank, on east bank of slough in open timber; copper bolt in tile surmounted by iron pipe (U. S.C.E.b.m. 169/4):		
Copper bolt	584.77	Bull.569
Cap on pipe	588.79	
Lake City	1243,G1249	C&NW
Lake Mills	1266,G1266	M&StL
Lake Mills	1257	C&NW
Lake Mills, crossing M&StL	1258	C&NW
Lake Okoboji, West, hill back of Lakeside Laboratory, Millers Bay	1510	IaGS
Lake Park	1469,G1469	CRI&P
Lakeside	1407	CM&StP
Lakes Okoboji	1409	CM&StP
Lakewood	1331.8	CStPM&O

Station	Elevation feet	Authority
Lake View	1243	C&NW
Lakota	1156	CRI&P
Lamoille	936,G936	C&NW
Lamoni	1123,G1126	CB&Q
Lamont	1045.9	CGW
Lamont, T. 90 N., R. 7 W., NE. cor. sec. 21, at road crossing; iron post stamped ''1061 DBQ''	1,061.951	Bull. 569
Lamont, in front of CGW RR station; top of rail	1,045.6	Bull. 569
La Motte	911,G910	CM&StP
La Motte, T. 86 N., R. 4 E., SW. ¼ sec. 6, junction of wagon roads near Anton Ernest's house; iron post stamped ''708''	700.149	Bull. 569
La Motte, T. 87 N., R. 3 E., sec. 22, SE. cor. Nat Mandor's shed, west side of road, 200 feet SW. of bridge over Tete des Morts creek, on half-section line; iron post stamped ''718''	709.829	Bull. 569
La Motte, sec. 4, T. 86 N., R. 3 E., cor. Market and Water Sts., 40 feet NE. of railroad; iron post stamped ''923''	914.661	Bull. 569
La Motte, middle NE. ¼ sec. 6, Richland Tp.	1125	USGS
La Motte, east ½ sec. 6, Prairie Spring Tp.	1190	USGS
La Motte, Middle Prairie Spring Tp.	740	USGS
Lamp Siding, stock pen	1114	CM&StP
Lanesboro	1141.5,G1148	CGW
Langdon	1370,G1371	M&StL
Langworthy	867,G868	CM&StP
Lansing	635,G630	CM&StP
Lansing, NE. of intersection of Main and Second Sts., near SW. cor. implement warehouse of Nielande & Co.; aluminum tablet stamped ''653 DBQ''	654.493	Bull. 569
Lansing, T. 99 N., R. 4 W., on east side sec. 20 (map shows B.M. in sec. 16), 12 feet west of NE. cor. post cemetery; iron post stamped ''1216 DBQ''	1,217.533	Bull. 569
Lansing, Carol Island, planted on, 250 meters below head of Ferry slough, 25 meters back from shore, opposite foot of first small island below head of Ferry slough, 100 meters above a log cabin, in bunch of elms; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 204/2):		
Copper bolt	618.62	Bull. 569
Cap on pipe	622.59	
Lansing, Capoli bluff, on right bank directly under, 0.5 meter outside of right-of-way fence of CM&StP Ry (bluff side), 25 meters above upper end of sharp curve around foot of Capoli bluff; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 204/3):		
Copper bolt	654.43	Bull. 569
Cap on pipe	658.37	
Lansing, Island 148, 400 meters above head of, on large island, in bunch of willows, 50 meters back from shore, 150 meters above head of bay; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 205/2):		
Copper bolt	615.50	Bull. 569
Cap on pipe	619.45	
Lansing, 2 miles below station, in meadow at foot of bluffs on property of Julius Nelson, 0.5 meter toward bluffs from fence along wagon road, 155 meters below milepost 123-38, 120 meters above culvert 518; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 205/3):		
Copper bolt	653.78	Bull. 569
Cap on pipe	657.74	

STATION	ELEVATION FEET	AUTHORITY
Lansing, in front of CM&StP Ry station; base of rail (U.S.C.E.b.m.)	632.69	Bull. 569
Lansing, on SE. cor. G. W. Herndt's warehouse; high-water mark of June, 1880	633.98	Bull. 569
Lansing, Island 146, on high ground in bunch of elms, 40 meters back from shore at Government light, opposite upper end of Lansing; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 206/2):		
Copper bolt	619.61	Bull. 569
Cap on pipe	623.57	
Lansing, opposite 1-mile post above, 34 meters back from railroad, at foot of bluffs, 75 meters above an old mill that stands on bank of slough, and is last building in upper end of Lansing; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 206/3):		
Copper bolt	644.83	Bull. 569
Cap on pipe	648.77	
Lansing, 1.5 miles above, on upstream side and river end of downstream abutment of CM&StP Ry bridge 530K, 0.8 foot below track and 7 feet east of center; square cut (U.S.C.E.t.b.m. 26, R. B)	637.35	Bull. 569
Lansing, Island 140, opposite foot of Island 141, 30 meters back from shore, 100 meters below upper end of timber, 30 meters below an old shed, inside a lot, 1 meter from east fence; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 207/3):		
Copper bolt	620.70	Bull. 569
Cap on pipe	624.67	
Lansing, 3 miles above, planted at foot of bluffs, 1 meter east of west right-of-way fence of CM&StP Ry, 425 meters above bridge 540K, 475 meters above a house, 0.5 mile above triangulation station Cowles, opposite end of railroad curve, 0.5 mile below schoolhouse; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 207/4):		
Copper bolt	640.19	Bull. 569
Cap on pipe	644.15	
Lansing, 3.8 miles above, on downstream side and river end of upstream stone abutment of CM&StP Ry bridge 546K, 3 feet below track, 8 feet toward river from center; square cut (U.S.C.E.t.b.m. 27, R. B)	635.73	Bull. 569
Lansing, hydrant, Main and Front Sts	G640	USGS
Lansing, Mississippi river, low water	G612	Miss. Riv. Com.
Lansing, Mississippi river, high water	G632	Miss. Riv. Com.
Lansing	G632	Weather Bur.
Lanyon	1171	FtDDM&S
La Porte City	817,G812	CRI&P
La Porte City, north end of wye, subgrade	816.84	WCF&N
Larchwood	1468,G1462	CRI&P
Larchwood	G1465	Weather Bur.
Larrabee	1367,G1366	IC
Latimer	1247	M&StL
Latty, union station with CRI&P	725	CB&Q
Latty	726,G733	CRI&P
Laurel	1048,G1034	M&StL
Laurens	1313,G1312	C&NW
Laurens, crossing CRI&P	1304	C&NW
Laurens	1303,G1303	CRI&P
Laurens, crossing C&NW	1305	CRI&P
Lavinia	1219,G1214	CM&StP
Lawler	1084,G1088	CM&StP
Lawn Hill	1080	C&NW

Station	Elevation feet	Authority
Lawton	1170	C&NW
Leando, see Douds		
Le Claire, DRI&NW station	587	CB&Q
Le Claire	590	CM&StP
Le Claire	586.13	CD&M
Le Claire, Union Station	G580	DRI&NW
Le Claire, Mississippi river, low water	G562	Miss. Riv. Com.
Le Claire, Mississippi river, high water	G576	Miss. Riv. Com.
Le Claire	G576	Weather Bur.
Le Claire, 0.8 mile below Hampton, Ill., 0.5 meter west of east wagon road fence and 0.5 meter south of east-west line through center of sec. 13, T. 78, R. 4 E., 100 meters south of Mr. Dodd's house, 170 meters south of Pigeon Creek, near foot of bluffs; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 152/4):		
Copper bolt	588.47	Bull. 569
Cap on pipe	592.49	
Le Claire, 100 meters above mouth of Spencer creek, opposite point midway between red barn and white house in walnut grove on left bank, 10 meters above road running back to farmhouse on bluff; highest point of large sandstone rock (U.S.C.E.t.b.m. 6 R. B)	562.23	Bull. 569
Le Claire, lower edge of, 1 meter west of east right of way fence of railroad, 325 meters above bridge 370 over Barber creek, on line of fence dividing lots owned by James Clark and George Cooley, 0.5 mile below Port Byron, Ill., 10 meters E. 4° to east end of north abutment of bridge 468; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 154/2):		
Copper bolt	583.72	Bull. 569
Cap on pipe	587.74	
Le Claire, near NE. cor. Louis Schworm's house on Dodge St., SW. cor. alley between Main St. and Wisconsin Ave.; copper bolt leaded horizontally in east face of stone porch 1 foot above ground, 8 inches from NE. cor. porch and 2.6 feet from top of porch, marked "M.R.C.U.⊙ S.B.M." (U.S.C.E.b.m. 154/3):	601.00	Bull. 569
Le Claire, on SE. cor. old frame warehouse between river and rear of building, 1 block north of Becker's store (U.S.C.E. high-water mark of 1870)	573.81	Bull. 569
Ledyard	1150	C&NW
Leeds, platform	1108	GN
Leeds, crossing IC	1111	GN
Leeds	1117,G1113	IC
Lees Siding	868	CRI&P
Le Grand	938,G938	C&NW
Lehigh	945	FtDDM&S
Lehigh	956.0	CGW
Lehigh, T. 87 N., R. 28 W., cor. secs. 1, 2, 11 and 12, T road N., 40 ft. NE. of road fork, in base of corner fence post, marked "1,112"; spike	1,112.13	USGS
Lehigh, 0.67 mile N. of, on W. side of river, 80 ft. W. of CGW RR. 70 ft. NW. of road fork, on N. side of main road leading W., 15 ft. N. of fence, in root of 12-inch elm tree, marked "947.8"; copper nail and washer	947.93	USGS
Lehigh, at highway bridge over Des Moines river, at W. end of bridge, 1.5 ft. N. of edge of flooring and 0.5 ft. lower than same, in top of concrete abutment; bronze tablet stamped "Iowa 1919 954"	953.627	USGS
Water level, July 2, 1919, at 1 p.m.	933.500	USGS
Lehigh, 0.50 mile NE. of, top of hill and T road S., 35 ft. S.		

Station	Elevation feet	Authority
of road fork, on E. side of road leading S., 15 ft. N. of fence corner, in base of telephone pole, marked ''1,103.5''; spike	1,103.59	USGS
Lehigh, 0.71 mile NE. of, at T road E., 40 ft. SW. of road fork, in concrete base of fence post, marked ''1,111.8''; chiseled square	1,111.96	USGS
Lehigh, T. 87 N., R. 27 W., cor. secs. 5, 6, 7 and 8, at T road N., 30 ft. NW. of road fork, 3 ft. S. of fence cor., in base of telephone pole, marked ''1,107.8''; spike	1,107.95	USGS
Lehigh, Tps. 87 and 88 N., R. 27 W., cor. of secs. 4, 5, 32 and 33, 45 feet NW. of center of crossroads, 3 ft. east of fence cor.; iron post stamped ''Iowa 1919 1,094''	1,093.624	USGS
Lehigh, T. 87 N., R. 27 W., cor. secs. 4, 5, 8 and 9, 50 feet NW. of center of crossroads, 12 feet west of fence corner, on fence line, on north side of road, in root of large maple tree, marked ''1,105.7''; copper nail and washer	1,105.53	USGS
Lehigh, T. 87 N., R. 27 W., quarter cor., south side of sec. 5, 50 feet NW. of center of road fork, in base of corner fence post, marked ''1,097.5''; spike	1,097.30	USGS
Lehigh, T. 87 N., R. 27 W., quarter cor., south side of sec. 8, at section line crossing road, on west side of road, on section and fence line, in base of large gate post, marked ''1,104.5''; spike	1,104.31	USGS
Lehigh, T. 87 N., R. 27 W., same loc. as above, pavement leading to E. L. Woodle's residence, point just outside of gate on NE. edge (not a B.M.), marked ''1,104.4''	1,104.23	USGS
Lehigh, 2 miles east by 1 mile south of, at schoolhouse, at front end of, 2 feet from east edge of; bronze tablet stamped ''Iowa 1919 1,081''	1,081.238	USGS
Lehigh, 1 mile south by 2.5 miles east of, T. 87 N., R. 27 W., S. line sec. 16, at old ford across Des Moines river, on west bank of river where it flows north, 50 feet south of ford, in base of 2-foot oak tree, marked ''931.6''; spike	931.37	USGS
Lehigh, 1 mile south by 2.5 miles east of, at old ford across Des Moines river, on east bank of river, where it flows north, 120 feet south of ford, 20 feet west of road and 10 feet east of water's edge, in root of 12-inch elder tree, marked ''928.5''; copper nail and washer	928.30	USGS
Elevation of water level at this point (high water), June 9, 1919	925.000	USGS
Lehigh, T. 87 N., R. 27 W., quarter cor., north side of NW. quarter sec. 33, at T road north, 50 feet NW. of road fork, in base of telephone pole, marked ''1,120.7''; spike	1,120.48	USGS
Lehigh, T. 87 N., R. 27 W., cor. of secs. 28, 29, 32 and 33, T road south, 50 feet NW. of road fork, in base of telephone pole, marked ''1,123.1''; spike	1,122.89	USGS
Leighton, B.M. top of monument M.P. 308	751.58	CRI&P
Leighton, B.M. top of monument M.P. 309	758.94	CRI&P
Leighton, top of rail, center of depot	765.5	CRI&P
Leighton, B.M. top of monument M.P. 310	766.14	CRI&P
Leighton, B.M. top of monument M.P. 311	774.04	CRI&P
Leighton, B.M. top of monument M.P. 312	780.80	CRI&P
Leighton, B.M. top of monument M.P. 313	792.49	CRI&P
Leighton, T. 76 N., R. 17 W., center of sec. 26, crossroads, in corner fence post; three 40-penny nails	848.67	Bull. 569
Leighton, T. 76 N., R. 17 W., quarter corner on east side of sec. 25, on stone at intersection of crossroads; painted square	842.51	Bull. 569
Leighton, T. 76 N., R. 17 W., 0.25 mile north of SW. cor.		

STATION	ELEVATION FEET	AUTHORITY
sec. 19, T corner; iron post stamped "Prim. Trav. Sta. No. 8, Iowa 1908, 813"	811.246	Bull. 569
Leighton, T. 76 N., R. 17 W., 0.2 mile west of SE. cor. sec. 1, in projecting knob of base of 14-inch oak tree; 40-penny nail; T corner	796.01	Bull. 569
Leighton, T. 76 N., R. 17 W., 0.3 mile west of SE. cor. sec. 13, T corner, on west side of road, 40 feet north of center of road; iron post stamped "735 Iowa"	733.317	Bull. 569
Leighton, T. 76 N., R. 17 W., SW. cor. sec. 15, on east side of road, 17 feet southeast of road intersection, 10 feet south of corner fence post; crossroads	840.341	Bull. 569
Leighton, 0.5 mile east of, railway crossing; top of rail	758.13	Bull. 569
Leighton, quarter corner on south side of sec. 35, T. 76 N., R. 17 W., west side of road, 50 feet north of railroad; iron post stamped "761 Iowa"	759.497	Bull. 569
Leland	1218,G1217	M&StL
Le Mars, junction switch with IC	1232.6	CStPM&O
Le Mars, union station	1234,G1232	IC
Le Mars, junction with CStPM&O	1233,G1232	IC
Le Mars	G1224	Weather Bur.
Lena	1130,G1126	M&StL
Lenox	1295,G1293	CB&Q
Lenox	G1250	Weather Bur.
Leon	1019,G1019	CB&Q
Leon, Des Moines line	1026	CB&Q
Le Roy	1113,G1112	CB&Q
Leroy, Minn.	1286,G1285	CM&StP
Leroy, Minn.	1283.1,G1282	CGW
Leroy, Minn., crossing CM&StP	1286.7,G1284	CGW
Leslie	1177	CB&Q
Lester	1379	GN
Lester, crossing CRI&P	1373	GN
Lester	1380	CRI&P
Letts	650	CRI&P
Letts, divide, 2 miles east of	706	CRI&P
Leverett	1365,G1363	CRI&P
Leverett, crossing CM&StP	1381	CRI&P
Levey	782,G782	CB&Q
Levey, 0.5 mile north of, 6 miles below Des Moines, top of east side of concrete pier at north end of CB&Q RR bridge over Des Moines river (U.S.C.E.b.m. 57) (destroyed)	789.92	Bull. 569
Levey, 15 feet west of road, 175 feet NW. of E. S. Irwin's house; iron post stamped "Prim. Trav. Sta. No. 7, 782 Adj 1903"	780.515	Bull. 569
Lewis	1154,G1157	CRI&P
Lewis, bed of Spring creek west of	1080	IaGS
Lewis, bed of Nishnabotna river below dam at	1093	IaGS
Lewis, crest of hill at	1208	IaGS
Lewis, base of sandstone on Spring creek, west of	1102	IaGS
Liberty Center, Warren Co., T. 74 N., R. 23 W., NW. cor. sec. 3, moved 100 feet west of point, 30 feet south by 60 feet east of crossroads, in limestone rock; aluminum tablet stamped "Prim. Trav. Sta. No. 6 937 Adj" set in 4 by 4 inch concrete post	932.253	Bull. 569
Liberty Center, T. 74 N., R. 23 W., NE. cor. sec. 3, in SW. cor. T road south, in top of west end of plank culvert; copper nail	935.80	Bull. 569
Liberty Center, T. 74 N., R. 23 W., SE. cor. sec. 3, in NW. cor. crossroads, 2 feet west of corner post; iron post stamped "Iowa 934, 1913"	933.865	Bull. 569

STATION	ELEVATION FEET	AUTHORITY
Liberty Center, T. 74 N., R. 23 W., at NW. cor. sec. 35, in SE. cor. crossroads, in root on west side of twin maple tree; copper nail	1,016.45	Bull. 569
Liberty Center, T. 74 N., R. 23 W., at quarter corner on east side sec. 27, at SW. cor. crossroads, 7 feet south of telephone pole; iron post stamped "Iowa, 1021, 1913"	1,021.180	Bull. 569
Liberty Center, 1 mile east of, T. 74 N., R. 23 W., at SW. cor. sec. 14, in NE. angle of crossroads, 75 feet NE. of section corner, in root of 14-inch cottonwood tree; copper nail	1,014.23	Bull. 569
Liberty Center, T. 74 N., R. 23 W., at NW. cor. sec. 14, in SE. angle of crossroads, 5 feet north of corner post, in stump of telephone pole; copper nail	1,013.64	Bull. 569
Liberty Center, T. 74 N., R. 23 W., at SE. cor. sec. 3, in NW. cor. crossroads, 2 feet west of corner post; iron post stamped "Iowa, 934, 1913"	933.865	Bull. 569
Libertyville	754	CRI&P
Libertyville, crossing CB&Q	754	CRI&P
Libertyville	750	CB&Q
Libertyville, crossing CRI&P	753	CB&Q
Lida	854.9,G849	CGW
Lida, North river at	840	IaGS
Lidderdale	1236.5,G1244	CGW
Lima	932,G933	CM&StP
Lime Kilns	710	CRI&P
Lime Springs	1246,G1245	CM&StP
Linby, crossing CM&StP	810.8	CB&Q
Linby	815,G817	CM&StP
Linby, crossing CB&Q	815	CM&StP
Lincoln	1059.4,G1059	CGW
Linden	1124,G1126	CM&StP
Lineville	1084	CRI&P
Linn	749,G756	CRI&P
Linn Grove	1256,G1257	C&NW
Linwood, union station with CRI&P	564	CM&StP
Linwood	565	CRI&P
Linwood, 0.25 mile above hotel at, 1 meter east of west fence of road on section line dividing secs. 23 and 24, 2 meters north of north fence on Davenport road, 20 meters from river bank; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 147/3):		
Copper bolt	558.96	Bull. 569
Cap on pipe	562.97	
Lisbon	873,G873	C&NW
Liscomb	1004,G997	M&StL
Little Cedar	1181.0	CGW
Littleport, T. 92 N., R. 4 W., SW. ¼ sec. 16, in SE. cor. schoolhouse yard; iron post stamped "929 DBQ"	930.628	Bull. 569
Littleport	700,G698	CM&StP
Little Rock	1477	CRI&P
Little Rock, 1 mile west of	1505	IaGS
Livermore	1132,G1134	M&StL
Livermore	1142,G1136	CRI&P
Livermore, crossing M&StL	1131	CRI&P
Lockridge	729,G732	CB&Q
Logan	1036,G1033	IC
Logan	1033	C&NW
Lohrville	1148.3,G1155	CGW
Lohrville, crossing CM&StP	1138.4,G1144	CGW
Lohrville, crossing C&NW	1138.3,G1144	CGW
Lohrville	1155	C&NW

Station	Elevation feet	Authority
Lohrville, crossing CM&StP	1142	C&NW
Lohrville	1145,G1149	CM&StP
Lohrville, crossing C&NW	1143,G1146	CM&StP
Lone Rock	1210	C&NW
Lone Tree	707	CRI&P
Long Grove	782	CM&StP
Long Point	804	C&NW
Longview	747	CB&Q
Lorah	1197,G1204	CRI&P
Lorah, creek bed east of	1184	IaGS
Lorimor	1230.5,G1227	CGW
Lost Nation	741,G744	CM&StP
Lothrop	822,G829	CRI&P
Louisa	819,G814	CM&StP
Louisa, crossing over IC, CM&StP track	815,G812	CM&StP
Louisa, crossing, IC track	G789	CM&StP
Louisa, crossing over WCF&N	815	CM&StP
Loveland	1004,G1007	C&NW
Loveland, crossing under IC	1001	C&NW
Loveland, on SW. cor. bridge 979 over Boyer river, 0.3 foot east of bedplate under inclined end post, 2.5 feet from north edge of abutment; copper bolt in stone (U.S.C.E. p.b.m. 356)	1,000.119	Bull. 569
Lovilia	930.8,G932	CB&Q
Lovilia	932	WRR
Lovilia, T. 73 N., R. 18 W., near center SE. ¼ sec. 23, 280 feet south of T road east, on west side of highway, in top center of concrete headwall to culvert under road; chiseled square, painted "U.S.B.M. 943.9"	943.79	USGS
Lovilia, T. 73 N., R. 18 W., center of sec. 23, in SE. angle of road forks, 4 feet east of corner fence post, in top of concrete post; bronze tablet stamped "E.B. No. 6 1924 Iowa" painted "U.S.P.B.M. 931.0"	930.897	USGS
Lovilia, reference mark, 120 feet north by 50 feet west of tablet, 20 feet east of house, in root on east side of a 2-foot maple tree; copper nail and washer	931.97	USGS
Lovilia, T. 73 N., R. 18 W., near NE. cor. sec. 23, 1,800 feet NE. of switch to coal mine, on NE. cor. small trestle over small drain, along C&NW RR; on large bolt-head with chiseled cross, painted "U.S.B.M. 863.1"	863.00	USGS
Lovilia, T. 73 N., R. 18 W., near center of sec. 13, 230 feet north of road crossing C&NW Ry, in top center of east headwall to concrete bridge over small creek; chiseled square, painted "U.S.B.M. 828.9"	828.77	USGS
Lovilia, T. 73 N., R. 17 W., near SW. cor. sec. 7, 110 feet south by 40 feet east of road crossing C&NW Ry, in NW. cor. of timbered pasture, in root on NW. side of a 2.5-foot oak tree; copper nail and washer, painted "U.S.B.M. 809.4"	809.27	USGS
Lovilia, T. 73 N., Rs. 17 and 18 W., cor. secs. 1, 7, 6 and 12, in NW. angle of crossroads, 5 feet north by 0.5 foot east of corner fence post; top of 0.75-inch gas pipe driven in ground, painted "U.S.B.M. 918.0"	917.95	USGS
Lowden	717,G717	C&NW
Low Moor	640,G643	C&NW
Luana	1123,G1128	CM&StP
Lucas	885.69,G888	CB&Q
Lucas, T. 72 N., R. 23 W., at quarter corner, on north side of sec. 11, in SW. angle of crossroads, 1 foot south of corner post, in top of wooden peg; wire nail	1,044.64	Bull. 569
Lucas, 0.5 mile west by 0.5 mile north of, T. 72 N., R. 23		

Station	Elevation feet	Authority
W., at center of sec. 14, at center of crossroads, in top of rock presumed to be section stone; bottom of square cut	970.89	Bull. 569
Lucas, in front of CB&Q RR station; top of rail	888.98	Bull. 569
Lucas, near center of town, at SW. cor. Leehart's drug store; iron post stamped ''Iowa, 895, 1913''	895.010	Bull. 569
Lucas, 0.8 mile east of, at NE. angle of T road north, in top of sandstone rock 5 feet north of corner post; bottom of chiseled square	892.21	Bull. 569
Lucas, 1 mile east of, CB&Q RR crossing, top of rail	878.5	Bull. 569
Lucas, Whitebreast creek; water elevation, 11 a.m., July 31, 1913, ''854.2''	854.3	Bull. 569
Lucas, 1.8 miles east of, at SW. angle of T road south, 100 feet south of corner post, driven flush with ground; iron rod, 11 inches long	867.35	Bull. 569
Lucas, T. 72 N., R. 22 W., near NE. cor. sec. 30, at NE. angle of crossroads, 2 feet north of corner post; iron post stamped ''Iowa 1044, 1913''	1,043.891	Bull. 569
Lucas, T. 72 N., R. 22 W., about 1,000 feet west of the SE. cor. sec. 20, at NE. cor. bridge over creek, in plank; copper nail	889.35	Bull. 569
Lundgren, B.M. pole No. 1735	1142.81	FtDDM&S
Lundgren, T. 87 N., Rs. 28 and 29 W., cor. secs. 6, 7, 1 and 12, at T road south, 50 ft. SW. of road fork, on concrete base of corner fence post, marked ''1,137.6''; chiseled point	1,137.63	USGS
Lundgren, T. 87 N., R. 28 W., cor. secs. 5, 6, 7 and 8, 30 ft. SE. of center of crossroads, on top of steel sewer, marked ''1,126''; cross mark	1,126.12	USGS
Lundgren, T. 87 N., R. 28 W., cor. secs. 4, 5, 8 and 9, 50 ft. SW. of center of crossroads, 1.5 ft. N. of fence line; iron post stamped ''Iowa 1919 Prim. Trav. Sta. No. 8 1,123''	1,122.728	USGS
Lundgren, T. 87 N., R. 29 W., at cor. secs. 11, 12, 13 and 14, 70 feet north by 30 feet west of center of crossroads, in field along fence line, 20 feet north of fence corner, in top of large granite bowlder; chiseled square, T.B.M. 1,148.1	1,148.00	USGS
Lundgren, T. 87 N., R. 29 W., cor. secs. 1, 2, 11 and 12, 160 feet south of crossroads, on east side of road in concrete front of schoolhouse 6 feet north of front door, 1.0 foot west of wall and about 1 foot above ground; bronze tablet stamped ''Iowa 1919 1,148''	1,147.582	USGS
Lundgren, T. 87 N., R. 29 W., west sixteenth corner south side of sec. 4, at T road north, east side of T road and north side of east and west road, in base of corner fence post, marked ''1,151''; spike	1,151.06	USGS
Lundgren. T. 87 N., R. 29 W., cor. secs. 3, 4, 9 and 10, 70 feet SW. of crossroads, 25 feet SW. of cor. of fence in school yard enclosure, in root of 18-inch maple tree, marked ''1,156.5''; copper nail and washer	1,156.55	USGS
Lundgren, T. 87 N., R. 29 W., cor. secs. 2, 3, 10 and 11, 50 feet SW. of center of crossroads, in base of corner fence post, marked ''1,153.4''; spike	1,153.49	USGS
Lundgren, T. 87 N., R. 29 W., cor. secs. 1, 2, 11 and 12, 160 feet south of crossroads, on east side of road in concrete front of schoolhouse, 6 feet north of front door, 16 feet west of wall and about 1 foot above ground; bronze tablet stamped ''Iowa 1919 1,148	1,147.582	USGS
Lundgren, railway crossing at, 20 feet south of crossing, 3		

Station	Elevation feet	Authority
feet west of track, in base of power transmission pole, marked "1,142.6"; spike	1,142.65	USGS
Lundgren, T. 87 N., R. 29 W., quarter cor., north side of sec. 1, at road crossing, 50 feet east of railway track, on south side of highway on fence line, in root of large maple tree marked "1,125.2"; copper nail and washer	1,125.24	USGS
Lundgren, T. 88 N., R. 29 W., quarter cor., north side of sec. 36, 30 feet south of railway crossing, 4 feet west of track, in base of power transmission pole, marked "1,117.3"; spike	1,117.36	USGS
Luray	939.2,G936	CGW
Luther	1093,G1095	CM&StP
Luther, 2 miles south of, SW. cor. sec. 6, Garden Tp., at T road; spike in base of telephone pole, marked "1077.70"	1,076.37	Bull. 569
Luther, 1 mile south of, at T road, SW. cor. sec. 31, Colfax Tp.; iron post stamped "1080"	1,078.397	Bull. 569
Luther, at road crossing, NE. cor. sec. 36, Worth Tp.; copper nail in root of maple tree	1,100.75	Bull. 569
Luther, 1 mile north of, at road crossing, SW. cor. sec. 19, Colfax Tp.; spike in base of telephone pole	1,097.79	Bull. 569
Luther, 2 miles north of, at road crossing, SE. cor. sec. 13, Worth Tp.; iron post stamped "1106"	1,104.565	Bull. 569
Luther, 2 miles north by 1 mile west of, at road crossing, in sec. 23, Worth Tp.; spike in base of telephone pole	1,120.11	Bull. 569
Luther, 2 miles north by 3 miles west of, SW. cor. sec. 15, Worth Tp.; iron post stamped "Prim. Trav. Sta. No. 15, 1094"	1,092.664	Bull. 569
Luther, 1.5 miles north by 3 miles west of, at T road, in front of Gildea school, in sec. 22, Worth Tp.; copper nail in root of oak tree on east side of north-south highway	1,089.77	Bull. 569
Luton	1080	CM&StP
Luverne	1167	C&NW
Luverne, crossing M&StL	1156	C&NW
Luverne	1168,G1169	M&StL
Luverne, crossing C&NW	1156,G1156	M&StL
Luxemburg, sec. 21, T. 90 N., R. 2 W., in Catholic churchyard, iron post stamped "1179 DBQ"	1,180.636	Bull. 569
Luzerne	893,G897	C&NW
Lybrand, Allamakee Co., T. 96 N., R. 6 W., SW. cor. schoolhouse yard; iron post stamped "1186 DBQ"	1,185.654	Bull. 569
Lyle, Minn.	1203	IC
Lyle, Minn., crossing CM&StP	1205	IC
Lyle, Minn., crossing CGW	1208	IC
Lyle, Minn.	1204	CM&StP
Lyle, crossing IC	1201	CM&StP
Lynnville	892	M&StL
Lynnville Junction	922	M&StL
Lyons	592,G589	CM&StP
Lyons, crossing C&NW	592	CM&StP
Lyons	588	C&NW
Lyons, crossing CM&StP	589	C&NW
Lyons, 1 mile above, 30 meters above yard limits of CM&St P Ry, 12 meters west of that railroad company's tracks, on side of bluff near bottom, 1 meter east of fence, 5.5 meters above fence corner, 100 meters below house of Peter Johnson; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 162/3):		
Copper bolt	599.34	Bull. 569
Cap on pipe	603.38	
Lyons, in scattering timber on Fulton Island, 100 meters from river bank, opposite center of Island 279, 200		

STATION	ELEVATION FEET	AUTHORITY
meters above head of small slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 164/2):		
Copper bolt	580.80	Bull. 569
Cap on pipe	584.80	
Lytton	1225,G1220	CM&StP
McCallsburg	1094,G1089	M&StL
McCallsburg, crossing CRI&P	1089	M&StL
McCallsburg	1080	CRI&P
McCallsburg, crossing M&StL	1080	CRI&P
McCausland	610	CRI&P
McClains Park	862.81	DM&CI
McClelland	1239.4,G1245	CGW
McCloy, M.P. 429	1231,G1232	IC
McConville	965	ISU
McCook, S. Dakota	1111	CM&StP
McDanel	974	ISU
McGregor	627,G627	CM&StP
McGregor, 3.2 miles below, 0.5 mile below mouth of Wisconsin river, 1,968 feet below milepost 67 of CM&StP Ry, 45 feet west of center of track, directly opposite lower end of bridge K382, in which t.b.m. 231 is located, in steeply inclined face of hard ledge of rock, marked "U.S.⊙P.B.M."; copper bolt (U.S.C.E.p.b.m. 238)	635.872	Bull. 569
McGregor, 0.5 mile below mouth of Wisconsin river, on south abutment of bridge K382, on river end of second course of stone from top, 1 foot from northeast corner of stone marked "U□S"; highest point in square (U.S.C.E.t.b.m. 231)	627.561	Bull. 569
McGregor, 1.8 miles below, 275 feet above milepost 66, directly opposite Pictured Rock, on right of way of CM&StP Ry, 35 feet east of center of track; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m 236 and 237):		
Copper bolt	627.771	Bull. 569
Cap on pipe	631.774	
McGregor, 1.8 miles below, 55 meters above milepost 66, on bluff side of CM&StP Ry, 15 feet from center, on large prominent bowlder, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 230)	632.167	Bull. 569
McGregor, 1.8 miles below, on right of way of CM&StP Ry, 11 meters east of center of track, 84 meters above milepost 66, directly opposite Pictured Rocks; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 196/3):		
Copper bolt	627.78	Bull. 569
Cap on pipe	631.78	
McGregor, in front of CM&StP Ry station; base of rail (U.S.C.E.b.m.)	627.17	Bull. 569
McGregor, SW. from little park in center of town, in west end of brick building owned by Mrs. J. Reynolds, now occupied by Huntington Grain Firm, 23 inches south from N.W. cor. and 4 feet and 10 inches above ground; copper bolt, marked "U.S.⊙P.B.M." (U.S.C.E.p.b.m. 235)	632.804	Bull. 569
McGregor, on north side of Main St., just above Masonic block, in brick building occupied by Elbling Cigar Manufactory, in stone doorsill 2 feet from SW. cor. building, 4.5 inches back from front line; copper bolt marked "U.S.⊙P.B.M." (U.S.C.E.p.b.m. 234)	631.655	Bull. 569
McGregor, at NW. cor. Main St. and railroad, at sidewalk entrance to Gregor McGregor's residence, on river end		

