NORTH DAKOTA STATE AGENCY
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PUBLIC DOCUMENT NO. 30

FOURTH BIENNIAL REPORT

OF THE

STATE ENGINEER

TO THE

GOVERNOR OF NORTH DAKOTA

FOR THE

YEARS 1909-1910

WATER COMMISSION
FILE COPY
DO NOT REMOVE

BISMARCK:
TRIBUNE, STATE PRINTERS AND BINDERS
1910.

LETTER OF TRANSMITTAL.

Bismarck, North Dakota, Sept. 30, 1910.

Honorable John Burke, Governor.

SIR: As provided by our statutes, I have the honor to transmit herewith report of the transactions of the department of the State Engineer, from September 30, 1908, to September 30, 1910.

Very respectfully yours,

T. R. ATKINSON,
State Engineer.

LIST OF OFFICERS AND EMPLOYES IN THE STATE ENGINEER'S OFFICE.

T. R. Atkinson ..... State Engineer
J. W. Bliss ..... Assistant State Engineer
J. M. Hansen ..... Draughtsman
Ruby Schumann ..... Stenographer

FINANCIAL STATEMENT.

WARRANT ACCOUNT

FOR PROMOTION OF IRRIGATION AND DRAINAGE FROM NOVEMBER 1, 1908, TO NOVEMBER 1, 1910.

No.	Date	To Whom Issued	Amount
77139	11- 6-1908	Northern Express Co.	$ 1.30
77147	11- 6-1908	Western Union Telegraph Co.	1.45
77165	11-12-1908	T. R. Atkinson	208.33
77174	11-19-1908	Ralph Brown	4.00
77175	11-20-1909	Jay W. Bliss	54.84
77181	11-21-1908	Northern Pacific Ry. Co.	.25
77262	12- 1-1908	I. E. Schnieder	75.00
77263	12- 1-1908	Jay W. Bliss	50.00
77444	12- 7-1908	Northern Express Co.	1.30
77448	12- 7-1908	Western Union Telegraph Co.	.25
77450	12- 8-1908	T. R. Atkinson	208.33
77481	12-12-1908	A. G. Patterson, P. M.	10.00
77539	12-16-1908	T. R. Atkinson	16.95
77540	12-16-1908	T. R. Atkinson	6.60
77541	12-16-1908	Bismarck Implement Co.	6.00
77542	12-16-1908	Washburn Livery Co.	20.90
77545	12-16-1908	North Dakota Ind. Telephone Co.	.80
77595	12-18-1908	Jay W. Bliss	100.00
77640	12-21-1908	I. E. Schnieder	75.00
77749	12-26-1908	Palladium Publishing Co.	4.00
77820	1-18-1909	T. R. Atkinson	208.33
78176	1-28-1909	A. G. Patterson, P. M.	10.00
77178	1-28-1909	Jay W. Bliss	100.00
78188	1-30-1909	I. E. Schnieder	75.00
78287	2- 2-1909	Western Union Telegraph Co.	.25
78427	2- 5-1909	T. R. Atkinson	8.50
78428	2- 5-1909	Jay W. Bliss	21.50
77440	2- 6-1909	Northern Express Co.	.35
78927	2-18-1909	T. R. Atkinson	208.33
78954	2-23-1909	Jay W. Bliss	50.00
79424	3- 8-1909	Northern Express Co.	2.25
79499	3-15-1909	A. G. Patterson, P. M.	11.50
79522	3-19-1909	T. R. Atkinson	208.33
79813	3-27-1909	Eugene Dietzgen Co.	4.24
79911	3-31-1909	Jay W. Bliss	100.00
79912	3-31-1909	I. E. Schnieder	83.33
80029	4- 5-1909	Register of Deeds, McLean county	3.00
80082	4- 7-1909	Northern Express Co.	2.00
80122	4- 8-1909	T. R. Atkinson	28.01
80204	4- 9-1909	Eugene Dietzgen Co.	12.52
80205	4- 9-1909	R. D. Hoskins	50.00

WARRANT ACCOUNT—Continued.

No.	Date	To Whom Issued	Amount
80206	4- 9-1909	M. H. Jewell	50.00
80208	4- 9-1909	Washburn Livery	18.80
80935	4-23-1909	T. R. Atkinson	208.33
80951	4-23-1909	Jay W. Bliss	100.00
80973	4-26-1909	Bismarck Tribune Co.	2.00
80980	4-26-1909	Western Union Telegraph Co.	1.30
81174	4-30-1909	A. G. Patterson, P. M.	10.00
81186	5- 1-1909	I. E. Schnieder	83.33
81387	5- 5-1909	Palladium Publishing Co.	2.75
81531	5- 6-1909	T. R. Atkinson	26.85
81595	5- 7-1909	Northern Express Co.	1.15
81725	5-10-1909	Eugene Dietzgen Co.	14.64
81835	5-19-1909	T. R. Atkinson	208.33
81836	5-19-1909	Jay W. Bliss	100.00
81596	5-29-1909	J. M. Hansen	50.32
82165	6- 3-1909	I. E. Schnieder	83.33
82287	6- 5-1909	John Olegney	7.25
82288	6- 5-1909	C. A. Huntley	20.80
82289	6- 5-1909	C. A. Huntley	5.50
82405	6- 8-1909	Northern Express Co.	1.60
82427	6-11-1909	Hoskins Stationery Co.	3.45
82594	6-29-1909	Jay W. Bliss	100.00
82595	6-29-1909	I. E. Schnieder	83.33
82599	6-30-1908	Northern Pacific Ry. Co.	2.64
82641	7- 1-1909	Earl Patton	27.00
82642	7- 1-1909	Russ Asseltine	11.00
82643	7- 1-1909	A. B. Falconer	16.66
82647	7- 1-1909	Thorn Dickinson	50.00
82665	7- 1-1909	T. R. Atkinson	208.33
82788	7- 9-1909	Northern Express Co.	.60
82798	7- 9-1909	Bismarck Tribune Co.	26.00
82856	7- 9-1909	Jay W. Bliss	69.92
82857	7- 9-1909	Earl H. Patton	11.25
82858	7- 9-1909	A. C. Hinckley	11.05
82859	7- 9-1909	I. E. Schnieder	4.75
82860	7- 9-1909	Harvey Bagnell	5.00
82938	7-15-1909	T. R. Atkinson	208.33
82939	7-16-1909	A. G. Patterson, P. M.	10.00
83053	7-26-1909	North Dakota Ind. Telephone Co.	.30
83061	7-27-1909	T. R. Atkinson	8.55
83062	7-27-1909	T. R. Atkinson	22.55
83172	7-31-1909	Jay W. Bliss	100.00
87173	7-31-1909	I. E. Schnieder	83.33
83205	8- 3-1909	Western Union Telegraph Co.	10.08
83213	8- 3-1909	Western Union Telegraph Co.	.75
83214	8- 5-1909	Western Union Telegraph Co.	.25
83240	8- 7-1909	T. R. Atkinson	208.33
83254	8-10-1909	Thorn Dickinson	6.45
83255	8-10-1909	A. B. Falconer	27.42
83256	8-10-1909	Earl Patton	6.00
83389	8-14-1909	A. G. Patterson, P. M.	10.00
83442	8-20-1909	Eugene Dietzgen & Co.	10.02
83443	8-20-1909	I. E. Schnieder	83.33
83444	8-20-1909	Mandan Mercantile Co.	35.50

WARRANT ACCOUNT—Continued.

No.	Date	To Whom Issued	Amount
83445	8-20-1909	Jay W. Bliss	51.33
83446	8-20-1909	Eugene Dietzgen Co.	22.33
83589	8-26-1909	Western Express Co.	1.15
83671	8-31-1909	Jay W. Bliss	100.00
83705	8-31-1909	Chas. Hanson	80.00
83722	9- 1-1909	Earl Patton	8.00
83743	9- 7-1909	Thorn Dickinson	22.58
83799	9- 8-1909	T. R. Atkinson	8.50
83800	9- 8-1909	J. W. Bliss	33.85
83801	9- 8-1909	J. W. Bliss	48.90
83802	9- 8-1909	J. W. Bliss	11.20
83854	9- 8-1909	Northern Express Co.	2.80
83882	9- 9-1909	Eugene Dietzgen & Co.	11.29
83886	9-10-1909	T. R. Atkinson	208.33
84200	9-30-1909	A. B. Falconer	6.00
84201	9-30-1909	Erastus Williams, Jr.	12.00
84202	9-30-1909	J. M. Hansen	24.00
84203	9-30-1909	I. E. Schnieder	83.33
84204	9-30-1909	Jay W. Bliss	100.00
84331	10-12-1909	Western Union Telegraph Co.	.75
84339	10-12-1909	Northern Express Co.	3.85
84354	10-14-1909	T. R. Atkinson	208.33
84417	10-21-1909	Eugene Dietzgen & Co.	4.07
84418	10-22-1909	Washburn Livery Barn	15.00
84437	10-22-1909	T. R. Atkinson	48.05
84438	10-22-1909	Jay W. Bliss	12.20
84629	11- 1-1909	Jay W. Bliss	100.00
84630	11- 1-1909	I. E. Schnieder	83.33
84631	11- 1-1909	J. M. Hansen	30.00
84632	11- 1-1909	E. A. Williams, Jr.	26.00
84746	11- 3-1909	T. R. Atkinson	4.35
84747	11- 3-1909	T. R. Atkinson	11.35
84905	11- 5-1909	Bismarck Tribune Co.	7.50
85006	11-11-1909	North Dakota Ind. Telephone Co.	2.80
85009	11-11-1909	North Dakota Ind. Telephone Co.	.15
85022	11-15-1909	Western Union Telegraph Co.	1.12
85068	11-17-1909	A. G. Patterson, P. M.	10.00
85069	11-19-1909	Jay W. Bliss	125.00
85081	11-24-1909	T. R. Atkinson	208.33
85206	11-30-1909	I. E. Schnieder	83.33
85207	11-30-1909	J. M. Hanson	27.00
85208	11-30-1909	E. A. Williams, Jr.	32.00
85531	12- 8-1909	Jay W. Bliss	36.50
85533	12- 8-1909	Bismarck Implement Co.	3.00
85562	12- 9-1909	Western Express Co.	.45
85566	12- 9-1909	Western Union Telegraph Co.	.27
85570	12- 9-1909	Northern Express Co.	1.90
85599	12-13-1909	T. R. Atkinson	14.20
85657	12-14-1909	Jay W. Bliss	125.00
85768	12-20-1909	I. E. Schnieder	83.33
85769	12-20-1909	J. M. Hanson	75.00
85770	12-20-1909	T. R. Atkinson	208.33
85831	12-22-1909	Jay W. Bliss	136.90
85868	1- 5-1910	N. D. Independent Telephone Co.	.40

WARRANT ACCOUNT—Continued.

No.	Date	To Whom Issued	Amount
86052	1-22-1910	Jay W. Bliss	125.00
86120	1-27-1910	I. E. Schnieder	83.33
86121	1-27-1910	J. M. Hanson	70.16
86122	1-27-1910	T. R. Atkinson	208.33
86202	1-28-1910	A. G. Patterson, P. M.	10.00
86240	2- 1-1910	Bismarck Tribune Co.	11.50
86245	2- 1-1910	Bismarck Tribune Co.	8.50
86272	2- 2-1910	Bismarck Tribune Co.	12.75
86321	2- 7-1910	Western Union Telegraph Co.	.25
86374	2- 8-1910	Jay W. Bliss	71.90
86471	2-14-1910	Northern Express Co.	1.65
86502	2-15-1910	C. A. Huntley	4.00
86503	2-15-1910	Jay W. Bliss	17.55
86504	2-15-1910	Eugene Dietzgen & Co.	8.13
86505	2-15-1910	Eugene Dietzgen & Co.	11.89
86662	2-21-1910	T. R. Atkinson	208.33
86663	2-21-1910	Jay W. Bliss	125.00
86761	3- 1-1910	J. M. Hanson	75.00
86912	3- 8-1910	T. R. Atkinson	208.33
87007	3-15-1910	A. G. Patterson, P. M.	10.00
87009	3-15-1910	T. R. Atkinson	21.75
87010	3-15-1910	Eugene Dietzgen & Co.	5.20
87216	3-19-1910	Jay W. Bliss	125.00
87258	3-21-1910	Northern Express Co.	1.70
87367	4- 1-1910	H. J. Davis	75.00
87628	4- 6-1910	Eugene Dietzgen & Co.	3.60
87629	4- 6-1910	Eugene Dietzgen & Co.	19.49
87650	4- 6-1910	Bismarck Tribune Co.	11.75
87755	4- 8-1910	Western Union Telegraph Co.	.64
87777	4- 9-1910	Northern Express Co.	4.10
87809	4-25-1910	Jay W. Bliss	95.80
87810	4-25-1910	T. R. Atkinson	208.33
87828	4-29-1910	H. J. Davis	75.00
87930	5- 3-1910	A. G. Patterson, P. M.	4.00
88001	5- 5-1910	Eugene Dietzgen & Co.	7.20
88002	5- 5-1910	French & Welch Hdwe. Co.	9.00
88465	5-16-1910	Northern Express Co.	1.90
88526	5-26-1910	T. R. Atkinson	208.33
88528	5-27-1910	A. G. Patterson, P. M.	12.00
88718	6- 1-1910	Jay W. Bliss	88.71
88719	6- 1-1910	H. J. Davis	75.00
88720	6- 1-1910	Carl Johnson	28.39
88721	6- 1-1910	Howard Flint	12.50
88722	6- 1-1910	George Ebner	4.84
88789	6- 7-1910	C. A. Huntley	4.00
88790	6- 7-1910	Eugene Dietzgen & Co.	26.18
88791	6- 7-1910	T. R. Atkinson	10.25
88878	6- 8-1910	Northern Express Co.	5.25
89155	6-22-1910	T. R. Atkinson	208.33
89166	6-25-1910	H. J. Davis	75.00
89177	6-27-1910	T. R. Atkinson	9.95
89178	6-27-1910	T. R. Atkinson	11.85
89179	6-27-1910	Jay W. Bliss	20.75
89180	6-27-1910	C. A. Huntley	19.00

WARRANT ACCOUNT—Continued.

No.	Date	To Whom Issued	Amount
89436	7- 7-1910	Thorn Dickinson	62.50
89437	7- 7-1910	Carl Johnson	28.00
89438	7- 7-1910	Mrs. P. A. Evans	10.00
89439	7- 7-1910	Geo. Ebner	35.00
89440	7- 7-1910	J. W. Bliss	87.50
89504	7- 7-1910	Western Union Telegraph Co.	1.06
89511	7- 7-1910	Northern Express Co.	.35
89673	7-16-1910	A. G. Patterson, P. M.	5.00
89707	7-27-1910	Frank Greenshield	22.58
89716	7-29-1910	T. R. Atkinson	208.33
89717	7-29-1910	J. W. Bliss	125.00
89718	7-29-1910	H. J. Davis	75.00
89719	7-29-1910	Geo. Ebner	50.00
89788	8- 1-1910	Thorn Dickinson	96.77
89844	8- 6-1910	A. G. Patterson, P. M.	5.00
89866	8-10-1910	Western Union Telegraph Co.	.25
89872	8-10-1910	Northern Express Co.	2.20
89879	8-11-1910	T. R. Atkinson	23.10
89880	8-11-1910	T. R. Atkinson	12.65
89881	8-11-1910	J. W. Bliss	25.30
89882	8-11-1910	E. Dietzgen Co.	18.52
89883	8-11-1910	E. Dietzgen Co.	8.06
89884	8-11-1910	E. Dietzgen Co.	3.27
89885	8-11-1910	C. A. Huntley	11.00
89886	8-11-1910	Keuffel & Esser Co.	34.20
90023	8-12-1910	H. J. Davis	29.00
90063	8-13-1910	Bismarck Tribune Co.	6.75
90068	8-13-1910	Palladium	5.50
90128	8-18-1910	Julia A. Robinson	49.36
90201	9- 1-1910	T. R. Atkinson	208.33
90202	9- 1-1910	Thorn Dickinson	125.00
90203	9- 1-1910	J. W. Bliss	68.55
90204	9- 1-1910	J. M. Hanson	17.50
90205	9- 1-1910	Howard Flint	7.50
90400	9-16-1910	Thorn Dickinson	9.85
90618	9-20-1910	Western Union Telegraph Co.	.50
90659	9-20-1910	Democrat Printing Co.	4.60
90710	9-21-1909	Eugene Dietzgen Co.	5.60
90736	9-24-1910	Northern Express Co.	4.01
90741	9-28-1910	A. G. Patterson, P. M.	5.00
90791	10- 1-1910	T. R. Atkinson	208.33
90799	10- 1-1910	Ruby Schumann	75.00
91004	10-24-1910	C. A. Huntley	9.00
91005	10-24-1910	T. R. Atkinson	13.20
91006	10-24-1910	T. R. Atkinson	14.45
91174	10-25-1910	Democrat Printing Co.	3.36
91182	10-25-1910	Northern Express Co.	3.50
		Total	$ 10,754.92
		Balance in fund November 25, 1910	$ 2,753.92

RECEIPTS OF STATE ENGINEER'S OFFICE

FROM NOVEMBER 1, 1908, TO NOVEMBER 1, 1910.

Date	Items	Amount
11-16-1908	Copies of field notes	$ 32.00
11-16-1908	Recording permits Nos. 19 and 20	3.50
11-18-1908	Proof of publication No. 18	1.00
12- 7-1908	Field notes	1.00
12-10-1908	Field notes	3.00
12-12-1908	Roseau Lake drainage warrant	216.55
1- 2-1909	Field notes	1.20
1- 2-1909	Recording fees No. 17	1.75
1-10-1909	Field Notes	22.80
1-10-1909	Application for permit No. 21	5.00
1-12-1909	Field notes	10.00
2- 5-1909	Field notes	71.00
2- 9-1909	Field notes	1.25
2-19-1909	Field notes	19.00
2-24-1909	Field notes	1.00
3- 3-1909	Field notes	1.50
3-19-1909	Proof of publication No. 21	1.00
4- 5-1909	Field notes	72.00
4- 5-1909	Field notes	4.00
4- 7-1909	Application for permit No. 22	5.00
4- 8-1909	Application for permit No. 23	5.00
4-14-1909	Field notes	.50
4-15-1909	Application for permit No. 24	5.00
4-29-1909	Application for permit No. 25	5.00
5- 6-1909	Field notes	90.00
5- 8-1909	Field notes	1.00
5-12-1909	Field notes	1.00
5-24-1909	Application for permits Nos. 26 and 27	10.00
6- 2-1909	Field notes	1.00
6- 5-1909	Proof of publication No. 22	1.00
6- 8-1909	Proof of publication No. 23	1.00
6-14-1909	Application for permit No. 28	25.00
6-15-1909	Field notes	24.00
6-16-1909	Recording fee No. 22	1.75
6-25-1909	Field notes	1.80
7- 8-1909	Recording fee No. 23	1.75
7- 8-1909	Field notes	1.00
7-14-1909	Field notes	7.00
7-20-1909	Field notes	1.00
8- 3-1909	Field notes	90.05
8- 3-1909	Proof of Publication No. 28	1.00
8- 3-1909	Proof of Publication No. 26	1.00
8- 3-1909	Proof of Publication No. 27	1.00
8- 4-1909	Field notes	39.00
8-10-1909	Field notes	2.00
8-21-1909	Field notes	1.00
8-23-1909	Recording fees Nos. 26 and 27	3.50
8-25-1909	Field notes	2.00
9- 1-1909	Recording fee No. 28	1.75
9- 2-1909	Field notes	2.00
9- 4-1909	Field notes	8.50
9- 9-1909	Field notes	2.00

RECEIPTS—Continued.