Station	Elevation feet	Authority
of bottom step, on level with sidewalk, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 228)	628.838	Bull. 569
McGregor, T. 95 N., R. 3 W., SE. ¼ sec. 33, SW. cor. schoolhouse; iron post stamped "1103 DBQ"	1,104.674	Bull. 569
McIntire	1280.2,G1279	CGW
McNally	1330.51	C&NW
McPaul	946,G941	CB&Q
McPaul, 1.3 miles SW. of station, 656 feet north by 26 feet west of SE. cor. SW. ¼ sec. 5, T. 69 N., R. 42 W., on land of William Woods, 3 feet west of hedge on west side of public road; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 330 equals 114/3):		
Copper bolt	931.360	Bull. 569
Cap on pipe	935.352	
McPaul, 4,941 feet north of station, 46 feet south of center of public road, 13 feet south of fence corner, 48 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 331):		
Copper bolt	936.875	Bull. 569
Cap on pipe	940.890	
McPaul, T. 69 N., R. 43 W., 810 feet north of SW. cor. sec. 5, on east side of north-south road; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 114/2):		
Copper bolt	931.21	Bull. 569
Cap on pipe	935.29	
McPherson	1109	CB&Q
McVeigh	747	CB&Q
Macedonia	1111.6,G1107	CB&Q
Mackey, 2 miles south of, T. 85 N., R. 25 W., SW. cor. sec. 27, NE. cor. crossroads, just east of fence corner; iron post stamped "1009"	1,008.180	Bull. 569
Mackey, 1 mile south of, T. 85 N., R. 25 W., cor. secs. 21, 22, 27 and 28, 20 feet east of center of crossroads, in center of road east; chiseled square cut in top of stone, marked "1025.2"	1,024.12	Bull. 569
Mackey, T. 85 N., R. 25 W., SW. cor. sec. 15, NE. cor. crossroads, at schoolhouse; copper nail in base of telephone pole, marked "1004.9"	1,003.87	Bull. 569
Mackey, 1 mile north of, T. 85 N., R. 25 W., SE. cor. sec. 9, NW. cor. crossroads, at fence corner; iron post stamped "978"	976.833	Bull. 569
Mackey, 2 miles north of, T. 85 N., R. 25 W., cor. secs. 3, 4, 9, and 10, 10 feet south of center of crossroads; chiseled square on top of stone, marked "1025.96"	1,024.87	Bull. 569
Mackey, 3 miles north of, T. 86 N., R. 25 W., SE. cor. sec. 33, NW. cor. crossroads, in west end of plank drain under road to north, at mail-box post; copper nail, marked "1028.9"	1,027.75	Bull. 569
Mackey, 4 miles north of, T. 86 N., R. 25 W., NE. cor. sec. 33, SW. cor. crossroads; copper nail in base of telephone pole, marked "1039.2"	1,038.10	Bull. 569
Mackey, 5 miles north of, T. 86 N., R. 25 W., SE. cor. sec. 21, 8 miles west of Randall, NW. cor. crossroads, at fence corner; iron post stamped "1061"	1,060.100	Bull. 569
Mackey, Boone Co., 2 miles south by 1 mile east of, T. 85 N., R. 25 W., SW. cor. sec. 26, NE. cor. crossroads; copper nail in base of telephone pole, marked "964.3"	963.25	Bull. 569
Mackey, 2 miles south by 2 miles east of, T. 85 N., R. 25 W., NW. cor. sec. 36, south side of road at T road north,		

	Elevation feet	Authority
east side of private road south; copper nail in base of telephone pole, marked "978.98"	977.97	Bull. 569
Mackey, 2 miles south by 3 miles east of, T. 85 N., R. 25 W., SE. cor. sec. 25, on north-south county line between Boone and Story counties, NW. cor. crossroads; copper nail in base of telephone pole, marked "969.1"	968.09	Bull. 569
Maclay	1365,G1363	CRI&P
Macuta, base of rail opposite station sign	533.8,G533	AT&SF
Macy	1162	IC
Madison Junction (Hayfield)	1214	M&StL
Madrid (main line)	1000,G1001	CM&StP
Madrid, Boone line	1021	CM&StP
Madrid, crossing C&CB division	1021	CM&StP
Madrid, 3 miles west of, at road crossing, SE. cor. sec. 28, Cass Tp.; iron post stamped "894"	892.973	Bull. 569
Madrid, T. 81 N., R. 25 W., NE. cor. sec. 5; spike in telephone pole, marked, "U.S.B.M. 991"	989.69	Bull. 569
Madrid, T. 81 N., R. 25 W., SE. cor. sec. 5; spike in corner fence post, marked "U.S.B.M. 992"	991.00	Bull. 569
Madrid, 2 miles east by 3 miles south of, at T road, NE. cor. sec. 17, Madison Tp.; spike in base of fence post	938.17	Bull. 569
Madrid, 2 miles east by 3.5 miles south of, at road crossing near United Brethren Church, east side of sec. 17, Madison Tp.; spike in root of maple tree	975.07	Bull. 569
Madrid, T. 82 N., R. 25 W., south corner between secs. 27 and 28; spike in corner fence post, marked "U.S.B.M. 1010"	1,008.46	Bull. 569
Madrid, T. 82 N., R. 25 W., SE. cor. sec. 29; iron post stamped "1000"	998.766	Bull. 569
Madrid, on south end of middle pier of cement railroad bridge about 250 feet east of station; aluminum tablet stamped "997"	995.769	Bull. 569
Madrid, 1.9 miles north of, on east side of north-south highway; spike in base of telephone pole at T road	1,042.24	Bull. 569
Madrid, 2.4 miles north of, SW. cor. sec. 18, Garden Tp., at T road; iron post stamped "1033"	1,031.730	Bull. 569
Madrid, 3.3 miles north of, at SW. cor. sec. 7, Garden Tp., at road crossing; spike in base of telephone pole	1,060.45	Bull. 569
Madura, changed to Cranston	660,G663	CM&StP
Magill	1219.0	CGW
Maine	997	ISU
Malcom	889,G892	CRI&P
Mallard	1220	M&StL
Malone	658,G659	C&NW
Maloy	1120.0,G1120	CGW
Malta	1068,G1058	M&StL
Malvern	1045.5,G1047	CB&Q
Malvern, top of rail	996.50	T&N
Malvern	1000	WRR
Malvern, crossing CB&Q	1005	WRR
Malvern	G995	Weather Bur.
Manchester, in front of IC RR station; top of rail	941.9	Bull. 569
Manchester, 150 feet south of stock yards, on west side of IC RR track, south side of street; iron post stamped "949"	939.802	Bull. 569
Manchester, railroad crossing Maquoketa river	G919	USGS
Manchester	941	IC
Manilla	1317,G1320	CM&StP
Manilla, divide 3 miles west of	1465	CM&StP
Manly	1204.1,G1199	CGW
Manly, crossing CRI&P	1205.1,G1199	CGW

	Elevation feet	Authority
Manly	1210,G1202	M&StL
Manly, crossing CRI&P	1211	M&StL
Manly, crossing CGW	1210	M&StL
Manning	1324,G1324	C&NW
Manning	1364	CM&StP
Manning, crossing over C&NW and CGW	1360	CM&StP
Manning	1320.2	CGW
Manson	1234,G1232	CRI&P
Manson, crossing IC	1237	CRI&P
Manson	1237,G1233	IC
Manson, crossing CRI&P	1236,G1233	IC
Maple Hill	1285,G1275	CRI&P
Maple Hill, crossing C&NW	1280	CRI&P
Maple River	1265,G1263	C&NW
Mapleton	1113	C&NW
Mapleton	1135,G1138	CM&StP
Mapleton, crossing over C&NW	1134	CM&StP
Maquoketa	701,G691	CM&StP
Maquoketa	G688	Weather Bur.
Maquoketa	687,G684	C&NW
Maquoketa, center Maquoketa Tp.	700	USGS
Maquoketa, center South Fork Tp.	660	USGS
Marathon	1392,G1395	C&NW
Marathon, crossing CM&StP	1392	C&NW
Marathon	1391,G1395	CM&StP
Marathon, crossing C&NW	1393	CM&StP
Marble Rock	1018,G1002	CRI&P
Marcus	1455,G1451	IC
Marengo	735,G738	CRI&P
Marietta	898,G892	M&StL
Marion	841,G848	CM&StP
Marne	1190,G1193	CRI&P
Marne, 75 feet south of track, opposite a point 100 feet west of station, 10 feet south of corner post of P. C. Meredith's yard; iron post	1,184.096	Bull. 569
Marne, in front of CRI&P station, top of rail	1,193.3	Bull. 569
Marne, 3 miles east of, in NW. stone abutment of bridge 444; aluminum tablet (reset in 1906 by railroad engineer)	1,211.1	Bull. 569
Marne, 3 miles east of, on NE. cor. east abutment; chiseled cross	1,210.18	Bull. 569
Marquette (formerly North McGregor)	627,G624	CM&St.P
Marquette, in front of station; base of rail (U.S.C.E.b.m.)	627.74	Bull. 569
Marquette, at upper end of, where bluffs come out to tracks, 0.5 meter east of perpendicular rock cliff and at an elevation about 9 meters higher than railroad tracks, 15 meters above sign "R. R. Crossing Stop 400 feet;" copper bolt in solid rock surmounted by iron pipe (U.S. C.E.b.m. 197/3):		
Copper bolt	664.02	Bull. 569
Cap on pipe	666.75	
Marquette, on north side of North St., in O. A. Bratsberg's brick store, in water table 1 foot east of entrance, marked "U.S.⊙P.B.M."; copper bolt (U.S.C.E.p.b.m. 233)	631.292	Bull. 569
Marquette, 131 feet below station, 8 feet east of SE. cor. small wagon road and footbridge, 6 feet below floor on river end of south abutment; highest point in square, marked "U□S" (U.S.C.E.t.b.m. 227)	620.727	Bull. 569
Marquette, 2 miles west of, at top of Hatch Hill, on south		

Station	Elevation feet	Authority
side of road, in NW. cor. yard of J. K. Gray; iron post stamped "1096 DBQ"	1,096.904	Bull. 569
Marquette, Mississippi river, low water	G604	Miss. Riv. Com.
Marquette, Mississippi river, high water	G626	Miss. Riv. Com.
Marquette	G626	Weather Bur.
Marsh, Black Hawk Co.	963	IC
Marsh, Louisa Co.	744,G737	M&StL
Marshalltown	889,G883	M&StL
Marshalltown, crossing C&NW and CGW	897,G891	M&StL
Marshalltown	884	C&NW
Marshalltown, crossing M&StL and CGW	893	C&NW
Marshalltown	897.8,G899	CGW
Marshalltown, crossing C&NW and M&StL	876.1,G890	CGW
Marshalltown, crossing Timber creek east of	861	C&NW
Marshalltown, crossing Timber creek east of	877	M&StL
Martelle	906,G908	CM&StP
Martensdale	824	CRI&P
Martensdale, crossing under CGW	830	CRI&P
Martensdale, crossing CRI&P	833.2	CB&Q
Martensdale	866.6	CGW
Martensdale, Middle river at CB&Q bridge at	816	IaGS
Martins	630	CRI&P
Martinsburg	821,G814	M&StL
Martinsburg	805	CB&Q
Marysville, Marion Co., bridge at	760.5	IaGS
Mason City	1125	M&StL
Mason City	1121.1,G1120	CGW
Mason City, crossing C&NW	1135.7,G1124	CGW
Mason City, crossing CM&StP	G1146	CGW
Mason City	1120	C&NW
Mason City, crossing CM&StP	1141	C&NW
Mason City, crossing M&StL	1181	C&NW
Mason City	1125,G1126	CM&StP
Mason City, junction with Ia.&Minn. Div	1129	CM&StP
Mason City, crossing CGW	1142	CM&StP
Mason City	G1130	Weather Bur.
Mason City Junction, crossing M&StL	1128,G1131	CM&StP
Mason City Junction, crossing CM&StP	1134	M&StL
Masonville	1002,G1004	IC
Massena	1212.64,G1211	CB&Q
Massena, crest of hill north of	1306	IaGS
Massena, SW. cor. sec. 31, T. 74 N., R. 34 W	1206	IaGS
Massena, center of Massena Tp.	1316	IaGS
Massena, level Nodaway river south of station	1183	IaGS
Massena, crest of ridge one mile south of	1306	IaGS
Massey	621	CM&StP
Massey, about 3 miles below, on right of way of CM&StP Ry, 0.5 meter from fence, opposite a point about 10 meters below a post on roadbed marked "34-127," 400 meters below railroad bridge 74K; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 177/3):		
Copper bolt	623.20	Bull. 569
Cap on pipe	627.18	
Massey, 1 mile below foot of Ninemile Island, on south abutment of bridge 76, west end, on second course of stone from top, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 311)	611.551	Bull. 569
Massey, opposite foot of Ninemile Island, at wood yard, 20 feet below road leading from wood yard across CM&StP Ry track up bluff, 36 feet east from center of track and 2 feet west of east right-of-way fence; copper bolt		

Station	Elevation feet	Authority
in tile surmounted by iron pipe (U.S.C.E.p.b.m. 288 and 289):		
Copper bolt	603.772	Bull. 569
Cap on pipe	607.771	
Massey station, 1.4 miles below, on south abutment of CM&StP Ry bridge 78K, west end, on second course of stone from top, on SW. cor., marked "U□S"; highest point in square (U.S.C.E.t.b.m. 308)	607.082	Bull. 569
Massey, behind Ninemile Island, 0.5 mile below Massey station, 1,970 feet below milepost 124-37, 449 feet above CM&StP Ry bridge 80K, 170 feet below bridge 82K, 30 feet west of center of track, spike in base of black-oak tree (U.S.C.E.t.b.m. 307)	609.690	Bull. 569
Massey, 50 meters below railroad station, on right of way CM&StP Ry, 50 meters toward river from foot of bluffs, 0.5 meter from farthest fence from river; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 178/3):		
Copper bolt	619.67	Bull. 569
Cap on pipe	623.62	
Massillon	733,G720	CM&StP
Matlock	1395,G1395	IC
Maurice	1307,G1308	C&NW
Maurice, crossing GN	1292	C&NW
Maurice	1303	GN
Maurice, crossing over C&NW	1313	GN
Maurice, C&NW track	1289	GN
Maurice, 3 miles east of	1395	IaGS
Max	1555,G1561	CM&StP
Maxon	947	M&StL
Maxon, crossing CB&Q	949	M&StL
Maxon	941.5,G944	CB&Q
Maxon, 220 feet NE. of water tank, at road crossing CB&Q RR, 20 feet south of tracks, in top on NE. cor. concrete retaining wall to culvert over switch cables; chiseled square, painted "U.S.B.M. 945.3"	945.12	USGS
Maxon, road crossing M&StL RR near above location, top of north rail	933.2	USGS
Maxon	G944	Weather Bur.
Maxwell	885,G874	CM&StP
Maynard	1099	CRI&P
Maynard, T. 92 N., R. 8 W., NE. cor. sec. 21; in school yard; iron post stamped "1168"	1,168.916	Bull. 569
Maynard, NE. cor. sec. 21, T. 92 N., R. 9 W.; iron post stamped "1164 DBQ"	1,165.162	Bull. 569
Maynard, 120 feet south of CRI&P Ry station, at crossing; top of rail	1,102.4	Bull. 569
Maynard, 5 miles east of, center Smithfield Tp.	1168	IaGS
Meadows	1009	ISU
Mechanicsville	896,G895	C&NW
Mechanicsville	G899	Weather Bur.
Mederville	735,G733	CM&StP
Mederville, SW. ¼ sec. 22, T. 92 N., R. 5 W., SW. cor. schoolhouse yard; iron post stamped "767 DBQ"	768.000	Bull 569
Mediapolis, union station with CB&Q	774	CRI&P
Mediapolis, junction with CRI&P	772	CB&Q
Meigs, M.P. 182	530	CB&Q
Melbourne	1045.0,G1041	CGW
Melbourne, crossing M&StL	1052.0	CGW
Melbourne, crossing over CM&StP	1058.6	CGW
Melbourne	1031	CM&StP
Melbourne, crossing under CGW	1032	CM&StP
Melcher	948	CRI&P

STATION	ELEVATION FEET	AUTHORITY
Melcher, T. 74 N., R. 21 W., at SE. cor. sec. 6, at NW. cor. T road west, on top of north end of corrugated iron drain; painted square	850.22	Bull. 569
Melcher, T. 74 N., R. 21 W., near SW. cor. sec. 8, 200 feet NW. of road forks, at west end of steel highway bridge over Whitebreast creeek, top course, north end of sandstone abutment; bottom of chiseled square	801.43	Bull. 569
Melcher, Whitebreast creek, surface of water, July 1, 1913	781.8	Bull. 569
Melcher, T. 74 N., R. 21 W., at NW. cor. sec. 16, opposite T road west, 20 feet east by 2 feet south of section corner stone; iron post stamped "Iowa, 947, 1913"	946.588	Bull. 569
Melcher, T. 74 N., R. 21 W., at quarter corner on west side of sec. 9, at center of T road east, on east side in root of 36-inch cottonwood tree; copper nail	894.00	Bull. 569
Melcher, T. 74 N., R. 21 W., at quarter corner on east side of sec. 9, at summit of hill, 25 feet NW. of quarter corner stone, 2 feet west of fence corner, in top of wooden peg; copper nail	918.99	Bull. 569
Melcher, 1.3 miles west of, T. 74 N., R. 21 W., about 0.25 mile east of SW. cor. sec. 3, 35 feet NW. of road intersection, in peg at foot of 20-inch oak tree; copper nail	921.28	Bull. 569
Melcher, T. 74 N., R. 21 W., near quarter corner on east side of sec. 17, at NW. cor. T road north, in crotch near base of corner post; copper nail	956.95	Bull. 569
Melcher, T. 74 N., R. 21 W., near quarter corner on east side of sec. 16, in SW. cor. T road south, 15 feet west of center of triangular grass plat, 10 feet NW. of mail box, in top of wooden peg; copper nail	852.77	Bull. 569
Melcher, T. 74 N., R. 21 W., about 0.25 mile south of quarter corner on west side of sec. 22, at angle in road to west, in top of wooden peg, at SW. cor. yard; copper nail	985.13	Bull. 569
Melcher, T. 74 N., R. 20 W., 0.25 mile west of the SE. cor. sec. 30, in NW. angle crossroads, 8 feet north of corner post; iron post stamped "Iowa 887, 1913"	887.445	Bull. 569
Melcher, T. 74 N., R. 20 W., 0.25 mile east of quarter corner on north side of sec. 30, at elbow road (north to east) 1 foot east of corner post on inside of turn, in top of wooden peg; copper nail	898.27	Bull. 569
Melcher, T. 74 N., R. 20 W., at quarter corner on east side sec. 19, in NW. angle of T road west, 5 feet north of corner post, in top of peg; copper nail	922.70	Bull. 569
Melcher, T. 74 N., R. 20 W., at quarter corner on east side sec. 18, at NW. angle of crossroads, SE. cor. yard, in root of 18-inch maple tree; copper nail	924.56	Bull. 569
Melcher, T. 74 N., R. 20 W., in SE. cor. sec. 7, opposite T road east, on west side of north-south road, 15 feet north of fence corner; iron post stamped "Iowa 869, 1913"	869.649	Bull. 569
Melcher, T. 74 N., R. 20 W., at NW. cor. sec. 16, in SE. angle of T road south, 20 inches east of corner post, in top of peg; copper nail	906.34	Bull. 569
Melcher, T. 74 N., R. 20 W., at quarter corner on south side of sec. 9, at T road north, 20 feet north of road junction, in SE. cor. bridge floor; copper nail	807.17	Bull. 569
Melcher, T. 74 N., R. 20 W., at quarter corner on north side of sec. 9, in SW. angle of crossroads, south end of plank drain, in top of; copper nail	869.37	Bull. 569
Melcher, T. 74 N., R. 20 W., at quarter corner on north side of sec. 4, in SW. angle of T road south, 1 foot east of corner post, in top of wooden peg; copper nail	881.16	Bull. 569
Melcher, T. 74 N., R. 20 W., 0.25 mile east of NW. cor. sec.		

Station	Elevation feet	Authority
4, 20 feet south and 15 feet west of junction of T road north, 3 feet north of fence; iron post stamped ''901 Iowa''	900.001	Bull. 569
Melcher, T. 75 N., R. 21 W., 0.25 mile north of SW. cor. sec. 23, at T road on east side of north and south road, 35 feet east of fence, 10 feet north of north fence on east-west road; iron post stamped ''912 Iowa''	910.688	Bull. 569
Melcher, T. 75 N., R. 20 W., 0.25 mile east of SW. cor. sec. 33, 20 feet south and 15 feet west of junction of T road north and east and west road; 3 feet north of fence; iron post stamped ''901 Iowa''	900.001	Bull. 569
Melcher, T. 75 N., R. 21 W., 0.25 mile west of SE. cor. sec. 35, 18 feet east and 10 feet south of center of crossroads, near corner fence post at SE. angle T road, in stone; aluminum tablet stamped ''Prim. Trav. Sta. No. 4, 927, Iowa''	925.789	Bull. 569
Melcher, west side of Dallas, stone at corporation limits, in center of road; painted ''919.8'' on fence	919.72	Bull. 569
Melcher, at west side of Dallas, 200 feet NW. of highway bridge over CRI&P Ry, at SW. cor. main east-west street with T road north, in root of 10-inch maple tree; copper nail	946.32	Bull. 569
Melrose	870,G871	CB&Q
Melrose, T. 72 N., R. 20 W., in NW. cor. sec. 36, in SE. angle of crossroads, 250 feet west of schoolhouse, on tail wall of concrete drain; bottom of chiseled square	999.80	Bull.569
Melrose, T. 72 N., R. 20 W., 0.25 mile east of quarter corner on north side of sec. 36, in SW. angle of crossroads, north of La Grange Church, 5 feet west of fence corner; iron post stamped ''Iowa 1012, 1913''	1,012.489	Bull.569
Melrose, T. 72 N., R. 19 W., near NE. cor. sec. 31, on south side of road, at crest of hill, on east side of drive leading into S. L. Auxier's residence, on concrete block at gate; painted square	1,003.95	Bull.569
Melrose, T. 72 N., R. 19 W., at quarter corner between secs. 29 and 32, at T road north, in front of Wayne School, on section stone; chiseled circle	1,010.28	Bull.569
Melrose, 1.5 miles north of, T. 72 N., R. 19 W., at quarter corner on south side of sec. 28, in NW. angle of T road north, 5 feet north of corner post; iron post stamped ''Iowa 994, 1913''	994.370	Bull.569
Melrose, T. 72 N., R. 19 W., at center of sec. 21, in NW. angle of crossroads, 12 feet north of corner post, in top of wooden peg; copper nail	981.80	Bull.569
Meltonville	1202.9,G1196	CGW
Melvin	1585,G1581	CRI&P
Mendota, Mo.	881.6,G883	CB&Q
Menlo	1261,G1264	CRI&P
Menlo, 1.5 miles west of, in NW. abutment of bridge 385 (bridge over wagon road); aluminum tablet	1,279.018	Bull. 569
Menlo, in front of CRI&P Ry station; top of rail	1,265.2	Bull. 569
Menlo, 30 feet south of track, opposite point 300 feet east of station, 75 feet east of road crossing; iron post	1,263.893	Bull. 569
Menlo, SW. ¼ sec. 1, T. 76 N., R. 31 W.	1098	IaGS
Meriden	1404,G1402	IC
Merle Junction, Creston branch	1154.6	CB&Q
Merle Junction, Shenandoah line	1169	CB&Q
Merrill	1177.9	C&NW
Merrill, union station with CStPM&O	1177,G1174	IC
Merrill, crossing C&NW	G1174	IC
Merrill	1177	GN
Mertensville	702	CB&Q

Station	Elevation feet	Authority
Mertensville, crossing under CB&Q, Mt. Pleasant line	681	CB&Q
Meservey	1256.3,G1255	CGW
Meservey, 1 mile south of, Franklin-Cerro Gordo Co. line	1256	CGW
Metz	787,G790	CRI&P
Miami, Tps. 73 and 74 N., Rs. 17 and 18 W., Tp. cor. in SE. angle of T road south, 20 feet south by 1 foot west of corner of yard fence to farmhouse, in top of concrete post; bronze tablet stamped "E.B. No. 7 1924 Iowa" painted "U.S.P.B.M. 914.9"	914.796	USGS
Miami, reference mark, 65 feet north by 85 feet east of tablet, in root on SE. side of a 5-foot cottonwood tree; copper nail and washer	914.78	USGS
Miami	778.35	C&NW
Middle Amana	717	CM&StP
Middle Amana, crossing under CRI&P	746	CM&StP
Middletown	724,G724	CB&Q
Midland, Lyon Co.	1435	CRI&P
Midland Junction, Clinton Co.	595,G593	CM&StP
Mid River, top of rail on south line sec. 22, Tp. 81, R. 7, 1100 feet east of SW. cor. sec. 22	706.50	CR&IC
Mid River, top of rail on south line sec. 27, Tp. 81, R. 7, 550 feet west of SE. cor. sec. 27	725.30	CR&IC
Midvale	996	FtDDM&S
Midvale, T. 82 N., R. 24 W., 0.25 mile north of center of sec. 2, road to east; spike in telephone pole; marked "U.S.B.M. 977"	976.11	Bull. 569
Midvale, T. 82 N., R. 24 W., SW. cor. SE. ¼ sec. 2; iron post stamped "979"	977.405	Bull. 569
Midvale, T. 82 N., R. 24 W., NW. cor. of NE. ¼ sec. 14; spike in telephone pole, marked "U.S.B.M. 1001"	1,000.12	Bull. 569
Midway	683,G681	CRI&P
Miles	780,G780	CM&StP
Milford	1439,G1441	CM&StP
Miller, Hancock Co.	1225	CRI&P
Miller, Polk Co.	873.55	DM&CI
Milleray, Dubuque Co., T. 87 N., R. 1 E., SE. ¼ sec. 11, NE. cor. frame building at junction of roads going south (formerly Melleray post office, commonly called the "Corners"); iron post stamped "1065"	1,065.583	Bull. 569
Millerton	1074	CRI&P
Millman	834.4	CGW
Millman	G830	Weather Bur.
Mill Rock, Jackson Co.	715	USGS
Millville	640,G639	CM&StP
Millville, NW. cor. sec. 15, T. 91 N., R. 2 W.; iron post stamped "638"	639.310	Bull. 569
Millville, T. 91 N., R. 3 W., near center of sec. 13, 100 feet east of junction of roads; iron post stamped "897"	898.170	Bull. 569
Milo	973,G972	CB&Q
Milo, T. 74 N., R. 23 W., NW. cor. sec. 1, SW. angle of crossroads; in limestone rock 8 by 8 by 33 inches, set 32 inches in ground; aluminum tablet stamped "977 Adj"	976.674	Bull. 569
Milo, T. 74 N., R. 23 W., SW. cor. sec. 1, in NE. cor. crossroads, at Greenplain School, west side of concrete walk, top of south end, date 1911; mark on raised part of upper loop of figure "9"	990.90	Bull. 569
Milo, T. 74 N., Rs. 22 and 23 W., at cor. secs. 6, 7, 1 and 12, in center of crossroads, 3.5 miles south of Milo, in section stone; highest point of square cut	948.83	Bull. 569
Milo, T. 74 N., R. 22 W., SE. cor. sec. 6, in NW. cor.		

Station	Elevation feet	Authority
crossroads, 3 feet east of corner post; iron post stamped "Iowa 880, 1913"	880.465	Bull. 569
Milo, 1.75 miles west of, T. 75 N., R. 23 W., west of center of sec. 23, at SW. cor. crossroads, 10 feet south of corner post, in limestone rock, 6 by 8 by 30 inches, set 29 inches in ground; aluminum tablet stamped "896 Adj"	894.377	Bull. 569
Milo, T. 75 N., R. 23 W., about 0.25 mile east of NW. cor. sec. 26, opposite T road west, 2 feet south of telephone pole, in top of wooden peg; copper nail	921.55	Bull. 569
Milo, T. 75 N. R. 23 W., about 0.25 mile east of the SW. cor. sec. 26, at NW. cor. crossroads, 12 feet north of corner post, in root of 12-inch locust tree; copper nail	908.92	Bull. 569
Milo, T. 75 N., R. 23 W., sec. 10, 0.25 mile west of NE. cor., 4 feet west of corner post, at SW. angle of road forks, limestone rock 8 by 9 by 32 inches; aluminum tablet stamped "958 Adj"	957.178	Bull. 569
Milo, South river at CB&Q bridge south of	775	IaGS
Milton	804,G803	CB&Q
Minburn	1052,G1046	M&StL
Minden	1178.2,G1185	CGW
Minden, crossing CRI&P	1177.8,G1191	CGW
Minden	1193	CRI&P
Minden, 100 feet south of CRI&P Ry track, opposite a point 120 feet west of station, 6 feet south of wagon road; iron post	1,187.345	Bull. 569
Minden, in front of CRI&P Ry station; top of rail	1,196.8	Bull. 569
Minden, 0.25 mile east of, in SW. concrete abutment of CRI&P Ry bridge crossing the CGW Ry track, 2 feet from outer corner of abutment; aluminum tablet	1,201.385	Bull. 569
Mineola	1028	WRR
Mineola	1036	IaGS
Mineral Ridge, Boone Co., 0.5 mile north by 2.2 miles east of, T. 85 N., R. 26 W., NE. cor. sec. 16, SW. corner of crossroads; copper nail in base of telephone pole, marked "1163.0"	1,162.02	Bull. 569
Mineral Ridge, T. 85 N., R. 26 W., NE. cor. sec. 9, SW. cor. crossroads, 7 feet south of SW. fence corner; iron post stamped "1138"	1,136.704	Bull. 569
Mineral Ridge, T. 86 N., R. 26 W., SW. cor. sec. 34, on county line between Webster and Boone counties, NE. cor. crossroads; copper nail in base of corner fence post, marked "1106.4"	1,105.38	Bull. 569
Mineral Ridge (the village)	1200	USGS
Mineral Ridge (the hill) 1 mile north by 1 mile east of the village	1240	USGS
Minerva	919,G916	M&StL
Minerva Junction	890,G883	M&StL
Mingo	826.5,G823	CGW
Mississippi Park	607.00	CD&M
Missouri Valley	1005,G1006	C&NW
Missouri Valley, 2.2 miles south of, 300 feet south of south end of bridge 978, 90 feet south of milepost 20, 46 feet east of tracks; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 357):		
Copper bolt	994.995	Bull. 569
Cap on pipe	999.007	
Missouri Valley, at NW. cor. Second and Erie Sts., in SE. cor. Kreder's billiard hall, 7½ inches west of east face of building and 1.23 feet above sidewalk; copper bolt (U.S.C.E.p.b.m. 358)	1,006.448	Bull. 569
Missouri Valley, 3 miles west of, 335 feet east of east end of railway bridge 4, 886 feet west of milepost 3, 47 feet		

Station	Elevation feet	Authority
north of C&NW track; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 359):		
Copper bolt	1,001.635	Bull. 569
Cap on pipe	1,005.654	
Mitchell	1195	IC
Mitchellville	965,G967	CRI&P
Mitchellville	969.26	DM&CI
Modale	1015,G1016	C&NW
Modale, 0.8 mile south of, 195 feet north of railway bridge 10, 46 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 362):		
Copper bolt	1,008.745	Bull. 569
Cap on pipe	1,012.737	
Modale, 1 mile north of, 2,320 feet north of milepost 11, 60 feet south of highway crossing, 46 feet east of tracks; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 363):		
Copper bolt	1,010.123	Bull. 569
Cap on pipe	1,014.132	
Modale, T. 79 N., R. 45 W., 150 feet west of one-quarter post between secs. 22 and 27, between Soldier River and Horse Shoe Lake, on north side of east-west road; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 128/3):		
Copper bolt	1,012.83	Bull. 569
Cap on pipe	1,016.90	
Moingona	906,G905	C&NW
Moingona, 2 miles SE. of, near center sec. 17, Marcy Tp., west abutment of Sixteen to One Bridge over Des Moines river	872.80	Bull. 569
Moingona, 1.5 miles south of, at Y road, SE. cor. sec. 13, Marcy Tp.; iron post stamped "1060"	1,058.725	Bull. 569
Moingona, 1.5 miles south by 1.2 miles west of, at T road, south center SE. ¼ sec. 14, Marcy Tp.; spike in base of telephone pole	1,080.18	Bull. 569
Moingona, T. 83 N., R. 27 W., SW. cor. sec. 10, on north side of road at T road south, foot of corner fence post, west side of gate; chiseled square on concrete foundation, marked "1089.6"	1,088.74	Bull. 569
Moingona, T. 83 N., R. 27 W., NW. cor. sec. 22, SE. cor. crossroads, NW. cor. schoolhouse yard, inside fence corner; iron post stamped "Prim. Trav. Sta. No. 14, 1093"	1,092.280	Bull. 569
Mona, Mitchell Co.	1174,G1172	IC
Mona Siding, East switch, Black Hawk Co.	869	IC
Mondamin	1025,G1025	C&NW
Mondamin, 2 miles south of, 7 feet west of west right of way fence, 54 feet west of tracks; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 364):		
Copper bolt	1,013.797	Bull. 569
Cap on pipe	1,017.813	
Mondamin, 246 feet east of tracks, in center of sandstone block in SW. cor. brick building occupied by D. Ganet & Co., 0.71 foot from west wall of building; copper bolt (U.S.C.E.p.b.m. 365)	1,025.041	Bull. 569
Mondamin, 2,238 feet north of station, 889 feet south of public-road crossing, 33 feet south of milepost 17, 46 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 366):		
Copper bolt	1,022.003	Bull. 569
Cap on pipe	1,026.005	
Mondamin, 2.2 miles north of, 246 feet north of public-		

Station	Elevation feet	Authority
road crossing, 299 feet north of dwelling of Joseph Krummel, 105 feet east of tracks, in corner of field; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 367 equals 130/2):		
Copper bolt	1,020.506	Bull. 569
Cap on pipe	1,024.499	
Mondamin, T. 79 N., R. 45 W., on west side of section-line road between secs. 3 and 4, 1,208 feet south of NE. cor. sec. 4, on land owned by John Harrington, 2 miles from river; copper bolt in tile surmounted by iron pipe (U.S. C.E.b.m. 129/3):		
Copper bolt	1,013.67	Bull. 569
Cap on pipe	1,017.74	
Moneta	1452,G1447	CRI&P
Moningers	898,G896	M&StL
Monmouth	764,G761	C&NW
Monmouth, center Monmouth Tp.	712	USGS
Monona, in front of CM&StP Ry station; top of rail	1,215.6	Bull. 569
Monona, T. 95 N., R. 5 W., 0.2 mile north of center sec. 10, 60 feet north of railroad track, SE. of Walsh's house; iron post stamped "1184 DBQ"	1,185.584	Bull. 569
Monona	G1216	USGS
Monroe, B.M. top of monument M.P. 329	906.76	CRI&P
Monroe, B.M. top of monument M.P. 330	913.63	CRI&P
Monroe, B.M. top of monument M.P. 331	906.92	CRI&P
Monroe, top of rail, center of depot	921.4,G922	CRI&P
Monroe, B.M. top of monument M.P. 332	913.11	CRI&P
Monroe, B.M. top of monument M.P. 333	907.35	CRI&P
Montieth	1037,G1037	CRI&P
Montezuma	948,G958	CRI&P
Montezuma	969	M&StL
Montgomery	1451	CM&StP
Monticello	840,G839	CRI&P
Monticello, south end of railroad bridge over Maquoketa river	G823	USGS
Monticello, same as above	818	CM&StP
Monticello, highway crossing	G843	USGS
Montour	853,G850	C&NW
Montpelier	560,G566	CRI&P
Montpelier, union station with CRI&P	560	CM&StP
Montpelier, 2 miles north of, on middle pier of bridge over Pine creek, on line of CRI&P Ry, in north end of pier of bridge 60; brass bolt, marked "U.S.P.B.M." (U.S.C.E. p.b.m. 34)	554.605	Bull. 569
Montpelier, 1 kilometer south of, on south pier of CRI&P RR bridge 52, in west end of pier; brass bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 35)	564.812	Bull. 569
Montpelier, 0.5 mile east of station, on west abutment of CRI&P RR bridge 45, in south end of abutment; brass bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 35a)	557.309	Bull. 569
Montpelier, on bench about 0.25 mile above slough between islands 324 and 325, on cleared grassy spot at edge of timber, 91 meters back of wagon road, 100 meters back of Andalusia slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 145/2):		
Copper bolt	627.39	Bull. 569
Cap on pipe	631.42	
Montpelier, on street running north from station, opposite and in line with south side of schoolhouse, 0.5 meter east of wire fence on west side of street; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 145/3):		
Copper bolt	600.91	Bull. 569