Date	Items	Amount
9-18-1909	Application for permit No. 29	5.00
9-20-1909	Field notes	8.50
9-23-1909	Application for permit No. 30	5.00
9-24-1909	Field notes	1.50
9-25-1909	Field notes	1.50
10-12-1909	Field notes	3.00
10-15-1909	Recording fee No. 25	1.75
10-22-1909	Field notes	3.00
10-23-1909	Field notes	3.00
10-29-1909	Field notes	2.50
11- 4-1909	Field notes	4.00
11- 5-1909	Application for permit No. 31	5.00
11- 8-1909	Surveys	20.00
11-10-1909	Application for permit No. 32	5.00
11-10-1909	Proof of publication No. 30	1.00
11-12-1909	Field notes	6.00
11-16-1909	Field notes	177.75
11-22-1909	Certificates	1.00
11-26-1909	Field notes	105.00
12- 2-1909	Field notes	2.50
12- 4-1909	Recording permit No. 30	1.75
12- 6-1909	Field notes	3.00
12- 8-1909	Field notes	2.00
12-10-1909	Certificate	1.00
12-14-1909	Field notes	4.50
12-20-1909	Proof of publication No. 31	1.00
12-20-1909	Blue prints	6.00
12-22-1909	Field notes	9.00
12-27-1909	Field notes	60.00
12-31-1909	Field notes	1.50
1- 5-1910	Field notes	3.00
1-12-1910	Field notes	1.50
1-13-1910	Field notes	1.50
1-14-1910	Blue prints	12.00
1-18-1910	Fuller's Lake drainage warrant	118.85
1-19-1910	Field notes	3.60
1-20-1910	Field notes	1.00
1-24-1910	Surveys	15.00
1-26-1910	Recording permit No. 31	1.75
2- 1-1910	Field notes	90.00
2- 7-1910	Field notes	2.00
2-14-1910	Field notes	1.00
2-15-1910	Field notes	15.00
2-18-1910	Field notes	2.50
2-28-1910	Field notes	1.00
3-16-1910	Field notes	15.00
3-24-1910	Field notes	1.00
3-28-1910	Field notes	1.50
4- 6-1910	Field notes	22.00
4- 7-1910	Field notes	1.00
4-11-1910	Field notes	28.00
4-20-1910	Field notes	10.00
4-21-1910	Field notes	1.00
4-28-1910	Field notes	56.00

RECEIPTS—Continued.

Date	Items	Amount
4-29-1910	Field notes	2.00
5- 4-1910	Field notes	5.00
5- 5-1910	Field notes	3.00
5-13-1910	Field notes	2.00
5-26-1910	Field notes	54.00
5-31-1910	Field notes	1.00
6- 1-1910	Field notes	1.00
6-10-1910	Field notes	5.50
6-11-1910	Field notes	1.65
6-11-1910	Proof of publication No. 33	1.00
6-13-1910	Application for permit No. 34	5.00
7- 2-1910	Field notes	79.50
7-11-1910	Field notes	1.00
7-12-1910	Field notes	1.50
7-14-1910	Field notes	1.50
7-23-1910	Field notes	1.50
8- 1-1910	Application for permit No. 36	5.00
8- 2-1910	Roseau Lake drainage warrant	104.55
8- 5-1910	Field notes	3.00
8- 6-1910	Proof of publication No. 36	1.00
8-13-1910	Application for permit No. 37	5.00
8-19-1910	Recording fee No. 34	1.75
9-12-1910	Field notes	2.00
9-29-1910	Field notes	1.00
10- 7-1910	Application for permit No. 39	5.00
10- 7-1910	Surveys	20.00
10-15-1910	Application for permit No. 42	5.00
10-17-1910	Surveys	10.00
10-19-1910	Surveys	30.00
10-24-1910	Proof of publication No. 37	1.00
10-28-1910	Application for permit No. 43	5.00
	Deposited with state treasurer	$ 2,034.55

INTRODUCTION.

North Dakota during the past few years has witnessed the beginning of a development which will within the next few years place her well to the front rank in the agricultural states of the Union. During the last biennial period the assessed valuation of the state has increased fifty million dollars.

North Dakota probably has a larger percentage of its area arable than any other state. The total area of the state as compiled from the surveys of the townships by the United States Land Office is 45,153,179 acres. Of this amount 416,702 acres is the area of the water surface, leaving a total land area of 44,736,477 acres. From studies made by this office it is estimated that of the above area 42,150,000 acres is arable; the remainder, 2,586,477, being pasture land, of which 500,000 acres is forest.

The rapid influx of settlers during the past five years has caused the breaking up of large areas of land once considered of value for grazing only, which under good dry farming methods has shown that with a proper cropping system the lands in the western part of the state can be made to produce a revenue which compares well with that received from the more favorably located lands in the eastern part of the state.

During the time of the rapid influx of settlers the question of irrigation has received but little attention, but the last season has brought forcibly to the minds of the farmers the great value of irrigation water in assisting to bring the fertile lands in the western part of the state to their greatest development.

There is no question about the value of good dry farming methods applied to soil, but when to these dry farming methods is added the use of irrigation water properly applied, the revenue to be derived from these lands will easily double the revenue to be derived from the dry farmed lands. The total area of land in the state which is susceptible of irrigation is 1,540,000 acres. Of this amount 65,000 acres is now being irrigated and the season of 1911 will see an increased irrigation area of 10,000 acres. The total area of land in the state which can be improved by drainage is 2,780,000 acres, 475,000 already having been improved by the construction of ditches.

The climate of North Dakota is particularly well adapted for raising all small fruits and grains. The average length of the grow-

ing season at Bismarck, which is fairly typical of all parts of the state, is one hundred and thirty-eight days. The growing season is computed from the average date of the last killing frost in spring to the average date of the first killing frost in autumn. With the long periods of sunshine and daylight during the growing season and with a normal temperature during this season of 63° the state can well boast of the possibilities obtainable from its agricultural resources.

While the office of State Engineer was created primarily for the purpose of promoting irrigation work in the state, the office has, in addition to irrigation promotion, been of great value in assisting several counties in its drainage problems and in advice on highway and bridge construction. The legislature of 1909 passed an act making the state engineer custodian of the U. S. Land Office plats and field notes of all townships in the state. The presence of these plats and field notes in this office has been a great convenience and a source of considerable revenue to the state as well, on account of the funds derived from copies made for private parties.

The state engineer has acted as city engineer of Bismarck, at a mere nominal salary, and the holding of that office has been a saving to the state as well as to the city, in that it has enabled the state engineer to utilize the time of assistants in city or state work as occasion might demand, and thus more competent assistants can be obtained and all their time employed to the best advantage.

The office has assisted in the hydrographic work of the United States Geological Survey in the state and thus keeps in close touch with the run-off from the different stream systems.

The thanks of this office are due to the officers of the United States Reclamation Service for its co-operation in work of mutual interest to the state and government, and to Prof. E. F. Chandler of the state university, in charge of the hydrographic work in the state for the United States Geological Survey, for his assistance in all work pertaining to stream measurements that are of great value to this office.

While a report on the coal mines of the state for the year 1908 was compiled by this office, it was not published on account of lack of funds. This year it has been deemed advisable to include the report on the coal mines with the state engineer's report. During 1908 the mines reported as being in operation were employing an average of six hundred and forty-one men and the total output for the year was 382,055 tons.

There were four fatal and four non-fatal accidents during 1907 and 1908. Two of the fatal accidents were due to falls of roof, one to choke damp and one was caused by a motor.

During the year 1909 and 1910 personal examinations were made at eighty-eight mines and reports received on fifteen not

examined, making a total of one hundred and three mines in operation. The total number of men employed in 1909 and 1910 were 919 during the winter months and 341 during the summer. The average daily wage being two dollars. The coal mine inspection work has been done by J. W. Bliss, assistant in this office.

FILINGS MADE IN ACCORDANCE WITH THE IRRIGATION CODE SINCE THE LAST BIENNIAL REPORT.

No.	Name of Applicant	Lands to be Irrigated	Source of Supply	Amount of Water Claimed	Date of Claim
21	David C. Boyd	183 acres in sections 22, 26 and 27, T. 155 N., R. 94 W.	Coulees in sections 22 and 26, T. 155 N., R. 94 W.	2.25	1- 6-1909
22	Ida I. Ludolph	95.78 acres in section 10, T. 131 N., R. 106 W.	Duck Creek	1.2	4- 5-1909
23	J. B. Koppenhaver	320 acres in section 7, T. 147 N., R. 85 W.	Douglas Creek	4.0	4- 8-1909
24	State Reform School ..	80 acres in section 33, T. 139 N., R. 81 W.	Heart River	1.0	4-14-1909
25	John Yegen	600 acres in sections 13, 24 and 25, T. 138 N., R. 80 W.	Apple Creek	7.5	4-29-1909
26	Albert Roseno	113 acres in sections 27 and 28, T. 153 N., R. 90 W.	W. Fork Shell Creek.	1.4	5-21-1909
27	Julius Roseno	77 acres in sections 33 and 34, T. 153 N., R. 90 W.	W. Fork Shell Creek.	1.0	5-21-1909
28	Hawkin Isaacson	142 acres in sections 26 and 35. T. 160 N., R. 103 W.	Rains & melting snow	1.8	5-29-1909
29	Chas. and Eva Schafer.	245 acres in sections 23, 25 and 26, T. 150 N., R. 98 W.	Cherry Creek	3.1	9-13-1909
30	Northern Pacific Ry. Co.	Dam in section 8, T. 139 N., R. 96 W., for railway purposes	Heart River	2.0	9-16-1909
31	H. W. House	337.5 acres in sections 16, 17, 20 and 21, T. 146 N., R. 84 W	Winston Coulee	4.2	11- 3-1909
32	Richard O. Signalness..	135 acres in sections 3 and 4, T. 150 N., R. 96 W. and Sec. 34, T. 151 N., R. 96 W	Springs, rains and melting snows	2.0	11- 1-1909
33	Daniel Hawkins	40 acres in Section 34, T. 153 N., R. 93 W.	Dry Coulee	0.5	4-15-1910
34	Henry Stammen	720 acres in sections 6, 8, 17, 20 and 21, T. 158 N., R. 84 W.	Mouse River	9.0	6-13-1910
35	Joseph Ringer	110 acres in section 28, T. 153 N., R. 91 W.	Coulees in Sec 28, T. 153 N., R. 91 W. ..	1.4	6- 9-1910

36	Phillip Stammen	280 acres in sections 27, 28 and 34, T. 157 N., R. 84 W.	Mouse River	3.5	8- 5-1910
37	Jens P. Glein	140 acres in section 16, T. 157 N., R. 84 W.	Mouse River	1.75	8-11-1910
38	Ella Williams	304 acres in sections 2 and 11, T. 155 N., R. 94 W., and sections 15, 22, 26, 34 and 35, T. 156 N., R. 94 W.	White Earth Creek ..	3.8	10- 3-1910
39	Anna B. Bachman	181 acres in section 31, T. 159 N., R. 84 W.	Mouse River	2.26	9-29-1910
40	Edward Bryans	775 acres in sections 5, 6 and 8, T. 158 N., R. 84 W., and sections 24 and 25, T. 159 N., R. 85 W.	Mouse River	9.7	10-18-1910
42	E. E. Joslin	265 acres in sections 23, 24 and 26, T. 159 N., R. 85 W.	Mouse River	3.3	10-13-1910
41	....				
43	Ole Person	455 acres in sections 2, 3 and 4, T. 159 N., R. 85 W., and sections 33 and 34, T. 160 N., R. 85 W.	Mouse River	5.7	10-25-1910

IRRIGATION.

Interest in irrigation matters has received a great impetus during the past season, owing to the drouth conditions prevalent throughout the Northwest. Those who have been practicing irrigation in a small way have come to realize more fully the great benefits to be derived from artificial watering judiciously applied, especially to the lands west of the 100th meridian.

We have heard much about the rain belt moving west and the cultivation of the land bringing more rainfall, but all these notions are refuted by the facts gathered from the records of the last four thousand years. The fact is the state is so located that the eastern part has plenty of moisture nearly every year to mature bountiful crops, while the western part, lying in what is termed the semi-arid belt, does not receive as large an annual precipitation as the eastern part, and hence we are more apt to have seasons when the rainfall is not sufficient to provide for the proper growth of plant life. This fact we must all admit and a close study of this condition together with the knowledge which can be learned from those who have irrigated will lead to better results from our farming operations.

The use of irrigation water is not only an insurance against drouth and hot winds but is one of Nature's best fertilizers. Unfortunately, the Missouri river, which flows across the state, is so located that the use of its waters for irrigation purposes is limited to the bottom and first and second bench lands. The bed of the river being from three to four hundred feet lower than the surrounding prairie makes it impractical to pump water for irrigation purposes, and the slight fall of one foot to the mile makes any diversion scheme visionary.

However, we have sufficient flood water from our streams and coulees, if properly controlled, to irrigate one and one-half million acres and make them highly productive.

An interesting fact showing the value of irrigation from the flood waters of coulees could be easily observed on every field during the past season. On every low spot in a field of grain and especially wherever a small coulee sent its spring flood down over a portion of the field, there the crop yield was valuable. Many instances are known where the yield on these spots were from fifteen to twenty-five bushels per acre. Had the spring flood been properly controlled and spread over the land a much larger area would have given bountiful crops. Many farmers have already prepared to use the water and others are preparing to use it in the future. The flow from our streams should be held in reservoirs and made to enrich our soil and increase our yield of crops instead of going to waste as much of it is at present. Well water which can be readily pumped by windmills should be utilized for the purpose of irrigating small tracts of from one to ten acres when it is impractical to obtain water from streams and coulees.

MOUSE RIVER.

A glance at the map of the state will show one that the Mouse river comes into the state from Canada near the western edge of the new county of Renville, flows southeasterly through Minot and Velva, then northeasterly to Towner and from Towner northwesterly and again enters Canada near the central part of Bottineau county. The territory included in this loop was at one time the bed of a glacial lake and is very fertile soil. It is a curious fact that the valley land along the river from the international boundary to Towner can be easily irrigated and made exceedingly valuable while the land along the river from Towner northwest to the international boundary can be greatly improved by drainage. Much of it, in fact, is worthless without drainage. That part of the river from the international boundary to Towner has a greater fall per mile than the part flowing northwest from Towner to the international boundary and consequently the swifter flowing part of the stream has deposited its silt when reaching the slow current and has so completely filled the channel that in the last forty miles of the stream in Bottineau county the river completely covers the valley except in times of extreme low water. The number of acres of this valley which could have their value greatly enhanced by irrigation is approximately fifty thousand, while the number of acres which could be benefitted and reclaimed by drainage is forty thousand.

During the summer of 1910 Henry Stammen, a farmer living six miles south of Grano, in the valley, started an irrigation pumping plant, and although it was late in the season before he was able to apply water to his land, the results obtained by him were very satisfactory. Much of his irrigated land was in wild hay and pasture, the growth being mostly bluejoint. His yield from the irrigated hay land was about two tons per acre; while the unirrigated was not worth cutting. He also had about eighty acres of oats which he succeeded in partially irrigating which yielded an average of fifty bushels per acre. Seven acres of this oat field which was a little better irrigated than the remainder was carefully measured by the state engineer and threshed by itself. The yield was sventy-eight bushels per acre. The success of Mr. Stammen has encouraged several other farmers along the river to purchase pumping outfits and construct their ditches, and it is probable that at least five thousand acres of this valley will be irrigated next season.

OPERATIONS UNDER THE UNITED STATE RECLAMATION ACT.

As has been noted in previous reports, the United States Reclamation Service, since its organization, has made surveys of the Bismarck, Lower Yellowstone, Buford-Trenton, Williston, Nesson, Washburn and Oliver projects. Of these the ones which have been

constructed are the Williston, Buford-Trenton, and the Lower Yellowstone and the land withdrawn from settlement under the remaining ones has been restored to entry. Additional preliminary surveys and examinations were made by this service during the summer of 1909 on the Cannon Ball, Heart, Knife and Little Missouri rivers.

In all these surveys the state engineer's office has co-operated. H. N. Savage, supervising engineer for the northern district of the reclamation service has furnished this office with the following report concerning the progress of the construction work on the Williston, Buford-Trenton and Lower Yellowstone projects:

LOWER YELLOWSTONE PROJECT,

North Dakota-Montana.

The Lower Yellowstone project constructed by the United States Reclamation Service at a cost of approximately $3,000,000, covers 67,000 acres of land in North Dakota and Montana situated along the west side of the Yellowstone river. The lands irrigable from the canal system extend from a point about twenty miles below Glendive, Montana, to the Missouri river, a distance of 64 miles, and include about 24,000 acres of land in North Dakota. Surveys were commenced in 1904.

The construction work on the canal for the first unit of the project was completed in time for the delivery of water to all qualified applicants during the season of 1909. Water was first turned into the canal April 30, 1909, and an ample supply of water was delivered throughout the season.

In order to provide a full head of water for the main canal at all times, a dam having a miximum height of 12 feet and 700 feet long was constructed across the Yellowstone river at the headworks. A spillway 1,000 feet long extends south from the south end of the dam. The dam was completed in February, 1910, and is a notable structure. It is a timber crib, rock-filled design, held in place by nine rows of round piling, eight feet center to center, each way, extending entirely across the stream. Sheet piling also extend across the stream at the upper and lower toe of the structure. The dam is decked over with heavy timbers reinforced with 1"x4" strapiron.

The canal headworks is a massive masonry structure thirty feet high and has eleven gate openings five feet in diameter through which the water is admitted to the main canal, which has a capacity of eight hundred and fifty cubic feet of water per second.

All of the principal structures on the main canal are built of concrete and are substantial and durable in design and construction. Masonry structures are also used for carrying the very heavy cross drainage discharge under the canal. Ample sluiceways and spillways are provided for canal operation.

To facilitate the construction of the irrigation works, a telephone line was constructed from Glendive through the entire length of the project to Mondak and connected with the public telephone exchanges at each end. This telephone system is now used in connection with the operation of the canal system. The project office and district headquarters (3) are also connected with the Water Users' Electric Company's system and thereby connected with the long distance trunk system east and west.

The canal system operation force consist of an irrigation manager, with headquarters at LaMesa, fourteen miles down from the headworks, and three district superintendents of irrigation. The project is divided into three lateral districts, each having sixty to seventy miles of canals and laterals, and about twenty thousand acres of irrigable land.

The canal system was put in commission for the season of 1910, May 28th, and shut down October 11th.

Water applications have been perfected by the land owners on 13,195 acres of irrigable land.

The crops grown on the irrigable land during the past two seasons, considering the lack of irrigation experience on the part of the land owners, have been fair, wheat yielding twenty to thirty bushels to the acre and oats forty to sixty bushels to the acre; while non-irrigable land this season in the vicinity yielded on an average of about five bushels per acre.

A small acreage under the project has been planted to alfalfa, which is showing up well, and the area under this crop will be doubtless rapidly increased. The third cutting of alfalfa this season was harvested, the total yield per acre for the season has been over five tons in many instances.

At present the Lower Yellowstone project has transportation at Glendive, on the Northern Pacific railway, and at Mondak, on the Great Northern railway. The Northern Pacific Railway Company has about completed the grading of the first fifty miles of their projected water grade line from Glendive via Sydney and the Missouri river to Mandan. Several new towns have started up throughout the project along the new railway line and it is expected that track will be laid and trains running into Sidney in time to move the 1911 crop.

There are about twenty farm units public land now open to homestead entry and several thousand acres of land in private ownership which are held in areas in excess of the one hundred sixty acre maximum on which a single individual may perfect a water right under the Reclamation Act. These private lands are held for sale at prices from $15 to $30 per acre, subject to the terms of the Reclamation Service notice of December 21, 1908, which provides for repayment of the building cost of the project at the rate of $42.50 per acre in ten annual installments without interest.

The operation and maintenance charges, as fixed at present, are $1 per acre. The water right certificate entitles the holder to a maximum of two and one-half acre-feet per acre of water per annum, or so much thereof as may be necessary, which is ample and abundant for all requirements.

The Yellowstone river has a discharge varying during the irrigation season from a minimum of five thousand cubic feet per second to a maximum of one hundred sixty thousand cubic feet per second. A perfect water right is therefore assured the lands in the Lower Yellowstone project, which will be more and more appreciated as the settlers learn to avail of the opportunities and comparative value of the water right made available for their lands.

The lands are mostly so-called "bench lands," sloping gently toward the Yellowstone river. The general elevation of the project is 1,900 feet above sea level. The soil is rich loam and unusually uniform in surface and character.

BUFORD-TRENTON PROJECT.

The Buford-Trenton project embraces the land bordering the north bank of the Missouri river for a distance of about twenty miles east of the Montana-North Dakota state line, and is divided into two classes of land—the river bottoms, which comprise about 75 per cent of the total project, and the higher bench lands, which border these river bottoms. Between the towns of Buford and Trenton it will be possible to irrigate approximately 12,500 acres of land, about half of which is bench land. East of Trenton it is expected that about half of the total bottom lands of 6,000 acres can be irrigated.

The irrigation plan of the project involves the construction of electrically operated pumps, installed on a floating barge moored in the Missouri river and lifting water about thirty feet into a large settling basin where practically all the silt contained in the water is deposited. At the lower end of this basin the water flows directly into a canal which extends eastward about eight miles and furnishes water to about six thousand acres of bottom lands, and part of the water is pumped a second time an additional fifty feet into a canal which irrigates the bench lands. The pumps are all of the centrifugal type and driven by direct-connected electric motors. The power is generated at the power plant located about twenty-eight miles distant on the Williston project.

The construction of the first unit, comprising about four thousand acres of bench lands, was completed in 1907 and water was first delivered in the summer of 1908. No construction work has been undertaken for the canal system which supplies water to the bottom lands, but the necessary pumping machinery has been installed. No work has been started on the small flat east of the town of Trenton.

Thus far practically all the crops raised have been small grains, but it has been demonstrated that alfalfa, potatoes, and sugar beets will be staple crops in the near future. About eight hundred acres were irrigated in 1908 and while the season was not particularly satisfactory, it showed that the late irrigated crops were more than double the dry land crops obtained from the same kind of land.

Up to the present time a majority of the water users have declined to adopt the necessary by-laws required to levy and collect assessments, and owing to the reluctance on the part of many of the water users to meet the present requirements of the public notices, very little water has been delivered on this project during the present season, and it seems probable that not more than two hundred acres will be irrigated.

WILLISTON PROJECT.

The Williston project embraces about eight thousand acres of land lying in the Little Muddy valley north of the city of Williston, the lower bench lands on either side of this valley, and also two river bottoms—one to the east and one lying west of the city, each containing approximately two thousand acres of irrigable land.

The irrigation plan of this project involves the construction of a central steam turbine power plant, generating electricity for operating motor-driven centrifugal pumps installed on a barge moored in the Missouri river and in two small pumping stations. The water is lifted about thirty feet from the river into a settling basin where most of the silt is deposited. The main canal leading therefrom flows north about three miles up the valley to the power plant. About one mile from the basin along this canal is located a small pumping station which lifts water twenty-eight feet for irrigating the bench lands on the west side of the valley, and a portion of this water is lifted by steam-driven centrifugal pumps into two canals, one having a twenty-six foot and the other a fifty-six foot lift.

Power is obtained from North Dakota lignite coal. The hills immediately back of the power plant contain three valuable veins of this coal. At the present time the middle vein of about nine feet in thickness is being worked. The mine at the present time is sufficiently developed so that about 50,000 tons of coal can be taken from rooms at a cost of from $1.25 to $1.40 per ton delivered at the plant. This cost does not include the actual development of the mine. The coal is burned in semi-gas producing furnaces of the Dutch oven type.

The pumping machinery and canal system for the first unit, embracing about eight thousand acres of land, was completed in 1907, and water was first delivered to the land in the season of 1908. The first season was not particularly successful, owing to the fact that the farmers did not start taking water as early as

they should have, and there not being an adequate and continuous supply on account of minor defects which arose in the first operation of the machinery. Approximately two thousand acres was partially irrigated during the first season and results showed that this irrigation more than doubled, and in cases saved the entire crop. During the present season, practically the same area will be irrigated but under better conditions, as last year practically all cultivated lands were in small grains. This year there is a larger area of potatoes and alfalfa, and at the present time farmers are cutting the second crop and it seems that this portion of the country can always furnish two good crops and a pasture crop, and in favorable seasons three crops of alfalfa.

CROP DATA ON THE MISSOURI RIVER PROJECTS.

The following data has been received from the reclamation service concerning the crop yields on the North Dakota projects for the season of 1910. It should be borne in mind that owing to differences between the farmers on these projects and the officers of the reclamation service no farm crops were irrigated until June 20th, at which time the temperature had risen to 102°, accompanied by a strong southwest wind. This atmospheric condition together with conditions previously existing had placed the crops in such condition as to preclude the best results from the use of irrigation water. However, the results obtained show that the use of irrigation water is very valuable to the western half of the state. Dry farmed wheat in this locality yielded this season an average of five bushels per acre.

The best paying crop is alfalfa and that it can be raised all over North Dakota is now generally known. Under irrigation it reaches its best growth the third season and nearly every season three crops can be harvested with an annual yield of five tons per acre. S. Brownell raised a seed crop of alfalfa on the Williston project which yielded 5.67 bushels per acre which gives a gross return of sixty-eight dollars per acre.

M. Bartholomew raised one acre of cabbage which yielded 7,500 head, which at ten cents each makes a gross return of $750. A small patch of onions yielded at a rate of eight hundred twenty bushels per acre and sold at $2.50 per bushel.

Detailed report of some other yields are as follows:

G. M. Thomas, 14 acres wheat yielded 29.4 bushels per acre; 27 acres alfalfa yielded 3.2 tons per acre; 26 acres oats yielded 51.5 bushels per acre.

Judd Pettis, 12 acres alfalfa yielded 2.5 tons per acre.

C. Ellithorpe, 16.8 acres alfalfa yielded 3 tons per acre.

S. Brownell, 2 acres wheat yielded 32 bushels per acre; 25 acres wheat yielded 25 bushels per acre; 20.4 acres alfalfa yielded 3.3 tons per acre.

D. D. Davidson, 9 acres alfalfa yielded 3 tons per acre; 40 acres wheat yielded 20.6 bushels per acre.

H. V. Smith, 31 acres wheat yielded 21 bushels per acre; 16 acres oats yielded 40 bushels per acre.

DRAINAGE.

This office has done considerable amount of drainage work during the past four years, and the benefits derived from the drained land has, in every case, proven of far greater value than the cost of the drainage work.

Some of the more important undertakings are described below:

FULLER'S LAKE DRAIN NUMBER ONE.

Fuller's Lake Drain Number One is located in townships one hundred forty-four and one hundred forty-five, ranges fifty-four and fifty-five, Steele county. Surveys were made by this office in 1906, but owing to long drawn-out litigation was not completed until October, 1909. The work was let to John Kohler of Frazee, Minnesota, and was done by a steam dredge, the contract price being thirteen cents per cubic yard. The land reclaimed by the drain amounted to thirty-five hundred seventy-two acres, and has proved to be of the most valuable land in the county. About two hundred acres of this lying in the bed of Fuller's lake has raised a fine hay crop this season and will eventually prove to be exceedingly productive. The average cost per acre for the reclamation of this land was $3.50.

ROSEAU LAKE DRAIN.

Roseau Lake drain is located in township one hundred sixty-one, ranges fifty-eight and fifty-nine, Cavalier county. The length of the old drain is five and one-third miles. The number of acres reclaimed is eighteen hundred forty-nine, and the average cost per acre was two dollars and fifty-seven cents. Surveys were made in August, 1908, and the contract was let to A. T. LeVesconte of Langdon, North Dakota, at a price which was equivalent to about twenty cents per cubic yard. Mr. LeVesconte commenced work with a steam dredge in June, 1909, and completed the entire drain in October of the same year. The drained land has proven very productive. Some of the best crops in the county this season were raised on the drained lake bed.

WILLISTON LAKE DRAIN.

Williston Lake drain is located in townships one hundred sixty and one hundred sixty-one, ranges fifty-nine and sixty, Cavalier county. Surveys were made in the fall of 1909 and the work was commenced in June, 1910, and completed in September, 1910. This drain is four and one-half miles long and required the excavation

of twenty-five thousand one hundred and fifty cubic yards of earth. This work was let to A. T. LeVesconte of Langdon, North Dakota, at a price of fifteen cents per cubic yard, the work being done with a steam dredge. This drain will reclaim four hundred eighty-five acres, most of which was practically worthless before draining, but will now prove to be some of the most valuable land in Cavalier county. The average cost per acre for draining was nine dollars and fifty cents.

HUNTER'S LAKE DRAIN.

Hunter's Lake drain lies in townships one hundred sixty and one hundred sixty-one, range sixty, Cavalier county. Surveys for this drain were made in June and July, 1910. Contract for construction has not been let, but it is expected that all formalities will be completed so that the contract can be let and the work started early in the spring of 1911. The proposed drain will be two and nine-tenths miles long and will require the excavation of twenty-three thousand five hundred cubic yards of earth. The total number of acres reclaimed will be four hundred eighty-one, at an estimated cost per acre of seven dollars and seventy-five cents.

MOWBRAY LAKE DRAIN.

Mowbray Lake drain is located in township one hundred sixty-three, range sixty-one, Cavalier county. It is three and eight-tenths miles long. Surveys were made for this drain in July, 1910. Total number of acres to be benefitted is five hundred forty-four, at an estimated cost of eight dollars per acre. A light grade line of one and thirty-two hundredths feet per mile, combined with a very light fall of the coulee into which the drain empties, makes a very shallow cutting, which precludes the use of a dredge. The presence of many rocks and boulders for about one mile of its length increases the cost of construction. The light fall of the coulee into which the drain empties making a shallow cutting for the drain, makes it necessary to have a bottom width of twelve feet in order to have sufficient area in the drain to provide for the flow of water. This wide, shallow channel combined with a light grade line is conducive to growth of weeds and grass, and should the drain be constructed it will require a considerable amount expended annually for maintenance in order to give satisfactory drainage. Furthermore, it is probable that this drain will not give sufficient drainage to make the land arable and the only use to which the reclaimed land can be put is for the raising of wild hay.

MOUSE RIVER IMPROVEMENT.

The Mouse River improvement, to which reference was made in the third biennial report of this office, provides for the reclamation of twenty-two thousand two hundred and fifty-one acres of

overflowed lands in the valley of this river in northern McHenry and Bottineau counties, running north from section twenty, township one hundred fifty-nine, range seventy-seven to the international boundary. In order to provide a channel of sufficient fall it was found necessary to excavate the channel to the mouth of North Antler creek, which is fourteen miles north of the international boundary. Surveys were made by the state engineer in September and October of 1907, and the plans and specifications were completed by this office in the winter of 1907 and 1908. Owing to the magnitude of the work and consequently a large amount of detail work for the drainage commissioners, the letting of the contract was delayed until April 2, 1909. On the first day of April, 1909, a temporary restraining order was issued by the district court of the Ninth judicial district enjoining the drain commissioners from letting the contract for this work. Hearing on this order was held before the judge of the First judicial district at Grand Forks on April 10, 1909, and the temporary injunction made permanent. The defendants appealed to the supreme court and decision was rendered in their favor, on January 31, 1910. The plaintiffs applied for a re-hearing and the application was granted, the case again being before the court at the present time.

GEROUX SLOUGH DAM.

Geroux slough comprises about twenty-five hundred acres of land north of the Pembina river in Pembina county and six miles west of the city of Pembina. The land in this slough lies from eight to ten feet lower than the banks of the Pembina river.

In 1903 an attempt was made to drain this land by cutting a ditch through the banks of the river and constructing a dam and outlet with a gate to prevent the flood waters of the river from entering the ditch. It is quite evident that the cutting of this ditch through the river bank was a mistake. The drainage ditch should have been run north and east into the Red river. The dam that was constructed failed at the time of the first high water, resulting in the loss of the entire crop. In 1905 another and better dam was constructed, which, however, showed signs of weakness, and in October, 1909, the state engineer was called by the board of county commissioners and asked to design a permanent dam. Surveys were made at once, plans and specifications were prepared and the contract let for its construction in July, 1910.

This dam is constructed with a thirty-inch cast iron pipe one hundred feet long under the entire length, each end of the pipe being surrounded by a wall of concrete six feet high and extending across the entire width of the ditch and provided with suitable concrete aprons. A steel sluice gate is fitted to the pipe at the north end in such a manner that it can be closed in times of high water in the river and when the river subsides opened for the

drainage of the slough. The space between the concrete bulkheads is filled with earth. The slope of the riverside being two and one-half to one, is protected by brush ten feet long placed in the face of the slope in horizontal layers with the top end of the brush extending two feet beyond the face of the slope. This brush protection extends over the entire slope and in one or two seasons the growth of weeds and bushes will further assist in making a permanent slope. The north slope is constructed one and one-half to one and is protected by brush in the same manner as the river slope. The dam has a driveway thirty feet wide along the top.

The contract for the masonry and cast iron pipes was let to the Beach Manufacturing Company of Grand Forks and the work completed in August, 1910. The contract for the earth filling was let to local farmers who owned land in the slough and this part of the work was completed in October, 1910. The entire cost of the work amounted to twenty-seven hundred dollars.

INVESTIGATION OF STATE LANDS.

The board of university and school lands requested the state engineer to make examination of state land to be sold in Ward county on April 23, 1909. Owing to the late spring and the amount of snow lying on the ground it was impossible to make an examination of all the land prior to the date of the sale, and consequently some land was sold which on examination proved to be coal-bearing lands. This led to considerable confusion in the office of the board of university and school lands as well as in this office.

The method of making examination is by personal observation on the ground, taking into account the geological formation and location together with information that can be obtained from neighboring mines and wells in order to determine whether it is underlain with coal. This method is not satisfactory. The coal land properties of the state are becoming more valuable each year and an appropriation should be made to provide for the purchase of an equipment for drilling and for the necessary expense of making a careful examination of each quarter of land belonging to the state that is known to be in the coal area in order that definite knowledge of all school lands in the western part of the state may be recorded. The character of the land, its soil and topography can be taken at the same time without extra expense, thus giving in detail the character of the soil and topography of each piece of state land for future reference by the board of university and school lands.

GOOD ROADS EXPERIMENT STATION.

Chapter one hundred and thirty-three of the Session Laws of 1909 provides for the construction of experimental roads under the personal supervision of the board of trustees of public property and makes it the duty of the state engineer to furnish plans and

specifications for the experimental roads and to have supervision over the construction and maintenance.

The act does not provide for any appropriation to carry on any experiments. For this reason it has been impossible to accomplish the desired work. However, under the supervision of the state engineer and by the use of convicts from the state penitentiary the street railway line owned and operated by the state has been re-aligned and placed to permanent grade with new ties wherever needed. Using brick that were made at the penitentiary brick plant, eight blocks of the line of Fourth street has been paved between the rails and a three by twelve plank placed on the outside of each rail. This improvement in the line which has been desired for some time and adds much to the value of the street car line and to the attractiveness of Fourth street which is the main avenue from the business district of Bismarck to the capitol.

RIVER RECORDS.

By E. F. Chandler.

By the permission of the U. S. Geological Survey, the following tables of flow of important or typical streams in North Dakota and the Red River valley are selected and compiled from the records obtained under the direction of or by co-operation with the Geological Survey.

The methods followed in this work were described in the first report of the North Dakota state engineer, pages forty-nine to sixty-two, and also in the second report, pages forty-seven to forty-nine. In the Water Supply and Irrigation Papers series published by the Geological Survey, all these river records are published in complete form; in the introduction to each such volume the methods are fully discussed. The essential facts are stated below.

At each "river station" a gage is established, at which the height of the water surface in feet and tenths is read and recorded daily or several times daily. The zero of the gage is usually below the lowest known low-water, and often below the bottom of the channel, but the height of floods is easily seen by comparing the maximum flood height readings with the minimum low-water readings.

At suitable times, an engineer (called in this work a "hydrographer") makes instrumental measurements of the discharge, i. e., of the actual quantity of water flowing by the gage, and reads the gage-height. It is thus known how much water flows whenever the river is at that same gage-height (provided the channel does not change). If enough such measurements are secured, it thus becomes possible to compute from the record of daily gage-heights an accurate record of daily quantity that flowed by the station, and to tabulate these quantities in the most convenient form for reference.

In the following pages, the results have been arranged as tables of "monthly discharge," showing for each month the flow for the highest day of the month, the minimum flow, and the mean flow or average for the whole month. The figures of discharge are all in "second-feet," one second-foot being a flow that carries one cubic feet of water past the observer each second; a rapid current in a small channel, or a slow current in a large channel, carry the same amount of water past the observer.