Station	Elevation feet	Authority
Cap on pipe	604.94	
Montpelier, on street running north from station, opposite and in line with south side of schoolhouse, 0.5 meter east of wire fence on west side of street; iron post stamped "Mississippi River Commission 1892," surmounting U. S. Corps of Engineers b.m. 145/3. (The cap on this pipe is quite loose, varying from 0.01 to 0.02 foot in elevation)	604.94	Bull. 569
Montpelier, 1.25 miles north of, T. 77 N. R. 1 E., near NW. cor. sec. 13, west side of road, south side of drain, on top of fence post (about on level with roadbed); copper nail marked "702.94"	702.95	Bull. 569
Montpelier, T. 77 N., R. 1 E., about middle of west line of NW. ¼ sec. 12, SE. cor. T road south, 2.5 feet above center of road, 6 feet east of corner fence post; copper nail about middle of brace post, marked "762.20"	762.23	Bull. 569
Montpelier, T. 77 N., R. 1 E., center of north half of sec. 11; T road north, marked "733"	733	Bull. 569
Montpelier, T. 77 N., R. 1 E., about center of W. ½ NW. ¼ sec. 11, in SE. cor. T road south, 3 feet south of fence post, 15 feet east of fence line; iron post stamped "696"	695.922	Bull. 569
Montpelier, T. 77 N., R. 1 E., about center of N. ½ sec. 10, on south side of road opposite drive to residence of O. A. Bohnsack, in base of brace post; copper nail	659.40	Bull. 569
Montpelier, T. 77 N., R. 1 E., near north line of sec. 9; T road east, marked "629.9"	630	Bull. 569
Montpelier, T. 77 N., R. 1 E., about middle of north line of NE. ¼ sec. 9, SE. cor. bridge over branch of Pine creek, 150 feet west of north-south road, 1 foot north of east end of south truss; copper nail in floor, marked "633.10"	633.16	Bull. 569
Montrose	531.5	CB&Q
Montrose, Mississippi river, low water	G500	Miss. Riv. Com.
Montrose, in upper foundation stone of brick store building on south corner of Main and Cedar Sts., on east side, 3 feet from north corner; copper bolt, marked "U.S.P. B.M." (U.S.C.E.p.b.m. 3)	530.432	Bull. 569
Montrose, just above, 125 meters below mouth of Jack creek, 110 meters above upper warehouse in Montrose and 15 meters from river bank, in root of 30-inch tree in willow grove; spike (U.S.C.E. "61 Mackenzie") marked by circular iron plate spiked in tree	507.33	Bull. 569
Montrose, on east side of first warehouse above station, near center of building, marked with black paint; high-water marks (U.S.C.E. high-water marks of 1851, 1888, 1881, 1880):		
1851	514.65	Bull. 569
1888	513.09	
1881	512.25	
1880	511.40	
Montrose, opposite Nauvoo, Ill., on right bank of river, 11 meters from bank, in cluster of large soft maple trees, at mouth of Excelsior slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 115/3):		
Copper bolt	505.29	Bull. 569
Cap on pipe	509.30	
Montrose, 1.5 miles above, on sand ridge on west side of wagon road, 10 feet inside of fence, 300 meters below milepost 30, 300 meters above small shanty near corner of hedge fence; copper bolt in tile surmounted by iron		

Station	Elevation feet	Authority
pipe (U.S.C.E.b.m. 115/4 equals ⊙ Sand Ridge):		
Cap on pipe	546.88	Bull. 569
Montrose, Devils Island, 22 meters from bank of river, midway between shore and small slough running parallel with shore; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 116/3):		
Copper bolt	506.90	Bull. 569
Cap on pipe	510.90	
Montrose, Devils Island, 740 meters back of previous bench mark, on small ridge between pond and overflowed ground back; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 116/4):		
Copper bolt	507.59	Bull. 569
Cap on pipe	511.59	
Montrose, Bluff Park	518	CB&Q
Mooar	667,G666	CB&Q
Mooar	G654	Weather Bur.
Moore	791,G784	M&StL
Moorhead	1102	C&NW
Moorland	1146.7,G1152	CGW
Moorland, crossing M&StL	1147.0,G1152	CGW
Moorland,	1151	M&StL
Moorland, T. 88 N., R. 29 W., cor. secs. 20, 21, 28 and 29, 50 feet NW. of center of crossroads, in root of 18-inch maple tree, marked "1,143.9"; copper nail and washer	1,143.94	USGS
Moorland, T. 88 N., R. 29 W., cor. secs. 16, 17, 20 and 21, 60 feet NW. of center of crossroads, in base of corner fence post; marked "1,138.2"; spike	1,138.14	USGS
Moorland, T. 88 N., R. 29 W., cor. secs. 8, 9, 16 and 17, at T road south, 50 feet SE. of road fork, 6 feet east of fence corner, 2.5 feet north of fence line; iron post stamped "Iowa 1919 1,130"	1,129.955	USGS
Moorland, T. 88 N., R. 29 W., cor. secs. 9, 10, 15 and 16, T road west, 50 feet north of T road corners, in SE. cor. of bridge over drainage ditch, marked "1,116.6"; copper nail and washer	1,116.61	USGS
Moorland, T. 88 N., R. 29 W., cor. secs. 3, 4, 9 and 10, 100 feet NW. of center of crossroads, in root of 2.5 foot cotton wood tree; marked "1,129"; copper nail and washer	1,128.92	USGS
Moran	926.04	DM&CI
Moran, 2.5 miles south by 1 mile east of, at Y road, SE. cor. sec. 32, Des Moines Tp.; iron post stamped "878"	876.688	Bull. 569
Moran, 2.5 miles south of, at road crossing, SW. cor. sec. 32, Des Moines Tp.; spike in base of fence post	928.33	Bull. 569
Moravia	1009	ISU
Moravia	997,G1001	CM&StP
Moravia	999	WRR
Moravia, crossing CM&StP	995	WRR
Morgan Valley	750	WRR
Morgan Valley, see Bennington		
Morley	799,G800	CM&StP
Morningside	1234	CM&StP
Morning Sun	758,G752	M&StL
Morning Sun, crossing CRI&P	755,G748	M&StL
Morning Sun	741,G745	CRI&P
Morning Sun, crossing M&StL	748	CRI&P
Morning Sun, divide 2 miles west of	843	M&StL
Morrison	953,G947	CRI&P
Morse	760,G763	CRI&P
Moscow	647,G654	CRI&P
Motor, Warren Co., 1 mile west of, T. 75 N., R. 22 W., SE. cor. sec. 3, NW. angle of crossroads, sandstone rock 8 by		

Station	Elevation feet	Authority
10 by 24 inches, set 23 inches in ground; aluminum tablet stamped "943 Adj"	941.926	Bull. 569
Moulton	991	WRR
Moulton, crossing CB&Q	991	WRR
Moulton	990,G987	CB&Q
Moulton, crossing Wabash	976,G984	CB&Q
Moulton Junction	988	WRR
Mount Auburn	871,G863	CRI&P
Mount Ayr	1217,G1232	CB&Q
Mount Ayr	G1236	Weather Bur.
Mount Clara	684,G683	CB&Q
Mount Etna, Adams Co.	1090	IaGS
Mount Joy	749,G739	CM&StP
Mount Pleasant, Keokuk line	723,G719	CB&Q
Mount Pleasant, main line	725	CB&Q
Mount Pleasant	G729	Weather Bur.
Mount Sterling	655.7,G655	CB&Q
Mount Union	727,G720	CB&Q
Mount Vernon	843,G843	C&NW
Mount Vernon	G847	Weather Bur.
Mount Vernon, top of rail on east line sec. 7, Tp. 82, R. 5, 30 feet north of NE. cor. of SE. ¼ of NE. ¼ sec. 7	803.41	CR&IC
Mount Vernon, top of rail on east line sec. 8, Tp. 82, R. 5, at NE. cor. of SE. ¼ of NE. ¼ sec. 8	827.91	CR&IC
Mount Vernon, bench mark, mark on cement sidewalk at SE. cor. street intersection at west end of paving in Mount Vernon	867.32	CR&IC
Mount Vernon, paha at	932	IaGS
Mount Zion, B.M. top of monument M.P. 44	610.71	CRI&P
Mount Zion, B.M. top of monument M.P. 45	661.44	CRI&P
Mount Zion, top of rail, center of depot	696.2	CRI&P
Mount Zion, B.M. SW. cor. south tank pedestal; jct. Keosauqua branch	696.16	CRI&P
Mount Zion, B.M. top of monument M.P. 47	630.70	CRI&P
Mount Zion, B.M. top of monument M.P. 1, Keosauqua branch	719.96	CRI&P
Mount Zion, B.M. top of monument M.P. 2	701.11	CRI&P
Moville	1147	C&NW
Murphy	832	M&StL
Murray	1214,G1216	CB&Q
Muscatine	548,G552	CM&StP
Muscatine, Mississippi river, low water	G531	Miss. Riv. Com.
Muscatine, Mississippi river, high water, 1881	G547	Miss. Riv. Com.
Muscatine	547,G554	CRI&P
Muscatine, crossing Wilton line CRI&P	557.73	CD&M
Muscatine, junction with City Railway lines, top of rail	556.98	CD&M
Muscatine Bridge, 1.5 miles above, 1 meter north of hedge fence on property of Capt. John W. Anderson, 1 meter east of east line of John Berry's property, 3 meters 34° to 12-inch wild-cherry tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 141/4). (Cap of iron pipe had been removed; the pipe was removed, the line tied to copper bolt, and then pipe was put in place again, but no new elevation for top established)	595.68	Bull. 569
Muscatine, 7.5 miles south of, 22 meters south of gate leading to Esquire Walton's house, 8 meters north of wagon road, 15 meters from edge of river bank; top of stone with block over it and three marking stakes set 3 feet off and three small black-locust trees blazed near by; top of stone is about 1 foot below surface of ground (U.S.C.E.p.b.m. 25)	544.428	Bull. 569
Muscatine, 7 miles below, on brick foundation of E.		

Station	Elevation feet	Authority
Beatty's dwelling on right bank of river, in east side NE. cor. foundation; copper bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 26)	548.539	Bull. 569
Muscatine, on brick chimney of Hershey's lower sawmill, on middle of east face of chimney, about 3 feet above ground; copper bolt, marked "U.S.P.B.M." (U.S.C.E. p.b.m. 27)	550.455	Bull. 569
Muscatine, on waterworks chimney, in north face, about 1.1 meters from ground; copper bolt marked "U.S.P.B.M." (U.S.C.E.p.b.m. 28)	551.964	Bull. 569
Muscatine, 50 meters north of station, on north abutment of wagon bridge in NE. cor. abutment; copper bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 29)	552.417	Bull. 569
Muscatine, 3 miles north of, on abutment of CRI&P RR bridge, in top of stone coping of south end of west abutment; copper bolt, marked "U.S.P.B.M." (U.S.C. E.p.b.m. 30)	553.595	Bull. 569
Muscatine, 5 miles NE. of, on abutment of CRI&P RR bridge over Sweetland creek, in west end of north abutment; copper bolt, marked "U.S.P.B.M." (U.S.C.E. p.b.m. 31)	552.814	Bull. 569
Muscatine, 6 miles above, in natural rock on line of CRI&P RR, in face of rock where it has been blasted off for railroad bed, 4 feet above track, 20 feet north of center of track, 740 meters west of bridge 77; copper bolt, marked "U.S.P.B.M." (U.S.C.E.p.b.m. 32)	561.452	Bull. 569
Muscatine, 7 miles below, 1,149.5 meters (distance read by stadia) back of bench mark 138/2, in low ground on prairie, 40 meters west of small lake, 50 meters north of cultivated piece of ground which rises about 5 feet higher than prairie, midway between two old wagon roads that join 15 meters south; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 138/2):		
Copper bolt	532.81	Bull. 569
Cap on pipe	536.79	
Muscatine Island, 30 meters from river bank, 1 meter west of E. Beatty's front-yard fence, 4 meters 200° to 15-inch coffee-bean tree, 6 meters 80° to 24-inch honey locust, 30 meters 94° to NE. cor. Beatty's house; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 138/3):		
Copper bolt	545.14	Bull. 569
Cap on pipe	549.16	
Muscatine, Copperas creek, in open spot 100 meters below mouth of, 30 meters back of narrow island whose head is 100 meters above mouth of creek, 15 meters above fence corner, 4 meters east of wagon road, 80 meters below dwelling house on main bank of river; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 139/1):		
Copper bolt	539.86	Bull. 569
Cap on pipe	543.87	
Muscatine, 1 mile below head of Blanchard Island, on ridge 100 meters from river, 60 meters from slough on west, 25 meters from small slough on east; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 139/2):		
Copper bolt	541.85	Bull. 569
Cap on pipe	545.86	
Muscatine, 3.5 miles below, on property of D. Freeman, at intersection of two wire fences, one north-south and the other east-west, north of two lone cottonwood and birch trees; 204 meters north of south line of sec. 22, 156 meters west of levee; copper bolt in tile surmounted by		

STATION	ELEVATION FEET	AUTHORITY
iron pipe (U.S.C.E.b.m. 139/3):		
Copper bolt	539.81	Bull. 569
Cap on pipe	543.84	
Muscatine Island, along east-west hedge on property belonging to R. F. Parmelee, 12.5 meters 90° to center SE. ¼ sec. 21 along hedge; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 139/4):		
Copper bolt	547.42	Bull. 569
Cap on pipe	551.39	
Muscatine, in lower part of, on ridge between two sloughs, 7 meters west of one slough and 12 meters east of another slough, 100 meters above their junction, 530 meters from river bank, 486 meters from bench mark 140/2; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 140/1):		
Copper bolt	538.41	Bull. 569
Cap on pipe	542.44	
Muscatine, in lower part of, north of lumber yards, on side hill in meadow belonging to Weltz, 58 meters north of Bowling Green road along north-south fence; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 140/4):		
Copper bolt	644.85	Bull. 569
Cap on pipe	648.88	
Muscatine, on east side of waterworks building in top of stone foundation; cut (U.S.C.E. high-water mark of 1881)	548.04	Bull. 569
Muscatine, top of NE. cor. west abutment of Front St. wagon bridge, about 50 meters NE. of station (U.S.C.E. b.m.)	549.71	Bull. 569
Muscatine, in Iowa side of second pier, on SW. cor. pier; elevation of high water of 1892	549.19	Bull. 569
Muscatine, SE. cor. east pier on north side of railroad track, Muscatine high bridge; top of stone (U.S.C.E. b.m., city b.m.)	552.03	Bull. 569
Muscatine, on lower pier of third pair of tubular piers from Illinois side of Muscatine wagon bridge; high-water mark of 1892	548.95	Bull. 569
Muscatine bridge, 1.5 miles above, in timber 80 meters from river bank, on main bank, about 0.25 mile below head of Island 334; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 141/2):		
Copper bolt	542.84	Bull. 569
Cap on pipe	546.89	
Muscatine bridge, 1.5 miles above, 0.5 meter north of south right-of-way fence of CRI&P Ry, 192 meters west of bridge 93, 18 meters west of switch where siding runs to tile factory, 14.5 meters south of railroad track; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 141/3):		
Copper bolt	542.57	Bull. 569
Cap on pipe	546.60	
Muscatine bridge, 1.5 miles above, 1 meter north of hedge fence, on property of Capt. John W. Anderson, 1 meter east of east line of John Berry's property, 3 meters 34° to 12-inch wild-cherry tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 141/4):		
Copper bolt	595.68	Bull. 569
Cap on pipe	599.77	
Muscatine, Island 331, opposite foot of, 0.25 mile south of river, on line of north-south fence, 30 meters above fence corner at foot of bluff; copper bolt in tile sur-		

Station	Elevation feet	Authority
mounted by iron pipe (U.S.C.E.b.m. 142/2):		
Copper bolt	563.84	Bull. 569
Cap on pipe	567.85	
Muscatine, 4.5 miles above, on property of Mrs. McDonald, 30 meters below small creek crossed by railroad bridge 78, 5 meters east of SE. cor. house, 1 meter east of large apple tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 142/3):		
Copper bolt	569.33	Bull. 569
Cap on pipe	573.37	
Mystic	906	ISU
Mystic	892,G896	CM&StP
Mystic, crossing over CB&Q	948	CM&StP
Nahant	563	CRI&P
Napier	1044	FtDDM&S
Napier, T. 83 N., R. 25 W., NW. cor. sec. 36; spike in fence post marked "U.S.B.M. 1049"	1,047.96	Bull. 569
Napier, T. 83 N., R. 25 W., SE. cor. sec. 25; spike in telephone pole, marked "U.S.B.M. 1040"	1,038.76	Bull. 569
Nashua	971,G968	IC
Nashville	715	C&NW
National, Clayton Co., T. 94 N., R. 3 W., SW. ¼ sec. 8, NW. cor. schoolhouse yard; iron post stamped "699 DBQ"	700.235	Bull. 569
National, SE. ¼ sec. 15, T. 94 N., R. 4 W., in SW. cor. schoolhouse yard; iron post stamped "1110 DBQ"	1,111.436	Bull. 569
National, Hamilton Co.	1100	FtDDM&S
Nebraska City Junction	928,G923	CB&Q
Nebraska City Junction, 1.25 miles south of station, 384 feet west of house occupied by Johnson Gibson, 35 feet north of north end of farm gate, 46 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 326):		
Copper bolt	915.877	Bull. 569
Cap on pipe	919.900	
Nebraska City Junction, 3,844 feet north of station, 45 feet east of railroad, on sand knoll; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E. p.b.m. 327):		
Copper bolt	919.664	Bull. 569
Cap on pipe	923.689	
Nebraska City Junction, 3,884 feet north of station, 45 feet east of CB&Q RR track, on sand knoll; top of cap of iron pipe marked "Missouri River Commission"	923.689	Bull. 569
Nebraska City Junction, 600 feet north of station, 40 feet west of CB&Q RR tracks; iron post stamped "Prim. Trav. Sta. No. 1, 924, Adj, 1903"	922.450	Bull. 569
Nebraska City Junction, 2 miles west of, 40 feet south of crossing, 30 feet east of center of road; iron post stamped "923, Adj, 1903"	922.291	Bull. 569
Neils	1290	CRI&P
Nemaha	1322,G1318	CM&StP
Neoga	996	WRR
Neola	1096,G1100	CRI&P
Neola, crossing, CM&StP	1086	CRI&P
Neola, in first concrete bridge abutment west of town (CRI &P Ry bridge 483), on SE. side, 5 feet below level of track; aluminum tablet	1,088.890	Bull. 569
Neola, at Main Street crossing of CM&StP Ry, 20 feet west of street, 10 feet south of track, iron post	1,095.820	Bull. 569
Neola, in front of CRI&P Ry station; top of rail	1,098.7	Bull. 569
Neola	1093,G1098	CM&StP

STATION	ELEVATION FEET	AUTHORITY
Neola, crossing CRI&P	1090,G1093	CM&StP
Neola	G1111	Weather Bur.
Nepas	802	CRI&P
Nevada	990	CRI&P
Nevada, crossing under C&NW	954	CRI&P
Nevada	1003,G1001	C&NW
Nevada, T. 83 N., R. 23 W., SE. cor. sec. 4, 3.5 miles west of Nevada, 4.5 miles east of Ames, NW. cor. crossroads; iron post stamped ''967''	965.858	Bull. 569
Nevada, T. 84 N., R. 23 W., NE. cor. sec. 28, SW. cor. crossroads, 7 feet south of corner fence post; iron post stamped ''986''	985.177	Bull. 569
Nevada, T. 84 N., R. 23 W., SW. cor. sec. 27, NE. cor. crossroads; copper nail in base of telephone pole at fence corner, marked ''1000.8''	999.81	Bull. 569
Nevada, 1 mile north by 3.5 miles west of, T. 84 N., R. 23 W., SE. cor. sec. 33, on east-west township line between Milford and Grant townships, 60 feet NW. of center of crossroads; copper nail in base of telephone pole, marked ''990.9''	989.91	Bull. 569
Nevada, top of north rail of C&NW Ry crossing	978.1	Bull. 569
Nevinville, Adams Co.	1300	IaGS
New Albin	651,G646	CM&StP
New Albin schoolhouse, 22 feet NE. of NE. cor.; iron post stamped ''652 DBQ''	652.977	Bull. 569
New Albin, 100 meters above lower end of Island 135, on ridge, 100 meters above lower end of timber, 50 meters back from shore, 200 meters below point opposite warehouse at Tippets Landing; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 209/3):		
Copper bolt	622.09	Bull. 569
Cap on pipe	626.05	
New Albin, 75 meters east from east bank of Lost Slough, in low ground, in small bunch of willows; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 209/4):		
Copper bolt	618.49	Bull. 569
Cap on pipe	622.45	
New Albin, opposite CM&StP Ry station; base of rail (U.S.C.E.b.m.)	648.53	Bull. 569
New Albin, top of city corner stone on west side of CM&StP Ry track, 2 blocks north of station and just north of grain elevator (U.S.C.E.t.b.m. 29, R. B)	650.12	Bull. 569
New Albin, top of pipe monument on State line between Iowa and Minnesota (U.S.C.E.t.b.m. 30, R. B)	648.74	Bull. 569
New Albin, top of city corner stone which is on Iowa-Minnesota State line, 35 meters west of pipe monument, 8 meters east of east right-of-way fence of CM&StP Ry (U.S.C.E.t.b.m. 31, R. B)	648.06	Bull. 569
Newbern, Marion Co., T. 74 N., R. 21 W., about 0.25 mile north of quarter corner on west side of sec. 33, at angle to south in road east, 16 feet north of telephone pole, in top of wooden peg; copper nail	936.73	Bull. 569
Newbern, T. 73 N., R. 21 W., at NE. cor. sec. 5 at SW. cor. crossroads, 2 feet east of corner post, in top of osage stump; copper nail	1,007.58	Bull. 569
Newbern, T. 74 N., R. 21 W., about 250 feet east of SW. cor. sec. 34, opposite T road south, 80 feet NE. of bridge over Long Branch creek; iron post stamped ''Iowa, 904, 1913''	904.215	Bull. 569
Newbern, T. 73 N., R. 21 W., at SW. cor. sec. 3 in NE. angle crossroads, 28 feet north by 24 feet east of cor.		

Station	Elevation feet	Authority
secs. 3, 4, 9 and 10, in SW. cor. churchyard, in sandstone rock; bottom of chiseled square	999.22	Bull. 569
New Boston	643.5	AT&SF
New Boston, east line CB&Q overhead bridge, base of rail	662.9	AT&SF
New Boston, square cut in NE. cor. bottom step NW. abutment CB&Q bridge	664.95	AT&SF
New Boston, CB&Q track at crossing	G685	CB&Q
New Boston	697.2,G697	CB&Q
New Boston, Ill., 1 mile below, on right bank, 25 meters from shore, 7.3 meters 94° 30′ to 8-inch locust tree, 6.4 meters 341° to 15-inch elm, 8.8 meters 281° to 30-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 133/3):		
Copper bolt	532.19	Bull. 569
Cap on pipe	536.12	
New Boston, Ill., 1 mile below, on right bank, on back edge of slough 892.4 meters back of preceding bench mark, 7.5 meters 279° 30′ to 12-inch black-oak tree, 9.7 meters 28° 30′ to 12-inch elm tree, 9.9 meters 205° 30′ to 8-inch ash tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 133/4):		
Copper bolt	529.51	Bull. 569
Cap on pipe	533.53	
Newburg	1036,G1029	M&StL
Newcom, M.P. 440	1200,G1202	IC
Newell	1265,G1264	IC
Newhall	872,G869	CM&StP
New Hampton	1164,G1159	CM&StP
New Hampton, crossing CGW	1160,G1168	CM&StP
New Hampton	1150.7,G1159	CGW
New Hampton, crossing CM&StP	1159.6	CGW
New Hartford	893,G895	IC
New Liberty	797,G797	CRI&P
New London	765.47,G768	CB&Q
New Market	1198	CB&Q
Newport	730,G723	M&StL
New Providence hill	1130	IaGS
New Sharon	870,G859	M&StL
Newton	935	M&StL
Newton	942,G944	CRI&P
New Virginia	1026	CB&Q
New Virginia, South river at CB&Q bridge north of	914	IaGS
Nichols, Burlington line	634,G638	CRI&P
Nichols, Muscatine line	628	CRI&P
Niles	1097	FtDDM&S
Nira	736	CRI&P
Nixon, Dallas county	893.56	DM&CI
Noble	656	CB&Q
Nobleton, B.M. top of monument M.P. 345	931.56	CRI&P
Nobleton, B.M. top of monument M.P. 346	943.41	CRI&P
Nobleton, B.M. top of monument M.P. 347	944.92	CRI&P
Nobleton, B.M. top of monument M.P. 348	962.48	CRI&P
Nobleton, top of rail, center of depot	983.7	CRI&P
Nobleton, B.M. top of monument M.P. 349	956.00	CRI&P
Nobleton, B.M. top of monument M.P. 350	934.29	CRI&P
Nobleton, 4 miles south, 1 mile west of, T. 78 N., R. 22 W., 530 feet west of quarter corner on north side sec. 3, and 40 feet south of road, on concrete post; bronze tablet stamped "Prim. Trav. Sta. No. 26-L.S.-1924-Iowa" marked "895.8"	895.828	USGS
Nobleton, reference mark, 57 feet west and 7 feet north		

Station	Elevation feet	Authority
of "L.S. No. 26", in root on north side of 30-inch maple tree; copper nail and washer	893.22	USGS
Nobleton, T. 78 N., R. 22 W., 440 feet east of cor. secs. 2 and 3, on north side of, T road south, on west end of south railing of concrete highway bridge over Camp creek; chiseled square, marked "825.2"	825.20	USGS
Nobleton, T. 79 N., Rs. 21 and 22 W., near corner, on south side of secs. 31 and 36, 25 feet north and 30 feet west of T road north, top of east end of concrete foundation of gasoline pump; chiseled square, marked "901.9"	901.92	USGS
Nobleton, T. 78 N., R. 22 W., at NE. cor. sec. 1, 30 feet south and 20 feet west of crossroads, 5 feet south of fence corner, top of concrete wall; chiseled square, marked "925.7"	925.71	USGS
Nodaway	1084,G1084	CB&Q
Noels	634	CRI&P
Noels, crossing CM&StP	633	CRI&P
Noels, crossing CRI&P, union station	645,G636	CM&StP
Nora Springs or Nora Junction, union station with CM&StP and crossing	1064,G1062	CRI&P
Nora Springs	1058,G1063	CM&StP
Nora Springs Junction, union station with CRI&P	1064	CM&StP
Nordness	1031,G1035	CRI&P
Nordness, intersection of wagon roads	1031	USGS
Nordness, 0.5 mile south of, T. 97 N., R. 8 W., NE. ¼ NW. ¼ sec. 15, 3 rods north of crossing and road intersection, 2 feet east of right of way of CRI&P Ry; iron post stamped "1059 DBQ"	1,058.982	Bull. 569
Norman	1278,G1278	M&StL
Norris	870,G864	CRI&P
North Bellevue, see Bellevue, North		
Northboro	1050.8,G1047	CB&Q
Northboro, Iowa-Mo. state line	1020.5	CB&Q
North Buena Vista, Clayton Co., T. 91 N., R. 1 W., south side sec. 32, junction of John Richmond's road with main wagon road; iron post stamped "1181 DBQ"	1,181.159	Bul. 569
North Buena Vista, 0.5 mile below, on right of way of CM&StP Ry, 25 meters below lower end of railroad bridge 194, 7 meters from center of track toward bluffs; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 187/3):		
Copper bolt	624.80	Bul. 569
Cap on pipe	628.75	
North Buena Vista, opposite CM&StP Ry station; base of rail (U.S.C.E.b.m.)	625.32	Bul. 569
North Buena Vista, 2.6 miles above, on line of CM&StP Ry track, 16 meters below center of bridge 204K, at fence on bluff side, 11 meters from center of track; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 188/4):		
Copper bolt	617.11	Bul. 569
Cap on pipe	621.11	
North Buena Vista, 2 miles below. 1,575 feet below section post 11-12, 1,411 feet below bridge 188K, 775 feet above Dry Hollow Bridge 186K, on line of CM&StP Ry, 10 feet south from center, on ledge of rock marked "U□S"; highest point in square (U.S.C.E.t.b.m. 267)	627.696	Bul. 569
North Buena Vista, 0.8 mile below, 1.840 feet below milepost 94-67, 590 feet below bridge 194, on bluff side of track, 15 feet from center, on embedded bowlder, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 265)	628.161	Bull. 569

Station	Elevation feet	Authority
North Buena Vista, SE. cor. R. & E. Meuth's general store, 6 inches from south face and 4.3 feet above ground, in wall marked the same as p.b.m. 247, that is "U.S.⊙P. B.M."; copper bolt (U.S.C.E.p.b.m. 255)	627.519	Bull. 569
North Buena Vista, 82 feet above station and 35 feet above road crossing, on bluff side of track, 9 feet from center, about 2.5 feet above grade, on hard ledge of rock, marked "U□S"; being highest point in square (U.S.C. E.t.b.m. 264)	627.197	Bull. 569
North Buena Vista, 1 mile above, opposite foot of Island 196, 2,986 feet above milepost 93, 15 feet toward the bluff from center of CM&StP Ry track, on upper one of three large, prominent pieces of rock lying but a few feet from each other, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 262)	625.684	Bull. 569
North Buena Vista, 2.6 miles above, 53 feet below center of bridge 204K, on right of way of CM&StP Ry, at fence on bluff side, 36 feet from center of track; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 253 and 254):		
Copper bolt	617.115	Bull. 569
Cap on pipe	621.114	
North Buena Vista	626,G626	CM&StP
North English	784,G789	CM&StP
North Liberty, top of rail on south line of sec. 1, Tp. 80, R. 7, 567 feet west of S. ¼ cor. sec. 1	801.80	CR&IC
North Liberty, bench mark, top of water table on east side of center pier in south wall of substation	773.50	CR&IC
North Liberty, top of rail on south line sec. 12, Tp. 80, R. 7, SW. cor. of SE. ¼ of SE. ¼ of sec. 12	769.10	CR&IC
North Liberty, top of rail on south line sec. 13, Tp. 80, R. 7, on SW. cor. of SE. ¼ of SE. ¼ of sec. 13	761.30	CR&IC
North McGregor, changed to Marquette		
North Number 3	977	ISU
Northwood	1236	M&StL
Northwood	G1222	CRI&P
Northwood	G1222	Weather Bur.
Norwalk	919.16	CB&Q
Norwalk, North River at CB&Q bridge south of	806	IaGS
Norway	796,G792	C&NW
Norwich	1141,G1142	CB&Q
Norwood, Lucas Co., T. 73 N., R. 22 W., at quarter corner between secs. 17 and 18, at center of crossroads, on top of section stone; chiseled square	1,006.87	Bull. 569
Norwood, T. 73 N., R. 22 W., at quarter corner on west side of sec. 18, at NE. angle of crossroads, at east end of culvert, in top plank; copper nail	994.67	Bull. 569
Norwood, T. 73 N., R. 23 W., 0.25 mile north of SW. cor. sec. 13, at NE. angle of T road east, in root of 8-inch elm tree; copper nail	1,034.10	Bull. 569
Norwood, 0.5 mile east of, T. 73 N., R. 23 W., at quarter corner on south side of sec. 14, opposite center of T road south, at SE. cor. school yard, 2 feet south of corner post; iron post stamped "Iowa, 1037, 1913"	1,037.519	Bull. 569
Norwood, south end of concrete walk at church	1,040.60	Bull. 569
Norwood, 1 mile north of, at SW. cor. crossroads, in churchyard, at south side, east end of concrete walk, painted square	1,032.85	Bull. 569
Norwood, T. 73 N., R. 23 W., at NE. cor. sec. 10, in SW. angle of crossroads, opposite mile board, "Lucas 10, Indianola 19, Des Moines 35," 4 feet south of telephone		

Station	Elevation feet	Authority
pole; iron post stamped "Iowa, 1023, 1013" (moved, 1917, 18 ft. SW. of former location at same elevation)	1,023.127	Bull. 569
Norwood, Tps. 73 and 74 N., R. 23 W., at cor. secs. 2, 3, 34, and 35, on line between Lucas and Warren counties, at center of T road east, in top of section stone; bottom of square cut	1,001.44	Bull. 569
Norwood, T. 73 N., R. 23 W., at quarter corner between secs. 23 and 26, at center of crossroads, on section stone; chiseled circle	1,014.08	Bull. 569
Norwood, T. 73 N., R. 23 W., at center of sec. 35, opposite T road west, 4 feet north of osage post, on line with east-west fence on east side of road; iron post stamped "Iowa, 1030, 1913"	1,029.841	Bull. 569
Norwood, T. 72 N., R. 23 W., north center of sec. 2, on west side of road, 16 feet south of east-west fence line, in west end of plank drain; copper nail	1,036.18	Bull. 569
Nugent	791,G783	M&StL
Numa	1026,G1037	CRI&P
Nuttings	580.20	CD&M
Nutting Farms	574	DRI&NW
Oakdale, top of rail on south line sec. 30, Tp. 80, R. 6, 700 feet east of SW. cor. sec. 30	782.40	CR&IC
Oakdale, top of rail on south line sec. 24, Tp. 80, R. 7, on SW. cor. of SE. ¼ of SE. ¼ of sec. 24	793.40	CR&IC
Oakdale, bench mark, SW. cor. of concrete waiting platform	815.56	CR&IC
Oak Grove	998	M&StL
Oakland	1102,G1106	CRI&P
Oakland Mills	591.6,G595	CB&Q
Oakley	995,G993	CB&Q
Oakley, T. 73 N., R. 21 W., 0.25 mile east of NW. cor. sec. 20, at SW. cor. T road south, 250 feet west of schoolhouse, at base of corner post; top of stone	967.06	Bull. 569
Oakley, T. 73 N., R. 21 W., at quarter corner on north side of sec. 19, at NE. cor. road forks, on top of concrete wing wall of culvert; painted square	885.53	Bull. 569
Oakley, T. 73 N., R. 22 W., at quarter corner on north side of sec. 24, at SE. angle of T road south, 6 feet east of corner post; iron post stamped "Iowa, 933, 1913"	933.123	Bull. 569
Oakley, T. 73 N., R. 22 W., near quarter corner on north side of sec. 23, at SE. cor. T road east, at extreme NW. cor. Juergen's yard, in root of maple tree; copper nail	962.12	Bull. 569
Oakley, T. 73 N., R. 22 W., about 0.1 mile north of SW. cor. sec. 14, at T road east, on bridge over Whitebreast creek, near SE. cor. bridge floor; top of bolt	838.10	Bull. 569
Oakley, T. 73 N., R. 22 W., about 0.2 mile north of SW. cor. sec. 15, at SE. cor. crossroads, south end of small plank culvert, in top of; copper nail	967.47	Bull. 569
Oakley, T. 73 N., R. 22 W., at quarter corner on east side of sec. 17, in SW. angle at turn in road, just inside of fence, 3 feet SW. of corner post; iron post stamped "Iowa, 963, 1913"	962.892	Bull. 569
Oaks	964	ISU
Oakton	650	CM&StP
Oakville	550,G543	M&StL
Oasis	802,G800	CRI&P
Ocheyedan	1555,G1551	CRI&P
Ocheyedan Mound, Osceola county	1670	IaGS
Odebolt	1361,G1361	C&NW
Oelwein	1041.8,G1039	CGW
Oelwein, crossing CRI&P	1049.0,G1047	CGW
Oelwein	1053,G1049	CRI&P