One second-foot amounts to 646,272 gallons per day, and will cover almost two acres one foot deep in twenty-four hours.

As successive years vary considerably, an absolutely exact record of the flow of a river through one year would not tell how much would flow the next year; and as no two rivers are altogether alike in their conditions, records of as many as possible are needed, if use is to be made of the stream records. Therefore, rather than to spend a large appropriation in making a precise record of a single stream for one year, it is more advantageous to extend the work to as many streams for as long a period of years as funds will permit provided the work is not thereby so much reduced as to result in disproportionate loss of accuracy.

The column headed "accuracy" in the table applies to the mean flow for the month, but not always to the maximum or minimum; it depends upon the reliability of the daily observer, upon the permanency of the stream channel and the gage and other such conditions, and upon the number of discharge measurements; more measurements bring much greater accuracy to the computed results for the season.

The mean for any month marked A in the following tables may safely be assumed as accurate within five per cent; any month marked B, within ten per cent; C, within fifteen per cent; D, within twenty-five per cent; E indicates a rough estimate which is hoped to be within fifty per cent of the truth.

The summaries from October, 1908, to November, 1910, are given for these streams on the following pages:

Red river at Grand Forks, N. D.
Red river at Fargo, N. D.
Ottertail river at Fergus Falls, Minn.
Pembina river at Neche, N. D.
Red Lake river at Crookston, Minn.
Thief river near Thief River Falls, Minn.
Mouse river at Minot, N. D.
Little Muddy river at Williston, N. D.
Grand river (north branch) at Haley, N. D.
Heart river near Richardton, N. D.
Knife river near Broncho, N. D.
Painted Woods creek near Washburn, N. D.
Turtle creek near Washburn, N. D.
Missouri coulee near Sanger, N. D.
Mandan Lake creek near Hensler, N. D.

At some of these stations records have been maintained for only a small portion of the two-year period; the winter figures at most of them are lacking or are mere estimates, for in ordinary winters in this region the flow is too small to justify much expense in measurements.

Similar summaries of the records at these stations and others in the same region have been published in these reports.

1903-1904, in Third Report of North Dakota State Geological Survey.

1905-1906, in Second Report of North Dakota State Engineer.

1907-1908, in Third Report of North Dakota State Engineer.

More detailed figures are given in the Water Supply and Irrigation Papers series mentioned above, published by the United States from time to time through each year.

All the data of every kind on which these summaries and other less important unpublished ones rest, are kept on file in the Washington office of the U. S. Geological Survey, and copies are also kept in the office of the resident hydrographer, E. F. Chandler, postoffice address, University, N. D. Full information in regard to any desired records or investigations can be obtained from either office on request.

RED RIVER AT GRAND FORKS, N. D.

Gagings of the flow of the Red river at Grand Forks were begun by the United States Geological Survey in 1901, but a gage height record was kept at the direction of the United States corps of engineers. (war department) for about twenty years previously. The gaging station is located below the confluence of the Red and Red Lake rivers. The total drainage area is 25,000 square miles, of which 13,400 is in Minnesota.

The tables of discharge are based on the measurements in the list below and on forty-six measurements made during the eight preceding years, and are fairly accurate through the entire year.

MEASUREMENTS OF DISCHARGE.

Date	Name of Hydrographer	Gage Height	Discharge
10-21-1908	E. F. Chandler	6.06	1,240
1-25-1909	E. F. Chandler	6.00*	677
2-15-1909	E. F. Chandler	6.15*	592
4-26-1909	E. F. Chandler	11.15	3,780
7-30-1909	E. F. Chandler	18.73	9,200
11-23-1909	E. F. Chandler	7.78*	1,480
1-14-1910	J. O. Nomland and Chandler	8.77*	1,530
2-28-1910	J. O. Nomland	7.67*	1,030
3-23-1910	E. F. Chandler	30.17	18,280
7-25-1910	E. F. Chandler	5.12	830
8-20-1910	E. F. Chandler	3.39	366
10-14-1910	E. F. Chandler	3.36	395

*Frozen; means thickness of ice from 9.44 to 1.79 feet.

MONTHLY DISCHARGE OF RED RIVER AT GRAND FORKS, N. D.

Month	Accuracy	Maximum	Minimum	Mean
1908—October	A	1,710	1,270	1,440
November	C	1,490	.....	1,250
December	C	.....	.....	830
1909—January	C	.....	.....	703
February	C	.....	.....	564
March	C	.....	.....	747
April	C	5,180	2,480	4,330
May	A	3,690	2,780	3,090
June	B	5,050	2,380	3,200
July	B	9,260	2,150	3,780
August	B	8,040	4,320	5,580
September	B	4,920	2,530	3,170
October	B	2,480	1,970	2,230
November	B	2,430	1,040	1,900
December	C	.....	.....	2,430
1910—January	C	.....	.....	1,520
February	C	.....	.....	1,310
March	C	19,800	.....	8,740
April	A	10,800	5,020	7,840
May	A	8,440	2,750	4,340
June	A	2,570	1,160	1,950
July	A	1,140	704	862
August	A	690	373	487
September	A	562	313	420
October	A	492	343	413
November 1 to 12	A	429	282	371

River closed November 11, 1908; opened April 20, 1909; closed November 14, 1909; opened March 22, 1910; closed November 5, 1910.

Maximum gage heights: 16.5 feet April 8, 1909; 18.8 feet July 30, 1909; 30.7 feet March 22, 1910.

Minimum gage heights: 5.5 feet November 15, 1909; 8.0 feet July 20, 1909; 6.4 feet November 20, 1909; 2.9 feet September 24, 1910; 2.6 feet November 7, 1910.

RED RIVER AT FARGO, N. D.

The gaging station on the Red river at Fargo was established May 27, 1901. The drainage area above this point is 6,020 square miles, of which 1,750 square miles is in North Dakota, 500 square miles in South Dakota, and 3,770 square miles in Minnesota.

The tables of discharge are based on the measurements in the list below and forty-two measurements made during the eight preceding years, due allowance being made for the gradual slight changes in the channel.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
11- 7-1908	E. F. Chandler	8.10	450
5-15-1909	E. F. Chandler	9.54	887
6-26-1909	E. F. Chandler	9.25	757
7-27-1910	E. F. Chandler	6.74	150
8-16-1910	E. F. Chandler	5.98	56

MONTHLY DISCHARGE OF RED RIVER AT FARGO, N. D.

Month	Accuracy	Maximum	Minimum	Mean
1908—October	B	492	381	414
November	B	450	.....	360
December	C	.....	.....	300
1909—January	E	.....	.....	250
February	E	.....	.....	200
March	D	1,250	.....	400
April	C	1,150	770	944
May	A	1,780	797	937
June	A	1,610	743	1,110
July	A	743	450	606
August	A	853	541	685
September	A	970	690	788
October	A	825	664	762
November	C	664	.....	580
1910—March	C	4,700	.....	2,120
April	A	1,960	1,100	1,420
May	A	1,260	624	937
June	B	598	354	460
July	B	332	129	211
August	B	129	43	85
September	B	60	43	48
October	B	102	30	58
November 1 to 8	B	60	36	50

River closed November 13, 1908; opened April 16, 1909; closed November 15, 1909; opened March 21, 1910; closed November 9, 1910.

Maximum gage height: 13.0 feet March 30, 1909; 12.5 feet May 30, 1909; 23.2 feet March 19, 1910.

Minimum gage heights: 9.3 feet April 28, 1909; 8.0 feet July 3, 1909; 5.6 feet October 29, 1910.

OTTERTAIL RIVER NEAR FERGUS FALLS, MINN.

The gaging station on the Ottertail (or Red) river near Fergus Falls, Minn., was established May 6, 1904, and is located about three miles northeast of Fergus Falls. The drainage area above this point is 1,310 square miles.

The tables of discharge are based on the measurements in the list below and on sixteen previous measurements, and are unusually accurate through the whole of each open season.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
10-26-1908	E. F. Chandler	2.97	293
6-12-1909	E. F. Chandler	3.10	353
8- 4-1909	E. F. Chandler	2.99	306
8- 3-1909	E. F. Chandler	3.45	543
12-13-1909	E. F. Chandler	4.26*	440
2-21-1910	E. F. Chandler	4.08*	219
7-16-1910	Robert Follandsbee	2.60	167
8-23-1910	Robert Follandsbee	2.14	48.1

*Frozen; mean thickness of ice .62 and 1.60 feet.

MONTHLY DISCHARGE OF OTTERTAIL RIVER NEAR FERGUS FALLS, MINN.

Month	Accuracy	Maximum	Minimum	Mean
1908—October	A	336	276	301
November	A	276	240	261
December	C	.....	.....	220
1909—April	A	526	315	402
May	A	526	402	460
June	A	553	425	492
July	A	402	315	342
August	A	474	295	366
September	A	582	499	550
October	A	553	474	511
November	A	474	379	425
December	D	440	379	408
1910—January	D	.....	.....	325
February	C	.....	.....	240
March	C	426	200	285
April	A	449	402	434
May	A	449	357	417
June	A	357	236	294
July	A	236	98	163
August	B	98	36	64.8
September	B	52	16	32.6
October	B	98	22	48.3

Maximum gage heights: 3.5 feet June 4, 1909; 3.3 feet May, 1910.
Minimum gage heights: 2.8 feet November 28, 1908; 2.95 feet August 5, 1909; 1.9 feet September, 1910.

PEMBINA RIVER AT NECHE, N. D.

The gaging station on the Pembina river was established April 29, 1903, and is located at Neche, sixteen miles from the mouth of the river. The drainage area above this point is 2,940 square miles, of which 920 square miles is in North Dakota and 2,020 square miles in Manitoba.

The tables of discharge are based on the measurements in the lists below and thirty-one previous measurements, necessary allowances being made for changes that have several times occurred in the channel conditions determining the gage-height at season of lowest flow.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
7- 8-1909	E. F. Chandler	3.69	147
8-14-1909	E. F. Chandler	2.93	42
9- 1-1909	E. F. Chandler	2.81	28
7-28-1910	E. F. Chandler	2.36	8.6

MONTHLY DISCHARGE OF PEMBINA RIVER AT NECHE, N. D.

Month	Accuracy	Maximum	Minimum	Mean
1908—October	D	.....	.....	54
1909—June	D	654	.....	330
July	C	.....	73	130
August	B	100	22	48
September	B	32	22	28
October	B	73	32	46
November 1 to 14	C	67	38	51
1910—March 15 to 31	B	685	115	348
April	B	250	147	166
May	C	164	86	120
June		100	.....	61
July	C	100	9	35
August	D	9	3	6.5
September	D	7	3	3.6
October	D	.....	.....	6.4

Maximum gage heights: 6.4 feet June 6, 1909; 6.5 feet March 16, 1910.
Minimum gage heights: 2.8 feet September 17, 1910; 2.1 feet September 1, 1910.

RED LAKE RIVER AT CROOKSTON, MINN.

The gaging station at Crookston, Minn., was established May 19, 1901. The drainage area above Crookston is 5,525 square miles. Almost the entire discharge of the Red Lake river is included at this station, there being no considerable tributaries between this point and the mouth of the river at Grand Forks.

The tables of discharge are based on the measurements in the list below and thirty-eight previous measurements.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
12-23-1908	E. F. Chandler	4.54*	495
2-22-1909	E. F. Chandler	4.95*	323
6-18-1909	Hoyt and Chandler	4.42	660
6-30-1909	E. F. Chandler	6.20	1,660
8- 5-1909	E. F. Chandler	6.53	1,980
9- 4-1909	E. F. Chandler	6.09	1,810
11-16-1909	E. F. Chandler	3.75*	371
1- 8-1910	J. O. Nomland	6.57*	767
3- 1-1910	Nomland and Anderson	6.30*	646
4- 6-1910	J. O. Nomland	10.04	5,070
7-13-1910	E. F. Chandler	3.76	461
11- 7-1910	Chandler and Ebner	3.18	275
11- 7-1910	Chandler and Ebner	2.42	79

*Frozen. Mean thickness of ice, 0.1 feet to 2.61 feet.

MONTHLY DISCHARGE OF RED LAKE RIVER AT CROOKSTON, MINN.

Month	Accuracy	Maximum	Minimum	Mean
1908—October	A	1,040	605	860
November	C	.....	.....	803
December	C	.....	.....	437
1909—January	C	.....	.....	481
February	C	.....	.....	385
March	C	.....	.....	658
April	A	3,200	1,550	2,170
May	A	1,960	1,140	1,520
June	B	1,750	550	982
July	A	3,610	480	1,700
August	A	3,240	1,620	2,270
September	A	2,070	710	1,340
October	A	1,920	1,080	1,490
November	B	1,620	270	1,080
December	C	2,030	820	1,390
1910—January	C	.....	.....	754
February	C	.....	.....	740
March	B	5,460	.....	3,060

MONTHLY DISCHARGE OF RED LAKE RIVER—Continued.

Month	Accuracy	Maximum	Minimum	Mean
April	A	5,540	2,900	4,110
May	A	3,260	1,260	1,960
June	A	1,640	550	1,020
July	A	660	370	533
August	A	860	90	334
September	A	550	180	319
October	A	408	184	281
November 1 to 19	B	296	90	191

Maximum gage heights: 8.75 feet July 21, 1909; 14.2 feet March 20, 1910.
Minimum gage heights: 4.0 feet July 19, 1909; 2.4 feet November 7, 1910.

THIEF RIVER NEAR THIEF RIVER FALLS, MINN.

The gaging station on the Thief river was established July 1, 1909. It is located about six miles above the confluence of the Thief river with the Red Lake river at Thief River Falls, this being the most important tributary of the Red Lake river. The drainage area above the station is 1,010 square miles.

The tables of discharge are based on the measurements in the list below.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
7- 1-1909	E. F. Chandler	6.21	327
8- 2-1909	E. F. Chandler	6.36	381
8-16-1909	Chandler and Nomland	6.36	371
8-19-1909	Chandler and Nomland	6.14	288
9-15-1909	E. F. Chandler	6.25	324
10- 1-1909	J. O. Nomland	6.12	298
2- 7-1910	J. O. Nomland	6.24*	62
3-22-1910	J. O. Nomland	6.49	422
4- 9-1910	J. O. Nomland	8.82	1,266
4-25-1910	J. O. Nomland	8.05	998
5- 6-1910	J. O. Nomland	7.08	645
7-12-1910	E. F. Chandler	4.86	53
10- 6-1910	E. F. Chandler	3.35	0

*Frozen; mean ice thickness 1.68 feet.

MONTHLY DISCHARGE OF THIEF RIVER NEAR THIEF RIVER FALLS, MINN.

Month	Accuracy	Maximum	Minimum	Mean
1909—July	A	1,950	93	435
August	A	550	256	386
September	A	358	256	296
October	A	394	285	355
November	C	354	.....	276
December	D	.....	.....	173
1910—January	C	.....	.....	101
February	C	.....	.....	46
March	B	1,250	.....	330
April	A	1,420	817	1,130
May	A	785	229	427
June	A	225	72	155
July	A	190	46	103
August	A	104	22	41
September	B	26	0	8
October	A	0	0	0

Maximum gage heights: 10.6 feet July 19, 1909; 9.2 feet April 4, 1910.
Minimum gage heights: 5.2 feet July 10, 1909; 3.3 feet October, 1910.

MOUSE RIVER AT MINOT, N. D.

The gaging station on the Mouse river at Minot was established May 5, 1903. The drainage area above this point is 8,400 square miles, of which three-fourths in in Canada and one-fourth in North Dakota.

The tables of discharge are based on the measurements in the list below and thirty-four measurements made in previous years.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
10-11-1908	E. F. Chandler	3.82	13.1
10-11-1908	E. F. Chandler	3.82	11.7
4-12-1909	E. F. Chandler	10.34	1,040
9- 8-1909	E. F. Chandler	3.89	24.0
12-28-1909	E. F. Chandler	3.65	3.2
12-28-1909	E. F. Chandler	3.65	1.6
7-21-1910	E. F. Chandler	3.89	19.6
10-21-1910	E. F. Chandler	3.01	0.6

MONTHLY DISCHARGE OF MOUSE RIVER AT MINOT, N. D.

Month	Accuracy	Maximum	Minimum	Mean
1908—October	C	35	15	23.1
November	C	35	.....	30
December	D	.....	.....	15
1909—January	E	.....	.....	10
February	E	.....	.....	8
March	C	546	.....	156
April	A	1,094	436	726
May	A	421	231	289
June	A	546	174	322
July	B	163	28	82
August	B	70	9	37
September	B	52	1	13
October	D	.....	.....	1
November	D	.....	.....	2
December	D	.....	.....	2
1910—January	E	.....	.....	2
February	E	.....	.....	1.5
March	A	196	.....	127
April	A	207	141	171
May	A	141	79	113
June	A	70	28	47
July	A	35	10	20
August	C	7	0.3	2.2
September	C	.....	.....	0.4
October	C	.....	.....	0.5

Maximum gage heights: 9.5 feet April 14, 1909; 4.9 feet April 3, 1910.
Minimum gage heights: 3.3 feet October 15, 1909; 3.0 feet October 20, 1910.

LITTLE MUDDY RIVER NEAR WILLISTON, N. D.

The gaging station on the Little Muddy river was established February 4, 1904, and was located in section 19, township 155, range 100, about seven miles north of Williston and the mouth of the river. It was discontinued April 24, 1909, on account of lack of funds. The drainage area above this point may be considered as 800 square miles.

The tables of discharge are based on thirty-one measurements made in previous years.

MONTHLY DISCHARGE OF LITTLE MUDDY RIVER NEAR WILLISTON, N. D.

Month	Accuracy	Maximum	Minimum	Mean
1909—March 14 to 31	C	1,670	.....	476
April 1 to 24	B	330	6	72

GRAND RIVER AT HALEY, N. D. (NORTH BRANCH).

The gaging station on the Grand river at Haley was established May 11, 1908. The drainage area above this point is about 500 square miles. The tables of discharge are based on the measurements in the list below, which are too few in number to give well-checked results, but afford some basis for estimate at all stages recorded.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
5-11-1908	P. N. Ford	0.95	1.8
8-18-1908	E. F. Chandler	0.86	0.15
4- 5-1909	R. M. Stee	1.27	15.2
5- 6-1909	R. M. Stee	1.23	16.6
3-21-1910	J. W. Bliss	2.60	90.

MONTHLY DISCHARGE OF GRAND RIVER AT HALEY, N. D.