Station	Elevation feet	Authority
Oelwein, north wall of post office, in coping stone; aluminum tablet stamped "1044 DBQ"	1,045.347	Bull. 569
Oelwein, 5 miles east of, center Scott Tp.	1143	IaGS
Ogden	1099,G1100	M&StL
Ogden, crossing C&NW	1099,G1103	M&StL
Ogden	1097,G1094	C&NW
Ogden, crossing M&StL	1097	C&NW
Ogden, 3 miles south by 2 miles east of, at Marcy Center school, NW. cor. sec. 22, Marcy Tp., in corner of school lot; iron post stamped "Prim. Trav. Sta. No. 14, 1093"	1,092.28	Bull. 569
Ogden, 4 miles south by 2 miles east of, at road crossing, NE. cor. sec. 28, Marcy Tp.; spike in base of telephone pole	1,075.12	Bull. 569
Ogden, 5 miles south by 2 miles east of, at road crossing, SW. cor. sec. 27, Marcy Tp.; spike in base of telephone pole	1,085.24	Bull. 569
Ogden, 6 miles south by 2 miles east of, at road crossing, SE. cor. sec. 33, Marcy Tp.; iron post stamped "1088"	1,087.114	Bull. 569
Ogden, 7 miles south by 2 miles east of, at road crossing, SW. cor. sec. 3, Peoples Tp.; spike in base of telephone pole	1,108.50	Bull. 569
Ogden, 8 miles south by 2 miles east of, at road crossing, SE. cor. sec. 9, Peoples Tp.; spike in base of telephone pole	1,090.17	Bull. 569
Ogden, 9 miles south by 2 miles east of, at road crossing near church, NE. cor. sec. 21, Peoples Tp.; iron post stamped "1072"	1,071.035	Bull. 569
Ogden, 10 miles south by 2 miles east of, at road crossing, SE. cor. sec. 21, Peoples Tp.; spike in base of telephone pole	1,021.78	Bull. 569
Ogden, T. 84 N., R. 27 W., west center of NW. ¼ sec. 15, NE. cor. crossroads; chiseled square in top of stone, marked "1111.7"	1,110.79	Bull. 569
Ogden, T. 84 N., R. 27 W., 0.2 mile north of center of sec. 22, SE. cor. road forks east, 15 feet west of east fence line, 50 feet south of center of road forks; 8-penny nail about 1 foot above ground in south side of oak tree, marked "930.626"	929.73	Bull. 569
Ogden, T. 84 N., R. 27 W., near east center of SE. ¼ sec. 21, west side of road, top of hill, 200 feet south of bend in road to south, SE. cor. yard to house; spike in east side of trunk of hickory tree 1 foot in diameter, 1 foot above ground and marked "1088.2"	1,087.28	Bull. 569
Ogden, 1.5 miles north by 1.8 miles east of, T. 84 N., R. 27 W., south center of SE. ¼ sec. 21, center of road forks south; chiseled square on top of corner stone, marked "1088.5"	1,087.56	Bull. 569
Ogden, 0.5 mile north by 2 miles east of, T. 84 N., R. 27 W., SW. cor. sec. 27, on east side of north-south road at T road west, near telephone pole; iron post stamped "1064"	1,063.191	Bull. 569
Ogden, T. 84 N., R. 27 W., SE. cor. sec. 33 (near), SW. cor. crossroads; chiseled square on top of west end of concrete drain under road south, marked "1081"	1,080.10	Bull. 569
Ogden, 1.5 miles south by 2 miles east of, T. 83 N., R. 27 W., SE. cor. sec. 4, in NW. cor. T road north, SE. cor. schoolhouse yard; iron post stamped "1082"	1,081.348	Bull. 569
Olaf	1235,G1227	M&StL
Olds	737,G731	M&StL
Olin	755,G757	CM&StP
Olivet	803,G817	CRI&P

Station	Elevation feet	Authority
Olivet, T. 75 N., R. 17 W., 0.25 mile north of quarter corner on south side of sec. 12, at railway crossing; top of rail	810.53	Bull. 569
Olivet, T. 75 N., R. 17 W., near quarter corner on east side of sec. 11, railway crossing; top of rail	817.51	Bull. 569
Ollie	789,G782	M&StL
Olmitz, 2.5 miles north by 3.5 miles east of, T. 73 N., Rs. 19 and 20 W., 18 feet west of the corner of secs. 18, 19, 13, and 24, respectively, on line between Lucas and Monroe counties, in timber west of ravine, at corner of abandoned elbow road; iron post stamped ''Iowa 842, 1913''	842.197	Bull. 569
Olmitz, T. 73 N., R. 20 W., sec. 23, 0.25 mile north of quarter corner east side of, in SW. angle T road west, 16 inches west of corner post, in peg; copper nail	791.34	Bull. 569
Olmitz, T. 73 N., R. 20 W., sec. 22, 0.25 mile north by 0.25 mile east of center of, in SW. angle T road south, 4 feet west of corner post; iron post stamped ''Iowa 986, 1913''; 0.5 mile north by 0.5 mile east of Tipperary, ''Prim. Trav. Sta. No. 13''	986.636	Bull. 569
Olmitz, T. 73 N., R. 20 W., sec. 22, 0.25 mile north of quarter corner on west side of, 120 feet east of center of crossroads, in NW. cor. bridge floor; top of bolthead painted white	912.44	Bull. 569
Olmitz, T. 73 N., R. 20 W., sec. 20, NE. of center, at crossroads, 1 foot north of H. M. Taylor's mail box and mile board ''Chariton 12, Belinda 3 miles,'' in top of peg; copper nail	957.14	Bull. 569
Olmitz, T. 73 N., R. 20 W., 0.25 mile north of quarter corner on east side of sec. 30, in SW. angle of crossroads, 3 feet east of corner post, in top of peg; copper nail	984.43	Bull. 569
Olmitz, T. 73 N., R. 20 W., NW. cor. sec. 32, at crossroads, in NE. cor. bridge floor; copper nail in plank	919.31	Bull. 569
Olmitz, T. 73 N., R. 20 W., about 0.35 mile east of center of sec. 32, in NE. angle of T road at road forks, 430 feet north of bridge over North Cedar creek, 3 feet SE. of mail box, in top of peg; copper nail	839.52	Bull. 569
Olmitz, T. 72 N., R. 20 W., near quarter corner on east side of sec. 5, in NE. angle of road forks, 4 feet north of pasture gate (Baker's ranch); iron post stamped ''Iowa 997, 1913''	996.704	Bull. 569
Olmitz, T. 72 N., R. 20 W., near SE. cor. sec. 5, at T road south, 25 feet east by 15 feet north of center of road junction, in root of 8-inch hickory tree; copper nail	1,012.93	Bull. 569
Olmitz, T. 72 N., R. 20 W., in SW. cor. sec. 9, in NE. angle of T road north, top of concrete wing wall of culvert; bottom of chiseled square	989.95	Bull. 569
Olmitz, T. 72 N., R. 20 W., at SE. cor. sec. 7, on north side of road forks, 60 feet west of steel highway bridge over creek, 30 feet north of road junction; iron post stamped ''Iowa 880, 1913''	880.422	Bull. 569
Omaha, Nebr., in SE. cor. post-office building at Fifteenth and Dodge Sts.; top of small projection on top surface of third course of stone above sidewalk (U.S.C.E. city b.m.)	1,040.969	Bull. 569
Omaha, Nebr., on upper surface of water table of post-office building, cor. Fifteenth and Dodge Sts., 5.71 feet east of SW. cor. building; copper bolt in stone (U.S.C.E. p.b.m. 344)	1,039.932	Bull. 569
Omaha, Nebr., in top of pedestal block supporting first iron post on north side and west of cylindrical piers at west		

Station	Elevation feet	Authority
end of Omaha and Council Bluffs wagon bridge; top of copper bolt in stone (U.S.C.E.p.b.m. 345)	981.478	Bull. 569
Omaha, Nebr., 59 feet south of south cylindrical pier next to river, 137 feet southeast of south cylindrical pier next to approach abutment at west end of UP Ry bridge over Missouri river, 39 feet east of east switch track of CB&Q Ry; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 346 equals gage b.m.):		
Copper bolt	971.645	Bull. 569
Cap on pipe	975.612	
Omaha, Nebr., near, 3,976 feet east of east portal of UP Ry bridge over Missouri river, midway between two tracks of UP Ry; cross cut on top of stone post (U.S. C.E.t.b.m. 804)	1,005.933	Bull. 569
Omaha, East Junction	983	IC
Omaha, South Junction	980	IC
O'Malley	936.15	DM&CI
Onawa	1052,G1052	IC
Onawa, crossing C&NW	1052,G1052	IC
Onawa	1051,G1051	C&NW
Onawa, in NE. ¼ sec. 4, T. 83 N., R. 46 W., on north side of road along south side of quarter, 0.25 mile west of SE. cor. of quarter; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 135/2):		
Copper bolt	1,051.58	Bull. 569
Cap on pipe	1,055.65	
Onawa, T. 84 N., R. 46 W., 760 feet west of cor. secs. 25, 26, 35 and 36, on south side of road, on premises of Oscar Tuttle; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 135/3):		
Copper bolt	1,049.00	Bull. 569
Cap on pipe	1,053.05	
Onawa, 4 miles south of, 44 feet east of railway, on line with south side of E. S. Cody's farmhouse, 259 feet east of same; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E. p.b.m. 375):		
Copper bolt	1,042.268	Bull. 569
Cap on pipe	1,046.291	
Onawa, 2.2 miles south of, 1,585 feet south of milepost 37, 1,056 feet south of east-west road crossing, 45 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 376):		
Copper bolt	1,044.512	Bull. 569
Cap on pipe	1,048.535	
Onawa, at Iowa Ave. entrance of courthouse, 1.12 feet from face of sill, 0.43 foot from west jamb; copper bolt in west end of stone doorsill (U.S.C.E.p.b.m. 377)	1,052.436	Bull. 569
Onawa, in NW. cor. German Lutheran churchyard, corner Granite and Maple Sts., 3 feet from alley fence, 3 feet from SW. cor. of a stable; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 378 equals 134/3):		
Copper bolt	1,047.662	Bull. 569
Cap on pipe	1,051.727	
Onawa, 2.2 miles north of, 810 feet north of milepost 41, 180 feet north of north end of railway bridge 40, 44 feet east of C&NW track; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 379):		
Copper bolt	1,048.252	Bull. 569
Cap on pipe	1,052.252	
Onawa Junction, new	1186	IC
Onawa Junction, old location	1218,G1213	IC

Station	Elevation feet	Authority
Oneida	1047	CM&StP
Oneida, crossing CGW	1047,G1048	CM&StP
Oneida	1050.2,G1049	CGW
Oneida, crossing CM&StP	1051,G1051	CGW
Oneida, crossing M&O	1047,G1048	CM&StP
Onslow	918,G907	C&NW
Ontario	1002,G1001	C&NW
Ontario, south edge of, T. 84 N., R. 24 W., SW. cor. sec. 32, in NE. corner of road forks at road north; copper nail in root of willow tree, marked "998.9"	997.89	Bull. 569
Ontario, just east of station, at C&NW Ry crossing; top of south rail	1,000.6	Bull. 569
Ontario, 0.5 mile north of, T. 84 N., R. 24 W., west center of sec. 32, east side of north-south road at T road west; copper nail in base of butternut tree, marked "992.96"	991.99	Bull. 569
Ontario, highway bridge over Onion creek, spike head in NW. cor. flooring	933.49	Bull. 569
Ontario, T. 84 N., R. 24 W., near NW. cor. sec. 29, north end of tile drain under private road east, on east side of north-south road; painted square on top of, marked "986.8"	985.79	Bull. 569
Ontario, T. 84 N., R. 24 W., east center of sec. 19, SW. cor. road at T road south, in base of 3-foot oak tree; copper nail, marked "953.0"	951.98	Bull. 569
Ontario, T. 84 N., R. 24 W., center of sec. 19, center of T road north at schoolhouse; painted square cut in top of stone corner, marked "994.2"	993.18	Bull. 569
Oralabor	965	FtDDM&S
Oralabor	966,G970	C&NW
Oran	1043.6	CGW
Orange City	1411,G1412	C&NW
Orchard	1093,G1090	IC
Orient	1346,G1344	CB&Q
Orient, SE. ¼ sec. 16, T. 74 N., R. 30 W.	1312	IaGS
Orient, SE. ¼ sec. 1, T. 74 N., R. 30 W.	1079	IaGS
Orillia	969.4,G964	CGW
Orleans	1415	CRI&P
Orrton, M.P. 487	1019,G1014	IC
Orson	1036	C&NW
Ortonville	1040,G1041	CM&StP
Ortonville, 30 feet SE. of quarter corner north side of sec. 35, T. 79 N., R. 27 W., 4 feet south of corner fence post; iron post stamped "1037"	1,035.985	Bull. 569
Osage	1171.8,G1169	CGW
Osage, crossing IC	G1168	CGW
Osage	1172	IC
Osage, crossing CGW	1172	IC
Osage	G1184	Weather Bur.
Osborne, Clayton county	751,G750	CM&StP
Osborne, at CM&StP Ry crossing; top of rail	753.0	Bull. 569
Osceola, main line	1137,G1137	CB&Q
Osceola, Des Moines line	1141.7	CB&Q
Osceola	G1132	Weather Bur.
Osceola, base of Hertha limestone NW. cor. sec. 6, T. 72 N., R. 25 W.	1012	IaGS
Osgood	1235	CRI&P
Oskaloosa—Subgrade of track opposite center of depot	825.5	CRI&P
Oskaloosa, crossing CB&Q	823	CRI&P
Oskaloosa, crossing M&StL	803	CRI&P
Oskaloosa	832.5	CB&Q
Oskaloosa, crossing CRI&P	824	CB&Q
Oskaloosa, crossing M&StL	836	CB&Q

Station	Elevation feet	Authority
Oskaloosa	845,G838	M&StL
Oskaloosa, crossing over CRI&P	840	M&StL
Oskaloosa, crossing CRI&P track	819	M&StL
Oskaloosa, crossing CB&Q	849	M&StL
Oskaloosa	G843	Weather Bur.
Ossian	1266	CM&StP
Ossian, crossing CRI&P	1255,G1260	CM&StP
Ossian	1267,G1271	CRI&P
Ossian, crossing CM&StP	1256	CRI&P
Ossian, sec. 11, T. 96 N., R. 8 W., at Catholic Church, east side of north-south road, north side of east-west road; iron post stamped ''1263 DBQ''	1,263.219	Bull. 569
Osterdock	636,G635	CM&StP
Otero	780	CRI&P
Otho	1131,G1132	M&StL
Otis	721	C&NW
Otley, B.M. top of monument M.P. 323	879.74	CRI&P
Otley, B.M. top of monument M.P. 324	887.98	CRI&P
Otley, B.M. top of monument M.P. 325	896.54	CRI&P
Otley, B.M. top of monument M.P. 326	896.53	CRI&P
Otley, top of rail, center of depot	896.2,G893	CRI&P
Otley, B.M. top of monument M.P. 327	906.12	CRI&P
Otley, B.M. top of monument M.P. 328	892.38	CRI&P
Otley, T. 77 N., R. 19 W., SW. cor. sec. 14, T corner; corner stone in center of road	887.55	Bull. 569
Otley, T. 76 N., R. 19 W., SE. cor. sec. 13, in north root of large cottonwood tree at end of road; 40-penny nail	902.02	Bull. 569
Otley, T. 77 N., R. 18 W., 0.5 mile north of SE. cor. sec. 18, south side of east and west road, in north root of 10-inch soft-maple tree; 40-penny nail	873.02	Bull. 569
Otley, T. 77 N., R. 18 W., 0.5 mile north of NE. cor. sec. 17, on east side of north and south road, in SW. root of soft-maple tree 30 inches in diameter, T corner; 40-penny nail	853.82	Bull. 569
Otley, T. 77 N., R. 18 W., SE. cor. sec. 17, in SE. cor. Bethel Church yard, 35 feet SE. of front entrance of church; iron post stamped ''860 Iowa''	858.727	Bull. 569
Otley, T. 77 N., R. 19 W., 0.5 mile south of NW. cor. sec. 9, at T road corner, east of north and south road, near residence of Arie Vriezelaar, in line with center of east and west road, 3 feet west of fence; iron post stamped ''905 Iowa''	903.700	Bull. 569
Otley, south side of main street, T. 77 N., R. 19 W., 0.38 mile west of NE. cor. sec. 22, at T road near east edge of village, 15 feet north of fence line, 425 feet east of railroad; iron post stamped ''884 Iowa''	882.641	Bull. 569
Otley, in front of CRI&P Ry station; top of rail	896.0	Bull. 569
Otley, T. 77 N., R. 19 W., 0.25 mile north of SW. cor. sec. 25, south of Pella-Otley road, 24 feet east and 20 feet south of center of crossroads, 2 feet north of fence; iron post stamped ''883 Iowa''	881.652	Bull. 569
Oto	1092,G1095	IC
Otranto	1169,G1172	CM&StP
Otter Creek, Jackson Co.	1025	USGS
Otter Creek, middle Otter Creek Tp.	800	USGS
Otter Creek, NE. cor. Otter Creek Tp.	1080	USGS
Otter Creek, middle north side sec. 4, Otter Creek Tp.	1050	USGS
Ottosen	1165	CRI&P
Ottumwa	643,G649	CB&Q
Ottumwa	648,G648	CM&StP
Ottumwa, crossing CB&Q	G650	CM&StP
Ottumwa, crossing Wabash	648,G651	CM&StP

Station	Elevation feet	Authority
Ottumwa, crossing CRI&P	G650	CM&StP
Ottumwa	G649	Weather Bur.
Ottumwa, NW. cor. topmost stone on east end of north abutment of Vine St. highway bridge (U.S.C.E.b.m. 48)	644.66	Bull. 569
Ottumwa, above, on top and 0.5 foot from point of south end of concrete pier under east end of first girder from west end of CB&Q bridge, pier is first one east of west abutment (U.S.C.E.b.m. 79)	653.67	Bull. 569
Ottumwa, in top of west tube of second pier south of north or left bank, Blackhawk highway bridge (U.S. C.E.b.m. 80)	649.15	Bull. 569
Ottumwa, bottom of upstream end of third cross beam from south end of Market St. bridge (U.S.C.E.b.m. 82)	643.32	Bull. 569
Ottumwa, top of west side of second pier south of north or left bank of river, CM&StP bridge (U.S.C.E.b.m. 81)	645.82	Bull. 569
Ottumwa, bottom of downstream or east girder in south span of Wabash RR bridge (U.S.C.E.b.m. 83)	646.75	Bull. 569
Ottumwa, bottom of east side of first transverse beam south of fourth tubular pier from north end of Vine St. highway bridge (U.S.C.E.b.m. 84)	643.53	Bull. 569
Ottumwa, NW. cor. west wing of north abutment of Vine St. highway bridge (U.S.C.E.b.m. 85)	644.54	Bull. 569
Ottumwa, B.M. top of monument M.P. 74 (U.S.C.E.b.m. 47)	642.53	CRI&P
Ottumwa, B.M. top of watertable SW. cor. Leisy Brewing Co.	649.86	CRI&P
Ottumwa, top of rail, center Union Depot	645.2	CRI&P
Ottumwa, B.M. top of monument M.P. 77	650.81	CRI&P
Ottumwa, B.M. top of monument M.P. 78	648.90	CRI&P
Ottumwa, B.M. top of monument M.P. 79	650.31	CRI&P
Ottumwa, B.M. top of monument M.P. 80	654.29	CRI&P
Ottumwa, East	647	CB&Q
Ottumwa, South	640	WRR
Ottumwa Junction	645	CM&StP
Ottumwa Junction, crossing CB&Q and CRI&P	647	CM&StP
Owasa	1097	C&NW
Owego	1070,G1073	CM&StP
Oxford	736,G739	CRI&P
Oxford Junction, main line	722	CM&StP
Oxford Junction, Monticello line	727,G727	CM&StP
Oxford Mills, M.P. 24	725,G713	CM&StP
Oyens	1272,G1267	IC
Ozark, Jackson Co.	728	USGS
Pacific Junction	956,G957	CB&Q
Pacific Junction, 1.5 miles southwest of, on land owned by Charles Kroon, 32 feet east by 51 feet south of NW. cor. NE. ¼ NE. ¼ sec. 32, T. 72 N., R. 42 W.; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E. p.b.m. 336 equals 117/3):		
Copper bolt	949.519	Bull. 569
Cap on pipe	953.538	
Pacific Junction, 4,455 feet north of railway crossing at, 1,151 feet south of railway bridge over old channel of Keg creek, 43 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E. p.b.m. 337):		
Copper bolt	954.883	Bull. 569
Cap on pipe	958.896	
Pacific Junction, T. 72 N., R. 43 W., 40 feet south by 128 feet east of NW. cor. sec. 31, on south side of east-west road, in dooryard of Mrs. Lizzie Smith; copper bolt in		

Station	Elevation feet	Authority
tile surmounted by iron pipe (U.S.C.E.b.m. 117/2):		
Copper bolt	951.94	Bull. 569
Cap on pipe	955.99	
Pacific Junction, T. 72 N., R. 44 W., 1,010 feet south of NE. cor. sec. 12, on land owned by Alvin Lincoln, 1.25 miles from river, on west side of north-south road; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 118/2):		
Copper bolt	952.93	Bull. 569
Cap on pipe	956.99	
Packard	958,G953	CRI&P
Packwood	801.8	CB&Q
Page Center	1202.5,G1193	CB&Q
Palisades, top of rail, center line of overhead bridge on east line sec. 2, Tp. 82, R. 6, 345 feet north of NE. cor. of SE. ¼ of SE. ¼ sec. 2	776.91	CR&IC
Palisades, top of rail on east line sec. 12, Tp. 82, R. 6, 670 feet south of NE. cor. sec. 12	786.21	CR&IC
Palmer	1246,G1244	CRI&P
Palo	747,G751	CRI&P
Palsville	1243.2	CGW
Panama	1248,G1251	CM&StP
Panora	1055,G1058	CM&StP
Paralta	827,G829	CM&StP
Paralta, junction switch	G828	CM&StP
Paris	929,G944	CRI&P
Parkersburg	949,G951	IC
Parkersburg, crossing C&NW	G960	IC
Parkersburg	947	C&NW
Parkersburg, crossing over IC	960	C&NW
Parnell	854,G859	CM&StP
Paton	1106,G1101	M&StL
Pattee	1002.99	DM&CI
Patterson	873,G879	CRI&P
Patterson, Middle river at	827	IaGS
Paullina	1405,G1408	C&NW
Payne	928.7	CB&Q
Payne, T. 67 N., R. 42 W., near cor. secs. 7, 8, 17 and 18, at NW. cor. inclosed pasture about 600 feet S. 6¾° (mag.) E. from house owned by Moses Payne; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 110/3):		
Copper bolt	903.86	Bull. 569
Cap on pipe	907.93	
Pekay Junction	707,G699	M&StL
Pekin	808	CB&Q
Pella, B.M. top of monument M.P. 314	820.49	CRI&P
Pella, B.M. top of monument M.P. 315	860.63	CRI&P
Pella, B.M. top of monument M.P. 316	865.54	CRI&P
Pella, B.M. top of monument M.P. 317	874.89	CRI&P
Pella, top of rail, center of depot, Bul. 569, elev.=878.0	878.5,G877	CRI&P
Pella, B.M. NW. cor. water table of depot	879.80	CRI&P
Pella, B.M. top of monument M.P. 319	878.98	CRI&P
Pella, B.M. top of monument M.P. 320	880.61	CRI&P
Pella, B.M. top of monument M.P. 321	873.51	CRI&P
Pella, B.M. top of monument M.P. 322	875.54	CRI&P
Pella, T. 76 N., R. 17 W., 0.5 mile south of NW. cor. sec. 18, on east side of highway, 70 feet north of CRI&P Ry track, 12 feet east of center of highway; iron post stamped "856 Iowa"	854.548	Bull. 569
Pella, T. 76 N., R. 18 W., near NE. cor. sec. 14, center of roadway, railway crossing, south rail	870.7	Bull. 569

Station	Elevation feet	Authority
Pella, T. 77 N., R. 18 W., 0.25 mile south of NE. cor. sec. 14, 170 feet east of T corner, in north root of large cotton wood tree; 40-penny nail	806.50	Bull. 569
Pella, T. 77 N., R. 18 W., 0.25 mile west of NE. cor. sec. 13, west side of north and south road, opposite stone house, in east root of maple tree 20 inches in diameter; 40-penny nail	757.88	Bull. 569
Pella, T. 77 N., R. 18 W., 0.3 mile east by 0.2 mile south of NW. cor. sec. 22, T corner, in telephone post; three 40-penny nails	865.33	Bull. 569
Pella, T. 77 N., R. 18 W., 0.5 mile south by 0.3 mile west of NE. cor. sec. 23, west side of north and south road, 100 feet NW. of T corner, 24 feet NE. of large oak tree, 5 feet east of north and south fence; iron post	835.085	Bull. 569
Pella, opposite CRI&P Ry station; top of rail	878.0	Bull. 569
Pella, SE. cor. Central College campus; iron post stamped ''878 Iowa''	876.843	Bull. 569
Pella, T. 76 N., R. 18 W., 0.5 mile south of SE. cor. sec. 9, in telephone post; three 40-penny nails	853.92	Bull. 569
Pella, T. 76 N., R. 18 W., 0.3 mile west of SE. cor. sec. 9, T corner, on highest point of large rock near corner fence post; painted square	815.10	Bull. 569
Peoria, Mahaska Co., T. 77 N., R. 17 W., 0.3 mile south of sec. 7, on projecting knob of fence post, T corner; painted square	751.64	Bull. 569
Peoria, T. 77 N., R. 17 W., 0.3 mile north of SE. cor. sec. 8, on south side of east and west road, on bank, 18 feet east of corner fence post; iron post stamped ''806 Iowa''	804.856	Bull. 569
Peoria, T. 77 N., R. 17 W., 0.3 mile north by 0.2 mile west of SE. cor. sec. 9, in base of corner fence post; three 40-penny nails	843.72	Bull. 569
Peoria, T. 77 N., R. 17 W., 0.3 mile east of SW. cor. sec. 10, on stone 15 feet NW. of intersection of roads; painted square	820.35	Bull. 569
Peoria, T. 77 N., R. 17 W., SE. cor. sec. 10, in corner fence post; three 40-penny nails	857.35	Bull. 569
Peoria, T. 77 N., R. 17 W., 0.5 mile north by 0.3 mile east of SW. cor. sec. 14, in root of hickory tree; 40-penny nail	863.22	Bull. 569
Peoria, T. 77 N., R. 17 W., 0.5 mile north of SE. cor. sec. 14, on north side of east and west road, 60 feet NW. of intersection of roads, 3 feet south of east and west fence; iron post stamped ''875 Iowa''	873.856	Bull. 569
Peoria, T. 77 N., R. 17 W., 0.3 mile south by 0.2 mile west of NE. cor. sec. 23, in corner fence post; three 40-penny nails	854.24	Bull. 569
Peoria, T. 77 N., R. 17 W., 0.5 mile west of NE. cor. sec. 25, in fence post at corner, T corner; three 40-penny nails	857.79	Bull. 569
Peoria, T. 77 N., R. 17 W., 0.5 mile east of SW. cor. sec. 25, in corner fence post, T corner; three 40-penny nails	798.68	Bull. 569
Peoria, T. 77 N., R. 17 W., 0.5 mile south by 0.3 mile east of NW. cor. sec. 36, 15 feet east of center of north and south road, 50 feet north of east and west road, 18 feet north of corner fence post, 3 feet west of north and south fence; iron post stamped ''742 Iowa''	740.216	Bull. 569
Peoria, T. 77 N., R. 17 W., 0.3 mile west of SE. cor. sec. 36, at intersection of roads, in south root of 30-inch elm tree; three 40-penny nails	844.29	Bull. 569
Peosta	1036,G1036	IC
Peosta, 25 feet NW. of IC RR station, sec. 9, T. 88 N., R.		

Station	Elevation feet	Authority
1 E., 50 feet north of main track, beside wagon road; iron post stamped "1051"	1,041.585	Bull. 569
Percival	938,G934	CB&Q
Percival, 3 miles south of station, 13 feet north of farm gate, 627 feet north of road crossing, 45 feet east of railroad; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 328):		
Copper bolt	920.162	Bull. 569
Cap on pipe	924.181	
Percival, 784 feet north of center of station, 46 feet east of tracks; copper bolt in bench-mark stone (U.S.C.E. p.b.m. 329):		
Copper bolt	926.192	Bull. 569
Cap on pipe	930.221	
Percival, T. 68 N., R. 44 W., in NE. ¼ sec. 1, 665 feet south of north line of the quarter, 500 feet east of west line of the quarter, 610 feet south of house of Paul Heinlin, on left bank, on west side of north-south road; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 112/2):		
Copper bolt	925.43	Bull. 569
Cap on pipe	929.50	
Percival, T. 69 N., R. 44 W., 667 feet west of NE. cor. NW. ¼ sec. 30, in yard of Delos Williams, 75 feet south of east-west road; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 113/2):		
Copper bolt	928.50	Bull. 569
Cap on pipe	932.57	
Percival, T. 69 N., R. 43 W., in NE. cor. sec. 30, in dooryard of F. E. Wadhams; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 113/3):		
Copper bolt	928.93	Bull. 569
Cap on pipe	933.00	
Percy	750	WRR
Percy, 1.5 miles west of, 100 feet west of road, in south part of W. C. Wilson's yard, 1 foot north of Wabash RR fence at crossing south to highway bridge over Des Moines river, in top of concrete post, bronze tablet stamped "Prim. Trav. Sta. 24 LS 1904 IA (reset 1924)	772.989	USGS
Percy, 2 miles below, in root of twin 8-inch hackberry tree on fence line, 15 feet from bank of river, 15 feet east of small house owned by fishing club on land of J. Gould; 20d. nail in bench cut (U.S.C.E.b.m. 60)	741.44	Bull. 569
Percy, T. 77 N., R. 21 W., 0.25 mile west of NE. cor. sec. 13, T road corner, 15 feet west and 60 feet south of center of crossroads, 1 foot east of fence; iron post stamped "825 Iowa"	823.338	Bull. 569
Percy, see also Bennington		
Perkins	1458	GN
Perkins, crossing over CM&StP	1452	GN
Perkins, CM&StP track	1427	GN
Perkins	1427	CM&StP
Perkins, crossing under GN	1427,G1431	CM&StP
Perkins, crossing, GN track	1455,G1455	CM&StP
Perlee	673,G679	CRI&P
Perry	966,G961	M&StL
Perry, crossing CM&StP	G961	M&StL
Perry	949.37	DM&CI
Perry, crossing M&StL	962.80	DM&CI
Perry	965,G967	CM&StP
Perry, crossing M&StL	959	CM&StP
Perry, South	947.84	DM&CI

Station	Elevation feet	Authority
Pershing	956	CRI&P
Persia	1166,G1167	CM&StP
Peru	944.9,G939	CGW
Petersburg	1033.4	CGW
Petersburg, T. 90 N., R. 3 W., quarter corner east side of sec. 28, southeast corner of schoolhouse yard; iron post stamped "1090 DBQ"	1,091.140	Bull. 569
Peterson	1236,G1238	C&NW
Petersville	715	C&NW
Pickering	971,G984	CM&StP
Pickering, crossing under M&StL	G984	CM&StP
Pickering, crossing, M&StL track	G1006	CM&StP
Pickering	1018	M&StL
Pierson	1268,G1268	C&NW
Pilot Grove	643	CB&Q
Pilot Knob, Hancock county	1450	IaGS
Pilot Mound, Boone county	1109,G1109	M&StL
Pilot Mound, 1 mile east by 1.2 miles north of, T. 85 N., R. 27 W., east center of SE. ¼ sec. 9, NW. cor. crossroads; copper nail in base of corner fence post, marked "1159.1"	1,158.17	Bull.569
Pilot Mound, 1 mile east of, T. 86 N., R. 27 W., SW. cor. sec. 15, NE. cor. road forks north, at fence corner; iron post stamped "1121"	1,120.316	Bull.569
Pilot Mound, 4 miles south by 1 mile east of, T. 86 N., R. 27 W., NW. cor. sec. 10, SE. cor. road forks south, NW. cor. schoolhouse yard; iron post stamped "1119"	1,118.017	Bull.569
Pilot Mound, 4 miles north of, T. 86 N., R. 27 W., NE. cor. sec. 32, 60 feet SW. of center of crossroads, on west side of road; copper nail in root of 3-foot cottonwood tree, marked "1133.9"	1,132.95	Bull.569
Pilot Mound, 2.8 miles north of, T. 85 N., R. 27 W., north center of SW. ¼ sec. 4, SE. cor. crossroads; copper nail in base of telephone pole, marked "1140.0"	1,139.09	Bull.569
Pilot Mound, 1.5 miles northeast of, T. 85 N., R. 27 W., near center of SW. ¼ sec. 9, SE. cor. road forks east, south end of drain under road to east, 50 feet east of center of road forks; chiseled square on top of stone, marked "1140.7"	1,139.74	Bull.569
Pilot Mound, northeast edge of, T. 85 N., R. 27 W., SW. cor. sec. 16, NE. cor. crossroads; copper nail in base of telephone pole, marked "1110.3"	1,109.32	Bull.569
Pilot Mound, T. 85 N., R. 27 W., 0.2 mile north of SW. cor. sec. 21, bend in road to SE., north side of mound, east side of road, 15 feet north of fence corner; nail in top of stake in ground at fence post, marked "1124.9"	1,123.94	Bull.569
Pilot Mound, 1 mile south of, T. 85 N., R. 27 W., 0.1 mile east of SW. cor. sec. 21, in center of road forks at T road north; chiseled square on top of stone, marked "1127.7"	1,126.77	Bull.569
Pilot Mound, 2.2 miles south of, T. 85 N., R. 27 W., north center of NW. ¼ sec. 33, SE. cor. crossroads; chiseled square on top of stone on south side of east road, marked "1122.6"	1,121.67	Bull.569
Pilot Mound, T. 84 N., R. 27 W., north center of NW. ¼ sec. 4, on line between townships Pilot Mound and Yell, SW. cor. road forks at T road west; copper nail in top of south end of plank drain under road west, marked "1101.5"	1,100.60	Bull.569
Pilot Mound, T. 84 N., R. 27 W., south center of SW. ¼ sec. 4, NW. cor. road forks north; copper nail in base of telephone pole, marked "1110.0"	1,109.09	Bull.569