Month	Accuracy	Maximum	Minimum	Mean
1908—May 17 to 31	C	290	1.8	114
June	C	227	3.5	48
July	C	35	0.3	9.5
August	C	8	.....	1.2
September	B	0.5	0.5	0.5
October	B	4	0.5	0.8
November	B	0.5	0.5	0.5
December	D	.....	.....	0.5
1909—February	D	320	.....	38
March	C	350	20	102
April	B	20	0.5	7
May	C	500	0.5	20
June	C	400	10	99
July	B	28	3.5	12
August	B	150	2	11
September	C	2	2	2
October	C	3.5	2	2.1
November	C	2	2	2
December	D	.....	.....	2
1910—March	D	.....	.....	170
April	B	144	20	34
May	C	13	8	11
June	B	66	8	20
July	C	3.5	0.5	1.4
August	D	.....	.....	0.5
September	D	.....	.....	0.7
October	D	.....	.....	0.5

Maximum gage heights: 5.6 feet May 23, 1908; 6.7 feet March 1, 1909; 7.8 feet May 31, 1909; 6.9 feet June 9, 1909; 7.8 feet March 6, 1910.

Minimum gage heights: 0.8 feet August 10, 1908; 0.9 feet May 14, 1909; 1.8 feet June 7, 1909; 0.95 feet October 15, 1909; 0.9 feet September 1, 1910.

HEART RIVER NEAR RICHARDTON, N. D.

The gaging station on the Heart river was established May 18, 1903, and is located at the iron highway bridge ten miles south of Richardton. The drainage area above this point is 1,250 square miles.

The tables of discharge are based on twenty-five measurements obtained in former years, only one measurement having been made during the last biennial period, and this having been made while the current was not yet clear of ice. Hence the figures of flow at low stages may be subject to a very large percentage of errors for this period.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
4- 3-1909	J. W. Bliss	6.10	1.69

MONTHLY DISCHARGE OF HEART RIVER NEAR RICHARDTON.

Month	Accuracy	Maximum	Minimum	Mean
1908—October	B	172	4	27
November	D	.....	.....	7.5
1909—March	D	1,180	.....	520
April	B	275	22	97
May	B	966	11	168
June	C	3,930	29	586
July	B	1,420	29	265
August	C	2,350	16	403
September	C	37	7	18
October	D	11	4	7
November	E	.....	.....	12
1910—March	C	4,560	.....	1,170
April	C	102	4	30
May	D	11	4	7
June	C	116	2	27
July	D	46	1	8
August	D	4	0.3	1
September	D	.....	.....	0.5
October	D	.....	.....	0.8

Maximum gage heights: 11.0 feet March 23, 1909; 18.0 feet June 2, 1909; 14.2 feet August 13, 1909; 19.4 feet March 14, 1910.

Minimum gage heights: 4.4 feet May 14, 1909; 4.2 feet October 5, 1909; 3.9 feet September 2, 1910.

KNIFE RIVER NEAR BRONCHO, N. D.

The gaging station on the Knife river is north of Hebron, in section 4, township 142 north, range 90 west, being near Broncho postoffice. A station was first established on the river in this immediate vicinity May 29, 1903. The drainage area above this point is 1,260 square miles.

The tables of discharge are based upon the measurements in the list below in conjunction with the results of twenty-six measurements made in previous years at the same or neighboring points; the results are only approximate at highest stages because no extreme high stage discharge measurements have yet been obtained, and are subject to large percentage errors at low stages because of the small number of recent measurements.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
4- 3-1909	J. W. Bliss	5.70	194*

*Ice not entirely gone.

MONTHLY DISCHARGE OF KNIFE RIVER NEAR BRONCHO, N. D.

Month	Accuracy	Maximum	Minimum	Mean
1908—October	B	14	4	5.5
November	C	.....	.....	5
1909—March	C	1,540	20	650
April	B	334	23	97
May	B	824	10	103
June	C	2,300	18	375
July	B	1,020	14	154
August	B	915	10	157
September	C	18	7	11
October	C	18	10	14
November	D	.....	.....	13
1910—March	C	2,940	.....	789
April	C	75	18	32
May	C	18	14	15
June	B	481	10	56
July	D	18	4	8
August	D	10	4	9
September	D	14	10	12
October	D	.....	.....	10

River closed November 14, 1908; opened about March 2, 1909; closed November 17, 1909; opened about March 5, 1910.

Maximum gage heights: 11.9 feet March 24, 1909; 15.4 feet June 2, 1909; 9.0 feet August 14, 1909; 20.0 feet March 12, 1910.

Minimum gage heights: 3.6 feet May 15, 1909; 3.5 feet September 25, 1909; 3.4 feet July 20, 1910.

PAINTED WOODS CREEK NEAR WASHBURN, N. D.

The gaging station on Painted Woods creek near Washburn was established in March, 1909, and is located at the north side of section 34, township 144, range 81. Its drainage area is about 390 square miles.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
3-21-1909	J. W. Bliss	4.20*	55.3
3-25-1909	J. W. Bliss	4.00*	180
6-16-1909	T. Dickinson	1.10	5.4
7- 9-1909	T. Dickinson	0.70	1.3
3-29-1910	J. W. Bliss	1.10	2.0

*Some ice in channel.

MONTHLY DISCHARGE OF PAINTED WOODS CREEK NEAR WASHBURN, N. D.

Month	Accuracy	Maximum	Minimum	Mean
1909—March	E	215	1	53
April	D	110	4	22
May	C	7	2	4
June	C	9	4	6
July	D	4	1	2
August	D	5	0.5	1
September	D	2	0.5	1
October	D	1	0.5	0.5
November	D	.....	.....	0.5
1910—March 13 to 31	D	50	4	16
April	C	5	2	3
May	D	2	0.2	1
June	D	29	0.2	3
July	D	4	0.2	1.5
August	D	.....	.....	0.5
September	D	.....	.....	0.5

Maximum gage height: 4.5 feet March 20, 1909.
Minimum gage height: 0.4 feet September 11, 1909.

TURTLE CREEK NEAR WASHBURN, N. D.

The gaging station on Turtle creek near Washburn, N. D., was established in March, 1909, and is located near the northwest corner of section 15, township 144, range 81. The drainage area is about 440 square miles.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
3-26-1909	J. W. Bliss	5.50*	94
6-16-1909	T. Dickinson	2.20	1.8
3-30-1910	J. W. Bliss	2.50	2.4

*Some ice in channel.

MONTHLY DISCHARGE OF TURTLE CREEK NEAR WASHBURN, N. D.

Month	Accuracy	Maximum	Minimum	Mean
1909—April	E	46	1.5	11
May	D	5	1	1.8
June	D	14	1	3
July	D	1	0	0.5
August	E	.....	.....	0.
September	E	.....	.....	0.1
October	E	1	.....	0.3
November	E	.....	.....	0.2
1910—March 13 to 31	E	156	2	24
April	D	2	1.5	1.9
May	D	1.5	1	1.2
June	D	29	0	1.9
July	E	8	.....	1.2
August	E	.....	.....	0.2
September	E	.....	.....	0.1

Maximum gage heights: 5.6 feet March 26, 1909.
Minimum gage heights: 1.4 feet September 12, 1909.

MISSOURI COULEE NEAR SANGER, N. D.

The gaging station on Missouri coulee near Sanger, N. D., was established in March, 1909, and is located about one-half mile north of Sanger. The drainage area is about twenty-five square miles.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
4- 4-1909	J. W. Bliss	0.90	8.2
6-17-1909	T. Dickinson	0.50	.05
7- 8-1909	T. Dickinson	0.70	1.6

MONTHLY DISCHARGE OF MISSOURI COULEE NEAR SANGER, N. D.

Month	Accuracy	Maximum	Minimum	Mean
1909—April	E	90	0.5	11
May	B	4	0	1.0
June	B	8	0	0.4
July	B	4	0	0.4
August	C	4	0	0.3
September	C	.....	.....	0
October	C	.....	.....	0
November	C	.....	.....	0

MANDAN LAKE CREEK NEAR HENSLER, N. D.

The gaging station on Mandan Lake creek near Hensler, N. D., was established in March, 1909, and is located in section 34, township 144, range 83. The drainage area is about twenty-five square miles.

DISCHARGE MEASUREMENTS.

Date	Name of Hydrographer	Gage Height	Discharge
4- 5-1909	J. W. Bliss	5.00	9.0
6-17-1909	T. Dickinson	4.50	0.4
7- 8-1909	T. Dickinson	4.50	0.3

MONTHLY DISCHARGE OF MANDAN LAKE CREEK NEAR HENSLER, N. D.

Month	Accuracy.	Maximum	Minimum	Mean
1909—June 20 to 30	E	1.6	0.1	0.4
July	E	2.3	0.1	0.3
August	E	0.1	.....	0.1
September	E	0.6	.....	0.1

THE EFFECT OF THE 1910 DROUGHT ON THE RIVERS.

The fall of 1910 was very unusual in the low stage of the streams, and it may reasonably be predicted that this unprecedented low stage will continue through this winter. The effect of the deficiency of rainfall in the season of 1910 had been evident in the smallness of the farm crops, but was much more noticeable in the smallness of the rivers.

Through most of this region the rainfall between April 1st and November 1st was only about one-half of the normal rainfall for that period. Deficiency or excess in the rainfall causes much greater percentage variations in the streams within the few months following, for—speaking in general terms—if there is water available nearly the same amount disappears from the land in evaporation each year, regardless of whether the total rainfall has been small or large, and the water in the rivers is the surplus of rainfall over the demands of evaporation; this being only a small amount in this region, one inch is comparatively a much greater difference in the run-off than in the rainfall. (This was fully discussed in the Third Report of the State Engineer, pages 57 to 62.)

In the last summer and autumn the rivers fell below all previous low-water marks. Attention may be called to some striking examples from the river records that are summarized in his report and preceding reports.

Thief river above its gaging station drains one thousand and ten square miles of the northeastern portion of the Red River valley in Minnesota. In 1909 its discharge through the fall averaged three hundred and ten second-feet; in 1910, despite the fact that there was unusually large and long extended flood flow in April, so that all the bottom lands ought to have been well saturated underneath, the flow diminished through September until the stream was merely standing in pools, and the average for the fall was less than three second-feet.

The Ottertail river (or Red river) at Fergus Falls, Minn., which drains thirteen hundred and ten square miles, is a very steady stream on account of the lake storage from which it draws. Its August-September-October flow in the six years previous has always been between eight hundred and twenty and two hundred and seventy second-feet as extreme limits, with an average of four hundred and sixty; but in 1910 it diminished through the summer until by the end of August it was below fifty second-feet.

That the shortage has not been confined to a small district is shown by the record of the Red river at Grand Forks, which receives the drainage from a total of twenty-five thousand square miles. The average for the past seven years of the September-October flow at this point has been two thousand four hundred second-feet, and the September-October average for the lowest of the seven years was sixteen hundred second-feet. But in 1910 the

September-October average was only four hundred and sixteen second-feet, which sets a new record. The 1895 gage-height record, however, would indicate a flow of between six hundred and seven hundred at that time, though this cannot be perfectly checked.

The streams of western North Dakota are more subject to extreme low-water conditions than those in Minnesota, on account of the less amount of the normal rainfall; but unusually low records were made here also. The Mouse river at Minot drains eight thousand four hundred square miles. Its September-October flow in 1903 was four hundred and ninety second-feet, and in the six years following averaged thirty-two second-feet; in 1910 it was less than one second-foot.

The low stage of the streams has caused much annoyance and some expense where they are used as a supply for pumping plants. At many points the railroads have been obliged to build small dams or make them tighter in order to keep the water deep enough for the intakes of the suction pipes at their water tanks. The same thing was necessary at the waterworks intake of the city of Fargo, where a good coffer dam of sheet piling extending across the river was constructed in August to raise the water surface two feet. At Grand Forks in November a dam of fagots, timbers and gravel-bags was built to cause a two-foot rise in order that the water surface might be high enough over the intake pipe of the city waterworks to avoid danger of injury by the heavy winter ice.

It is unquestioned that the breaking and cultivation of the soil has had a tendency to cause a larger portion of the rainfall to be intercepted and less to reach the rivers than formerly. It is of course possible that the stream flow may thus have been permanently diminished so much that a frequent repetition of low stages such as the present will occur; but it is hardly fair to charge entirely against the agricultural operations so extreme a condition as that of the past fall, for there have been several very high flood seasons within a few years past. Probably the low water was chiefly due to the unusually small quantity of rainfall and to the way that it was distributed through the season; exceptional years will inevitably come occasionally, but it should not be feared that they will recur frequently.

THE FORT BERTHOLD INDIAN RESERVATION.

Especial interest attaches now to the resources of the area included within the Fort Berthold Indian reservation on account of the approaching opening of the reservation to settlement.

The reservation covers an area of 1,590 square miles in the center of the western half of North Dakota; its northern boundary is the 48th parallel of latitude, and it is roughly rectangular in form, being forty-five miles in length from east to west, with the southern boundary an irregular line thirty to thirty-eight miles south of the

opposite bound. One additional fractional township outside the southeast corner of the rectangle is also included.

It is divided into two nearly equal portions by the Missouri river, which enters near the northwest corner and leaves at the southeast. The larger portion is on the east and north side of the Missouri. nine hundred twenty square miles; the six hundred and seventy square miles remaining on the south and west side of the Missouri is subdivided by the Little Missouri river as it flows eastward to the Missouri, one hundred and eighty square miles being south of both rivers, and four hundred and ninety north of the Little Missouri.

A law passed by congress and approved June 1, 1910, provides for the partial opening of the reservation. The chief provisions in the act are these:

1. An allotment of one hundred sixty acres of agricultural land or of three hundred acres of grazing land is to be made to each member that is now living of the several tribes occupying the reservation; such allotment is to be in addition to any allotments heretofore made or enacted.

Provided, that no allotments to Indians can be made under this act on the east side of the Missouri river in the two northern tiers of townships (towns 152 and towns 152) nor in towns one hundred fifty or one hundred forty-nine of ranges eighty-seven, eighty-eight and eighty-nine. (N. B. This is somewhat more than a third of the whole reservation.)

2. That there be set aside permanently such tracts as are needed for agency, school and religious purposes and an agency farm, etc., and timber lands suitable for a forest reserve.

3. That lands bearing coal or other mineral, and tracts chiefly valuable for power sites or reservoir sites be withheld until further action of congress.

4. That suitable townsite locations shall be selected by the secretary of the interior.

5. That sections sixteen and thirty-six shall be granted to the state of North Dakota for school purposes; and that in case section sixteen or thirty-six in any township shall have been allotted to Indians or otherwise withdrawn, adjoining sections shall be granted in lieu.

6. That all the remaining land on the north and east sides of the Missouri river (except school sections 16 and 36) shall be classified and appraised by a commission appointed for that purpose; that the land shall be classified as agricultural land of the first class, agricultural land of the second class, grazing land, timber land, and mineral land.

7. That these lands shall then be disposed of under the provisions of the homestead and townsite laws of the United States; that they shall be opened for settlement and entry by proclamation of the president, which shall prescribe the time and manner. That

the appraised value of the land as already fixed by the commission shall be paid by each entryman, one-fifth at the time of entry and the balance in five annual equal installments of which the first is due two years after the date of entry; entries may be commuted by immediate payment of the whole appraised value. That in case of default in payments by an entryman, all his rights lapse. That the same fees and commissions shall be paid by the entryman as under previous laws.

8. That all the lands, however disposed of, shall still be subject to all laws of the United States pertaining to the introduction of intoxicants into the Indian country.

The remainder of the act concerns details of operation.

Two-thirds of the reservation was still unsurveyed, but since the passage of the act survey work has been pushed in order that everything may be ready for the opening as soon as possible.

On the north side of the Missouri river, the Indian settlements are Armstrong, in the center of town 147, range 88; Elbowoods, the agency, at the north side of township 147, range 90; and Shell Creek settlement, in the center of township 150, range 91; there are many Indian farms and dwellings scattered along the river between these settlements, but none are more than two or three miles from the river, and few are above Shell creek. On the south side there are a less number. Independence village is in the southeast part of township 150, range 91; there are small settlements at the mouth of the Little Missouri on the southern side of township 148, range 91, and near Ree in the northwest corner of township 146, range 88, and others living along the river between these points. The total Indian population as mentioned above is twelve hundred. Except in these portions the reservation is as yet entirely unsettled.

The topography near the Missouri river has the characteristic features of the Missouri valley in this whole portion of its course. The bottom lands and low bench lands along the river are bounded on each side by steep bluffs two hundred feet high; the total width between the bluffs is two to three miles. The river channel with its bordering sandbanks has a width of a quarter mile to a half mile, and runs down through the bottoms in long easy curves swinging against one bluff for a mile or more, then against the other.

The stretches of bottom land are sometimes a mile wide, and usually were wooded originally. Sometimes there are trees on the first bench, if low; but above this there are no trees or brush except along the ravines and at the sheltered side of bluffs and hills.

The sides of the valley are usually very steep, diversified by buttes and cutbanks, with deep ravines running back into the hills, giving to this strip the "band land" character; although the fertility of the soil may be satisfactory, the declivities are so abrupt, and it

is so cut by gullies, as to be nearly impassible, hence inconvenient for agriculture. Coal workings will ultimately develop at many points in this belt; lignite seams from three to five feet thick are already exposed, and there are doubtless better seams.

On the north side of the Missouri, after passing through the strip of bad lands, the high prairies are reached, gently rolling and passing down with easy slopes into the wide valleys of the creeks. After excluding the rough lands near the river, there remain fifteen solid townships along the northern and eastern sides of the reservation, most of which is well adapted for agriculture; the land is good, and the slopes such as to permit of roads in any direction. Furthermore, this tract is conveniently accessible; the railroad station of Garrison is less than twenty miles east, and the station of Plaza is just outside the boundary, two miles west of the northeast corner of the reservation. There is no doubt but that this land will be taken eagerly when the opening takes place.

On the south and west side of the Missouri the area included in the reservation is narrower; also, at the widest place it is intersected by the Little Missouri river, which here has a very deep valley through country of the extreme bad land character. Every point is therefore within six or eight miles of either the Missouri or the Little Missouri, and the tract is so much broken that, speaking in general terms, it is not suited for agriculture and its chief value is for grazing. This side of the reservation, however, will not at present be open for entry and probably almost all of it will be allotted to Indians at an early date.

On some of the streams of the reservation small irrigation projects can be developed in the future. A list of such streams is as follows:

Seven Mile creek, flowing by Armstrong, has sixty square miles drainage area, with good reservoir sites half way down. Small gravity projects would be possible in the lower valley, or all available water could be well used on the Missouri bottoms at the mouth of the creek.

Rising Water (or Lucky Mountain) creek, which enters the Missouri at the west side of township 149, range 90, drains one hundred twenty-five square miles or more, hence a total discharge of nearly 5,000 acre-feet each year could be expected from it, as an average. There is a good reservoir location a half mile above the mouth, where water not utilized higher up could be stored for use on about six hundred acres of bottoms north of the mouth of the creek and twenty-five hundred acres south of the mouth.

Shell creek is a considerable stream; it has a length in direct line of thirty-five miles, from its head which is nearly twenty miles north of the reservation boundary, to its mouth in the central part of township 150, range 91. The theoretical drainage area is four

hundred and ninety square miles, one hundred and ninety of which is outside the reservation boundary. About forty square miles of this drains into a lake or slough in the central part of township 151, range 92, that has an area of eight hundred and fifty acres and that seems never to have overflowed into the nearby branch of Shell creek; if one of the numerous possible pumping projects for taking water from the Missouri should be constructed, this lake would be an excellent storage reservoir, into which water could be pumped and gradually accumulated and held for as many months or years as necessary; a very short trench would furnish then an outlet from the lake into the main valley. The total area in the Shell Creek valley and at its mouth that could be reached by irrigation ditches if there were sufficient water is nearly fifty square miles. Diversion dams at almost any point along the main stream are practicable, the fall of the valley is five feet to the mile, and it lays very well for irrigation; but until storage reservoirs are constructed the flow would provide only spring flooding, as the summer flow of the streams in western North Dakota is usually small. Even with complete storage, the natural flow of the stream would be enough for only ten or twelve square miles. Hence, lignite being plentiful and the Missouri river close at hand, investigation of pumping plant projects or possibilities will be well worth while.

On the south side of the Missouri, the first tributary is Beaver creek, which flows by the village of Ree and discharges at the northwest corner of township 146, range 88. This drains seventy square miles, two-thirds of which is outside the south boundary of the reservation; if there were storage, the water could all be used on the large Missouri bottoms west of the mouth of Beaver creek.

A creek flowing east through the southern half of township 147, range 90, affords a good reservoir location at the middle of the east side of that town, just before it escapes from the hills out onto the Missouri bottoms, and all the water from its thirty-seven square miles of drainage area could be well used on the bottom lands northwest of the reservoir.

The Little Missouri river forms the southern boundary of the reservation from the middle of range 95 to the southwest corner of township 147, range 92; at that point it enters the reservation and turns northward, flowing nearly along the west side of that township to section 5, then east on its northern boundary and through the southern part of township 148, range 91, to the Missouri river. (Note—The portion within the reservation was unsurveyed until this season, and is seriously in error in all maps yet published.) Its valley is from half a mile to a mile in width, with good flats in the valley bottom; but the river makes many short turns, and strikes high cutbanks at every turn, or perpendicular bluffs, so that a long canal would be very expensive to construct

and almost impossible to maintain; the slope of the valley is less than three feet to the mile, hence the water could not be brought to the land except by a long canal or high dam. On account of the violence of the flood flows, which sometimes have certainly exceeded 20,000 second-feet and may have been nearly 30,000 second-feet, and on account of the lack of foundation (nothing better than soft shale and lignite being present) the expense of a high storage or diversion dam would be so great as to be prohibitive. The stream has so small a flow through the larger portion of each ordinary year that the amount of water of which use would be obtained would not be in any proportion to the expense.

Squaw creek, which rises near the southeast corner of township 149, range 94, and flows southeasterly into the Little Missouri in section 35, township 148, range 92, drains sixty square miles, more or less. There are fairly good reservoir sites a few miles above its mouth, and fine flats below that point large enough to use all the water.

Above the Little Missouri, the only streams large enough to deserve mention are Bear Den creek and Clark creek. Bear Den creek rises west of the reservation and flows east into the Missouri river in section 17, township 150, range 93, from a drainage area of about eighty square miles. Its valley is extremely deep and narrow, and there are good reservoir locations in the lower portion, but no large tracts on which to use the water.

Clark creek rises west of the reservation, flows easterly, and enters the Missouri in section 13, township 151, range 94. It drains about seventy square miles, and has good reservoir sites in the lower portion; but there is little land to which the water could be applied, except the wide Missouri bottoms two miles north of the mouth of Clark creek, and it would be difficult to carry a canal to these.

An examination of the streams of the reservation was made in the early part of August, 1910; the season has been unusually dry, and all the streams were very low or at the lowest possible point. Rough measurements showed the following flow in different streams:

Date.	Stream and Location.	Quantity of Discharge—second-feet.
Aug. 3.	Clark creek, sec. 12, twp. 151, r. 94	0.6
Aug. 4.	Bear Den creek, sec. 30, twp. 150, r. 94	0.9
Aug. 5.	Little Missouri river, sec. 5, twp. 147, r. 92	66.1
Aug. 5.	Squaw creek, sec. 35, twp. 148, r. 92	about 0.2
Aug. 6.	Squaw creek (after rain)	0.8
Aug. 7.	——creek, sec. 18, twp. 147, r. 89	0.1
Aug. 10.	Shell creek, sec. 33 twp. 151, r. 91	2.5
Aug. 10.	Rising Water creek, sec. 18, twp. 149, r. 90	1.2

It is not likely that there was any other stream in the whole reservation (except the Missouri river) which at that time carried

as much as 0.2 second-feet. But a similar table of stream-flow for all streams carrying more than one second-foot in the month of April would undoubtedly extend through several pages.

NORTH DAKOTA LIGNITE MINES.

North Dakota lignite mines are as a rule developed along the double entry system, though a few of the smaller operators use but a single entry, and there are some who follow no system whatever. A system of mining called the "stub entry" is employed in the government, the Davis and the Wallace mines. In the practice of this system a stub is turned from the cross entry and driven to a depth of about two hundred feet. It is cut about ten feet wide, and three feet from one side a row of props are set, to which a brattice is fastened, thus dividing the stub entry into two parts, a haulage way and a return air course. From the stub, rooms are turned beginning at the far end and working back towards the cross entry. Sometimes the stub entry is turned directly from the main entry. In all cases with the exception of strip pits and the Ingison mine the room and pillar method of mining is used, the width of the room and the pillars depending on the local character of the roof and the floor material. The rooms vary in width from ten to twenty-five feet and the pillars from eight to sixteen feet. The entries are driven as narrow as possible to reduce the timbering expense and to render the work as permanent as possible. In the case of the Ingison mine referred to, an entry is driven from the cross entry which just provides a haulage way to a depth of two hundred feet. It is then widened to thirty feet and the roof propped, and the work then proceeds something like a longwall retreat system, the coal being mined back fifteen feet on each side of the entry. The props are removed and the roof allowed to cave about twenty feet back from the face. In some localities the coal beds lie so near the surface that the process of mining it is reduced to the simple proposition of scraping away the overburden and loosening up the coal. A man and team can thus expose a large amount of coal which can be sold during the fall and winter months with but little labor and expense. Coal, however, found at this depth is only of commercial value when the overlying strata is of a very compact and impervious character, otherwise it will have slacked.

Timber for mining use with but few exceptions has to be shipped in from other states, the greater part of it being cedar and tamarack posts obtained from Minnesota. This makes timbering a serious item of expense, in many cases prohibiting the development of properties where the coal is less than six feet in thickness. Beds over six feet thick may be worked with a comparatively small amount of timbering by leaving a coal roof. This, however, depends on the thickness of the coal left, its firmness, the absence of vertical cracks and cleavages. Ordinarily all the cleavage plains follow the dip of the bed. Where any amount of coal is left for a roof, after the room has been driven to its full depth, it is shot down,

provided the roof clay is sufficiently strong, and provides some of the cheapest mined coal. As a rule, in case the roof coal is mined, no attempt is made to get any pillar coal, and conversely, when the pillars are robbed, usually no attempt is made to recover the roof coal because of the fact that the entries are made as narrow as possible and as much of a coal roof left as can be.

In many instances no timbering whatever is done in the entry work. In the case of some of the mines where it is possible to leave a five or six-foot roof of coal, a single row of props and caps are all that are required in the rooms and as they are worked out the props are taken out and used over and over, and the timbering expense thus reduced to a very low figure.

Tamarack and cedar posts from eight to twelve inches in diameter at the butt cost from twenty-two to thirty-five cents delivered at the mine, according to their length, which varies from six to nine feet, and the distance which they have to be hauled from the railroad. Mines adjacent to the Missouri river are timbered with elm, ash and cottonwood posts at a reasonable cost. There is a tendency in most cases to do an insufficient amount of timbering consistent with safety, due to the fact that in most of the mines the timbering is left to the judgment of the miners, some of whom are inexperienced and some who are experienced but careless.

There are but few mines which have an excessive amount of mine water to contend with and many of them are entirely dry. Steam, electric, windmill and hand pumps are used for drainage where needed.

Air shafts are generally used to provide ventilation, and are sometimes supplemented with furnaces for increasing the draft on humid days. Some of the mines equipped with power plants use fans for this purpose. Due to the entire absence of explosive gases which necessitates an abundant supply of good air, ventilation is sometimes neglected and the air furnished is not sufficient. Although this condition imposes no danger it sometimes reduces the efficiency of the miners.

Black powder of the variety known as FFF is the common blasting agent, with squibs for fuses. Forty per cent dynamite is preferred where the coal is not too badly shattered by its use.

Evidence that the general conditions of the lignite mines are quite satisfactory is furnished by the fact that no fatalities were reported for the year 1909 and but one for the year 1910 to date. Fritz Grittel was killed October 18th in a mine near Blue Grass. A fall of clay in the entry occasioned his death. On November 3, 1910, a couple of miners, Vernon Butler and R. Dorsmyth, were injured seriously by a delayed shot. The accident was due to carelessness and inexperience on the part of the miners in handling of the explosives.

On November 19th Leon Alger entered his room thinking his shot had gone off, only to meet the full force of the explosion in the entry to the room. He was badly burned about the face and arms. November 23rd a miner drilled into a loaded hole and received severe injuries to his face and arms.

DIRECTORY OF NORTH DAKOTA COAL MINES.

ADAMS COUNTY

Name of Mine and Name of Owner	Lessee	Post Office and Location
1. Clermont Coal Mine, State Land	Clermont Coal Company	Haynes, SW¼ NE¼ Sec. 16, T. 129, R. 94.
2. Farmer's Coal Mine, Farmer's Coal Co.	.....	Haynes, NW¼ SW¼ Sec. 9, T. 129, R. 94.
3. Haynes Lignite Coal Co., Haynes Lignite Coal Co.	.....	Haynes, NE¼ SE¼ Sec. 8, T. 129, R. 94.
4. Monroe Coal Mine, State Land.....	Monroe & Nippur	Haynes, SE¼ SE¼ Sec. 16, T. 129, R. 94.

BILLINGS COUNTY

5. De Mores Coal Mine, De Mores Estate	H. G. Kinmark	Medora, Lot 1, in Sec. 26, T. 140 N., R. 102.
6. Haas Coal Mine, F. G. Haas	.....	Bowman, NE¼ NE¼ Sec. 34, T. 133, R. 101.
7. Rodger's Coal Mine, C. Rodgers.....	George Clark	Bowman, NW¼ Sec. 19, T. 133, R. 101.

BOWMAN COUNTY

8. Scranton Coal Mine, Consolidated Coal Co.	.....	Scranton, SW¼ SW¼ Sec. 24, T. 131, R. 100.

BURKE COUNTY

9. Anderson Coal Mine, Andrew Anderson	.....	Columbus, NW¼ NW¼ Sec. 29, T. 162, R. 94.
10. Anderson Coal Mine, Niels Anderson...	.....	Stampede, NW¼ NW¼ Sec. 26, T. 162, R. 94.
11. Domrese Coal Mine, H. J. Domrese.....	.....	Columbus, NW¼ NW¼ Sec. 24, T. 162, R. 94.

12. Fenster Coal Mine, Fenster Bros.	.....	Larson, SE¼ NE¼ Sec. 7, T. 162, R. 94.
13. Gillie-Miller Coal Mine, Gillie & Miller.	J. S. Greenup	Columbus, SW¼ SE¼ Sec. 20, T. 162, R. 93.
14. Greenup Coal Mine, J. S. Greenup	.....	Columbus, SE¼ SW¼ Sec. 20, T. 162, R. 93.
15. Hall Coal Mine, Jerome Hall	.....	Larson, NE¼ NE¼ Sec. 7, T. 162, R. 94.
16. MacKee Coal Mine, S. G. Ruffcorn	.....	Portal, Lot 1, NW¼ Sec. 30, T. 164, R. 93.
17. Vick Coay Mine, Herman Vick	.....	Columbus, NE¼ SW¼ Sec. 19, T. 162, R. 94.
BURLEIGH COUNTY		
18. Eckman Coal Mine, Oscar Eckman	.....	Wilton, SE¼ of Sec. 8, T. 142, R. 79.
19. Lind Coal Mine, Mrs. A. C. Lind	.....	Wilton, NE¼ of Sec. 6, T. 142, R. 79.
20. Peterson Coal Mine, Charley Peterson	.....	Wilton, SW¼ of Sec. 9, T. 142, R. 79.
21. Wilton Coal Mine, Washburn Lignite Coal Co.	.....	Wilton, NW¼ of Sec. 1, T. 142, R. 80.
McLEAN COUNTY		
22. Bitumina Coal Mine, John Satterlund.	.....	Washburn, SW¼ NW¼ Sec. 6, T. 144, R. 82
23. Duchene Black Diamond Coal Mine, state land	J. J. Duchene	Garrison, NW¼ SE¼ Sec. 16, T. 148, R. 86
24. Love's Coal Mine, I. E. Love	.....	Wiprud, NW¼ SE¼ Sec. 36, T. 149, R. 81
25. Long & Arvidson Coal Mine, Long & Arvidson	Goldley & Isaackson	Turtle Lake, NW¼ Sec. 13, T. 146, R. 80
26. Youngquist Coal Mine, E. Youngquist	Sullivan & Barlow	Washburn, SE¼ NE¼ Sec. 10, T. 144, R. 83
MERCER COUNTY		
27. Haatvit Coal Mine, State Land	John Haatvit	Stanton, SW¼ Sec. 36, T. 145, R. 86
28. Jansen Coal Mine, State Land	B. Jansen	Stanton, NE¼ Sec. 16, T. 144, R. 85
29. Schmidt Coal Mine, State Land	Albert Schmidt	Aplin, Section 16, T. 143, R. 88

DIRECTORY OF NORTH DAKOTA COAL MINES.

MORTON COUNTY

Name of Mine and Name of Owner	Lessee	Post Office and Location
30. Feland Coal Mine, Theodore Feland ..	.....	Sims, SW¼ Sec. 13, T. 138, R. 86
31. Hebron Brick Company Coal Mine, Hebron Fire & Pressed Brick Co.	.....	Hebron, Section 11, T. 140, R. 90
32. North Star Coal Mine, Haven & Murray	H. T. Wadeson	Hebron, SW¼ Sec. 3, T. 140, R. 90
MOUNTRAIL COUNTY		
33. Blake Coal Mine, W. J. Blake	.....	Stanley, NE¼ SE¼ Sec. 12, T. 155, R. 92
34. Elgers Coal Mine, Andrew Elwshire ..	.....	Stanley, NE¼ SW¼ Sec. 13, T 155, R. 92
35. Gamble Coal Mine, Blikre & Slatten	.....	White Earth, SW¼ NW¼ Sec. 30, T. 158, R. 93.
36. Heinemeyer Coal Mine, State Land	C. J. Heinemeyer	Belden, NE¼ Sec. 16, T. 154, R. 91
37. Kale Coal Mine, W. F. Hartman	.....	Stanley, NE¼ NE¼ Sec. 13, T. 155, R. 92
38. New Coal Mine, Pete Toveson	.....	White Earth, SE¼ NW¼ Sec. 30, T. 158, R. 93
39. Papke Coal Mine, Emma E. Papke	.....	Stanley, SE¼ SE¼ Sec. 9, T. 154, R. 91
40. Porger Coal Mine, George Porger ...	.....	White Earth, E½ NW¼ Sec. 16, T. 156, R. 94
41. Robinson Coal Mine, Robinson Bros...	.....	White Earth, SW¼ SW¼, Sec. 25, T. 155, R. 94.
42. White Earth Coal Mine, White Earth Coal Mining Company	.....	White Earth, NW¼ NW¼ Sec. 15, T. 156, R. 94.
OLIVER COUNTY		
43. Flint Coal Mine, Mrs. Henregetta Flint.	.....	Hannover, SE¼ Sec. 9, T. 142, R. 85

RENVILLE COUNTY

44.	Christoferson Coal Mine, Christ Christoferson	.....	Carpio, SE¼ SW¼ Sec. 35, T. 158, R. 86
45.	Jewell Coal Mine, Gus Wahl	.....	Donnybrook, NW¼ SW¼ Sec. 29, T. 158, R. 86.
46.	Spring Farm Coal Mine, P. P. Tehelka.	Hawkins & Collins	Carpio, SW¼ NE¼ Sec. 33, T. 158, R. 86
47.	White Ash Coal Mine, Dorr Carroll	Gustafson & Reichman.	Carpio, Sec. 28, T. 158, R. 86

STARK COUNTY

48.	Lehigh Coal Mine, Consolidated Coal Co.	.....	Dickinson, SW¼ Sec. 8, T. 139, R. 95
49.	Missouri Slope Coal Mine	.....	Dickinson, SE¼ Sec. 7, T. 139, R. 95
50.	Riley Coal Mine, F. Riley	.....	Lehigh, NE¼ Sec. 8, T. 139, R. 95
51.	Zenith Coal Mine, Zenith Coal Company	.....	Zenith, SW¼ Sec. 6, T. 139, R. 98

WARD COUNTY

52.	Baden Coal Mine, Jonas Johnson	.....	Baden, NW¼ SE¼ Sec. 26, T. 159, R. 88
53.	Bertelson Coal Mine, M. A. Bertelson	.....	Kenmare, Lot 6 & SE¼ Sec. 29, T. 161, R. 88
54.	Broughton Coal Mine, State Land	G. B. Cummings	Coulee, SE¼ SE¼ Sec. 36, T. 159, R. 88
55.	Carpio Coal Mine, Jacob Karstenson	Adams & Lorenz	Carpio, NW¼ Sec. 12, T. 157, R. 86
56.	Colton Coal Mine, L. D. Colton	.....	Burlington, Sec. 12, T. 155, R. 84
57.	Coulee Coal Mine, Herbert French	.....	Baden, NW¼ Sec. 26, T. 159, R. 88
58.	Conan Coal Mine, D. A. Conan	J. Morrison	Burlington, Sec. 18, T. 155, R. 83
59.	Crosby Coal Mine, John Crosby	.....	Kenmare, NW¼ SE¼ Sec. 30, T. 161, R. 88
60.	Davis Coal Mine, Davis Coal Company.	.....	Burlington, NE¼ SW¼ Sec. 12, T. 155, R. 84
61.	Diamond Coal Mine, George Von Neida	.....	Kenmare, Lot 1, Sec. 9, T. 160, R. 88
62.	Forysthe Coal Mine, P. N. Forsythe	.....	Burlington, Lots 3 and 4, Sec. 5, T. 155, R. 84
63.	Hart Coal Mine, Harry Hart	.....	Kenmare, Lot 3, Sec. 20, T. 160, R. 88
64.	Hot Blast Coal Mine	Hodgson & McIntosh	Donnybrook, SW¼ NW¼ Sec. 5, T. 158, R. 87
65.	Hunewell Coal Mine, R. J. Hunewell	.....	Burlington, Sec. 13, T. 155, R. 83

DIRECTORY OF NORTH DAKOTA COAL MINES.