Station	Elevation feet	Authority
Pilot Mound (the hill)	1220	IaGS
Pinney (Union Park), top of rail on south line sec. 5, Tp. 82, R. 7, 2075 feet west of SE. cor. sec. 5	755.80	CR&IC
Pioneer	1190,G1170	M&StL
Pioneer, T. 90 N., R. 29 W., 250 feet north of quarter cor. between secs. 3 and 10, in SE. cor. of Mary L. Schuster's yard, in root of cottonwood tree (15 inches diameter); nail in washer T.B.M. "1,148.5"	1,148.22	USGS
Pioneer, T. 90 N., R. 29 W., center of sec. 10, 20 feet NE. of crossroads; iron post stamped "Iowa 1919, Prim. Trav. Sta. No. 9, 1,134"	1,133.441	USGS
Piper	1193	FtDDM&S
Pisgah	1060	C&NW
Pittsburg highway bridge, Van Buren Co., on top stone at angle in abutment, on south end of east abutment; cross mark (U.S.C.E.b.m. 31)	593.36	Bull. 569
Plainfield	944,G942	IC
Plano	1025,G1030	CB&Q
Plato	704,G703	CRI&P
Pleasant Creek	600,G603	CM&StP
Pleasanton	1088	CB&Q
Pleasant Prairie	778.87	CD&M
Pleasant Valley	590.31	CD&M
Pleasant Valley	G582	DRI&NW
Pleasant Valley, DRI&NW station	589	CB&Q
Pleasant Valley, DRI&NW station	592	CM&StP
Pleasantville	925.2,G926	CB&Q
Pleasantville, 0.75 mile SE. of, 230 feet NW. of road crossing, in top of east end of railroad culvert; Prim. Trav. Sta. No. 3; aluminum tablet stamped "882 Adj."	880.347	Bull. 569
Pleasantville, in front of station; top of rail	926.4	Bull. 569
Pleasantville, T. 76 N., R. 21 W., 0.5 mile south of NW. cor. sec. 14, at NE. angle crossroads, on stone; painted cross	915.76	Bull. 569
Pleasantville, T. 76 N., R. 20 W., center of sec. 18, north of east and west road, 25 feet west of corner fence post, 1 foot south of fence; iron post stamped "913 Iowa"	911.782	Bull. 569
Pleasantville, T. 76 N., R. 20 W., 0.5 mile south of NE. cor. sec. 18, in center of road, in root of white-elm tree 32 inches in diameter; nail	907.98	Bull. 569
Plessis	1522,G1520	CRI&P
Plover	1210,G1190	M&StL
Plum Creek	1177	C&NW
Plymouth	1125,G1128	CM&StP
Plymouth Junction	1125	CM&StP
Plymouth Junction, crossing CRI&P	1125	CM&StP
Plymouth Junction	1127,G1126	CRI&P
Plymouth Junction, crossing CM&StP	1127,G1126	CRI&P
Pocahontas	1227,G1222	CRI&P
Polk City	852	C&NW
Polk City, T. 80 N., R. 24 W., NE. ¼ SW. ¼ sec. 18, 150 feet west of road fork, Corydon Bridge; iron post stamped "850 Adj 1903"	848.913	Bull. 569
Polk City, Corydon Bridge, 1 mile west of, about center of sec. 14, T. 80 N., R. 25 W., 40 feet west of center of road, in A. L. Frazer's yard; iron post stamped "950 Adj 1903"	948.972	Bull. 569
Polk City, T. 81 N., Rs. 24 and 25 W., between secs. 1 and 6; spike in telephone pole, marked "U.S.B.M. 879"	878.22	Bull. 569
Polk City, in front of C&NW Ry station, top of rail	850.6	Bull. 569
Polk City, T. 80 N., R. 25 W., near NW. cor. sec. 12, north		

STATION	ELEVATION FEET	AUTHORITY
side of road at three corners; spike in telephone pole, marked "U.S.B.M. 906"	904.43	Bull. 569
Polk City, in NW. cor. front face of Polk City Savings Bank; aluminum tablet stamped "890"	888.624	Bull. 569
Polk City, T. 81 N., R. 25 W., SE. cor. NW. ¼ sec. 36, at three corners, road to west; top of rock marked "U.S.□ B.M. 916"	914.41	Bull. 569
Polk City, T. 81 N., R. 25 W., 450 feet north of NW. cor. sec. 25, on west side of road; spike in telephone pole, marked "U.S.B.M. 931"	931.14	Bull. 569
Polk City, T. 81 N., R. 25 W., NE. cor. sec. 23; iron post stamped "956"	954.557	Bull. 569
Polk City Junction	951	C&NW
Pomeroy	1243,G1241	IC
Popejoy	1155	CRI&P
Port Allen	608,G612	CRI&P
Portland	1077,G1082	CM&StP
Port Louisa, Mississippi river, low water	G526	Miss. Riv. Com.
Port Louisa, Mississippi river, high water	G542	Miss. Riv. Com.
Port Louisa, on top of SE. cor. stone foundation of tall chimney of old sawmill (mill now torn down) (U.S.C.E. p.b.m. 24)	545.429	Bull. 569
Port Louisa landing, Louisa Co., 2.5 miles below, 842 meters back of bench mark 135/2, 16.6 meters 300° to 18-inch elm tree, 14.6 meters 201° to 15-inch elm tree, 2.2 meters 82° to 9-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 135/1):		
Copper bolt	532.01	Bull. 569
Cap on pipe	536.02	
Port Louisa landing, 2.5 miles below, 10 meters from river shore, 7.6 meters 73° to 18-inch elm tree, 11.6 meters 191° to 30-inch cottonwood tree, 13.2 meters 316° to 10-inch black-oak tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 135/2):		
Copper bolt	533.93	Bull. 569
Cap on pipe	537.96	
Port Louisa, Turkey Island, on, 8 meters from east shore, 13 meters 333° to 8-inch willow, 15 meters 76° to 18-inch maple tree, 10 meters 137° to 10-inch willow tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 135/3):		
Copper bolt	532.44	Bull. 569
Cap on pipe	536.45	
Port Louisa landing, 2.5 miles below, on main shore, 10 meters from river bank, 18 meters 301° to 36-inch elm tree, 8.5 meters 126° to 48-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 135/4):		
Copper bolt	533.78	Bull. 569
Cap on pipe	537.79	
Port Louisa, in woods opposite, 279 meters from river, 11 meters west of slough, 45 meters above junction with another slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 136/1):		
Copper bolt	533.44	Bull. 569
Cap on pipe	537.46	
Port Louisa, 35 meters from shore in small open timber opposite, directly opposite foot of small towhead, 8.7 meters 18° to 30-inch elm tree, 4 meters 137° to 8-inch triple elm, 4 meters 200° to 12-inch elm tree; copper		

Station	Elevation feet	Authority
bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 136/2):		
Copper bolt	534.10	Bull. 569
Cap on pipe	538.11	
Port Louisa, in open spot at corner of roads on line of road running back from Port Louisa to the bluffs, on point where old house once stood, east of bridge over Muscatine Slough, 23 meters south of fence and 19 meters west of another fence; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 136/3):		
Copper bolt	537.03	Bull. 569
Cap on pipe	541.03	
Port Louisa, on line of wire fence on south side of road running back from Port Louisa, 135 feet west of fence corner at bend in road; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 136/4):		
Copper bolt	536.18	Bull. 569
Cap on pipe	540.24	
Port Louisa, on clearing on Island 346, 0.25 mile above foot of island, 25 meters from bank of river, 70 meters from bank of Illinois Slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 137/2):		
Copper bolt	535.83	Bull. 569
Cap on pipe	539.85	
Port Louisa, 3 miles above, 40 meters from river bank, 18 meters east of wagon road, 5.4 meters 29° to 18-inch cottonwood, 21.6 meters 319° to 30-inch elm, 12.7 meters 242° to 15-inch locust, 5 meters from bank is a sycamore (48 inches in diameter) nearly in line with bench mark and elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 137/3):		
Copper bolt	538.11	Bull. 569
Cap on pipe	542.14	
Portsmouth	1197,G1200	CM&StP
Postville	1195,G1192	CRI&P
Postville	1194,G1198	CM&StP
Postville, T. 95 N., R. 6 W., NE. cor. sec. 16, in SE. cor. school yard; iron post stamped "1075 DBQ"	1,075.526	Bull. 569
Postville, in front face of Commercial House; aluminum tablet stamped "1195 DBQ"	1,194.516	Bull. 569
Postville, in front of CM&StP Ry station; top of rail	1,197.3	Bull. 569
Postville Junction	1058,G1062	CRI&P
Potter	857,G855	CM&StP
Potters Siding	1049.2	CGW
Prairie City, B.M. top of monument M.P. 339	925.37	CRI&P
Prairie City, B.M. top of monument M.P. 340	927.23	CRI&P
Prairie City, top of rail, center of depot	924.3,G930	CRI&P
Prairie City, B.M. top of monument M.P. 341	921.22	CRI&P
Prairie City, B.M. top of monument M.P. 342	920.59	CRI&P
Prairie City, B.M. top of monument M.P. 343	930.06	CRI&P
Prairie City, B.M. top of monument M.P. 344	935.19	CRI&P
Prairie City, T. 78 N., R. 21 W., at north cor. secs. 5 and 6, 30 feet south and 30 feet east of T road south, near cemetery, on concrete post; bronze tablet stamped "Prim. Trav. Sta. No. 25-L.S.-1924,Ia.", marked "932.4"	932.466	USGS
Prairie City. reference mark, 69 feet west of "L.S. No. 25", in SW. angle of T road south, top of concrete post; iron rod	933.02	USGS
Prairie City, T. 79 N., R. 21 W., at south corner of secs. 33 and 34, 32 feet north and 20 feet east of T road north,		

STATION	ELEVATION FEET	AUTHORITY
1 foot NE. of telephone pole; top of 0.5-inch gas pipe, marked "908.0"	908.08	USGS
Prairie City, T. 79 N., R. 21 W., at SE. cor. sec. 34 in NW. angle of T road north, top of concrete culvert under highway; chiseled square, marked "883.1"	883.14	USGS
Prairie City, CRI&P Ry, at crossing of road between secs. 3 and 35, Tps. 78 and 79 N., R. 21 W.; top of east rail	921.0	USGS
Prairie City, T. 79 N., R. 21 W., at SE. cor. sec. 35, 60 feet west and 30 feet north of T road north, in root on south side of 4-foot cottonwood tree; copper nail and washer, marked "924.4"	924.48	USGS
Prairie City, T. 79 N., R. 21 W., SW. cor. sec. 25, in SW. cor. Valley School grounds, 4 feet north and 8 feet east of large willow tree, on concrete post; bronze tablet stamped "Prim. Trav. Sta. No. 21-L.S.-1924-Ia." marked "847.3"	847.365	USGS
Prairie City, reference mark, 16 feet west and 8 feet north of "L.S. No. 21", in root on north side of 2-foot maple tree; copper nail and washer	846.96	USGS
Prairie City, T. 79 N., R. 21 W., near cor. secs. 23, 24, 25 and 26, 270 feet north and 25 feet west of crossroads, in root on north side of 2-foot maple tree; copper nail and washer, marked "872.7"	872.76	USGS
Prairie City, T. 78 N., R. 21 W., at cor. secs. 1 and 2, on north side of Prairie City, 3 blocks north and 1 block east of city square, 1 block west of junction of Colfax road with State Highway No. 2 (Federal Highway No. 63), 25 feet north and 20 feet east of street intersection, in root on SW. side of 3.5-foot maple tree; copper nail and washer, marked "929.4"	929.45	USGS
Prairie City, CRI&P Ry, at road crossing, 1 block east of city square; top of north rail	925.7	USGS
Prairie City, at SE. limits of, 750 feet south of CRI&P Ry, west side of north and south road, 130 feet north of T road east, 40 feet south of street west; top of end of tile; chiseled square, marked "911.5"	911.57	USGS
Prairie City, 1 mile south of, T. 78 N., R. 21 W., at corner of secs. 1, 2, 11 and 12, in NE. angle of crossroads, top of concrete wall at fence corner; chiseled square, marked "928.0"	928.04	USGS
Prairie City, 2 miles south of, T. 78 N., R. 21 W., at cor. secs. 11, 12, 13 and 14, 30 feet north and 30 feet east of crossroads, on concrete post; bronze tablet stamped "Prim. Trav. Sta. No. 22-L.S.-1924-Ia.", marked "885.0"	885.037	USGS
Prairie City, reference mark, 65 feet south of "L.S. No. 22", in root of south side of forked maple tree; copper nail and washer	888.63	USGS
Prairie City, 3 miles south of, T. 78 N., R. 21 W., 430 feet south of cor. secs. 13, 14, 23 and 24, 580 feet south of L. Roovaart's house, on west side of road, top of heading of concrete culvert; chiseled square, marked "846.7"	846.73	USGS
Prairie City, 4 miles south of, T. 78 N., R. 21 W., near cor. secs. 23, 24, 25 and 26, 70 feet east and 20 feet south of crossroads, in root on west side of 2-foot elm tree; copper nail and washer, marked "862.4"	862.46	USGS
Prairie City, 5 miles south of, T. 78 N., R. 21 W., at cor. secs. 25, 26, 35 and 36, 40 feet south and 20 feet east of crossroads, on concrete post; bronze tablet stamped "Prim. Trav. Sta. No. 23-L.S.-1924-Ia."	913.070	USGS
Prairie City, reference mark, 62 feet west and 8 feet south		

Station	Elevation feet	Authority
of L.S. No. 23, top of concrete curb around churchyard; chiseled square	913.78	USGS
Prairiesburg, Linn Co., T. 86 N., R. 5 W., NW. cor. sec. 10, opposite side of road from Stromburg's residence; iron post stamped "1013"	1,004.245	Bull. 569
Prairie View	906.04	DM&CI
Preparation	1084	C&NW
Prescott	1153,G1153	CB&Q
Preston	659,G660	CM&StP
Primghar	1504,G1498	IC
Princeton	603.18	CD&M
Princeton	G597	DRI&NW
Princeton, DRI&NW station	606	CM&StP
Princeton, DRI&NW station	603.9	CB&Q
Princeton, 1.5 miles below, on property of Adam McCoy, 1 meter from SE. cor., at junction of wagon roads, one running along river and the other on line between secs. 14 and 15, T. 79, R. 5 E., 30 meters from bank of river; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 155/3):		
Copper bolt	589.29	Bull. 569
Cap on pipe	593.32	
Princeton, 1 mile below, in NE. cor. footplate on NE. cor. iron bridge over Bud creek; bolt with battered top (U. S.C.E.t.b.m. 11 R. B)	580.27	Bull. 569
Princeton, cut in stone culvert near river near center of town (U.S.C.E. high-water mark of June 16, 1880)	580.95	Bull. 569
Princeton, 1 mile above, on bluff wagon road, 2 meters north of south road fence, 150 meters west of where road turns from river and runs west, 130 meters east of north-south road; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 156/3):		
Copper bolt	587.04	Bull. 569
Cap on pipe	591.07	
Princeton, 1.5 miles NW. of, 1 meter north of south fence on bluff wagon road, at dividing line between Mary and Chas. Pinneo, 100 meters toward river from brick house belonging to Pinneo, at east end of picket fence, copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 156/4):		
Copper bolt	587.00	Bull. 569
Cap on pipe	591.02	
Prole	979	CB&Q
Promise City	1052,G1065	CB&Q
Pulaski	838,G833	CB&Q
Purdy	924	CRI&P
Putledge	809	CRI&P
Quandahl, Allamakee Co., T. 99 N., R. 6 W., about 0.2 mile north of SE. cor. sec. 9, in NW. cor. school yard; iron post stamped "731 DBQ"	729.578	Bull. 569
Quarry	874	C&NW
Quilhart	940	CRI&P
Quimby	1190,G1190	IC
Quincy, Adams Co.	1260	IaGS
Racine	1144	CRI&P
Radcliffe	1189,G1194	C&NW
Radcliffe	1152	CRI&P
Radcliffe, crossing over C&NW	1158	CRI&P
Rake	1167,G1154	CRI&P
Raleigh	1440,G1441	M&StL
Ralston	1123	C&NW
Randalia, in front of CRI&P Ry station; top of rail	1,103.6	Bull. 569

STATION	ELEVATION FEET	AUTHORITY
Randalia, southeast cor. sec. 16, T. 93 N., R. 9 W.; iron post stamped "1128 DBQ"	1,129.082	Bull. 569
Randalia	1103	CRI&P
Randall	1024	C&NW
Randall, 5 miles west of, T. 86 N., R. 24 W., SW. cor. sec. 19, on line between Ellsworth and Clear Lake Tps., NE. cor. crossroads; copper nail in top of corner fence post, marked "1046.7"	1,045.48	Bull. 569
Randall, 4 miles west by 2 miles south of, T. 86 N., R. 24 W., SE. cor. sec. 31, NW. cor. crossroads; copper nail in top of post at end of drain under north road, marked "1019.7"	1,018.70	Bull. 569
Randall, 4 miles west by 0.1 mile south of, T. 86 N., R. 24 W., SE. cor. sec. 30, NW. cor. crossroads, 15 feet north of NW. fence corner; on road side of 1-foot soft-maple tree; copper nail in root, marked "1041.7"	1,040.63	Bull. 569
Randall, 4 miles west of, T. 86 N., R. 24 W., SE. cor. sec. 19, NW. cor. crossroads; iron post stamped "1056"	1,055.205	Bull. 569
Randall, 3 miles west of, T. 86 N., R. 24 W., NW. cor. sec. 28, SE. cor. crossroads, SW. cor. plank bridge floor, 60 feet east of center of crossroads; copper nail in top, marked "1036.0"	1,034.95	Bull. 569
Randall, 2 miles west of, T. 86 N., R. 24 W., NE. cor. sec. 28, SW. cor. crossroads, NW. cor. bridge over creek; copper nail in top of west end of north plank bridge seat marked "1029.5"	1,028.45	Bull. 569
Randall, 1 mile west of, T. 86 N., R. 24 W., near SE. cor. sec. 22, NE. cor. bridge crossing stream; copper nail in floor, marked "1018.1"	1,017.04	Bull. 569
Randall, 0.5 mile west of, SE. cor. SW. ¼ sec. 23, T. 86 N., R. 24 W., NW. cor. road forks; chiseled square cut in top of north end of concrete drain, marked "1022.8"	1,021.69	Bull. 569
Randall, T. 86 N., R. 24 W., near NE. cor. sec. 26, at north edge of town, in NW. cor. schoolhouse yard; iron post stamped "1019"	1,017.895	Bull. 569
Randall, 2 miles south of, T. 86 N., R. 24 W., SW. cor. sec. 36, NE. cor. C&NW Ry crossing east-west county-line road; spike in post of cattle guard, marked "1018.7"	1,017.74	Bull. 569
Randall, T. 86 N., R. 24 W., east center of sec. 35, south side of road at bend to east, east side of railroad; spike in post of cattle guard, marked "1014.1"	1,013.20	Bull. 569
Randall, 1 mile south of, T. 86 N., R. 24 W., south center of SE. ¼ sec. 26, NW. cor. crossroads; copper nail in base of telephone pole, marked "1017.4"	1,016.47	Bull. 569
Randall, 4 miles east of, T. 86 N., R. 34 W., SW. cor. sec. 22, NE. cor. crossroads; at fence corner; iron post, stamped "1093"	1,091.423	Bull. 569
Randall, 3 miles east of, T. 86 N., R. 23 W., NE. cor. sec. 29, SW. cor. crossroads, at fence corner; chiseled square cut in top of large stone, marked "1046.8"	1,045.58	Bull. 569
Randall, 2 miles east of, T. 86 N., R. 23 W., SE. cor. sec. 19, NW. cor. crossroads; chiseled square on top of large rock, marked "1031.2"	1,029.92	Bull. 569
Randall, 1 mile east of, SW. cor. sec. 19, T. 86 N., R. 23 W., on township line between Scott and Ellsworth Tps., NE. cor. crossroads; chiseled square on top of stone at west end of drain under road, marked "1002.97"	1,001.75	Bull. 569
Randick	856	CRI&P
Randolph	971.6,G970	CB&Q
Rands	1183,G1185	CM&StP
Rathbun	867,G871	CM&StP
Raymond	884	IC

Station	Elevation feet	Authority
Readlyn	1030.5	CGW
Reasnor	759	CRI&P
Rector	725	CRI&P
Rector, T. 75 N., R. 19 W., NE. cor. sec. 3, 18 feet east of center of north and south road, in angle of fence; iron post stamped "849 Iowa"	847.507	Bull. 569
Rector, opposite signboard (CRI&P Ry); top of rail	810.4	Bull. 569
Redding	1138,G1130	CB&Q
Reddy	798.7	CGW
Redfield	956,G958	CM&StP
Red Oak	1077,G1077	CB&Q
Red Rock, Marion Co., top of round bolthead between two hexagonal nuts on extreme east side of north shore pier of highway bridge at (U.S.C.E.b.m. 62)	733.64	Bull. 569
Red Rock, on top of downstream end of outcropping ledge of red sandstone about 1 mile above highway bridge at Red Rock, river makes a sharp bend when it strikes this ledge, from which it is presumed the locality takes its name; square cut (U.S.C.E.b.m. 61)	722.24	Bull. 569
Reeve	1181	CRI&P
Reinbeck	932,G926	CRI&P
Reinbeck, crossing CGW	930	CRI&P
Reinbeck	924.9,G925	CGW
Reinbeck, crossing CRI&P	929.0,G929	CGW
Reinbeck	G926	Weather Bur.
Reinicker, M.P. 349	1197	IC
Relay (CB&Q Transfer, Centerville)	931	ISU
Rembrandt	1332,G1333	M&StL
Remsen	1326,G1324	IC
Renwick	1156	C&NW
Rhodes	1011,G1011	CM&StP
Riceville	1232.7,G1229	CGW
Richards	1191,G1193	IC
Richland	774,G768	M&StL
Richland	664,G674	CM&StP
Richland, crossing over M&StL	711	CM&StP
Ricketts	1303	C&NW
Rider	977,G979	CM&StP
Rider, T. 79 N., R. 25 W., SE. cor. SE. ¼ sec. 21, 20 feet west of junction with T road south, in field, 20 feet from large tree at corner; iron post stamped "956 Prim. Trav. Sta. No. 2"	954.389	Bull. 569
Ridgeway	1211,G1209	CM&StP
Ridgeway, McIntosh schoolhouse, 1.25 miles west of, 1.25 miles east of Madison Church, east of entrance to cemetery; iron post stamped "1194 DBQ"	1,193.625	Bull. 569
Ridley	1181,G1191	CM&StP
Riggs	773	CM&StP
Rinard	1163.8,G1170	CGW
Rinard, crossing FtDDM&S	1163.7	CGW
Rinard	1171	FtDDM&S
Ringsted	1272	C&NW
Rippey	1068,G1064	M&StL
Ritter	1431.4	CStPM&O
River Junction	641	CRI&P
Riverside	631,G641	CRI&P
River Sioux	1038,G1040	C&NW
River Sioux, 2.5 miles south of, 3,553 feet north of milepost 20, 51 feet east of tracks; copper bolt in bench-		

STATION	ELEVATION FEET	AUTHORITY
mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 368):		
Copper bolt	1,025.851	Bull. 569
Cap on pipe	1,029.857	
River Sioux, 1,260 feet south of station, 541 feet south of milepost 23, 45 feet east of tracks; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 369 equals 131/3):		
Copper bolt	1,031.986	Bull. 569
Cap on pipe	1,035.982	
River Sioux, 2.2 miles north of station, 1,634 feet north of milepost 25, 47 feet east of tracks; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E. p.b.m. 370):		
Copper bolt	1,028.922	Bull. 569
Cap on pipe	1,032.928	
River Sioux, 4.5 miles north of, at west right of way fence of C&NW Ry, 608 feet north of south line of Monona county; copper bolt in tile surmounted by iron pipe (U. S.C.E.b.m. 132/4):		
Copper bolt	1,027.88	Bull. 569
Cap on pipe	1,031.94	
Riverton	922,G926	CB&Q
Rizerville	975	ISU
Roberts, B.M. pole No. 1947	1129.81	FtDDM&S
Roberts, T. 88 N., R. 29 W., quarter cor. south side sec. 24, at second class road crossing, 25 feet west of track, 10 feet north of road, 2 feet east of fence; iron post stamped "Iowa 1919 1,128"	1,128.186	USGS
Roberts, T. 88 N., R. 29 W., quarter cor., south side of sec. 13, at Roberts crossing, 120 feet north of railway crossing, 5 feet west of track, in base of power transmission pole, marked "1,127.2"; spike	1,127.29	USGS
Roberts, T. 88 N., R. 29 W., quarter cor. south side of sec. 12, at railway crossing, 60 feet west of track, on north side of road, in root of 2.5 foot cottonwood tree marked "1,123.3"; copper nail and washer	1,123.39	USGS
Roberts, T. 88 N., R. 29 W., near quarter cor., east side of sec. 12, at overhead road crossing, 40 feet east of bridge, 6 feet east of track, in base of telephone pole, marked "1,085"; spike	1,085.06	USGS
Robertson	1179,G1175	CRI&P
Robins	854,G858	IC
Robins, 3 miles south of, crossing under CM&StP	790	IC
Robins, crossing under CM&StP	790	IC
Robins, center of depot, subgrade	834.73	WCF&N
Robins, 3 miles south, near Louisa, crossing under CM&StP	788.50	WCF&N
Rochester	690	CB&Q
Rochester, bridge over Des Moines river	691	CB&Q
Rochester, bottom Des Moines river	661	CB&Q
Rochester, rock under Des Moines river	646	CB&Q
Rockaway	620,G621	CM&StP
Rockdale, nail in S. end IC bridge No. 8	G619	USGS
Rockdale Mill	617	IC
Rock Falls	1109,G1104	CRI&P
Rockford	1022,G1021	CRI&P
Rockingham, 15 meters from river, 0.5 meter east of fence on Davenport wagon road, 136 meters NE. of Homann's south line; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 148/3):		
Copper bolt	555.02	Bull. 569

Station	Elevation feet	Authority
Cap on pipe	559.00	
Rock Island, Ill.	570	CRI&P
Rock Rapids	1361.6	CStPM&O
Rock Rapids, crossing IC	1381.6	CStPM&O
Rock Rapids, crossing CRI&P	1361.6	CStPM&O
Rock Rapids, state line	1391.3	CStPM&O
Rock Rapids	1350,G1345	CRI&P
Rock Rapids, crossing CStPM&O	1350,G1345	CRI&P
Rock Rapids	1349,G1349	IC
Rock Rapids, crossing CRI&P	1349	IC
Rock Rapids, crossing CStPM&O	1367	IC
Rock Rapids	G1358	Weather Bur.
Rock Rapids, 2 miles east of	1415	IaGS
Rock Valley, Ia. & Dak. line	1249,G1255	CM&StP
Rock Valley, junction with Rock Valley line	1247	CM&StP
Rock Valley, 3 miles east of	1323	IaGS
Rockwell	1138,G1130	M&StL
Rockwell City	1221	FtDDM&S
Rockwell City	1228,G1230	CM&StP
Rockwell City, crossing IC	1221,G1222	CM&StP
Rockwell City, crossing FtDDM&S	1221	CM&StP
Rockwell City	1220,G1223	IC
Rockwell City, crossing CM&StP and FtDDM&S	1219	IC
Rodman	1199,G1193	CRI&P
Rodney	1085,G1088	CM&StP
Rodney, crossing IC	1074	CM&StP
Roelyn	1159.1,G1165	CGW
Rogers	926	IC
Roland	1033,G1028	M&StL
Roland, 1 mile south by 1 mile west of, T. 85 N., R. 23 W., SE. cor. sec. 21, on west side of road at T road east, at fence line, at foot of telephone pole, 50 feet NW. of road forks, 35 feet north of east-west section line; iron post stamped ''995''	993.096	Bull. 569
Roland, 1 mile west of, T. 85 N., R. 23 W., NW. cor. sec. 22, SE. cor. crossroads; copper nail in base of electric-light line pole, marked ''1022.1''	1,020.73	Bull. 569
Roland, 1 mile west of, top of south rail at M&StL RR crossing	1,024.0	Bull. 569
Roland, 1.5 miles north by 1 mile west of, T. 85 N., R. 23 W., east center sec. 9, SW. cor. crossroads; iron post stamped ''1029''	1,027.347	Bull. 569
Roland, T. 85 N., R. 23 W., west center of SW. ¼ sec. 3, SE. cor. concrete bridge over Long Dick creek; chiseled square cut in base of concrete railing, marked ''1013.2''	1,011.85	Bull. 569
Roland, 3 miles north by 1 mile west of, T. 86 N., R. 23 W., SE. cor. sec. 33, county line between Hamilton and Story counties, NW. cor. crossroads; chiseled square on top of north guard of concrete culvert under road west, marked ''1024.9''	1,023.61	Bull. 569
Roland, 4 miles north by 1 mile west of, T. 86 N., R. 23 W., SW. cor. sec. 27, NE. cor. crossroads; painted square on top of north end of tile drain under road east, marked ''1056.96''	1,055.67	Bull. 569
Roland, T. 85 N., R. 23 W., SE. cor. sec. 29, 3.5 feet west of T road south, NW. cor. bridge over Bear creek; copper nail in plank flooring, marked ''964.65''	963.69	Bull. 569
Roland, 1 mile west by 2 miles south of, T. 85 N., R. 23 W., SE. cor. sec. 28, NW. cor. crossroads, 28 feet west of SE. cor. schoolhouse yard, inside of fence; copper nail in root on west side of 18-inch box-elder tree, marked ''1026.6''	1,025.682	Bull. 569

Station	Elevation feet	Authority
Roland, 1 mile west by 3 miles south of, Tps. 84 and 85 N., R. 23 W., cor. secs. 3, 4, 33, and 34, at road crossing; chiseled square on top of corner stone in center of road, marked "1038.9"	1,037.92	Bull. 569
Roland, 4 miles south by 1 mile west of, T. 84 N., R. 23 W., SE. cor. sec. 3, NE. cor. crossroads; iron post stamped "1025"	1,023.906	Bull. 569
Roland, T. 84 N., R. 23 W., SW. cor. sec. 10, NE. cor. crossroads; copper nail in top of north end of plank drain under road to east, marked "1013.0"	1,012.08	Bull. 569
Roland, T. 84 N., R. 23 W., NE. cor. sec. 21, SW. cor. crossroads, 20 feet north of SW. fence corner; chiseled square in top of large rock on bank of ditch, marked "992.2"	991.28	Bull. 569
Rolfe	1185	C&NW
Rolfe, crossing M&StL	1186	C&NW
Rolfe	1181	M&StL
Rome	628,G626	CB&Q
Roscoe	774,G763	CB&Q
Rosebrook	920	ISU
Rosedale, Hamilton Co., 2 miles north by 1 mile west of, T. 86 N., R. 25 W., SW. cor. sec. 23, NE. cor. crossroads, SW. cor. yard to residence, inside of fence corner; copper nail in root of 2-foot cottonwood tree facing fence corner, marked "1089.8"	1,088.66	Bull. 569
Rosedale, 2 miles north of, T. 86 N., R. 25 W., near SW. cor. sec. 24, 160 feet east of crossroads, east side of north end of drain under road to east; copper nail in top of cedar post marked "1052.5"	1,051.31	Bull. 569
Rose Hill	808,G822	CRI&P
Rose Hill, South Skunk river west of	718	IaGS
Ross	1354,G1353	C&NW
Rosseau, Marion Co., 0.38 mile north and 0.06 mile west of SW. cor. sec. 9, T. 76 N., R. 19 W., east of north and south road, 85 feet south of residence of J. P. Amos; iron post stamped "763 Iowa"	761.153	Bull. 569
Rosseau, T. 76 N., R. 19 W., 0.25 mile north of SW. cor. sec. 9, in west root of oak tree 24 inches in diameter; 40-penny nail	764.87	Bull. 569
Rossie	1413,G1409	CRI&P
Rossie, crossing M&StL	1368	CRI&P
Ross Junction	786	WRR
Rossville	939	CM&StP
Rowan	1212	CRI&P
Rowan, crossing CGW	1205	CRI&P
Rowan	1200.9,G1203	CGW
Rowan, crossing CRI&P	G1203	CGW
Rowena, S. Dakota	1406	IC
Rowley	981,G990	CRI&P
Rounds Park	G951	WCF&N
Royal	1417,G1414	CRI&P
Rubio	635,G638	CM&StP
Rubio, crossing Skunk river	632,G637	CM&StP
Rudd	1112,G1117	CM&StP
Runnells, T. 78 N., R. 22 W., near quarter corner on south side of sec. 33, 407 feet south of Wabash RR, at crossing of highway at curve in highway, 60 feet north of center line of highway east, 15 feet west of center line of highway north from curve, in top of concrete post; bronze tablet marked "762.4"	762.384	USGS
Runnells, reference mark, 54 feet S. 45° E. of B.M., top of SW. heading of concrete culvert; chiseled square	763.66	USGS

Station	Elevation feet	Authority
Runnells, T. 78 N., R. 22 W., 300 feet west of quarter corner on south side of sec. 34, 420 feet west of road junction, 300 feet west and 220 feet south of Wabash RR, at road crossing, in root on NE. side of 30-inch elm tree; copper nail and washer, marked "759.1"	759.04	USGS
Runnells	772	WRR
Runnells, 1 mile above, in top of south pier of highway bridge across Des Moines river; aluminum tablet (U.S. C.E.b.m. 58 equals U. S. Geological Survey primary traverse station mark No. 1)	764.64	Bull. 569
Russell	1034.8,G1037	CB&Q
Russell, 1 mile north by 1 mile west of, T. 72 N., R. 20 W., at NW. cor. sec. 31, in SE. angle of crossroads, 2 feet east of corner post; iron post stamped "Iowa 1036, 1913"	1,036.227	Bull. 569
Russell, 1 mile north of, T. 72 N., R. 20 W., SW. cor. sec. 29, in NE. angle of crossroads, 3 feet east of mile board "Albia 23," in root of elm stump; copper nail	1,027.82	Bull. 569
Russell, T. 72 N., R. 20 W., SW. cor. sec. 28, in NE. angle of T road north, east end of plank culvert, in top of plank; copper nail	1,023.67	Bull. 569
Russell, T. 72 N., R. 20 W., at SW. cor. sec. 27, in NE. angle of T road north, private road south, 140 feet east of Victory School, 5 feet east of fence corner; iron post stamped "Iowa 1023, 1913"	1,022.940	Bull. 569
Russell, T. 72 N., R. 20 W., at cor. sec. 26, 27, 34, and 35, at center of crossroads, on section stone; chiseled square	983.81	Bull. 569
Ruthven	1428,G1434	CM&StP
Ruthven, crossing M&StL	1425,G1431	CM&StP
Ruthven	1432	M&StL
Rutland	1122,G1128	C&NW
Rutledge, Marion line	832,G834	CM&StP
Rutledge, Muscatine line	831,G834	CM&StP
Ryan	1013	IC
Ryan, west side of sec. 18, T. 87 N., R. 5 W., east side of road crossing IC RR, about 50 feet north of railroad; iron post stamped "1020"	1,000.789	Bull. 569
Sabula	605,G603	CM&StP
Sabula, crossing Mississippi river	607,G606	CM&StP
Sabula, 0.5 mile below, in heavy timber, 0.5 mile below Sabula bridge, 235 meters east of east bank of chute behind Savanna Island, 50 meters back of dry slough; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 166/1):		
Copper bolt	577.92	Bull. 569
Cap on pipe	581.83	
Sabula, 0.5 mile below bridge at, on sand ridge back of willow bar, 50 meters from bank, ridge lies between two small dry sloughs; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 166/2):		
Copper bolt	581.33	Bull. 569
Cap on pipe	585.29	
Sabula, 0.8 mile below, in bunch of elms on Island 269, 200 meters below its head, 150 meters from river bank in line with cleared strip 50 meters wide running back from river, 100 meters from levee; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 166/3):		
Copper bolt	580.69	Bull. 569
Cap on pipe	584.72	
Sabula, in front of CM&StP Ry passenger station; base of rail	603.84	Bull. 569

Station	Elevation feet	Authority
Sabula railroad bridge, cut on top of south end of second pier from right bank (U.S.C.E.t.b.m. 27 R. B)	598.07	Bull. 569
Sabula bridge, gage on pier west of draw pier (U.S.C.E.), zero of gage	571.98	
Sabula Junction	595	CM&StP
Sac City	1201,G1196	CM&StP
Sac City	G1278	Weather Bur.
Sac City	1274,G1274	C&NW
Sac Junction	1230	C&NW
Sageville, Dubuque Co., T. 90 N., R. 2 E., sec. 34, on west end of north abutment of bridge over Maquoketa river, in stone; bronze tablet stamped "621 DBQ"	622.600	Bull. 569
St. Ansgar	1175,G1175	IC
St. Anthony	1003,G997	M&StL
St. Benedict	1272,G1264	M&StL
St. Charles	1067	CB&Q
St. Charles	G1070	Weather Bur.
St. Donatus, Jackson Co., near center sec. 7, T. 87 N., R. 4 E., iron post stamped "674"	666.028	Bull. 569
St. Donatus	G674	USGS
St. Francisville, Mo., three miles south of Sand Prairie, Ia. Aluminum tablet on H. C. Campbell's residence	G542	USGS
St. Francisville, Mo., Des Moines river, water surface	G497	USGS
St. Lucas, Fayette Co.	1060	IaGS
St. Marys	1036	CB&Q
St. Olaf	841,G845	CM&StP
Salem	715.4,G717	CB&Q
Salix	1082,G1084	C&NW
Salix, 2.5 miles south of, 240 feet south of farm crossing, 46 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 387):		
Copper bolt	1,071.825	Bull. 569
Cap on pipe	1,075.851	
Salix, 1,270 feet south of station, 144 feet north of south headblock at Salix siding, 46 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U. S.C.E.p.b.m. 388 equals 140/3):		
Copper bolt	1,078.718	Bull. 569
Cap on pipe	1,082.721	
Salix, 2.8 miles north of, 623 feet north of road crossing, 361 feet north of C. W. Wheeler's house, 47 feet east of railway, south side of old river bed; copper bolt in bench-bark stone surmounted by iron pipe (U.S.C.E. p.b.m. 389):		
Copper bolt	1,085.552	Bull. 569
Cap on pipe	1,089.558	
Samoa	595,G597	CM&StP
Sanborn	1547,G1552	CM&StP
Sand Prairie, B.M. top of monument M.P. 14	544.87	CRI&P
Sand Prairie, top of rail, depot	556.2	CRI&P
Sand Prairie, B.M. top of monument M.P 15	552.29	CRI&P
Sand Spring	902,G902	CM&StP
Sand Spring, T. 86 N., R. 3 W., NW. ¼ sec. 9, between railroad tracks, 500 feet north of switch; iron post stamped "849"	840.097	Bull. 569
Sandusky	532	CB&Q
Sandusky, Des Moines Rapids canal, 1 mile above middle lock of, between railroad track and osage hedge, 18.25 meters west of center of track, 4.5 meters east of hedge, 44.75 meters south of center of culvert 39A, 80 meters below large ice house standing between canal and railroad, 15.5 meters north of gateway leading up bluff to		

Station	Elevation feet	Authority
vineyard and wine cellar, 45 meters west of canal, 30 meters above point opposite figure 35 painted on west slope of canal wall; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 112/2):		
Copper bolt	519.04	Bull. 569
Cap on pipe	523.07	
Sandusky, 1 mile above, on SW. cor. west end of south abutment of culvert 36A of CB&Q RR (U.S.C.E. 32 R. B)	511.78	Bull. 569
Sandusky, Des Moines Rapids canal, 1 mile below guard lock at upper end of, on side of bluff between railroad and public road, 13 meters west of center of track, at point 140.7 meters north of small box culvert, 15 meters east of center of road at point 58 meters south of blazed maple tree by roadside where it ascends to pass over point of hill, 25 meters west of canal, nearly opposite figures 68 painted on west slope of canal wall; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 113/3):		
Copper bolt	525.14	Bull. 569
Cap on pipe	529.15	
Sandyville, Warren Co., 300 feet south of main crossroads, west side of road at fence behind hitching rack, limestone rock 8 by 8 by 32 inches, set 30 inches in ground; aluminum tablet stamped ''941 Adj''	940.721	Bull. 569
Santiago	841.4	CGW
Santiago, T. 80 N., R. 22 W., near cor. secs. 13, 14, 23 and 24, 650 feet east and 125 feet south of T road east, in root on NW. side of 2-foot cottonwood tree; copper nail and washer, marked ''802.9'' on tree	803.06	USGS
Santiago, Skunk river, surface of water underneath highway bridge on May 26, 1926, at 4 p.m.	795.92	USGS
Santiago, T. 80 N., R. 22 W., near quarter corner between secs. 23 and 24, top of NE. tube pier (concrete filled) of highway bridge over Skunk river; chiseled square, marked ''805.7''	805.90	USGS
Santiago, T. 80 N., R. 22 W., at quarter corner between secs. 25 and 26, 20 feet south and 35 feet west of T road west, 225 feet SE. of A. Schneider's house, on concrete post; bronze tablet stamped ''Prim. Trav. Sta. No. 17-L.S.-1924-Ia.'', marked ''862.6''	862.786	USGS
Santiago, reference mark is 43 feet N. 30° W. of ''L.S. No. 17'', in root on NE. side of 2-foot locust tree; copper nail and washer	862.90	USGS
Santiago, CGW RR at crossing in; top of rail	845.7	USGS
Santiago, T. 80 N., R. 22 W., about 0.25 mile west of center sec. 26, 140 feet west and 17 feet south of T road north, in root on north side of 15-inch elm tree; copper nail and washer, marked ''883.0''	883.17	USGS
Santiago, T. 80 N., R. 22 W., 0.25 mile west of center of sec. 27, in NE. angle of T road east, top of concrete culvert heading; chiseled square, marked ''911.2''	911.41	USGS
Santiago, T. 80 N., R. 22 W., 0.25 mile west of center of sec. 22, 30 feet east and 30 feet south of elbow in road from south to west, in root on north side of 30-inch forked maple tree; copper nail and washer, marked ''911.4''	911.64	USGS
Santiago, 2 miles west, 1 mile north of, T. 80 N., R. 22 W., at cor. secs. 15, 16, 21 and 22, 225 feet west of elbow, west and south, 80 feet north and 60 feet west of schoolhouse, on concrete post; bronze tablet stamped ''Prim. Trav. Sta. No. 16-L.S. 1924-Ia.''	846.857	USGS
Santiago, reference mark is 223 feet west of ''L.S. 16''		

STATION	ELEVATION FEET	AUTHORITY
on top of north heading of concrete culvert; chiseled square	838.45	USGS
Santiago, 2 miles west, 2 miles north of, T. 80 N., R. 22 W., at center of NE. ¼ of sec. 16, 40 feet north and 20 feet west of road corner, south and west, in root on west side of 15-inch pine tree; copper nail and washer, marked "850.8"	851.05	USGS
Santiago, 3 miles west, 2 miles north of, T. 80 N., R. 22 W., at corner secs. 8, 9, 16 and 17, 45 feet north and 20 feet west of crossroads, in root on SE. side of 4-foot cottonwood tree; copper nail and washer, marked "903.8"	904.13	USGS
Sargents Bluff	1093,G1095	C&NW
Sargents Bluff, crossing CM&StP	1087	C&NW
Sargents Bluff, 2.8 miles south of, 1,900 feet south of milepost 66, 656 feet north of road crossing, 1,352 feet north of Louis Godferson's house, 46 feet east of railway; copper bolt in bench-mark stone (U.S.C.E.p.b.m. 390):		
Copper bolt	1,085.257	Bull 569
Cap on pipe	1,089.273	
Sargents Bluff, in lot 1, block 2, 10 feet from SW. cor. E. T. Berry's house, 52 feet from NW. cor. Tenth and Walnut Sts.; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 391 equals 142/3):		
Copper bolt	1,090.273	Bull 569
Cap on pipe	1,094.263	
Sargents Bluff, 3 miles north of, 47 feet east of railway, 1,476 feet south of road crossing, 2 feet west of east right of way fence; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 392):		
Copper bolt	1,093.039	Bull 569
Cap on pipe	1,097.055	
Sargents Bluff, T. 87 N., R. 48 W., 680 feet north of SW. cor. sec. 12, at east side of section-line road, on premises of E. R. Allen; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 141/2):		
Copper bolt	1,087.84	Bull. 569
Cap on pipe	1,091.90	
Sattre, Winneshiek Co., T. 99 N., R. 7 W., sec. 15, 1 rod east of NE. cor. intersection of Locust and Sattre roads; iron post stamped "1159 DBQ"	1,158.943	Bull. 569
Savanna, Ill.	596	CM&StP
Sawyer	708	CB&Q
Saylor	960,G961	C&NW
Scarville	1246	C&NW
Schaller	1395,G1393	C&NW
Schleswig	1493	C&NW
Schleswig, hills in SE. ¼ sec. 24, T. 85 N., R. 40 W.	1535	IaGS
Scotch Grove	876,G876	CM&StP
Scranton	1179,G1177	C&NW
Searsboro	817,G806	M&StL
Secor	950	C&NW
Sedan, Shenandoah line	830	CB&Q
Sedan, Fort Madison line	830,G831	CB&Q
Sedan, crossing Shenandoah line CB&Q	830,G831	CB&Q
Sedan, junction I&StL	831	CB&Q
Selection	971	WRE
Selection	980	ISU
Selma, top of upstream side of second tube pier west of east end of highway bridge (U.S.C.E.b.m. 89)	613.28	Bull. 569
Selma, B.M. top of monument M.P. 57	611.03	CRI&P

Station	Elevation feet	Authority
Selma, B.M. top of monument M.P. 58	613.11	CRI&P
Selma, top of rail, center of depot (U.S.C.E.b.m. 41)	615.8	CRI&P
Selma, B.M. top of monument M.P. 60	615.29	CRI&P
Selma, B.M. top of monument M.P. 61	617.12	CRI&P
Seney	1227.8,G1227	CStPM&O
Sewal	1102,G1106	CM&StP
Sexton	1213,G1218	CM&StP
Seymour	1066,G1075	CRI&P
Seymour, crossing CM&StP	1059	CRI&P
Seymour	1070,G1074	CM&StP
Seymour, crossing CRI&P	1066,G1069	CM&StP
Seymour	G1079	Weather Bur.
Shady Oak, crossing Des Moines river	1023.65	FtDDM&S
Shady Oak, about 3 miles south by 1 mile east of Fort Dodge, at FtDDM&S Ry crossing over Des Moines river, 200 feet south of north end of bridge, 6.5 feet below level of track, in west concrete abutment; bronze tablet stamped ''Iowa 1919 1018''	1,017.860	USGS
Shady Oak, 1.02 miles north of, 60 feet north of hollow coming in from west, 4 feet west of track, in base of power transmission pole, marked ''1,050''; spike	1,050.14	USGS
Shady Oak, T. 86 N., R. 28 W., near quarter cor., north side of sec. 33, at highway and interurban railway crossing, 30 feet south of crossing, 5 feet east of track, in top of sawed off telephone pole standing 2 feet above ground marked ''1,103''; copper bolt	1,103.05	USGS
Shaffton, DRI&NW station	599	CM&StP
Shaffton	600.25	CD&M
Shaffton, crossing CRI&P	601.81	CD&M
Shaffton	G588	DRI&NW
Shaffton, DRI&NW station	595	CB&Q
Shaffton, 200 meters above mouth of Wapsipinicon river, 10 meters from river bank opposite foot of Adams Island, 20 meters north of a shanty, 8 meters 219° 30′ to 20-inch white-oak tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 157/3):		
Copper bolt	575.64	Bull. 569
Cap on pipe	579.64	
Shaffton, opposite, 3 miles below Albany, 15 meters from river bank, opposite point midway between Island 295 and first towhead below, 2.5 meters 121° 30′ to 15-inch elm, 58 meters 326° 30′ to 18-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 158/3):		
Copper bolt	574.66	Bull. 569
Cap on pipe	578.68	
Shaffton, see also Folletts, which is adjacent		
Shambaugh	983,G973	CB&Q
Shannon City	1146.9,G1144	CGW
Sharon	845	CRI&P
Sharpsburg	1273,G1270	CB&Q
Shawondassee Club station, 6 miles below Dubuque, on line CM&StP Ry, 76 feet below south end of platform and 86 feet above boundary fence between Paul Eiffer's and Frank Noel's lands, on west side of track, 47.1 feet from center: copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 286 and 287):		
Copper bolt	602.771	Bull. 569
Cap on pipe	606.771	
Sheffield	1079	CRI&P
Sheffield	1084,G1076	M&StL
Shelby	1292,G1295	CRI&P

Station	Elevation feet	Authority
Shelby, 3 miles west of, in NE. stone abutment of CRI&P Ry bridge 475; aluminum tablet	1,289.328	Bull. 569
Shelby, in front of CRI&P Ry station; top of rail	1,296	Bull. 569
Shelby, 160 feet west of CRI&P Ry track, opposite a point 150 feet north of station, near corner of park; iron post	1,294.654	Bull. 569
Sheldahl	1035,G1038	C&NW
Sheldahl, T. 81 N., R. 25 W., NW. cor. sec. 13; spike in telephone pole, marked "U.S.B.M. 960"	958.48	Bull. 569
Sheldahl, T. 81 N., R. 25 W., NW. cor. sec. 12; spike in fence post, marked "U.S.B.M. 1001"	999.52	Bull. 569
Sheldahl, T. 82 N., R. 25 W., SE. cor. sec. 35; iron post stamped "1008"	1,007.114	Bull. 569
Sheldahl, T. 82 N., R. 25 W., SW. cor. sec. 25; spike in base of telephone pole marked "U.S.B.M. 1024"	1,022.33	Bull. 569
Sheldon	1418,G1421	IC
Sheldon, crossing CM&StP	1420	IC
Sheldon, crossing CStPM&O	1416	IC
Sheldon	1409,G1415	CM&StP
Sheldon, crossing CStPM&O	1409,G1415	CM&StP
Sheldon, crossing IC	1415,G1421	CM&StP
Sheldon, crossing CM&StP, union station	1414.1	CStPM&O
Sheldon, crossing IC	1413.7	CStPM&O
Sheldon, 1 mile west of	1475	IaGS
Shell Rock	910.9,G910	CGW
Shell Rock, crossing CRI&P	932.5	CGW
Shell Rock	925,G921	CRI&P
Shellsburg	776,G774	CRI&P
Shenandoah	981	WRR
Shenandoah, crossing CB&Q	976	WRR
Shenandoah, Red Oak-Hamburg line	978.4,G974	CB&Q
Shenandoah, junction Red Oak and Shenandoah line	971.15	CB&Q
Shenandoah, crossing Wabash	973	CB&Q
Shepard	1167.8,G1164	CGW
Sherman	1133	CRI&P
Sherrill, 3 miles north and 1 mile west of, T. 91 N., R. 1 E., in fraction of Jefferson Tp., near SE. cor. sec. 35, in field; iron post	897.778	Bull. 569
Sherwood	1232,G1233	IC
Shipley	962	CRI&P
Shipley, T. 83 N., R. 24 W., center of east side of sec. 25; spike in telephone pole, marked "U.S.B.M. 932"	930.28	Bull. 569
Shipley, T. 83 N., R. 23 W., 0.25 mile east of west end of south border of sec. 19, iron post stamped "870"	869.015	Bull. 569
Shipley, T. 83 N., R. 23 W., 0.25 mile east of SW. cor. sec. 20, NE. cor. crossroads; spike in telephone pole, marked "U.S.B.M. 888"	886.92	Bull. 569
Shipley, T. 83 N., R. 23 W., SW. cor. sec. 21; spike in telephone pole, marked "U.S.B.M. 921"	919.81	Bull. 569
Shipley, T. 83 N., R. 23 W., NE. cor. NW. ¼ sec. 27; iron post stamped "958"	957.011	Bull. 569
Shipley, T. 83 N., R. 23 W., NW. cor. NE. ¼ sec. 34; spike in telephone pole, marked "U.S.B.M. 972"	970.36	Bull. 569
Shipley, T. 83 N., R. 23 W., SW. cor. SE. ¼ sec. 34; spike in telephone pole, marked "U.S.B.M. 1010"	1,008.33	Bull. 569
Shipley, T. 83 N., R. 23 W., NE. cor. NW. ¼ sec. 27, 0.2 mile west of Shipley, SW. cor. crossroads; iron post stamped "958"	957.011	Bull. 569
Shipley, T. 83 N., R. 23 W., cor. secs. 21, 22, 27 and 28, 0.8 mile west of Shipley, center of forks at T road north; chiseled square on top of corner stone, marked "961.1"	960.11	Bull. 569
Shipley, T. 83 N., R. 23 W., SE. cor. sec. 16, NW. cor.		

Station	Elevation feet	Authority
crossroads; copper nail in top of corner fence post, marked "988.5"	987.45	Bull. 569
Shipley, T. 83 N., R. 23 W., NW. cor. sec. 15, SE. cor. crossroads; copper nail in top of corner fence post, marked "968.2"	967.15	Bull. 569
Shopton	521.3	AT&SF
Shopton, top of T-rail marker M.P. 235	521.41	AT&SF
Showman, South Skunk river near	657	IaGS
Sibley	1516.0	CStPM&O
Sibley, crossing CRI&P	1506.4	CStPM&O
Sibley, 1 mile south of state line, also 3600 feet south of state line, about 1 mile south of Bigelow, Minn., track level	1653.6	CStPM&O
Sibley, 3500 feet south of state line, upland level	1659	CStPM&O
Sibley	1508,G1502	CRI&P
Sibley, crossing CStPM&O	1508,G1502	CRI&P
Sibley, center Wilson Tp.	1670	IaGS
Sibley	G1512	Weather Bur.
Sidney	1052,G1049	CB&Q
Sidney, public square	1156	IaGS
Sidney, Nishnabotna bottoms east of	915	IaGS
Sigourney	752	CRI&P
Sigourney, crossing CM&StP	751	CRI&P
Sigourney	785,G790	CM&StP
Sigourney, under crossing CRI&P	G763	CM&StP
Sigourney, under crossing, CM&StP tracks	785	CM&StP
Sigourney, Bridge creek east of	693	IaGS
Sigourney, Bridge creek north of	713	IaGS
Sigourney, German creek east of	688	IaGS
Sigourney, divide between Bridge and German creeks	808	IaGS
Sigourney, South, North Skunk river	658	City levels
Silver City	1046	WRR
Sinclair	917,G921	IC
Sinclair, crossing under C&NW	934	IC
Sioux Center	1447	GN
Sioux City, 22d St. Tel. office	1111.88	CStPM&O
Sioux City	1103,G1104	CM&StP
Sioux City	1106	IC
Sioux City, east main track, depot	1103	GN
Sioux City	1101,G1103	C&NW
Sioux City, crossing GN	1104	C&NW
Sioux City, crossing IC	1102	C&NW
Sioux City, Missouri river, extreme low water, 1882	G1076	Mo. River Com.
Sioux City, Missouri river, extreme high water, 1881	G1099	Mo. River Com.
Sioux City	G1135	Weather Bur.
Sioux City, 558 feet south of Missouri river bridge, 148 feet north of railroad bridge 60, 20 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 393):		
Copper bolt	1,098.038	Bull. 569
Cap on pipe	1,102.058	
Sioux City, in NW. cor. east pier of Missouri river bridge, 2 feet above ground, in seventeenth course of masonry below coping course; copper bolt (U.S.C.E.p.b.m. 394)	1,105.670	Bull. 569
Sioux City, 103 feet west of west side of eastern or shore pier of Missouri river bridge, almost vertically under north truss of east span and 69 feet west of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 395, gage bench mark):		
Cap on pipe	1,094.076	Bull. 569
Sioux City, in SW. cor. courthouse yard, 72 feet from SW. cor. courthouse, 135 feet from SE. cor. of same; copper		

Station	Elevation feet	Authority
bolt in bench-mark stone (U.S.C.E.p.b.m. 396 equals 143/3):		
Copper bolt	1,106.218	Bull. 569
Cap on pipe	1,110.237	
Sioux City, 39 feet north of NE. cor. Fifth and Pierce Sts.; top of ring bolt in sidewalk stone (U.S.C.E.t.b.m. 996)	1,108.512	Bull. 569
Sioux City, 3.5 miles above, 0.25 mile north of electric railway power house at Riverside Park, 121 feet north of north headblock, at foot of bluff, 52 feet east of railway, copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 397):		
Copper bolt	1,100.296	Bull. 569
Cap on pipe	1,104.312	
Sioux City, 6 miles above, 515 feet south of south end of railway bridge over Big Sioux river, 3 feet east of west right-of-way fence; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 398):		
Copper bolt	1,102.875	Bull. 569
Cap on pipe	1,106.884	
Sioux City, 6 miles above, on land of Mrs. Rose Pacquette, 50 feet west of CM&StP Ry track, 190 feet south of south end of railway bridge over Big Sioux river, 5 feet west of right-of-way fence; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 399):		
Copper bolt	1,098.367	Bull. 569
Cap[1] on pipe	1,102.373	
Sioux City, head of Bacon Hollow	1398	City Engineer
Sioux City, top of Prospect Hill	1281	City Engineer
Sioux City, top of sandstone, Prospect Hill	1097	City Engineer
Sioux Falls, S. Dakota	1396,G1396	IC
Sioux Falls, East, S. Dakota	1320,G1323	IC
Sioux Rapids	1263,G1272	C&NW
Sioux Rapids, crossing under M&StL	1278	C&NW
Sioux Rapids	1309,G1308	M&StL
Sioux Rapids, crossing over C&NW	1296	M&StL
Sioux Rapids, crossing, C&NW tracks	1266	M&StL
Slater	1042	C&NW
Slater, union station with C&NW	1041,G1040	CM&StP
Slater, T. 82 N., R. 25 W., south cor. between secs. 26 and 27; spike in telephone pole, marked "U.S.B.M. 1008"	1,007.00	Bull. 569
Slater, T. 82 N., R. 25 W., NW. cor. sec. 25; spike in fence post, marked "U.S.B.M. 1040"	1,038.63	Bull. 569
Slater, T. 82 N., R. 25 W., SE. cor. sec. 14; iron post stamped "1049"	1,047.809	Bull. 569
Slater, T. 82 N., R. 25 W., NE. cor. sec. 14; spike in telephone pole, marked "U.S.B.M. 1044"	1,042.59	Bull. 569
Slater, T. 82 N., R. 25 W., SW. cor. sec. 1; spike in fence post, marked "U.S.B.M. 1040"	1,037.60	CRI&P
Slifer	1148,G1157	CRI&P
Sloan	1074,G1076	C&NW
Sloan, T. 85 N., R. 47 W., 1,068 feet north of west quarter post of sec. 22, opposite Omaha Mission, on east side of section-line road, in dooryard of George Nelson; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 138/2):		
Copper bolt	1,066.95	Bull. 569
Cap on pipe	1,071.02	
Sloan, T. 86 N., R. 47 W., 1,670 feet south of NE. cor. sec. 26, on west side of north-south road; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 139/2):		
Copper bolt	1,071.28	Bull. 569
Cap on pipe	1,075.35	

[1] In 1905 Cap reported stolen

Station	Elevation feet	Authority
Sloan, 3 miles south of, 1,345 feet south of milepost 52, 47 feet west of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 383 equals 138/3):		
Copper bolt	1,062.826	Bull. 569
Cap on pipe	1,066.888	
Sloan, 1,335 feet south of, 47 feet west of railway, 3 feet south of south side of east-west public road; copper bolt in bench-mark stone surmounted by iron pipe (U.S. C.E.p.b.m. 384):		
Copper bolt	1,068.075	Bull. 569
Cap on pipe	1,072.078	
Sloan, on corner of Fourth and Evans Sts.; cross cut on NE. cor. of stone doorsill of State bank (U.S.C.E.p.b.m. 385)	1,076.622	Bull. 569
Sloan, 5,256 feet north of station, 879 feet south of milepost 56, 49 feet west of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 386 equals 139/3):		
Copper bolt	1,069.624	Bul. 569
Cap on pipe	1,073.630	
Smithland	1078,G1080	IC
Smithland, crossing CM&StP	1074,G1080	IC
Smiths, Jackson Co.	611,G607	CM&StP
Smiths, 1.2 miles below, behind Bellevue slough, on CM&St P Ry, 148 feet below stone culvert about in center of short, heavy fill, at lower end of long curve, 60 feet east of center of track, several feet outside of right of way, 1,902 feet above bridge 50, on 10-inch oak tree; spike in root (U.S.C.E.t.b.m. 323)	608.798	Bull. 569
Smiths, 0.8 mile above, on opposite side of track from t.b. m. 321, at head of Bellevue slough, 110 feet above bridge 56, 55 feet below lower line of A. M. Brown's house, 12 feet below cattle guard, on river side of track, 16 feet from center, on small bench of ground between cattle guard and gate leading down to river; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 298 and 299):		
Copper bolt	602.147	Bull. 569
Cap on pipe	606.130	
Smiths, above, at point of bluff at head of Bellevue slough, at lower end of cut, in front of house owned by A. M. Brown, 15 feet below path running to this house, 125 feet above bridge 56, at upper side of cattle guard, 12 feet west of center of track, on natural ledge of rock, marked "U.□S."; highest point in square (U.S.C.E. t.b.m. 321)	607.607	Bull. 569
Smiths Siding, Monona Co., stock pen	1315	CM&StP
Sneffs	651,G646	CM&StP
Snodgrass Siding	818	CB&Q
Sny Magill	628,G627	CM&StP
Sny Magill station, 1,214 feet below lower switch block of, 50 feet below milepost 70 from LaCrosse, just east of west right of way fence, 30 feet from center of track, behind islands 176 and 178 on line of CM&StP Ry; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 239 and 240):		
Copper bolt	624.539	Bull. 569
Cap on pipe	628.532	
Sny Magill, at head of Island 176,482 feet above milepost 68 from La Crosse, on south abutment of bridge 378K of CM&StP Ry, at its east end, on third course of		

STATION	ELEVATION FEET	AUTHORITY
stone from top, 3 feet west from east end of stone and 3 inches back from north face, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 232)	624.822	Bull. 569
Sny Magill, on Island 176, 25 meters back from bank of river, 100 meters above head of Wyalusing Slough, which is opposite Wyalusing, Wis.; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 195/3):		
Copper bolt	612.73	Bull. 569
Cap on pipe	616.68	
Sny Magill, opposite Wyalusing, Wis., on side of bluff, 1 meter east of perpendicular rock cliff, 25 meters west of center of CM&StP Ry track, 40 meters above log house, on path leading from log house to spring, 300 meters above railroad bridge 364 over Sny Magill creek; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 195/4):		
Copper bolt	649.08	Bull. 569
Cap on pipe	653.03	
Solberg	1209.9	CGW
Soldier	1133	C&NW
Solomon	1141	WRR
Solon	789,G794	CRI&P
Somers	1151.9,G1157	CGW
Somers, crossing CRI&P	1151.0,G1156	CGW
Somers	1158	CRI&P
Somers, crossing CGW	1156	CRI&P
Somers, crossing IC	1181	CRI&P
South Amana	880,G882	CM&StP
South Amana	745,G746	CRI&P
South English	832,G840	CRI&P
South Number 3	977	ISU
Spaulding	1349.6,G1348	CB&Q
Spechts Ferry	613,G613	CM&StP
Spechts Ferry, 3.1 miles below, 2.2 miles above Little Maquoketa river, on line of CM&StP Ry, 912 feet below milepost 108-53, and opposite lower end of bridge 128 over Leisures Creek, 49 feet east from center of track, on right of way, in corner of fence formed by main fence and wing fence to bridge 128, in slope of bluff; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 269 and 270):		
Copper bolt	618.092	Bull. 569
Cap on pipe	622.119	
Spechts Ferry, 1.5 miles below, at Parsons bar, on extreme point of bluff, between rock quarry where t.b.m. 280 is located and railroad bridge 134, 25.5 feet south from center of track; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 267 and 268):		
Copper bolt	609.572	Bull. 569
Cap on pipe	613.585	
Spechts Ferry, 1.5 miles below, at Parsons bar, in cove or borrow pit at lower end, and base of heavy sidehill cut, 300 feet more or less above bridge 134, where railroad leaves river bank and enters woods, on natural ledge of hard rock, 50 feet from track center, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 280)	618.565	Bull. 569
Spechts Ferry, 0.3 mile below CM&StP Ry station at, 0.5 mile above milepost 106-55, 82 feet below large bare ledge of rock inclining at an angle of about 45° with horizon, on bluff side of track, 10 feet from center, on natural ledge of rock, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 279)	617.899	Bull. 569

Station	Elevation feet	Authority
Spechts Ferry, 354 feet below center of CM&StP station, 164 feet below bridge 140, 174 feet below lower side of stone milk house, 1 foot above fence forming west side of railroad cattle pen, on bluff side of track, 37.4 feet from center; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 265 and 266):		
Copper bolt	611.409	Bull. 569
Cap on pipe	615.409	
Spechts Ferry, at NE. cor. Specht's house, on water table, but a few inches above corner, marked "B⊙M"; highest point on front segment of circle (U.S.C.E. old U.S. b.m. a)	615.927	Bull. 569
Spechts Ferry, on upper stone doorstep to Specht's stone house, downstream end, front edge, marked "⊙"; highest point in upper portion of circle (U.S.C.E. old p.b.m. 30)	615.452	Bull. 569
Spechts Ferry, on right bank of Island 213, 0.8 mile below its head, 15 meters back from bank of river on high ground, opposite rock quarry on right bank; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 183/2):		
Copper bolt	598.90	Bull. 569
Cap on pipe	602.87	
Spechts Ferry, 1.5 miles below, 0.5 meter west of east right-of-way fence of CM&StP Ry, between tenth and eleventh telegraph poles, below signboard which reads "Slow to 6 miles an hour," 55 meters above wagon road crossing at rock quarry, 175 meters above railroad bridge 138K; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 183/3):		
Copper bolt	613.35	Bull. 569
Cap on pipe	617.3	
Spechts Ferry, in front of CM&StP Ry station; base of rail (U.S.C.E.)	613.80	Bull. 569
Spechts Ferry, Mississippi river, low water	G590	Miss. Riv. Com.
Spechts Ferry, Mississippi river, high water	G611	Miss. Riv. Com.
Spechts Ferry, T. 91 N., R. 1 E., in fraction of Jefferson Tp., near SE. cor. sec. 35, in field; iron post	897.778	Bull. 569
Spencer	1314,G1315	M&StL
Spencer, crossing CM&StP	1305,G1315	M&StL
Spencer, Ia. & Dak. line	1314,G1319	CM&StP
Spencer, Des Moines line	1318,G1319	CM&StP
Spencer, crossing M&StL	1318	CM&StP
Spencer, junction with Ia. & Dak. Div.	1318	CM&StP
Spencer	G1319	Weather Bur.
Sperry, union station with CRI&P	751	CB&Q
Sperry	753,G757	CRI&P
Spirit Lake	1465,G1457	CRI&P
Spirit Lake	1468	CM&StP
Spirit Lake	G1458	Weather Bur.
Spragueville	633	CM&StP
Springdale	1117	IC
Spring Grove	553	CB&Q
Spring Hill	810,G817	CRI&P
Springville	845,G846	CM&StP
Stacyville	1203,G1208	IC
Stacyville Jct., South switch	1189,G1189	IC
Stacyville Jct., North switch	1178	IC
Stanhope	1119,G1122	C&NW
Stanhope, T. 86 N., R. 26 W., NW. cor. sec. 36, SE. cor. crossroads, at foot of corner fence post; chiseled square on top of stone, marked "1061.4"	1,060.47	Bull.569
Stanhope, 1 mile west by 4.5 miles south of, T. 86 N., R.		