WARD COUNTY—Continued.

Name of Mine and Name of Owner	Lessee	Post Office and Location
66. Ingison Coal Mine, J. D. Ingison	.....	Kenmare, Lot 3, Sec. 30, T. 161, R. 88
67. Kenmare Brick & Coal Co. Mine, Kenmare Brick & Coal Company	.....	Kenmare, Sec. 8, T. 159, R. 88
68. Knorr Coal Mine, G. J. Knorr	.....	Sawyer, NE¼ Sec. 30, T. 152, R. 81
69. Leeson Coal Mine, J. J. Leeson	.....	Sawyer, NE¼ NW¼ Sec. 19, T. 152, R. 81
70. Little Minnie Coal Mine, Foxholm Lignite Coal Company	.....	Foxholm, NE¼ NE¼ Sec. 11, T. 156, R. 85
71. Lloyd Coal Mine, D. J. Lloyd	.....	Burlington, SE¼ SE¼ Sec. 31, T. 156. R. 84
72. McClure Coal Mine, McClure Coal Co.	.....	Tasker, NE¼ SE¼ Sec. 19, T. 156, R. 84
73. Murray Coal Mine, Muray Coal Co. ..	.....	Sawyer, SE¼ NE¼ Sec. 29, T. 152, R. 81
74. Red Flag Coal Mine G. Knowles.....	.....	Velva, NW¼ NW¼ Sec. 35, T. 152, R. 81
75. Scott Coal Mine, Scott Coal Company.	.....	Burlington, SW¼ SW¼ Sec. 32, T. 156, R. 84
76. Scotty Coal Mine, Andrew Barrie	.....	Burlington, SE¼ SE¼ Sec. 1, T. 155, R. 84
77. Smith Dry Coal Mine, Smith Dry Coal Company	.....	Kenmare, Lot 1, Sec. 7, T. 160, R. 88
78. Soo Coal Mine, H. L. Laughlin	C. A. Buie	Kenmare, NE¼ NW¼ Sec. 31, T. 161, R. 88
79. Spencer Coal Mine, William Spencer ..	E. E. Spitzer	Donnybrook, Sec. 31, T. 159, R. 87
80. Stafford Coal Mine, Stafford Land Co. .	.....	Sawyer, NE¼ NE¼ Sec. 15, T. 152, R. 82
81. Strong Coal Mine, A. W. Ditmer	Joe Strong	Velva, SE¼ NW¼ Sec. 27, T. 152, R. 81
82. Vadneis Coal Mine, Vadneis Bros.	.....	Kenmare, SE¼ SE¼ Sec. 29, T. 160, R. 88
83. Wallace Coal Mine, Davis Coal Company	J. S. Wallace	Burlington, SE¼ SE¼ Sec. 2, T. 155, R. 84
84. Westergaard Coal Mine, A. K. Westergaard	.....	Kenmare, NE¼ NW¼ Sec. 32, T. 161, R. 88

WILLIAMS COUNTY

85. Black Diamond Coal Mine, Williston Land Company	.....	Williston, SW¼ NE¼ Sec. 33, T. 154, R. 100

86.	Camp Creek Coal Mine, State Land	E. E. Ryall	Williston, NW¼ SE¼ Sec. 16, T. 155, R. 101
87.	Coulter Coal Mine, Coulter Bros.	A. Thompson	Williston, SW¼ Sec. 10, T. 154, R. 101
88.	Dougherty Coal Mine, C. C. Dougherty		Noonan, NE¼ NW¼ Sec. 10, T. 162, R. 95
89.	Good Coal Mine, State Land	T. E. Good	Williston, NW¼ SW¼ Sec. 36, T. 155, R. 101
90.	Government Coal Mine, Williston Irrigation Project		Williston, SE¼ NE¼ Sec. 7, T. 154, R. 100
91.	Head Coal Mine, P. G. Head		Williston, NE¼ SE¼ Sec. 7, T. 154, R. 101
92.	Hess Coal Mine, State Land	C. A. Hess	Squires, NE¼ Sec. 36, T. 155, R. 104
93.	Johnson's Coal Mine, State Land	Bert Johnson	Hofflund, NE¼ Sec. 36, T. 155, R. 96
94.	Larsen Coal Mine, State Land	J. J. Larsen	Williston, NW¼ Sec. 36, T. 155, R. 102
95.	Low Level Coal Mine, John Bruegger.		Avoca, SW¼ Sec. 3, T. 154, R. 100
96.	Moorman Coal Mine, J. Moorman		Wheelock, NW¼ SW¼ Sec. 29, T. 155, R. 97
97.	Morrow Coal Mine, State Land	L. A. Morrow	Epping, NE¼ NW¼ Sec. 16, T. 155, R. 99
98.	Noonan Coal Mine, Noonan Bros.		Noonan, SE¼ SE¼ Sec. 4, T. 162, R. 95
99.	Old Nelson Coal Mine, State Land	Monroe Beard	Ray NW¼ SW¼ Sec. 16, T. 155, R. 97
100.	Parker Coal Mine, State Land	Bert Mackee	Noonan, NE¼ SE¼ Sec. 3, T. 162, R. 95
101.	Reynolds Coal Mine, Reynolds & Gardiner	C. N. Truax	Noonan, NE¼ SE¼ Sec. 12, T. 162, R. 95
102.	Truax Coal Mine, E. M. Truax		Noonan, E½ NE¼ Sec 10, T. 162, R. 95
103.	Williston Lignite Coal Mine, D. A.		Williston, NE¼ SE¼ Sec. 33, T. 154, R. 100

TABLE I.

Name of Mine and Kind of Opening	Depth of Coal Bed, in feet	Thickness of Coal Bed, in feet	Thickness of Coal Mined, in feet	System of Mining	Method of Mining	Method of Ventilation
ADAMS COUNTY						
1. Clermont Coal Mine, slope.....	30	12	9	Single entry	Blast off solid ..	Air shaft.
2. Farmers' Coal Mine, slope	30	12	9	Single entry	Blast off solid ..	Air shaft.
3. Haynes Lignite Coal Mine, slope	30	12	9	Single entry	Blast off solid ..	Air shaft.
4. Monroe Coal Mine, slope	40	12	9	Single entry	Blast off solid ..	Air shaft.
BILLINGS COUNTY						
5. De Mores Coal Mine, drift	300	10	7	Single entry	Blast off solid ..	.....
6. Haas Coal Mine, strip pit	4	3	3	.....	.....	.....
7. Rodgers' Coal Mine, strip pit ...	2	6	6	.....	.....	.....
BOWMAN COUNTY						
8. Scranton Coal Mine, slope	40	19	10	Double entry	Blast off solid ..	Air shaft.
BURKE COUNTY						
9. Anderson Coal Mine, strip pit ..	6	5	5	Surface	.....	.....
10. Anderson Coal Mine, strip pit .	20	8	8	Surface	.....	.....
11. Domrese Coal Mine, strip pit ...	8	9	9	.....	.....	.....
12. Fenster Coal Mine, strip pit	6	6	6	.....	.....	.....
13. Gille-Miller Coal Mine, strip pit	8–25	9–11	9–11	.....	.....	.....
14. Greenup Coal Mine, strip pit ...	5–15	8	8	.....	.....	.....
15. Hall Coal Mine, drift	80	5	5	Single entry	Blast off solid ..	.....

16. MacKee Coal Mine, drift.....	30	7–8	6	Double entry	Blast off solid ..	Air shaft.
17. Vick Coal Mine, strip pit	6	6	6	....	....	.....
BURLEIGH COUNTY						
18. Eckman Coal Mine, slope	45	13	7	Single entry	Blast off solid ..	Air shaft.
19. Lind Coal Mine, slope	35	2	7	Single entry	Blast off solid ..	Air shaft.
20. Peterson Coal Mine, slope	50	11	7	Single entry	Blast off solid ..	Air shaft.
21. Wilton Coal Mine, shaft and slope	50	11–16	7	Double entry	Undercutting	Fan.
McLEAN COUNTY						
22. Bitumina Coal Mine, drift	50	9	6	Double entry	Blast off solid ..	Air shaft.
23. Duchene Black Diamond Coal Mine, strip pit	5	3	3	....	....	.....
24. Long & Arvidson Coal Mine, drift	40	4	4	Single entry	Pick mining	.....
25. Love's Coal Mine, shaft	31	7	5–6	Single entry	Pick mining	Air shaft.
26. Youngquist Coal Mine, drift ...	35	9	7	....	....	.....
MERCER COUNTY						
27. Haatvit Coal Mine, strip pit	15	4	4	Scraping	....	.....
28. Jansen Coal Mine, strip pit	8	4–5	4–5	Scraping	....	.....
29. Schmidt Coal Mine, strip pit ...	9	3	3	Scraping	....	.....
MORTON COUNTY						
30. Feland Coal Mine, drift.....	35	6–6	6	Double entry	Blast off solid ..	Air shaft.
31. Hebron Brick Co. Coal Mine, drift	80	6	6	Double entry	Blast off solid ..	Air shaft.
32. North Star Coal Mine, drift	80	10	7	Double entry	Blast off solid ..	Air shaft.

TABLE 1—Continued

MOUNTRAIL COUNTY

Name of Mine and Kind of Opening	Depth of Coal Bed, in feet	Thickness of Coal Bed, in feet	Thickness of Coal Mined, in feet	System of Mining	Method of Mining	Method of Ventilation
33. Blake Coal Mine, drift	50	5–6	5–6	Single entry	Pick mining	.....
34. Elgers Coal Mine, strip pit	15	4	4	.....	.....	.....
35. Gamble Coal Mine, strip pit	8	5	5	.....	.....	.....
36. Heinemeyer Coal Mine, strip pit	12	3	3	.....	.....	.....
37. Kale Coal Mine, strip pit	14	4–6	4–6	.....	.....	.....
38. New Coal Mine, strip pit	10	5	5	.....	.....	.....
39. Papke Coal Mine, strip pit	12	4	4	.....	.....	.....
40. Porger Coal Mine, drift	90	6–7	5–6	Single entry	Pick mining	.....
41. Robinson Coal Mine, drift	100	10	10	Single entry	Blast off solid	.....
42. White Earth Coal Mine, drift	200	6	6	Double entry	Blast off solid	.....
OLIVER COUNTY						
43. Flint Coal Mine, strip pit	10	3	3	.....	.....	.....
RENVILLE COUNTY						
44. Christoferson Coal Mine, drift	80	2–6	2–6	Single entry	Pick mining	Air shaft.
45. Jewell Coal Mine, slope	100	3	3	Double entry	Pick mining	Air shaft.
46. Spring Farm Coal Mine, drift	90	2–6	2–6	Single entry	Pick mining	Air shaft.
47. White Ash Coal Mine, slope	90	2–5	2–5	Single entry	Pick mining	Air shaft.

STARK COUNTY

48.	Lehigh Coal Mine, drift	60–100	14	7	Double entry	Blast off solid ..	Air shaft.
49.	Missouri Slope Coal Mine, drift	60	9	7	Single entry	Blast off solid ..	Air shaft.
50.	Riley Coal Mine, drift	80	14	7	....	Blast off solid ..	.....
51.	Zenith Coal Mine, slope	100	18	8	Double entry	Blast off solid ..	Air shaft.

WARD COUNTY

52.	Baden Coal Mine, drift	110	2–6	2–6	Single entry	Pick mining	Air shaft.
53.	Bertelson Coal Mine, drift & shaft	140	5	5	Double entry	Blast off solid ..	Air shaft.
54.	Broughton Coal Mine, drift	120	3	3	Single entry	Pick mining	.....
55.	Carpio Coal Mine, slope	80	4	4	Double entry	Pick mining	Air shaft.
56.	Colton Coal Mine, shaft	80	9	7	Double entry	Blast off solid ..	Air shaft.
57.	Coulee Coal Mine, shaft	100	3	3	Single entry	Pick mining	Air shaft.
58.	Conan Coal Mine, drift	75	9	6	Double entry	Blast off solid ..	Air shaft.
59.	Crosby Coal Mine, drift	135	5–6	5–6	Double entry	Undermining	Air shaft.
60.	Davis Coal Mine, slope	160	8–6	6	Double entry	Blast off solid ..	Air shaft & furnace
61.	Diamond Coal Mine, drift	90	5–6	5–6	Single entry	Top mining	Air shaft.
62.	Forsythe Coal Mine, slope	150	7–8	7–8	Double entry	Blast off solid ..	Air shaft.
63.	Hart Coal Mine, drift	100	5	5	Single entry	Pick mining	Air shaft.
64.	Hot Blast Coal Mine, drift	75–100	2–6	2–6	Single entry	Pick mining	Air shaft.
65.	Hunewell Coal Mine, drift	100	10–11	7	Double entry	Blast off solid ..	Air shaft.
66.	Ingison Coal Mine, drift	125–145	5–6	5–6	Double entry	Undermining	Air shaft.
67.	Kenmare Brick & Coal Company's Coal Mine, drift	180	4	4	Double entry	Undermining	Air shaft.
68.	Knorr Coal Mine, drift	140	14	10	Single entry	Blast off solid ..	Air shaft.
69.	Leeson Coal Mine, strip pit	14	14	14	....	....	.....
70.	Little Minnie Coal Mine, slope .	40	11	7	Double entry	Blast off solid ..	Air shaft.
71.	Lloyd Coal Mine, slope	150	9	9	Double entry	Blast off solid ..	Air shaft.
72.	McClure Coal Mine, drift	75–150	7–8	5–8	Double entry	Blast off solid ..	Air shaft.
73.	Murray Coal Mine, drift	150	12	9	Single entry	Blast off solid ..	Air shaft.
74.	Red Flag Coal Mine, strip pit ...	7	8	8	....	....	.....

TABLE 1—Continued

WARD COUNTY—Continued.

Neme of Mine and Kind of Opening	Depth of Coal Bed, in feet	Thickness of Coal Bed in feet	Thickness of coal mined in feet	System of Mining	Method of Mining	Method of Ventilation
75. Scott Coal Mine, drift	175	6–6	6–6	Double entry	Blast off solid ..	Air shaft.
76. Scotty Coal Mine, shaft	32	10	7–4	Double entry	Blast off solid ..	Air shaft.
77. Smith Dry Coal Mine, slope	175	5–6	5–6	Double entry	Undercutting	Air shaft.
78. Soo Coal Mine, shaft	120	6–6	6–6	Single entry	Undermining	.....
79. Spencer Coal Mine, drift	120	2½–3	2½–3	Single entry	Pick mining	.....
80. Stafford Coal Mine, drift	100	6–18	6–12	Single entry	Blast off solid ..	Air shaft.
81. Strong Coal Mine, strip pit	10–18	9	9	.....	.....	.....
82. Vadneis Coal Mine, drift	190	3–8	3–8	Single entry	Undermining	Air shaft.
83. Wallace Coal Mine, slope	80	10	7–8	Double entry	Blast off solid ..	Air shaft & furnace
84. Westergaard Coal Mine, drift ...	100	5	5	Single entry	Top mining	Air shaft.
WILLIAMS COUNTY						
85. Black Diamond Coal Mine, drift	110	10	7	Double entry	Blast off solid ..	Air shaft.
86. Camp Creek Coal Mine, strip pit	2–10	6	6	.....	.....	.....
87. Coulter Coal Mine, drift	40	5	5	Single entry	Blast off solid ..	Air shaft.
88. Dougherty Coal Mine, slope ...	65	9	6	Double entry	Undermining	Air shaft.
89. Good Coal Mine, drift	35	11	7	Single entry	Blast off solid ..	Air shaft.
90. Government Coal Mine, drift ...	100	9	6	Double entry	Blast off solid ..	Air shaft & furnace
91. Head Coal Mine, drift	35	9	7	Single entry	Blast off solid ..	.....
92. Hess Coal Mine, drift	20	5–7	5–7	Single entry	Pick mining	.....
93. Johnson's Coal Mine, drift	45	5	4	Single entry	Blast off solid ..	.....
94. Larsen Coal Mine, strip pit	16	4	4	.....	.....	.....
95. Low Level Coal Mine, slope ...	150	10	8	Double entry	Undercutting	Air shaft.
96. Moorman Coal Mine, drift	60	8	6	Single entry	Blast off solid ..	Air shaft.

97. Morrow Coal Mine, strip pit ..	15	5–10	5–10	.....	.....	.....
98. Noonan Coal Mine, shaft and drift	34	8	6	Single entry	Undermining	Air shaft.
99. Old Nelson Coal Mine, drift ...	26	10	5	Single entry	Undermining	Air shaft.
100. Parker Coal Mine, drift	40	6	5	Double entry	Blast off solid ..	.....
101. Reynolds Coal Mine, drift	30	3	3	Single entry	Pick mining	Air shaft.
102. Truax Coal Mine, slope	35	7	6	Double entry	Blast off solid ..	Air shaft.
103. Williston Lignite Coal Co. Mine, drift	120	10	6–6	Single entry	Blast off solid ..	Air shaft.

TABLE II.

ADAMS COUNTY.