STATION	ELEVATION FEET	AUTHORITY
25 W., NW. cor. sec. 31, on north-south township line between Marion and Clear Lake townships, south of Stanhope, SE. cor. crossroads, at fence corner; iron post stamped "1033"	1,031.596	Bull.569
Stanhope, T. 86 N., R. 25 W., 0.1 mile east of south center of sec. 30, NE. cor. of T road north, in corner fence post; copper nail marked "1030.5"	1,029.63	Bull.569
Stanhope, 3.5 miles south of, T. 86 N., R. 25 W., SW. cor. sec. 20, NE. cor. T road north, in base of corner fence post; copper nail, marked "1046.0"	1,045.17	Bull.569
Stanhope, 3.5 miles south by 1 mile east of, T. 86 N., R. 25 W., cor. secs. 20, 21, 28 and 29, in center of T road south at forks; chiseled square on top of corner stone, marked "1062.5"	1,061.71	Bull.569
Stanley	1106.7,G1106	CGW
Stanley, T. 91 N., R. 8 W., NE. cor. sec. 21, at crossroads; iron post stamped "1143 DBQ"	1,144.385	Bull.569
Stanton	1170,G1172	CB&Q
Stanwood	845,G847	C&NW
Stark	832	C&NW
Stark	821.5	CB&Q
Stark, crossing C&NW	821	CB&Q
State Center	1077	M&StL
State Center	1070	C&NW
Steamboat Rock	983,G978	M&StL
Steen, Minn.	1485,G1485	IC
Stennett	1055.14,G1052	CB&Q
Steuben, platform	872,G871	CB&Q
Stilson	1204,G1207	M&StL
Stimsons, abandoned	1207,G1205	CM&StP
Stockport	747	CB&Q
Stockton, main line	717,G720	CRI&P
Stockton, crossing Bennett line	711	CRI&P
Stockton, Bennett line	729	CRI&P
Stone City	815,G815	CM&StP
Stonega	1167	IC
Storm Lake	1435,G1436	IC
Storm Lake, connection M&StL	1440	IC
Storm Lake, crossing over CM&StP	1442,G1437	IC
Storm Lake	1430,G1427	CM&StP
Storm Lake, crossing M&StL	1435,G1430	CM&StP
Storm Lake, crossing under IC	1417	CM&StP
Storm Lake	1432,G1433	M&StL
Storm Lake, crossing CM&StP	1421	M&StL
Storm Lake, crossing IC	1425	M&StL
Storms	932.11	DM&CI
Story City	1014,G1011	M&StL
Story City	1016	C&NW
Story City, 1 mile east of, T. 85 N., R. 23 W., center of sec. 7, at center of T road south; chiseled square in top of corner stone, marked "998.0"	997.06	Bull. 569
Story City, 2.5 miles east of, T. 85 N., R. 23 W., east center of sec. 8, SW. cor. crossroads; copper nail in base of telephone pole, marked "1009.8"	1,008.87	Bull. 569
Story City, 3.5 miles south of, T. 85 N., R. 24 W., SE. cor. sec. 26, NW. cor. crossroads, 50 feet west of fence corner; copper nail in base of willow stump, marked "959.1"	958.10	Bull. 569
Story City, 3.5 miles south by 0.5 mile east of, T. 85 N., Rs. 23 and 24 W., cor. secs. 25, 36, 30 and 31; in center of crossroads; chiseled square on top of stone corner mark, marked "968.6"	967.65	Bull. 569

Station	Elevation feet	Authority
Story City, T. 85 N., R. 23 W., near south center of sec. 30, in NW. cor. flooring of steel highway bridge over Skunk river; painted spike head marked "944.5"	943.53	Bull. 569
Story City, T. 85 N., R. 23 W., SE. cor. sec. 30, NW. cor. forks at road north, 10 feet west of NW. fence corner, 40 feet NW. of section corner stone; iron post stamped "973"	971.796	Bull. 569
Story City, 1.5 miles south by 4.5 miles west of, T. 85 N., R. 24 W., SW. cor. sec. 17, NE. cor. crossroads; copper nail in top of fence anchor post, marked "1068.3"	1,067.32	Bull. 569
Story City, 0.5 mile south by 4.5 miles west of, T. 85 N., R. 24 W., SE. cor. sec. 7, NW. cor. crossroads, at fence corner; iron post stamped "1047"	1,045.580	Bull. 569
Story City, 0.5 mile north by 4.5 miles west of, T. 85 N., R. 24 W., SE. cor. sec. 6, NW. cor. crossroads; copper nail in top of west end of plank drain under road north, marked "1018.5"	1,017.52	Bull. 569
Story City, 2.5 miles south of, T. 85 N., R. 24 W., SE. cor. sec. 23, NW. cor. road forks, copper nail in base of willow tree at fence corner, marked "1088.6." (This marking is probably an error)	987.66	Bull. 569
Story City, 1.5 miles south of, T. 85 N., R. 24 W., SW. cor. sec. 13, NE. cor. crossroads, copper nail in top of east end, south side of plank drain under road north, marked "999.9"	998.89	Bull. 569
Story City, SW. edge of, T. 85 N., R. 24 W., NW. cor. sec. 13, SE. cor. crossroads; copper nail in base of telephone pole, marked "1012.7"	1,011.69	Bull. 569
Story City, street crossing at east edge of, near center of sec. 12, T. 85 N., R. 24 W., at road leading north on half-section line, NE. cor. street intersection; chiseled square in top of concrete crosswalk at gutter crossing, marked "1001.4"	1,000.47	Bull. 569
Story City, NE. part of, near center of sec. 12, T. 85 N., R. 24 W., 1 block north of Main St., at SW. cor. high-school building; iron post stamped "1000"	998.864	Bull. 569
Story City, T. 85 N., R. 24 W., SW. cor. sec. 1, road crossing C&NW Ry, NE. cor. intersection; top of bolthead at SE. cor. bridge No. 2205", marked "1019.3"	1,018.35	Bull. 569
Story City, T. 85 N., R. 24 W., east center of sec. 2, SW. cor. crossing; top of bolthead at north end of guard-rail of railroad bridge 2205, marked "1024.9"	1,024.01	Bull. 569
Stout	1025	C&NW
Stowes Ranch station	874.55	DM&CI
Strahan	1128	WRR
Stratford	1113,G1116	C&NW
Stratford, 1.5 miles south by 2 miles west of, T. 86 N., R. 27 W., north center of sec. 23, inside of fence corner, SE. cor. crossroads; iron post stamped "1111"	1,110.058	Bull. 569
Stratford, T. 86 N., R. 27 W., near north center of NW. ¼ sec. 22, SW. cor. road forks at T road south; copper nail in corner fence post, marked "1106.9"	1,105.93	Bull. 569
Stratford, T. 86 N., R. 27 W., near north center of sec. 21, east end of south side of steel highway bridge over Des Moines river; painted bolthead in top of southeast circular pier, marked "920.5"	919.55	Bull. 569
Stratford, 2.5 miles east by 3 miles south of, T. 86 N., R. 26 W., NW. cor. sec. 34, SE. cor. crossroads, at fence corner; iron post stamped "1084"	1,082.577	Bull. 569
Stratford, T. 86 N., R. 26 W., SE. cor. sec. 27, NW. cor. crossroads; painted square on top of west end of tile drain under road north, marked "1045.4"	1,044.45	Bull. 569

Station	Elevation feet	Authority
Stratford, 1.5 miles east by 3 miles south of, T. 86 N., R. 26 W., cor. secs. 28, 29, 32 and 33, center of crossroads; chiseled square on top of stone, marked "1076.0"	1,075.00	Bull. 569
Stratford, 2.5 miles south by 1.5 miles east of, T. 86 N., R. 26 W., NE. cor. sec. 29, 60 feet south of road forks west; painted square on top of west end of tile drain under road to south, marked "1074.3"	1,073.26	Bull. 569
Stratford, 2.5 miles south of, T. 86 N., R. 26 W., north center of sec. 30, south side of road, 55 feet west of center of road at forks north, at fence corner; iron post stamped "1121"	1,120.101	Bull. 569
Stratford, T. 86 N., R. 27 W., 0.1 mile west of south center of sec. 24, 280 feet east of house on north side of road; chiseled square on top of stone at north end of drain under road, marked "1124.9"	1,123.94	Bull. 569
Stratford, T. 86 N., R. 27 W., south center of sec. 23, at T road east, west side of road; copper nail in base of corner fence post, marked "1128.1"	1,127.10	Bull. 569
Strawberry Point	1213	CM&StP
Strawberry Point, T. 91 N., R. 6 W., quarter corner north side sec. 21; iron post stamped "1221 DBQ"	1,222.344	Bull. 569
Strawberry Point, in front of CM&StP Ry station; top of rail	1,217.2	Bull. 569
Strawberry Point, T. 91 N., R. 7 W., NE. cor. sec. 21, in school yard; iron post stamped "114 DBQ"	1,114.811	Bull. 569
Struble	1261	GN
Stuart	1205,G1207	CRI&P
Stuart	G1216	Weather Bur.
Stuart, in NW. cor. station grass plat, 300 feet west of station, 60 feet north of track, 1 foot east of sidewalk; iron post	1,210.150	Bull. 569
Stuart, in front of CRI&P Ry station; top of rail	1,208.0	Bull. 569
Stuart, in stone water table of high school, about 6 feet east of entrance; aluminum tablet	1.206.045	Bull. 569
Stulta	770,G774	CM&StP
Sugar Creek—Base rail bridge 71 (1-155 ft. T.L.T) north end	511.2	CRI&P
Sugar Creek, top of monument M.P. 5	501.38	CRI&P
Sugar Creek, top of monument M.P. 6	504.81	CRI&P
Sugar Creek, top of monument M.P. 7	512.72	CRI&P
Sugar Creek, top of monument M.P. 9	513.84	CRI&P
Sully	929	M&StL
Sulphur Springs	1311,G1311	IC
Summerset	788,G794	CRI&P
Summerset, Middle river near	775	IaGS
Summerset Junction	786,G791	CRI&P
Summit, Fremont Co.	1048	WRR
Summit, Guthrie Co.	1148	CM&StP
Summit, Muscatine Co.	713,G718	CRI&P
Summit, Story Co.	1056	IaGS
Summit, Gary Moraine near	1075	IaGS
Summitville	674.2,G674	CB&Q
Sumner	1063.6,G1063	CGW
Sunbury	765	CRI&P
Sunnyside	1104	CRI&P
Superior	1501	CRI&P
Sutherland	1427,G1424	C&NW
Sutherland, crossing IC	1473	C&NW
Swaledale	1148.6	CGW
Swan, 100 feet south of, 55 feet west of track, 5 feet south of sidewalk, in corner of grass plot; iron post stamped "772 Adj"	771.050	Bull.569

Station	Elevation feet	Authority
Swan, in front of CB&Q RR station; top of rail	763.3	Bull.569
Swan	758.9,G762	CB&Q
Swan, South river, RR bridge west of	761.88	CB&Q
Swan, South river, level of, at RR bridge	735	IaGS
Swanwood	919	FtDDM&S
Swanwood	960	CRI&P
Swanwood Junction	923	CRI&P
Swea City	1187,G1174	CRI&P
Sweetland	741.07	CD&M
Sweetland, Muscatine Co., T. 77 N., R. 1 W., near center of south line NW. ¼ sec. 2, on telegraph road, south end of east steel floor beam of bridge over Pine creek; painted square, marked "637.65"	637.77	Bull.569
Sweetland, T. 77 N., R. 1 W., about quarter corner between secs. 2 and 3; T road south, marked "665.6"	666	Bull.569
Sweetland, T. 77 N., R. 1 W., near NW. cor. SW. ¼ sec. 3, on south side of road, 30 feet west of telegraph pole 485, 10 feet east of north-south fence line, in base of brace post; copper nail marked "748.26"	748.39	Bull.569
Sweetland, T. 77 N., R. 1 W., NE. cor. NW. ¼ sec. 9, SW. cor. crossroads, 5 feet west of fence corner, 1 foot north of fence; iron post stamped "752"	752.651	Bull.569
Sweetland, T. 77 N., R 1. W., SW. cor. SE. ¼ sec. 9, NE. cor. crossroads, on north concrete head wall of drain; chiseled square marked "741.84"	742.00	Bull.569
Sweetland, T. 77 N., R. 1 W., NE. cor. NW. ¼ sec. 21, SW. cor. crossroads, west end of cast-iron drainpipe; painted square, marked "723.31"	723.48	Bull.569
Sweetland, T. 77 N., R. 1 W., about center of SW. ¼ sec. 21, south tree of row of four maple trees on north side of walk leading to Mr. Sabbath's residence; in root of tree; copper nail marked "731.63"	731.81	Bull.569
Swisher, top of rail on south line sec. 32, Tp. 82, R. 7, at SW. cor. sec. 32	843.00	CR&IC
Swisher, bench mark, notch cut in top of water table on SW. cor. of substation	799.13	CR&IC
Swisher, top of rail at same location as above	797.80	CR&IC
Swisher, top of rail on south line sec. 8, Tp. 81, R. 7, 1750 feet east of SW. cor. sec. 8	765.90	CR&IC
Tabor, top of rail	1249.72	T&N
Tabor	1240	IaGS
Taintor	884	M&StL
Talmage	1076.5,G1072	CGW
Tama	819,G820	C&NW
Tama, crossing CM&StP	819	C&NW
Tama	822,G819	CM&StP
Tama, crossing C&NW main line	819,G816	CM&StP
Tara, union station with M&StL	1146,G1153	IC
Tara, crossing M&StL	1150,G1153	IC
Tara	1147	M&StL
Tara, 2.5 miles north of, T. 89 N., R. 29 W., near center of sec. 8. at road crossing, 100 ft. SE. of crossing, 60 ft. S. of bridge, on W. side of small creek; copper nail and washer. in root of 8-inch oak tree, marked "1,088.9"	1,088.82	USGS
Tara, 2.5 miles north of, east rail at crossing (line follows highways E. 1.89 miles from this point)	1,093.15	USGS
Tara, T. 89 N., R. 29 W., center of sec. 9, 25 ft. S. of road center, on fence line, in base of telephone pole, marked "1,114.1"; spike	1,113.97	USGS
Tara, T. 89 N., R. 29 W., center of sec. 10, T. road N., 50 ft. NE. of road fork; iron post stamped "IOWA 1919 1,109"	1,108.456	USGS

Station	Elevation feet	Authority
Tara, T. 89 N., R. 29 W., center of sec. 27, at T road south, 40 ft. NW. of road forks, in base of gate post, marked "1,127.8"; spike	1,127.61	USGS
Tara, T. 89 N., R. 29 W., quarter corner, west side of sec. 27, 250 feet north of T road east, 25 feet NW. of railway crossing, in base of railway sign post, marked 1,119.5"; spike	1,119.46	USGS
Taylor	892.95	DM&CI
Teeds Grove	683,G685	CM&StP
Templeton	1431	CM&StP
Tennant	1271.4	CGW
Terril	1415,G1417	M&StL
Thayer	1101,G1104	CB&Q
Thompson	1272,G1259	CRI&P
Thor	1150,G1152	C&NW
Thor, T. 91 N., R. 27 W., at cor. secs. 25, 26, 35 and 36, in top of concrete step to west entrance to Fairview schoolhouse; chiseled square painted "1,133.3"	1,133.23	USGS
Thor, T. 91 N., R. 27 W., at cor. secs. 23, 24, 25 and 26, in south wingwall to west abutment of steel bridge over large ditch; chiseled square painted "1,122.1"	1,122.05	USGS
Thor, T. 91 N., R. 27 W., near cor. secs. 13, 14, 23 and 24, 49.9 feet due south of the below iron post, in east end of concrete culvert	1,136.58	USGS
Thor, 3 miles east of, T. 91 N., R. 27 W., at cor. secs. 13, 14, 23 and 24, in SW. cor. schoolyard at crossroads; iron post stamped "Iowa 1921"	1,134.223	USGS
Thor, T. 91 N., R. 27 W., center sec. 14, 60 feet east by 20 feet north of junction of T road north, in root of soft maple tree (14 inches in diameter); copper nail and washer marked "U.S.G.S.B.M." T.B.M. 1,141.4	1,141.36	USGS
Thor, T. 91 N., R. 27 W., 0.3 mile north of quarter cor. between secs. 11 and 14, on east side of road, in NW. cor. willow grove, in root of willow tree (12 inches in diameter); copper nail and washer marked "U.S.G.S.B.M." T.B.M. 1,134.2	1,134.20	USGS
Thor, T. 91 N., R. 27 W., quarter cor. between secs. 2 and 11, 250 feet east of center of crossroads, in south wingwall of west abutment of steel bridge over large ditch; chiseled square, T.B.M. 1,130.9	1,130.90	USGS
Thor, T. 92 N., R. 27 W., at south quarter cor. sec. 35, 570 feet east of junction of T road south, near SW. cor. of Mr. Henry Harvey's yard, in root of willow tree (14 inches in diameter); nail in washer marked "U.S.G.S. B.M." T.B.M. 1,148.6	1,148.62	USGS
Thornburg	869,G878	CRI&P
Thornburg Junction	859	CRI&P
Thornton	1191.3,G1192	CGW
Thorpe	1046.0,G1046	CGW
Thorpe, T. 90 N., R. 5 W., SW. cor. sec. 21; iron post stamped "1016 DBQ"	1,017.270	Bull.569
Thrall	1141,G1144	C&NW
Ticonic	1090,G1089	IC
Tiffin	684,G687	CRI&P
Tileville, abandoned	G1072	CRI&P
Tilton	823	C&NW
Tingley	1252,G1251	CB&Q
Tioga	808	C&NW
Tipperary, 0.5 mile north by 0.5 mile east of, T. 73 N., R. 20 W., sec. 22, 0.25 mile north by 0.25 mile east of center of, in SW. angle T road south, 4 feet west of corner		

Station	Elevation feet	Authority
post; iron post stamped "Iowa 986, 1913"; Prim. Trav. Sta. 13	986.636	Bull.569
Tipton	806,G807	CRI&P
Titonka	1162	CRI&P
Titus	765,G769	CM&StP
Toddville	771,G780	CRI&P
Toeterville	1200,G1209	IC
Togo	1103.6	CB&Q
Toledo	848,G852	C&NW
Toledo	G856	Weather Bur.
Toronto	732,G720	CM&StP
Tower 307	808	CB&Q
Tracy, Des Moines line	715.5,G717	CB&Q
Tracy, Oskaloosa line	710	CB&Q
Tracy, crossing Wabash	710	CB&Q
Tracy, RR bridge over Walnut creek south of	702.34	CB&Q
Tracy, bed of Walnut creek at RR bridge south of	680	IaGS
Tracy	729	WRR
Tracy, hexagonal bolthead on downstream side of east or left bank pier of Bellefontaine highway bridge over Des Moines river (U.S.C.E.b.m. 69)	694.48	Bull 569
Tracy, below, 2 feet from point of north end of east pier of CB&Q RR bridge (U.S.C.E.b.m. 70)	689.42	Bull 569
Tracy, T. 75 N., R. 18 W., 0.25 mile north of SW. cor. sec. 30, on north side of road near SW. cor. Vigilance School grounds; iron post stamped "886 Iowa"	884.979	Bull 569
Tracy, T. 75 N., R. 18 W., center of sec. 29, T corner, on highest point of rock at intersection; painted square	836.60	Bull 569
Tracy, T. 75 N., R. 18 W., 0.25 mile east of quarter corner on west side of sec. 27; iron post stamped "849 Iowa"	847.652	Bull 569
Tracy, T. 75 N., R. 18 W., 0.5 mile north of SE. cor. sec. 26, T corner, at side of road; stone	757.70	Bull 569
Tracy, 2 blocks south of CB&Q RR station, north side of street, 3 feet south of fence, 60 feet east of CB&Q RR track; iron post stamped "730 Iowa" (Junction point)	728.302	Bull 569
Tracy, 0.5 mile east of, railroad crossing; north rail	694.94	Bull 569
Tracy, 3.5 miles east of, east of wagon road, railroad crossing; top of south rail	704.62	Bull 569
Tracy, Tps. 74 and 75 N., R. 17 W., cor. secs. 5, 6, 31 and 32, in SW. angle of roads at T road south, 25 feet west by 1 foot north of fence corner, in top of concrete post; bronze tablet stamped "E.B. No. 9 1924 Iowa", painted "U.S.B.M. 810.8"	810.724	USGS
Tracy, reference mark, 30 feet east by 1 foot north of tablet, in top center on east end of concrete retaining wall to metal culvert under road; chiseled square	809.06	USGS
Tracy, T. 75 N., R. 17 W., near center of sec. 31, 3 feet south of SW. cor. steel bridge over Cedar creek, in top of stone retaining wall; chiseled square, painted "U.S. B.M. 697.0"	696.93	USGS
Tracy, about 1 mile east of, at road crossing CB&Q RR; top of north rail	695.0	USGS
Tracy, about 1 mile east of, in NW. angle of roads, at T road west, 5 feet north by 1 foot east of corner fence post, driven in ground; top of 0.75-inch gas pipe, painted "U.S.B.M. 691.0"	690.97	USGS
Tracy, on downstream side of east (left bank) pier of Bellefontaine highway bridge over Des Moines river, 0.2 feet above surface of pier; top of hexagonal bolthead, marked with chiseled cross (U.S.C.E.B.M. 69=696.16, see Bull. 569, p. 118)	694.482	USGS
Tracy, reference mark is 157 feet S. 70° E. of B.M., on		

Station	Elevation feet	Authority
east bank of river, in root on NE. side of 3-foot elm tree; copper nail and washer	686.73	USGS
Tracy, T. 75 N., R. 17 W., in SW. ¼ SE. ¼ sec. 20, 50 feet west and 20 feet north of angle in road, in bench on south side of 1-foot maple tree; copper nail and washer	685.35	USGS
Traer	921,G916	CRI&P
Traer, crossing C&NW	915	CRI&P
Traer	891	C&NW
Traer, crossing CRI&P	891	C&NW
Trask	998,G1001	CM&StP
Trask, crossing under ISU	937,G941	CM&StP
Trask, ISU track	G965	CM&StP
Trask	1010	ISU
Tripoli	1015.5	CGW
Troy	881,G878	CB&Q
Truax	714	C&NW
Truesdale	1359,G1360	M&StL
Truro	1077	CB&Q
Tuckers	972.71	DM&CI
Turin	1048	C&NW
Turkey River	622,G623	CM&StP
Turkey River Junction, opposite CM&StP Ry station; base of rail (U.S.C.E.b.m.)	621.66	Bull. 569
Turkey River Junction, on Island 189, 400 meters above its foot, 75 meters from right bank of Cassville slough, 100 meters below mouth of small slough which empties into Cassville slough, on small clearing on ridge; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 189/2):		
Copper bolt	605.01	Bull. 569
Cap on pipe	608.97	
Turkey River Junction, opposite a point 0.5 mile above foot of Island 189, on right bank of Guttenberg channel, 50 meters below head of small slough and 10 meters back from bank of river; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 189/3):		
Copper bolt	603.73	Bull. 569
Cap on pipe	607.68	
Turkey River station, 0.5 mile above, on right of way of CM&StP Ry, 0.5 meter from north fence, 8.5 rail lengths above a sign "Turkey River Stop Junction"; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 189/4):		
Copper bolt	607.00	Bull. 569
Cap on pipe	610.97	
Turkey River Junction, on Island 189, on high ridge 80 meters from left bank of Guttenberg Channel, 25 meters above patch of trees and willows along river bank; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 190/3):		
Copper bolt	608.37	Bull. 569
Cap on pipe	612.31	
Turkey River Junction, 1,689 feet below station, 1,660 feet above milepost 90, 50 feet above very large and prominent bowlder on west side of track, 328 feet above farmhouse at point of woods on river side of track, 15 feet west of center, on ledge of rock, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 258)	623.119	Bull. 569
Turkey River Junction, 1,148 feet above station, at upper end of CM&StP Ry bridge 212, over Turkey river, on west end of pier, carrying also t.b.m. 257, 14 inches east		

Station	Elevation feet	Authority
from extreme point of rounding capstone; copper bolt marked "U.S.⊙P.B.M." (U.S.C.E.p.b.m. 252)	616.498	Bull. 569
Turkey River Junction, on line of CM&StP Ry, on upper stone pier of bridge 212, on west side of track, 9 feet from west end of pier and 7 inches back from its north face; highest point in square, marked "U□S" (U.S.C. E.t.b.m. 257)	616.485	Bull. 569
Turkey River Junction, 1,552 feet above bridge 212, on line of CM&StP Ry, 118 feet above cattle guard, 249 feet below sign "Turkey River Junction, stop," 13 feet west of center of track, 23 feet below t.b.m. 257, 2 feet above grade of ties, in ledge of rock, marked "U.S. ⊙P.B.M."; copper bolt (U.S.C.E.p.b.m. 251)	626.403	Bull. 569
Turkey River Junction, 738 feet above switch, 1,575 feet above CM&StP Ry bridge 212 over Turkey river, 8 feet west from center of track, 2 feet above grade of track, on natural ledge of rock, marked "U□S" on its face; highest point in square (U.S.C.E.t.b.m. 256)	624.681	Bull. 569
Turkey River Junction, on north side of river, 1.8 miles above point of bluff at CM&StP Ry, 331 feet below mile-post 87 (from LaCrosse), 12 feet west of center of track, on ledge of rock, marked "U□S"; highest point in square (U.S.C.E.t.b.m. 254)	630.694	Bull. 569
Turkey River Junction	623,G622	CM&StP
Turner	906,G908	CRI&P
Turners Park, top of rail on south line sec. 8, Tp. 82 N., R. 7, 1350 feet west of SE. cor. sec. 8	777.90	CR&IC
Turnout	754,G756	CRI&P
Tuskego	1172,G1175	CB&Q
Twin Springs	740.0	CGW
Tyrells Spur	1206	CRI&P
Tyrone	825	CB&Q
Tyrone, T. 72 N., Rs. 18 and 19 W., north sixteenth corner between secs. 25 and 30, 165 feet N. and 1 foot W. of old position at NE. cor. of intersection of T road east; iron post marked "Prim. Trav. Sta. No. 8 Iowa 1914", stamped "E.b. No. 1 1924 Iowa." As reset 1926 by C. V. Bair	974.050	USGS
Tyrone, reference mark, 40 feet west of P.B.M., on west side of road, 8 inches east of corner fence post; 1-inch gas pipe projecting 3 inches above ground, painted "984.0"	983.98	USGS
Tyrone, T. 72 N., R. 18 W., about 0.2 mile SW. of NE. cor. sec. 30, at right angle bend in SE. angle of road, 5 feet east of corner fence post; gas pipe projecting 3 inches above ground, painted "U.S. 983.7"	983.65	USGS
Tyrone, T. 72 N., R. 18 W., near center of NE. ¼ sec. 29, north side of road, in south root of 48-inch cottonwood tree; copper nail and washer, painted "U.S. 980.2"	980.17	USGS
Tyrone, concrete bridge near above location, north rail of, painted circle "936.2"	936.2	USGS
Tyrone, T. 72 N., R. 18 W., about 0.38 mile east of NW. cor. sec. 28, north side of road, east side of driveway to house, in south base of 28-inch cottonwood tree; copper nail and washer, tree is painted "976.9"	976.84	USGS
Udell	985,G996	CRI&P
Udell	997	WRR
Udell, crossing over CRI&P	1007	WRR
Uhls Crossing	933.25	DM&CI
Ulmer	1268,G1252	IC
Underwood	1073,G1078	CRI&P
Underwood	1061,G1065	CM&StP

STATION	ELEVATION FEET	AUTHORITY
Underwood, 50 feet west of track, 15 feet south of first road crossing track south of station, 50 feet SW. of telegraph pole 483-21; iron post	1,073.973	Bull. 569
Underwood, in first concrete culvert south of station, 20 feet east of CRI&P Ry track, near telegraph pole 483-24 ''G''; aluminum tablet	1,072.536	Bull. 569
Underwood; in front of CRI&P station; top of rail	1,077.4	Bull. 569
Union	940,G933	M&StL
Union, 3 miles south of, river level at Hardin-Marshall Co. line	910	IaGS
Unionville	925,G936	CRI&P
Urbana, M.P. 36, subgrade	901.25	WCF&N
Ute	1202,G1205	CM&StP
Ute, crossing C&NW	1178	CM&StP
Ute	1166	C&NW
Vail	1257,G1260	C&NW
Valdora	1047	CM&StP
Valeria	859.3,G855	CGW
Valeria, T. 80 N., R. 21 W., at quarter corner between secs. 14 and 23, 20 feet east of T road west, on concrete post; bronze tablet stamped ''Prim. Trav. Sta. No. 19-L.S.-1924-Ia.'', marked ''862.3''	862.454	USGS
Valeria, reference mark is 158 feet S. 20° W. of L.S. No. 19, top of west heading of concrete culvert; chiseled square	860.52	USGS
Valeria, T. 80 N., R. 21 W., near corner of secs. 15, 16, 21 and 22, 370 feet east of crossroads, top of east end of north heading of concrete bridge; chiseled square marked ''887.7''	887.89	USGS
Valeria, T. 80 N., R. 21 W., near corner of secs. 16, 17, 20 and 21, 55 feet south and 25 feet east of T road south, in root on north side of 2-foot maple tree; copper nail and washer, marked ''951.6''	951.76	USGS
Valeria, T. 80 N., R. 21 W., at cor. secs. 17, 18, 19 and 20, 730 feet west and 115 feet north of station at Valeria, 25 feet south and 25 feet east of T road north, 1.5 feet south of wire fence, on concrete post; bronze tablet stamped ''W.R.B. No. 1'' marked ''877.0''	877.147	USGS
Valeria, reference mark is 635 feet east of ''W.R.B. No. 1'', top of east end of south railing of concrete culvert; chiseled square	857.98	USGS
Valeria, T. 80 N., Rs. 21 and 22 W., at cor. secs. 13, 18, 19 and 24, in NE. angle of crossroads, top of east end of iron tube; painted square, marked ''803.4''	803.53	USGS
Valley Junction, CRI&P station	818	M&StL
Valley Junction	811,G814	CRI&P
Valley Junction, 150 feet north of track, opposite point 180 feet east of station, in fence corner; iron post	811.271	Bull. 569
Valley Junction, in front of CRI&P station; top of rail	812.9	Bull. 569
Valley Junction, 1 mile east of, 70 feet south of track, 100 feet west of right-of-way gate; iron post	805.924	Bull. 569
Valley Junction, in foundation of public school, 1 foot west of entrance door; aluminum tablet stamped ''821 Adj 1903''	819.615	Bull. 569
Vancleve	1059,G1045	M&StL
Van Horne	946,G943	CM&StP
Van Meter, 60 feet north of track opposite west end of station, in grass plat, opposite a point about halfway between station and water tank, 20 feet north of road, near Main Street crossing; iron post	872.406	Bull. 569
Van Meter, in front of CRI&P Ry station; top of rail	873.5	Bull. 569

Station	Elevation feet	Authority
Van Meter, 1.25 miles east of, in SW. abutment of bridge 358; aluminum tablet	861.901	Bull. 569
Van Meter, T. 78 N., R. 27 W., NW. cor. sec. 10, 20 feet west of, 4 feet north of corner fence post by roadside; iron post stamped "983"	981.357	Bull. 569
Van Meter	870,G874	CRI&P
Van Wert, Des Moines line	1166	CB&Q
Van Wert, Shenandoah line	1158,G1155	CB&Q
Van Wert, crossing Des Moines line	G1157	CB&Q
Varina	1258,G1261	CM&StP
Ventura	1256,G1263	CM&StP
Veo	750	CB&Q
Verdi	665	CRI&P
Vernon	670	CRI&P
Victor	802,G805	CRI&P
Victoria (milk platform)	1117.2	CGW
Viele	542,G541	CB&Q
Viele, 1 mile south of, in top of west end of south abutment of CB&Q RR bridge over Panther creek; copper bolt marked "U.S.P.B.M." (U.S.C.E.p.b.m. 4)	543.293	Bull. 569
Viele, 0.5 mile below, in NE. cornerstone of middle pier of CB&Q RR bridge over Sugar creek; copper bolt marked "U.S.P.B.M." (U.S.C.E.p.b.m 5)	537.361	Bull. 569
Viele, 0.5 mile north of, in top of stone abutment of CB&Q RR bridge over Little Devil creek; copper bolt marked "U.S.P.B.M." (U.S.C.E.p.b.m. 6)	542.318	Bull. 569
Village Creek, Allamakee Co., T. 93 N., R. 3 W., at quarter corner east side sec. 31, near NW. cor. fence post of cemetery; iron post stamped "1148 DBQ"	1,149.940	Bull. 569
Village Creek, near NW. cor. schoolhouse; iron post stamped "646 DBQ"	647,072	Bull. 569
Villisca	1050,G1050	CB&Q
Villisca	G1050	Weather Bur.
Vincennes, SW. ¼ sec. 22, T. 66 N., R. 6 W., in NW. cor. foundation of house of R. Sargent; aluminum tablet stamped "555A"; as accepted in 1926 by U.S.C.E. from Keokuk	555.597	Bull. 569
Vincent	1134.4,G1139	CGW
Vincent, 1.5 miles north by 1.5 miles west of, T. 90 N., R. 27 W., cor. secs. 8, 9, 16 and 17, 35 feet NE. of center of crossroads; iron post stamped "1,128 IOWA 1919"	1,128.065	USGS
Vincent, T. 90 N., R. 27 W., corner of secs. 9, 10, 15 and 16, at T road S., 35 ft. SE. of road fork, in base of corner fence post, marked "1,127.8": spike	1,127.60	USGS
Vincent, 1.5 miles north of, T. 90 N., R. 27 W., quarter corner, S. side of sec. 10, 75 ft. NE. of crossroads; in root of large willow tree, marked "1,131.5"; copper nail and washer	1,131.30	USGS
Vincent, T. 90 N., R. 27 W., T road west, south center of sec. 11, 30 feet NW. of road fork, in base of corner fence post, marked "1.142.1"; spike	1,141.89	USGS
Vincent, T. 90 N., R. 27 W., at quarter cor. secs. 2 and 11, 60 feet south by 30 feet east of center of T road junction south, in root of soft maple tree (10 inches in diameter); copper nail and washer marked "U.S.G.S.B.M."	1,138.53	USGS
Vincent, T. 90 N., R. 27 W., near SW. cor. sec. 2, 201 feet due west of post (Prim. Trav. Sta. No. 13), in north fence line of east and west road, in root of cottonwood tree (24 inches in diameter); copper nail and washer marked "U.S.G.S.B.M."	1,133.45	USGS
Vincent, T. 90 N., R. 27 W., near cor. secs. 1, 2, 11 and 12,		

STATION	ELEVATION FEET	AUTHORITY
at school yard, NE. cor. of road intersection; iron post stamped "Prim. Trav. Sta. No. 13 1919"	1,131.649	USGS
Vincent, Tps. 90 and 91 N., R. 27 W., at cor. secs. 1, 2, 35 and 36, in SE. cor. of sec. 35, NW. cor. of crossroads, in concrete foundation supporting cor. of fence post; chiseled square "1,124.2"	1,124.23	USGS
Vining	861,G857	CM&StP
Vining	G810	Weather Bur.
Vinton	804,G810	CRI&P
Viola	873,G874	CM&StP
Volga City	795,G794	CM&StP
Volga City, at CM&StP crossing; top of rail	789.9	Bull. 569
Volga City, in SE. cor. school yard; iron post stamped "794 DBQ"	795.143	Bull. 569
Volga City, T. 93 N., R. 6 W., NE. ¼ sec. 21, SE. cor. school yard; iron post stamped "1147 DBQ"	1,148.733	Bull. 569
Volney, Allamakee Co., T. 96 N., R. 5 W., 700 feet east of quarter corner west side sec. 23, north side of Hickory Creek, 80 feet SW. of NW. cor. bridge 16, south side of road; iron post stamped "787 DBQ"	787.791	Bull. 569
Volney, T. 96 N., R. 4 W., south of quarter corner west sec. 8, on summit of hill north of Yellow river; iron post stamped "1099 DBQ"	1,100.680	Bull. 569
Voorhies	997	C&NW
Wabash Junction	881	CB&Q
Wadena, in front of CM&StP Ry station; top of rail	873.9	Bull. 569
Wadena, in front of CM&StP Ry station; iron post stamped "874 DBQ"	874.485	Bull. 569
Wadena	875	CM&StP
Wadleigh, M.P. 388	1170	IC
Wagner	956	FtDDM&S
Walcott	727,G730	CRI&P
Walford	801,G806	CM&StP
Walker	882,G890	CRI&P
Wallingford	1282	CRI&P
Wall Lake	1232,G1233	C&NW
Wall Lake	1231,G1232	IC
Walnut, 300 feet south of track opposite point on track 300 feet west of station, 5 feet SW. of second telegraph pole south of track; iron post	1,285.285	Bull.569
Walnut, in front of CRI&P station; top of rail	1,294.8	Bull.569
Walnut, 2.5 miles east of, in NW. abutment of bridge 449; aluminum tablet	1,286.181	Bull.569
Walnut	1290,G1292	CRI&P
Waneta, changed to Max	1555	CM&StP
Wapello	583,G588	CRI&P
Wapello, 0.25 mile above Iowa City landing, 20 meters from west edge of swamp, 813 meters back of following-described bench mark, 9.3 meters 16° 30′ to 15-inch ash tree. 6.9 meters 79° 30′ to 15-inch willow, 6.7 meters 238° 30′ to 12-inch birch tree: copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 134/1):		
Copper bolt	529.49	Bull. 569
Cap on pipe	533.51	
Wapello, 0.25 mile above Iowa City landing, on ridge between wide sand bar and narrow slough running parallel to river, 10 meters from natural river bank. 14 meters 319° to 18-inch maple tree. 4.6 meters 63° 30′ to 24-inch cottonwood, 11.2 meters 269° to 12-inch willow tree: copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 134/2):		
Copper bolt	533.22	Bull. 569

Station	Elevation feet	Authority
Cap on pipe	537.22	
Wapello, 0.25 mile above Iowa City landing, 10 meters from bank just north of dry slough, 17.5 meters 43° to 12-inch black oak, 8.7 meters 297° to 15-inch black oak; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 134/3):		
Copper bolt	530.46	Bull. 569
Cap on pipe	534.46	
Wapello, 0.25 mile above Iowa City landing, on top of old embankment, apparently a railroad dump, 970 meters back of bench mark 134/3, on line with bench marks 134/2 and 134/3, 9.3 meters 283° to 15-inch cottonwood tree, 9 meters 38° 30′ to 15-inch cottonwood, 2.6 meters 176° to 20-inch cottonwood tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 134/4):		
Copper bolt	540.05	Bull. 569
Cap on pipe	544.07	
Ware	1287,G1285	CRI&P
Warren	707,G707	CB&Q
Washburn	833,G827	CRI&P
Washington	755,G746	CB&Q
Washington	754,G765	CRI&P
Washington, crossing CM&StP	754	CRI&P
Washington	756	CM&StP
Washington, crossing CRI&P	753	CM&StP
Washington	G769	Weather Bur.
Washington Mills	799,G797	CM&StP
Washington Mills, sec. 1, T. 86 N., R. 1 E., south side of road crossing north line of CM&StP Ry, fence corner near William Cannon's gate, 20 feet SE. of cattle guard; iron post stamped "868"	858.444	Bull. 569
Washta	1158,G1157	IC
Wassonville mill	706	IaGS
Waterloo, East, track junction at Newell St., subgrade	873.49	WCF&N
Waterloo, crossing under CGW, subgrade	847.2	WCF&N
Waterloo, crossing CGW, top of rail	868.37	WCF&N
Waterloo, crossing IC, subgrade	843.94	WCF&N
Waterloo, crossing IC, top of rail IC track	844.89	WCF&N
Waterloo, 4th and Mulberry Sts., top of rail	842.82	WCF&N
Waterloo	849,G852	IC
Waterloo, crossing CGW	847,G852	IC
Waterloo, crossing WCF&N	852	IC
Waterloo, crossing CRI&P	G852	IC
Waterloo, East Belt Junction	847	IC
Waterloo, West Belt Junction	853	IC
Waterloo, West	846.1	CGW
Waterloo, East	845.5,G845	CGW
Waterloo, Cedar river bridge	G848	CGW
Waterloo, East, crossing under IC, CGW track	848.4,G849	CGW
Waterloo, East, crossing IC track	G871	CGW
Waterloo, West, crossing CRI&P	846.6,G845	CGW
Waterloo	845,G841	CRI&P
Waterloo	G856	Weather Bur.
Waterville	833,G832	CM&StP
Watkins	814,G812	C&NW
Watson, Clayton Co., 0.2 mile NW. of cor. sec. 4, T. 95 N., R. 4 W., 13 feet north of corner fence post at intersection of roads; iron post stamped "1179 DBQ"	1,179.987	Bull. 569
Waubeek, paha southwest of	1040	IaGS
Waucoma	1045,G1044	CM&StP
Waukee	1030,G1032	CM&StP
Waukee, crossing M&StL	1036,G1038	CM&StP

Station	Elevation feet	Authority
Waukee	G1039	Weather Bur.
Waukee	1043,G1033	M&StL
Waukee, 35 feet SE. of NW. cor. sec. 33, T. 79 N., R. 26 W., 4 feet south of corner fence post; iron post stamped "1035"	1,033.817	Bull. 569
Waukee, Pleasant View schoolhouse, T. 79 N., R. 26 W., 35 feet NE. of NW. cor. sec. 36, 8 feet east of corner fence post, in school yard; iron post stamped "1032"	1,030.227	Bull. 569
Waukon	1216,G1216	CM&StP
Waukon, T. 97 N., R. 5 W., quarter corner west side sec. 16, just off highway, NE. cor. crossroads; iron post stamped "1218 DBQ"	1,219.328	Bull. 569
Waukon, (Iron Hill), T. 98 N., R. 5 W., 1,300 feet NE. of center sec. 17, 15 feet SE. of NW. corner post of north fence line; iron post stamped "1320 DBQ"	1,321.049	Bull. 569
Waukon Junction	630,G629	CM&StP
Waukon Junction, Island 163, planted on, on high ground in bunch of cottonwoods, 30 meters back from east shore, 100 meters above a running slough opposite foot of Island 164, 25 meters north of small dry slough; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 200/3):		
Copper bolt	615.02	Bull. 569
Cap on pipe	618.98	
Waukon Junction, 1.25 miles above, at foot of bluffs, 0.5 mile above triangulation station "Painted Rocks," in corner of fences, 1 meter west of west right of way fence of CM&StP Ry, 15 meters north of road crossing, 30 meters below bridge 456; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 200/4):		
Copper bolt	633.30	Bull. 569
Cap on pipe	637.27	
Waupeton	624,G623	CM&StP
Waupeton, Island 204, about opposite foot of, on Island 203, on lower end of island, 20 meters from river bank; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 185/2):		
Copper bolt	602.31	Bull. 569
Cap on pipe	606.25	
Waupeton, Hurricane Island, opposite head of first towhead below foot of, on south side of CM&StP Ry track, 6.5 meters north of south right-of-way fence, on prominent high ridge running out from bluff, 6 meters from and 4.5 meters higher than railroad track; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 185/3 equals △ (in circle) Rumpel):		
Copper bolt	637.29	Bull. 569
Cap on pipe	641.25	
Waupeton, 260 meters below, 187 meters below railroad bridge 172, on north face of bluff at point where it begins to curve to south, 11 meters south from center of CM&StP Ry track, 0.6 meter south from right-of-way fence; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 186/3 equals p.b.m. 258-259):		
Copper bolt	615.84	Bull. 569
Cap on pipe	619.83	
Waupeton, opposite CM&StP Ry station; base of rail (U.S.C.E.b.m.)	623.97	Bull. 569
Waupeton, 2.1 miles below, 1.2 miles below Cameron, on line of CM&StP Ry, 2,053 feet above milepost 100-61, 100 feet below very large and conspicuous piece of ledge covered with vines lying on bluff side of right of way, on		

Station	Elevation feet	Authority
bowlder marked "U□S"; highest point in square (U.S.C.E.t.b.m. 273)	626.449	Bull. 569
Waupeton, 853 feet below, 612 feet below bridge 172, on north face of bluff, at point where it begins to curve to south, 36 feet south from center of CM&StP Ry track, 2 feet south from south right-of-way fence; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 258 and 259):		
Copper bolt	615.842	Bull. 569
Cap on pipe	619.831	
Waupeton, 1,171 feet above station, 420 feet below milepost 97-64, 262 feet above bridge 174, on bluff side of track, 10 feet from center, on natural ledge of rock, about level with grade, marked "U□S" on its face; highest point in square (U.S.C.E.t.b.m. 270)	626.302	Bull. 569
Waupeton, 1.2 miles above, 593 feet below milepost 96-65, 377 feet above bridge 180K, just below prominent ledge of white rock on bluff side of track, 10 feet from center, also 146 meters below bridge 182, 2 feet above grade of track, on ledge of rock marked "U□S"; highest point in square (U.S.C.E.t.b.m. 269)	629.438	Bull. 569
Waupeton, 1.5 miles above, 1,739 feet above milepost 96-65, 122 feet above bridge 186K over Dry Hollow, on bluff side of track, 16.5 feet from center, just outside of right of way fence; copper bolt in tile surmounted by iron pipe (U.S.C.E.p.b.m. 256 and 257):		
Copper bolt	623.781	Bull. 569
Cap on pipe	627.781	
Waverly	920.3	CGW
Waverly, IC crossing	935.5	CGW
Waverly	941,G936	IC
Waverly, crossing CRI&P	943	IC
Waverly, crossing CGW	938,G936	IC
Waverly	910	CRI&P
Waverly, crossing IC	925	CRI&P
Waverly, at Ellsworth St., top of rail	918.4	WCF&N
Waverly, city datum plane	812.86	
Waverly	G948	Weather Bur.
Waverly Junction	901	CRI&P
Waverly Junction	G917	CGW
Wayland	745,G738	M&StL
Wayland Crossing	633	CB&Q
Wayne	694	CB&Q
Wayside	1006	ISU
Webb	1368	CM&StP
Webb, crossing CRI&P	1378	CM&StP
Webster	848,G858	CRI&P
Webster, crossing CM&StP	846	CRI&P
Webster	854,G859	CM&StP
Webster, crossing CRI&P	853	CM&StP
Webster City	1050.G1047	IC
Webster City, crossing C&NW	1053,G1047	IC
Webster City	1044	FtDDM&S
Webster City	1043,G1044	C&NW
Webster City, crossing IC	1053	C&NW
Weed or Herring	1227	C&NW
Weldon	1146.G1146	CB&Q
Wellman	688,G698	CRI&P
Wellsburg	1068,G1058	CRI&P
Wellston	737	CM&StP
Welton	708,G701	CM&StP
Wescott	531	CB&Q

Station	Elevation feet	Authority
Wesley	1252,G1257	CM&StP
West Bend	1203,G1197	CRI&P
West Bend	G1197	Weather Bur.
Westboro, Mo.	986	CB&Q
West Branch	714,G718	CRI&P
West Chester	963	CRI&P
West Davenport, see Davenport, West		
Westfield, Black Hawk Co.	853	CRI&P
Westfield, Plymouth Co.	1137,G1133	CM&StP
Westfield, T. 91 N., R. 48 W., sec. 6, NW. cor.; iron post stamped "Ynktn 1314"	1,313.920	Bull. 569
Westfield, 15 meters west of railway, 21 meters north of road, 6.55 meters south of NE. cor. Hopkins elevator, 0.3 meter above ground, 0.1 meter north of south edge of jasper rock, at east edge; bottom of square hole (U.S.C.&G.S.b.m. V)	1,129.926	Bull. 569
Westfield, 1 kilometer north of, 13 meters west of railway, 12 meters south of road, 1 meter west of fence, 0.3 meter below rails; copper bolt in top of stone post lettered "U.S.B.M." (U.S.C.&G.S.b.m. U)	1,129.263	Bull. 569
Westfield, 1.6 kilometers south of, 14 meters east of railway, 15 meters west of road along track, 5 meters north of road, 1 meter south and west of fences, 0.6 meter below rails; copper bolt in top of stone post lettered "U.S.B.M." (U.S.C.&G.S.b.m. W)	1,121.937	Bull. 569
Westfield, 3.2 kilometers south of, 14 meters east of railway, 12 meters west of road along track, 6 meters north of road, 0.8 meter below rails; iron pipe (U.S.C.&G.S. b.m. X)	1,127.225	Bull. 569
Westfield, 4.2 kilometers south of, 1,017 meters east of bridge over Big Sioux river, 4 meters east of private road, 14 meters south of track, on jasper rock of quartzite, roughly squared for building purposes, about 1 by 0.5 by 3 meters, set 1 meter north of fence and 0.2 meter above rails; bottom of square hole (U.S.C.&G.S.b.m. Y)	1,116.369	Bull. 569
Westfield, 5.2 kilometers south of, at east end of railway bridge over Big Sioux river, on NE. pier of central four under old railway water tank, on extreme NW. cor. of stone, at upper level, 0.4 meter above ground; bottom of square hole (U.S.C.&G.S.b.m. Z)	1,118.088	Bull. 569
Westgate	1093.4,G1092	CGW
Westgate, B.M. on doorsill of schoolhouse	G1114	USGS
West Grove	942,G942	CB&Q
West Grove	943	WRR
West Keithsburg	548	M&StL
West Keithsburg, Mississippi river	531	M&StL
West Keithsburg, 500 meters below upper end of Benton Bay, 18 meters from shore, 9.1 meters 341° 30′ to 10-inch locust, 1 meter 206° to 34-inch elm tree, 19.3 meters 73° to 20-inch elm tree, 18 meters 87° to 20-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E. b.m. 130/2):		
Copper bolt	527.77	Bull. 569
Cap on pipe	531.79	
West Keithsburg, on lower end of Island 360, 20 meters from bank of main channel, 8.2 meters 94° to 30-inch elm tree; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 130/3):		
Copper bolt	524.70	Bull. 569
Cap on pipe	528.72	
West Liberty	665,G673	CRI&P
West Okoboji	1437	CRI&P

Station	Elevation feet	Authority
Weston, 3 miles west of, 0.25 mile south of milepost 491, in concrete culvert on east side of track; aluminum tablet	1,021.296	Bull. 569
Weston, in front of CRI&P Ry station; top of rail	1,036.4	Bull. 569
Weston, 100 feet north of CRI&P Ry station, 15 feet west of track; iron post	1,037.399	Bull. 569
Weston	1033,G1035	CRI&P
Weston	1033,G1037	CM&StP
West Point	754.8	CB&Q
West Side	1324,G1326	C&NW
West Union, corner of Main and Walnut Sts., south wall of building of public school, in coping stone; aluminum tablet stamped "1186 DBQ"	1,187.570	Bull. 569
West Union, in front of CM&StP Ry station; top of rail	1,104.6	Bull. 569
West Union, at junction of CM&StP Ry with CRI&P Ry	1,106.7	Bull. 569
West Union, in front of CRI&P Ry station; top of rail	1,105.9	Bull. 569
West Union, south meridian stone in county-fair grounds; aluminum tablet stamped "1111 DBQ"	1,112.163	Bull. 569
West Union	1107	CM&StP
West Union, crossing CRI&P	1108	CM&StP
West Union	1105	CRI&P
Wever	541,G540	CB&Q
What Cheer	741,G751	CRI&P
What Cheer	762	C&NW
Wheatland	683,G671	CM&StP
Wheatland, crossing C&NW	676,G664	CM&StP
Wheatland	680,G682	C&NW
Wheatland, crossing CM&StP	675	C&NW
Wheeler	1050,G1046	CM&StP
Wheelerwood	1157	C&NW
Wheeling, 0.75 mile east of, north side of road, 120 feet west of track at road crossing; iron post stamped "910 Adj"	908.872	Bull.569
Whitebreast	1042,G1043	CB&Q
White City, T. 74 N., R. 17 W., about 700 feet east of quarter corner between secs. 35 and 36, 15 feet south of C&NW Ry track, in top center on west end of culvert under railroad; bolthead, painted "U.S.B.M. 743.4"	743.09	USGS
White City, T. 74 N., R. 17 W., near SE. cor. SW. 1/4 sec. 25, 60 feet north of road crossing C&NW Ry, on west side of road, 1 foot east of fence, driven in ground; 0.75-inch gas pipe, painted "U.S.B.M. 728.9"	728.55	USGS
White City, T. 74 N., R. 17 W., at quarter corner between secs. 25 and 26, 60 feet west by 25 feet south of center of roads, at T road north on top of high bank, in root on north side of a 1-foot elm tree; copper nail and washer, painted "U.S.B.M. 810.9"	810.58	USGS
White City, T. 74 N., R. 17 W., near quarter corner between secs. 23 and 24, 35 feet north of bridge over Big Bluff creek, on west side of road, 6 feet east of fence, in root on west side of a 3-foot elm tree; copper nail and washer, painted "U.S.B.M. 712.2"	711.83	USGS
White City, near corner of secs. 13, 14, 23 and 24, T. 74 N., R. 17 W., at road crossing C&NW Ry; top of north rail	721.03	USGS
White City, T. 74 N., R. 17 W., at cor. secs. 13, 14, 23 and 24, in NE. angle of crossroads, 7 feet north by 1 foot west of corner fence post in top of concrete post; bronze tablet stamped "E.B. No. 14 1924 Iowa", painted "U.S.B.M. 735.7"	735.392	USGS
White City, reference mark, 35 feet north of tablet on east side of road to north, 1 foot west of fence, in root on		

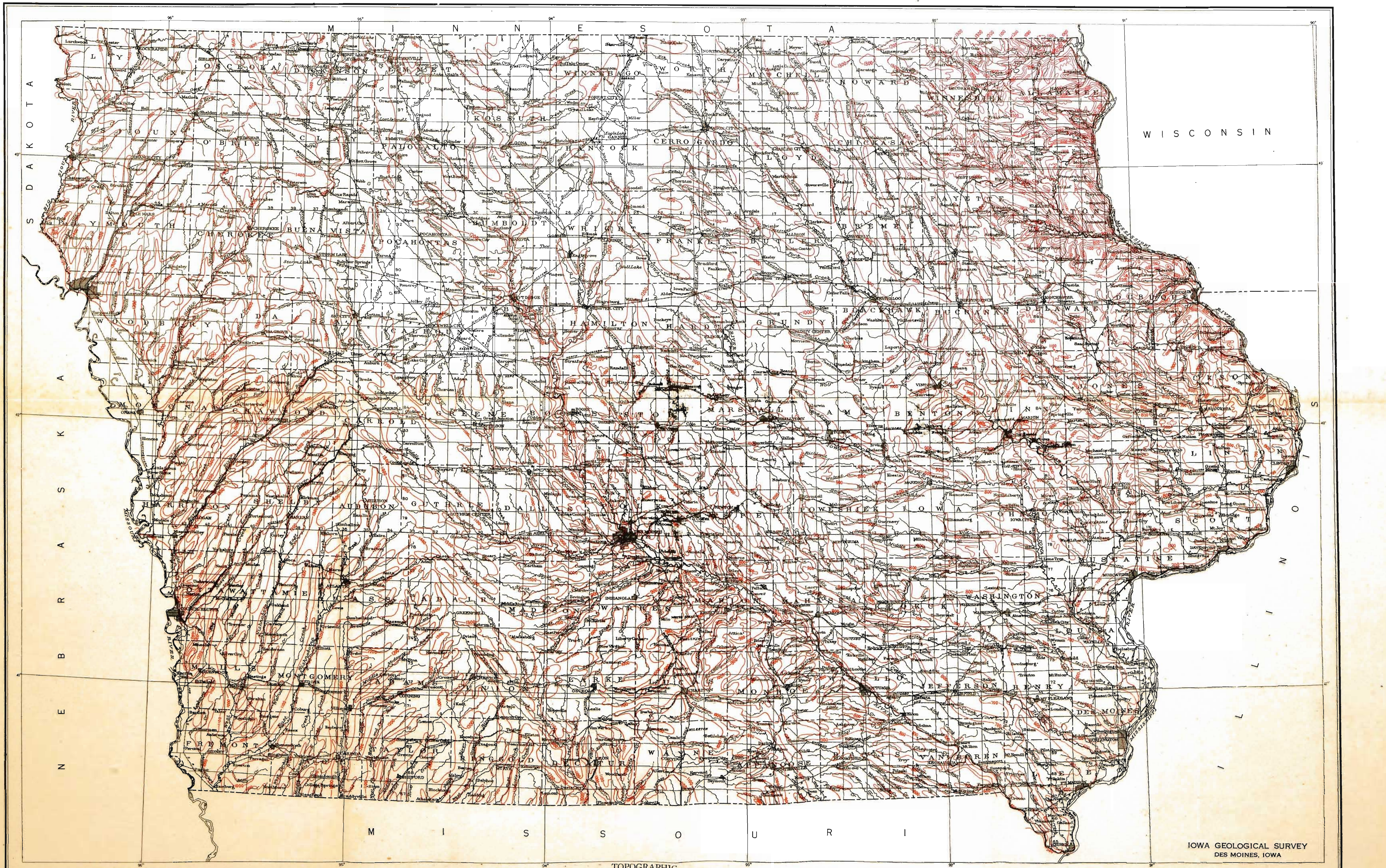
STATION	ELEVATION FEET	AUTHORITY
NE. side of 6-inch box-elder tree; copper nail and washer	734.71	USGS
White City, T. 74 N., R. 17 W., center of sec. 13, in NE. angle of roads at T road north, in top center of concrete headwall to culvert under road; chiseled square, painted "U.S.B.M. 787.0"	786.66	USGS
White City, T. 74 N., R. 17 W., at quarter corner between secs. 12 and 13, in NW. angle of crossroads, 60 feet north by 15 feet east of fence corner, in root on east side of 3-foot oak tree; copper nail and washer, painted "U.S.B.M. 843.2"	842.84	USGS
White City, T. 74 N., R. 17 W., quarter corner between secs. 1 and 12, in NW. angle of roads at T road west, 6 feet east of fence corner, 1 foot south of west end of metal culvert under road, in top of a large stone; chiseled square, painted "U.S.B.M. 740.1"	739.69	USGS
White City, Riverside Church, at forks of road just north of Eveland bridge, in NE. cor. yard; iron post stamped "Prim. Trav. Sta. No. 9, 1908 E.B. No. 15 1924 Iowa", painted "U.S.B.M. 680.8" (Bul. 569, p. 117, U.S.C.E. B.M. 54=681.30)	680.422	USGS
White City, reference mark, 65 feet south by 12 feet west of P.B.M., in SE. cor. Riverside Church yard, in root on SW. side of 2-foot maple tree; copper nail and washer	682.31	USGS
White City, Eveland highway bridge, top of upstream end second pier from north or left bank, U.S.C.E. B.M. 72 (Engineers' elevation P. 117, Bul. 569=688.13)	687.087	USGS
White Cloud	993	WRR
White Cloud, crossing CB&Q	992	WRR
White Cloud	973	IaGS
Whiting	1061,G1061	C&NW
Whiting, T. 84 N., R. 46 W., 990 feet north of SW. cor. sec. 7, opposite Blackbirds Hill, on east side of section-line road, 490 feet south of G. H. Brooks's house; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 137/2):		
Copper bolt	1,061.76	Bull. 569
Cap on pipe	1,065.81	
Whiting, T. 84 N., R. 46 W., 476 feet north of SE. cor. sec. 4, on west side of section-line road, on land owned by M. Crawford; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 137/3):		
Copper bolt	1,058.25	Bull. 569
Cap on pipe	1,062.32	
Whiting station, 2.8 miles south of, 958 feet south of milepost 44, 46 feet east of railway, 3 feet from east right-of-way fence, 6 feet south of south fence of road crossing; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 380):		
Copper bolt	1,051.186	Bull. 569
Cap on pipe	1,055.211	
Whiting station, 1,050 feet south of, 66 feet south of south headblock at Whiting, 46 feet east of railway; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 381):		
Copper bolt	1.057.058	Bull. 569
Cap on pipe	1,061.129	
Whiting station, 2.5 miles north of, 282 feet south of milepost 49, 46 feet east of railway, opposite Daley's dwell-		

Station	Elevation feet	Authority
ing; copper bolt in bench-mark stone surmounted by iron pipe (U.S.C.E.p.b.m. 382):		
Copper bolt	1,060.444	Bull. 569
Cap on pipe	1,064.460	
Whittemore	1201,G1206	CM&StP
Whitten	1040,G1041	C&NW
Wick	891	CB&Q
Wightman	1172.6,G1179	CGW
Wilke	1147,G1145	IC
Wilkins	617,G616	CM&StP
Wilkins, see also second entry under Massey		
Willett, M.P. 479	1067	IC
Willett, crossing over C&NW	1071	IC
Williams	1206,G1212	IC
Williamsburg	760,G765	CM&StP
Williamson, Adams Co.	1300	IaGS
Williamson, Lucas Co.	1022	CRI&P
Williamson, T. 73 N., R. 21 W., at center of sec. 23, at T road west, 4 feet west of NW. cor. Sam Brightwell's yard, in top of peg; copper nail	1,011.80	Bull. 569
Williamson, T. 72 N., R. 21 W., west of center of sec. 4, opposite road to east, on west side of north-south road, 1 foot north of telephone pole; in top of wooden peg; copper nail	875.17	Bull. 569
Williamson, T. 73 N., R. 21 W., north of quarter corner on south side of sec. 33, at jog in road about 0.2 mile north of township line, 1 foot east of telephone pole, in top of wooden peg; copper nail	993.12	Bull. 569
Williamson, T. 73 N., R. 21 W., at quarter corner on south side of sec. 28, opposite T road south, 40 feet NE. of intersection, 3 feet south of fence; iron post stamped ''Iowa, 974 1913''	974.338	Bull. 569
Williamson, T. 73 N., R. 21 W., cor. secs. 27, 28, 33 and 34, near center of T road north, in root of 8-inch willow tree; copper nail	987.91	Bull. 569
Williamson, T. 73 N., R. 21 W., at SE. cor. sec. 21, in NW. angle of T road west, 1 foot east of end of hedge fence, in top of osage peg; copper nail	1,019.07	Bull. 569
Williamson, T. 73 N., R. 21 W., at cor. secs. 9, 10, 15 and 16, in center of crossroads, on section stone, chiseled circle	1,009.65	Bull. 569
Williamson, T. 73 N., R. 21 W., at SE. cor. sec. 16, in NW. angle T road west in SE. cor. school yard (Center School); iron post stamped ''Iowa, 993, 1913''	993.558	Bull. 569
Williamson, T. 73 N., R. 21 W., at quarter corner between secs. 21 and 22, at T road east, in NW. cor. bridge floor, in plank; copper nail	957.97	Bull. 569
Williamson, T. 73 N., R. 21 W., at center of sec. 22, opposite T road south, on north side of east-west road, 2.5 feet south of wire gate, in top of peg; copper nail	1,009.29	Bull. 569
Williamson, T. 73 N., R. 21 W., about 0.15 mile west of SE. cor. sec. 17, at NW. cor. crossroads 33 feet west of center of crossroads, in top of charred maple stump; copper nail	,012.93	Bull. 569
Willit, Van Buren Co.	602,G601	CB&Q
Wilson	777	CRI&P
Wilton	676,G679	CRI&P
Wilton	G683	Weather Bur.
Winfield	704,G697	M&StL
Winfield, crossing CB&Q	682,G675	M&StL
Winfield	704,G698	CB&Q
Winkelmans	1056,G1058	CM&StP

Station	Elevation feet	Authority
Winslow	890,G884	CRI&P
Winterset	1117,G1118	CRI&P
Winterset	G1129	**Weather Bur.**
Winthrop	1038,G1042	IC
Wiota	1200,G1202	CRI&P
Wiota, 50 feet north of track, opposite point on track about 700 feet west of station; iron post	1,199.238	Bull. 569
Wiota, in front of CRI&P Ry station; top of rail	1,203.5	Bull. 569
Wiota, bed of Turkey creek at	1185	IaGS
Wise, crossing wagon road	986	IC
Witmer	795	CRI&P
Woden	1233	CRI&P
Wolf, B.M. spike in pole No. 646	1086.71	FtDDM&S
Wolf	1091	M&StL
Wolf, crossing FtDDM&S	1093	M&StL
Woodbine	1058,G1058	C&NW
Woodbine, crossing under IC	1044	C&NW
Woodbine	1071,G1069	IC
Woodburn	957,G961	CB&Q
Woodburn, upland south of	1100	IaGS
Woodburn, creek bed at	943	IaGS
Woodward	1060,G1065	CM&StP
Woodward, 1 mile south by 2 miles west of, at T road, north side of sec. 14, Beaver township; iron post stamped "910"	909.150	Bull. 569
Woodward, 2 miles west of, at road crossing; SE. cor. sec. 3, Beaver township; spike in base of telephone pole	950.81	Bull. 569
Woodward, 0.5 mile north by 2 miles west of, at T road, SE. cor. sec. 34, Peoples township; spike in base of fence post	1,007.94	Bull. 569
Woodward, 1 mile north by 2 miles west of, at road crossing, west side of sec. 35, Peoples township; spike in base of fence post	1,016.31	Bull. 569
Woodward, 1.5 miles north by 2 miles west of, at T road, SE. cor. of sec. 27, Peoples township; spike in base of fence post	1,038.34	Bull. 569
Woodward, 5 miles south of, at road crossing, SW. cor. sec. 31, Des Moines township; spike in base of fence post	983.61	Bull. 569
Woodward, 5 miles south by 1 mile west of, at road crossing, NW. cor. sec. 1, Sugar Grove township; spike in base of fence post	982.40	Bull. 569
Woodward, 5 miles south by 2 miles west of, at T road, NW. cor. sec. 2, Sugar Grove township; spike in base of fence post	954.08	Bull. 569
Woodward, 5 miles south by 3 miles west of, at road crossing, SE. cor. sec. 33, Beaver township; iron post stamped "955"	954.107	Bull. 569
Woodward, 4 miles south by 3 miles west of, at road crossing, SE. cor. sec. 28, Beaver township; spike in base of fence post	930.85	Bull. 569
Woodward, 3 miles west by 3 miles south of, at road crossing, NW. cor. sec. 27, Beaver township; spike in base of telephone pole	941.37	Bull. 569
Woodward, 2 miles south by 3 miles west of, at T road near school building, NW. cor. sec. 22, Beaver township; spike in base of telephone pole	961.13	Bull. 569
Woodward, 2.5 miles west by 3 miles north of, at road crossing; NW. cor. sec. 26, Peoples township; spike in base of telephone pole	1,071.49	Bull. 569
Woodward, 1.5 miles west by 2.5 miles north of, at T road, SW. cor. sec. 24, Peoples township; spike in base of fence post (map says 1067)	1,072.43	Bull. 569

Station	Elevation feet	Authority
Woodward, 0.5 mile west by 2.0 miles north of, at road crossing, east center of sec. 25, Peoples township; spike in base of telephone pole	1,058.08	Bull. 569
Woodward, 2 miles north of, at T road, center of sec. 30, Cass township; iron post stamped "1038"	1,036.898	Bull. 569
Woodward, 2 miles north by 1 mile east of, at T road, center of sec. 29, Cass township; spike in base of telephone pole	1,023.94	Bull. 569
Woolson	745.62	CB&Q
Woolstock	1088,G1090	C&NW
Workman Crossing	947	ISU
Worthington	919,G920	CM&StP
Worthington, T. 87 N., R. 2 W., center sec. 16, at SE. cor. junction of wagon roads; iron post stamped "886"	877.897	Bull. 569
Worthington, T. 87 N., R. 3 W., cor. secs. 10, 11, 14 and 15; iron post stamped "952"	943.004	Bull. 569
Worthington, T. 88 N., R. 3 W., near center NE. ¼ sec. 36, 50 feet SE. of highway bridge over Maquoketa river; iron post stamped "908"	896.874	Bull. 569
Worthington, near north line of sec. 31, T. 88 N., R. 2 W., SW. cor. A St. and Fourth Ave.; iron post stamped "931"	921.206	Bull. 569
Wren, crossing IC	1145	GN
Wren, M.P. 497	1151	IC
Wren, crossing GN	1150	IC
Wren	1148.55	C&NW
Wren, junction switch with IC	1146.7	C&NW
Wright	846	C&NW
Wright	850,G843	M&StL
Wright, crossing C&NW	840	M&StL
Wyman	728	CB&Q
Wyoming	815,G813	CM&StP
Yale	1126,G1128	CM&StP
Yarmouth	814	CB&Q
Yellow River	630,G629	CM&StP
Yellow River, Island 166, planted on, 20 meters back from shore on high ground, 600 meters above head of Island 169; copper bolt in tile surmounted by iron pipe (U.S. C.E.b.m. 198/2):		
Copper bolt	616.07	Bull. 569
Cap on pipe	620.05	
Yellow River station, 300 meters above, on south side of bluff about 0.5 mile above Yellow river, opposite a point 5 meters above headblock of switch; 15 meters west of center of railroad track; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 198/3):		
Copper bolt	655.68	Bull. 569
Cap on pipe	659.65	
Yellow River, Island 166, on high ground at west edge of garden and 30 meters below small house at north end of cultivated field, 20 meters back from shore, 15 meters south of dead 4-foot cottonwood which branches into four prongs about 12 feet above ground, opposite mouth of Paint creek, 800 meters below Government light; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 199/2):		
Copper bolt	620.10	Bull. 569
Cap on pipe	624.06	
Yetter	1214	IC
Yoder	876	CRI&P
Yorkshire	1132,G1135	CM&StP
Yorktown	1038,G1033	CB&Q

Station	Elevation feet	Authority
Young, top of rail on south line of sec. 35, Tp. 81, R. 7, 750 feet west of S. ¼ cor. sec. 35	770.70	CR&IC
Zacharys	934	CRI&P
Zaneta	911	C&NW
Zearing	1060,G1053	M&StL
Zollicoffer Lake, 150 meters above railroad station at, in right of way of CM&StP Ry, 0.5 meter from fence, at foot of bald bluff, 25 meters above upper end of curve at station; copper bolt in tile surmounted by iron pipe (U.S.C.E.b.m. 182/3):		
Copper bolt	623.54	Bull. 569
Cap on pipe	626.13	
Zumwalt	1000	FtDDM&S
[Established by Iowa State College Students]		
Zumwalt, pole A308, 1.3 feet above ground, in track side of; spike	1,021.40	Bull. 569
Zumwalt, T. 83 N., R. 24 W., spike in track side of pole A273, 1 foot above ground, pole is on south side of east-west road along north line of sec. 20	1,004.33	Bull. 569
Zumwalt station, spike in telephone pole 39 feet south of pole A253, 16 feet west of center line of track, 1 foot above ground	983.91	Bull. 569
Zumwalt, pole A225, 45 feet north of, on NE. cor. east head wall of 12-inch pipe; square cut	959.42	Bull. 569
Zumwalt, pole A195, 1 foot above ground, in track side of; spike	935.66	Bull. 569
Zwingle	893	CM&StP
Zwingle, sec. 2, T. 86 N., R. 2 E., road crossing CM&StP Ry, near west section line, 10 feet south of track; iron post stamped "921"	912.386	Bull. 569
Zwingle station, sec. 35, T. 87 N., R. 2 E., CM&StP Ry, west end of platform; iron post stamped "902"	893.977	Bull. 569



TOPOGRAPHIC

MAP OF IOWA

Scale $\frac{1}{500000}$

10 0 10 20 30 40 50 Miles

CONTOUR INTERVAL: 100 FEET

1925

AMERICAN LITHO & PTG CO DES MOINES IA

GEORGE F. KAY, DIRECTOR

Base compiled from U. S. Geological Survey atlas sheets, Land Office data, surveys by Mississippi and Missouri River commissions, county maps and other data. Used by permission of the U. S. Geological Survey.

Contour lines drawn by James H. Lees. Based on topographic maps of the U. S. Geological Survey and on profile charts of the railroad lines of Iowa.

INDEX

D