Name of Mine	Number of Men in Winter	Number of Men in Summer	Daily Wages	Price Paid per Foot, in Entry	Price Paid per Ton, in Entry	Price Paid per Ton, in Room	Date of Inspection	Date Reported
1. Clermont Coal Mine	4	2	$ 2.00	.....	.....	.....	2- 2-1910	
2. Farmers' Coal Mine	5	2	.....	.....	$ .70	$ .70	2- 2-1910	
3. Haynes Lignite Coal Mine	3	1	.....	.....	.70	.70	2- 2-1910	
4. Monroe Coal Mine	6	2	.....	.....	.50	.50	2- 2-1910	
BILLINGS COUNTY								
5. De Mores Coal Mine	2	.....	$ 1.50	.....	$ 1.00	$ 1.00	1-28-1910	
6. Haas Coal Mine	1	.....	1.50	.....	.....	.....	1-31-1910	
7. Rodgers Coal Mine	1	.....	1.50	.....	.....	.....	1-31-1910	
BOWMAN COUNTY								
8. Scranton Coal Mine	30	8	.....	.....	$ .50	$ .50	2- 1-1910	
BURKE COUNTY								
9. Anderson Coal Mine	4	.....	$ 1.25	.....	.....	.....	11-28-1909	
10. Anderson Coal Mine	3	2	1.25	.....	.....	.....	11-28-1909	
11. Domrese Coal Mine	4	2	1.50	.....	.....	.....	11-28-1909	
12. Fenster Coal Mine	8	4	1.50	.....	.....	.....	11-30-1909	
13. Gillie-Miller Coal Mine	5	3	1.50	.....	.....	.....	11-28-1909	
14. Greenup Coal Mine	3	.....	1.50	.....	.....	.....	11-28-1909	
15. Hall Coal Mine	3	.....	.....	.....	$ 1.00	$ .75	11-30-1909	

16. MacKee Coal Mine	5	3	.....	.....	1.10	.75	12-29-1909	
17. Vick Coal Mine	3	1	1.50	.....	.....	.....	11-28-1909	
BURLEIGH COUNTY								
18. Eckman Coal Mine	1	.....	.....	.....	.....	$ .75	12-20-1909	
19. Lind Coal Mine	4	1	.....	.....	$ 1.00	.75	12-20-1909	
20. Peterson Coal Mine	2	.....	.....	.....	1.00	.75	12-20-1909	
21. Wilton Coal Mine	200	60	.....	.....	.....	.....	1-21-1910	
McLEAN COUNTY								
22. Bitumina Coal Mine	10	4	.....	.....	$ .70	$ .50	12-17-1909	
23. Duchene Black Diamond Coal Mine	.....	1	$ 3.50	.....	.....	.....	.....	2-17-1910
24. Long & Arvidson Coal Mine	2	.....	.....	.....	1.10	1.00	.....	3- 8-1910
25. Love's Coal Mine	5	2	2.25	.15	.90	.80	.....	2-10-1910
26. Youngquist Coal Mine	3	.....	.....	.....	.90	.75	12-17-1909	
MERCER COUNTY								
27. Haatvit Coal Mine	2	.....	$ 2.00	.....	.....	.....	.....	2- 6-1910
28. Jansen Coal Mine	1	1	1.50	.....	.....	.....	.....	2-15-1910
29. Schmidt Coal Mine	1	.....	1.50	.....	.....	.....	.....	2- 8-1910
MORTON COUNTY								
30. Feland Coal Mine	8	4	$ 2.00	$ 1.00	.....	$ .75	1-25-1910	
31. Hebron Brick Co. Coal Mine	6	6	3.50	.....	.....	.75	1-26-1910	
32. North Star Coal Mine	4	2	.....	1.00	.....	.55	1-26-1910	

TABLE II—Continued

MOUNTRAIL COUNTY

Name of Mine	Number of Men, in Winter	Number of Men, in Summer	Daily Wages	Price Paid per Foot, in Entry	Price Paid per Ton, in Entry	Price Paid per Ton, in Room	Date of Inspection	Date Reported
33. Blake Coal Mine	2	.....	.....	.....	$ 1.10	$ 1.00	11-25-1909	
34. Elgers Coal Mine	3	.....	$ 1.50	.....	.....	.....	11-25-1909	
35. Gamble Coal Mine	3	.....	1.50	.....	.....	.....	11-24-1909	
36. Heinemeyer Coal Mine	1	1	2.00	.....	.....	.....	.....	2-28-1910
37. Kale Coal Mine	3	2	1.50	.....	.....	.....	11-25-1909	
38. New Coal Mine	3	2	1.50	.....	.....	.....	11-24-1909	
39. Papke Coal Mine	3	1	1.50	.....	.....	.....	11-25-1909	
40. Porger Coal Mine	1	.....	2.00	.....	.90	.70	11-23-1909	
41. Robinson Coal Mine	1	.....	.....	.....	.90	.90	11-23-1909	
42. White Earth Coal Mine	6	2	.....	.....	.90	.70	11-23-1909	

OLIVER COUNTY

43. Flint Coal Mine	2	.....	$ 1.50	.....	.....	.....	.....	2-16-1910

RENVILLE COUNTY

44. Christoferson Coal Mine	3	1	.....	.....	$ 1.00	$ 1.00	12- 8-1909	
45. Jewell Coal Mine	4	4	.....	.....	1.00	1.00	12- 8-1909	
46. Spring Farm Coal Mine	4	.....	.....	.....	1.50	1.00	12- 8-1909	
47. White Ash Coal Mine	4	.....	.....	.....	1.10	.90	12- 8-1909	

STARK COUNTY

48.	Lehigh Coal Mine	100	40	.....	.....	$ .47	$ .42	1-27-1910
49.	Missouri Slope Coal Mine	5	4	.....	.....	.....	.75	1-27-1910
50.	Riley Coal Mine	.....	.....	.....	.....	.35	.35	1-27-1910
51.	Zenith Coal Mine	70	60	.....	.....	.70	.60	1-28-1910

WARD COUNTY

52.	Baden Coal Mine	6	2	.....	.....	$ 1.20	$ 1.00	12- 9-1909
53.	Bertelson Coal Mine	15	4	.....	.....	1.30	.90	12- 6-1909
54.	Broughton Coal Mine	2	.....	.....	.....	1.00	1.00	12- 9-1909
55.	Carpio Coal Mine	4	.....	.....	$ 1.50	.....	1.00	12-10-1909
56.	Colton Coal Mine	.....	.....	.....	.....	.95	.75	12-11-1909
57.	Coulee Coal Mine	4	.....	.....	.....	1.10	1.00	12- 9-1909
58.	Coonan Coal Mine	3	.....	.....	.....	1.00	.80	12-11-1909
59.	Crosby Coal Mine	4	1	.....	1.50	.....	.90	12- 6-1909
60.	Davis Coal Mine	15	5	.....	.....	.90	.70	12-13-1909
61.	Diamond Coal Mine	6	2	.....	.....	1.20	.90	12- 1-1909
62.	Forsythe Coal Mine	6	2	.....	.....	.90	.70	12-12-1909
63.	Hart Coal Mine	8	3	.....	.....	1.20	.90	12- 1-1909
64.	Hot Blast Coal Mine	3	.....	.....	.....	.....	1.20	12- 9-1909
65.	Hunewell Coal Mine	5	2	.....	.....	1.10	.80	12-11-1909
66.	Ingison Coal Mine	5	2	.....	.....	1.00	1.00	12- 4-1909
67.	Kenmare Brick & Coal Co. Coal Mine	15	6	.....	1.40	.....	.90	12- 2-1909
68.	Knorr Coal Mine	2	.....	.....	.....	1.00	.75	12-15-1909
69.	Leeson Coal Mine	4	4	1.50	.....	.....	.....	12-15-1909
70.	Little Minnie Coal Mine	12	6	.....	.....	1.10	.80	12-10-1909
71.	Lloyd Coal Mine	7	3	.....	.....	.90	.70	12-11-1909
72.	McClure Coal Mine	50	25	.....	.50	.70	.70	12-10-1909
73.	Murray Coal Mine	4	2	.....	.....	1.00	.70	12-15-1909
74.	Red Flag Coal Mine	2	.....	1.50	.....	.....	.....	12-15-1909
75.	Scott Coal Mine	14	5	.....	.....	1.00	.70	12-11-1909

TABLE II—Continued

WARD COUNTY—Continued.

Name of Mine	Number of Men in Winter	Number of Men, in Summer	Daily Wages	Price Paid per Foot, in Entry	Price Paid per Ton, in Entry	Price Paid per Ton, in Room	Date of Inspection	Date Reported
76. Scotty Coal Mine	3	1	.....	.50	.80	.80	12-11-1909	
77. Smith Dry Coal Mine	40	15	.....	.....	1.30	.90	12- 7-1909	
78. Soo Coal Mine	6	.....	.....	.....	1.20	.90	12- 6-1909	
79. Spencer Coal Mine	2	.....	.....	.....	1.00	1.00	12- 9-1909	
80. Stafford Coal Mine	3	.....	.....	.....	.75	.65	12-15-1909	
81. Strong Coal Mine	4	2	.....	.....	.....	.70	12-15-1909	
82. Vadneis Coal Mine	4	1	.....	1.40	.....	.90	12- 2-1909	
83. Wallace Coal Mine	10	3	.....	.....	.90	.70	12-11-1909	
84. Westergaard Coal Mine	3	.....	.....	.....	1.15	.90	12- 2-1909	

WILLIAMS COUNTY

85. Black Diamond Coal Mine	5	3	.....	.....	$ .90	$ .70	11-16-1909	
86. Camp Creek Coal Mine	1	.....	$ 1.75	.....	.....	.....	.....	1-27-1910
87. Coulter Coal Mine	2	.....	.....	.....	.90	.70	11-17-1909	
88. Dougherty Coal Mine	10	3	.....	$ 1.40	.....	.80	11-18-1909	
89. Good Coal Mine	3	.....	.....	.....	.90	.70	11-17-1909	
90. Government Coal Mine	.....	10	.....	.....	.80	.60	.....	11-18-1909
91. Head Coal Mine	3	.....	.....	.....	.80	.70	11-18-1909	
92. Hess Coal Mine	1	.....	1.50	.....	.....	.....	.....	2- 4-1910
93. Johnson's Coal Mine	2	.....	1.50	.....	.....	.....	.....	2- 6-1910
94. Larsen Coal Mine	1	.....	1.50	.....	.....	.....	11-17-1909	
95. Low Level Coal Mine	18	4	.....	.....	.90	.70	12-18-1909	

96. Moorman Coal Mine	.....	.....	.....	.....	1.00	1.00	11-20-1909	
97. Morrow Coal Mine	1	.....	1.50	.....	.....	.....	.....	2- 8-1910
98. Noonan Coal Mine	22	4	.....	.....	1.15	.80	11-30-1909	
99. Old Nelson Coal Mine	1	.....	.....	.....	.75	.75	.....	1-27-1910
100. Parker Coal Mine	5	.....	.....	.....	1.00	.70	11-30-1909	
101. Reynolds Coal Mine	3	.....	.....	.....	1.10	.80	11-16-1909	
102. Truax Coal Mine	9	3	.....	.....	1.10	.75	.....	11-30-1909
103. Williston Lignite Coal Mine	4	2	.....	.....	.90	.70	11-16-1909	

TABLE III.

ADAMS COUNTY

Name of Mine	Average Daily Output, Tons	Total Output, Tons	Average Selling Price at Mine	Total Value of Output
1. Clermont Coal Mine	8	1,150	$ 1.75	$ 2,012.50
2. Farmers' Coal Mine	10	1,000	1.75	1,750.00
3. Haynes Lignite Coal Mine ...	9	1,375	1.75	2,406.25
4. Monroe Coal Mine	25	2,963	1.75	5,185.25
BILLINGS COUNTY				
5. DeMores Coal Mine	6	300	$ 2.25	$ 675.00
6. Haas Coal Mine	.....	50	1.25	62.50
7. Rodgers Coal Mine	.....	50	1.25	62.50
BOWMAN COUNTY				
8. Scranton Coal Mine	47	8,584	$ 1.35	$11,588.40
BURKE COUNTY				
9. Anderson Coal Mine	12	600	$ 1.25	$ 750.00
10. Anderson Coal Mine	7	1,698	1.25	2,122.50
11. Domrese Coal Mine	20	2,000	1.00	2,000.00
12. Fenster Coal Mine	23	2,500	1.20	3,000.00
13. Gille-Miller Coal Mine	15	2,800	1.20	3,360.00
14. Greenup Coal Mine	10	800	1.20	960.00
15. Hall Coal Mine	4	400	1.50	600.00
16. MacKee Coal Mine	15	3,000	2.00	6,000.00
17. Vick Coal Mine	10	1,500	1.20	1,800.00
BURLEIGH COUNTY				
18. Eckman Coal Mine	10	1,000	$ 1.50	$ 1,500.00
19. Lind Coal Mine	14	1,900	1.50	2,850.00
20. Peterson Coal Mine	10	1,000	1.50	1,500.00
21. Wilton Coal Mine	400	115,340	1.50	173,010.00
McLEAN COUNTY				
22. Bitumina Coal Mine	20	3,750	$ 1.50	$ 5,625.00
23. Duchene Black Diamond Coal Mine	4	221	1.60	353.60
24. Love's Coal Mine	6	626	2.25	1,408.50
25. Long & Arvidson Coal Mine..	2	50	2.00	100.00
26. Youngquist Coal Mine	3	300	1.50	450.00

TABLE III.—Continued

MERCER COUNTY

Name of Mine	Average Daily Output, Tons	Total Output, Tons	Average Selling Price at Mine	Total Value of Output
27. Haatvit Coal Mine	7	150	$ 1.50	$ 225.00
28. Jansen Coal Mine	6	100	1.00	100.00
29. Schmidt Coal Mine	3	90	1.00	90.00

MORTON COUNTY

30. Feland Coal Mine	20	4,000	$ 1.50	$ 6,000.00
31. Hebron Brick Company Mine.	25	8,300	1.25	10,375.00
32. North Star Coal Mine	12	1,700	1.25	2,125.00

MOUNTRAIL COUNTY

33. Blake Coal Mine	4	250	$ 1.75	$ 437.50
34. Elgers Coal Mine.....	3	150	1.75	262.50
35. Gamble Coal Mine	2	100	1.50	150.00
36. Heinemeyer Coal Mine	5	335	2.00	670.00
37. Kale Coal Mine	8	600	1.75	1,050.00
38. New Coal Mine	6	667	1.75	1,167.25
39. Papke Coal Mine	4	350	1.75	612.50
40. Porger Coal Mine	3	240	1.50	360.00
41. Robinson Coal Mine	6	600	1.00	600.00
42. White Earth Coal Mine	10	2,655	2.00	5,310.00

OLIVER COUNTY

43. Flint Coal Mine	2	125	$ 1.25	$ 156.25

RENVILLE COUNTY

44. Christoferson Coal Mine	4	400	$ 2.00	$ 800.00
45. Jewell Coal Mine	15	4,416	2.00	8,832.00
46. Spring Farm Coal Mine	8	800	2.00	1,600.00
47. White Ash Coal Mine	8	800	2.00	1,600.00

STARK COUNTY

48. Lehigh Coal Mine	123	38,371	$ 1.35	$51,800.85
49. Missouri Slope Coal Mine	15	2,000	1.25	2,500.00
50. Riley Coal Mine	.....	1,000	.35	350.00
51. Zenith Coal Mine	35	11,550	1.25	14,437.50

TABLE III.—Continued

WARD COUNTY

	Name of Mine	Average Daily Output Tons	Total Output, Tons	Average Selling Price at Mine	Total Value of Output
52.	Baden Coal Mine	10	1,400	$ 2.00	$ 2,800.00
53.	Bertelson Coal Mine	20	6,000	2.50	15,000.00
54.	Broughton Coal Mine	3	150	2.25	337.50
55.	Carpio Coal Mine	10	800	2.00	1,600.00
56.	Colton Coal Mine	15	2,000	1.50	3,000.00
57.	Coulee Coal Mine	2	140	2.00	280.00
58.	Conan Coal Mine	3	300	2.00	600.00
59.	Crosby Coal Mine	5	1,138	2.50	2,845.00
60.	Davis Coal Mine	35	10,214	1.50	15,321.00
61.	Diamond Coal Mine	15	3,000	2.50	7,500.00
62.	Forsythe Coal Mine	20	4,600	1.75	8,050.00
63.	Hart Coal Mine	20	1,825	2.50	4,562.50
64.	Hot Blast Coal Mine	4	385	2.25	866.25
65.	Hunewell Coal Mine	10	3,000	2.00	6,000.00
66.	Ingison Coal Mine	4	1,199	2.50	2,997.50
67.	Kenmare Brick & Coal Company Coal Mine	15	4,000	2.50	10,000.00
68.	Knorr Coal Mine	2	300	1.50	450.00
69.	Leeson Coal Mine	15	4,000	1.50	6,000.00
70.	Little Minnie Coal Mine	25	7,000	1.80	12,600.00
71.	Lloyd Coal Mine	15	5,000	1.80	9,000.00
72.	McClure Coal Mine	60	15,895	1.84	29,246.80
73.	Murray Coal Mine	7	1,500	1.50	2,250.00
74.	Red Flag Coal Mine	5	535	1.50	802.50
75.	Scott Coal Mine	25	5,142	2.00	10,284.00
76.	Scotty Coal Mine	5	1,000	2.00	2,000.00
77.	Smith Dry Coal Mine	35	10,824	1.60	17,318.40
78.	Soo Coal Mine	5	500	2.50	1,250.00
79.	Spencer Coal Mine	3–4	200	2.50	500.00
80.	Stafford Coal Mine	10	1,500	1.90	2,850.00
81.	Strong Coal Mine	12	1,500	1.20	1,800.00
82.	Vadneis Coal Mine	6	1,200	2.50	3,000.00
83.	Wallace Coal Mine	30	8,763	1.80	15,773.40
84.	Westergaard Coal Mine	10	1,000	2.50	2,500.00

WILLIAMS COUNTY

85.	Black Diamond Coal Mine	14	2,806	$ 1.50	$ 4,209.00
86.	Camp Creek Coal Mine	.....	35	1.50	52.50
87.	Coulter Coal Mine	4	400	1.50	600.00
88.	Dougherty Coal Mine	10	2,500	1,50	3,750.00
89.	Good Coal Mine	5	700	1.50	1,050.00
90.	Government Coal Mine	30	4,456	1,50	6,684.00
91.	Head Coal Mine	3	200	1.50	300.00
92.	Hess Coal Mine	2	78	1.50	117.00
93.	Johnson Coal Mine	3	270	1.50	405.00
94.	Larsen Coal Mine	.....	50	.75	37.50
95.	Low Level Coal Mine	25	6,331	1.75	11,079.25

TABLE III—Continued.

WILLIAMS COUNTY—Continued.

Name of Mine	Average Daily Output, Tons	Total Output, Tons	Average Selling Price at Mine	Total Value of Output
96. Moorman Coal Mine	4	150	1.50	225.00
97. Morrow Coal Mine	4	436	1.75	763.00
98. Noonan Coal Mine	10	4,000	1.50	6,000.00
99. Old Nelson Coal Mine	.....	35	1.50	52.50
100. Parker Coal Mine	5	200	1.50	300.00
101. Reynolds Coal Mine	5	300	1.50	450.00
102. Truax Coal Mine	25	5,907	2.00	11,814.00
103. Williston Lignite Coal Mine	15	3,000	1.50	4,500.00

COAL PRODUCTION BY COUNTIES.

County	No. of Mines	Tonnage	Value of Output
Adams	4	6,488	$ 11,354.00
Billings	3	400	800.00
Bowman	1	8,584	11,588.40
Burke	9	15,298	20,592.50
Burleigh	4	119,240	178,860.00
McLean	5	4,947	7,937.10
Mercer	3	340	415.00
Morton	3	14,000	18,500.00
Mountrail	10	5,947	10,619.75
Oliver	1	125	156.25
Renville	4	6,416	12,832.00
Stark	4	52,921	69,088.35
Ward	33	106,010	199,384.85
Williams	19	31,854	52,388.75
Total	103	372,570	$ 594,516.95

NAMES OF MINES THAT SHIP COAL.

ADAMS COUNTY

Name of Mine	Operator and Postoffice
4. Monroe Coal Mine	Monroe & Nippur .....Haynes

BOWMAN COUNTY

8. Scranton Coal Mine	Consolidated Coal Company, Scranton

BURKE COUNTY

11. Domrese Coal Mine	H. J. Domrese .....Columbus
12. Fenster Coal Mine	Fenster Bros. .....Larson
13. Gillie-Miller Coal Mine ...	J. S. Greenup .....Columbus

BURLEIGH COUNTY

21. Wilton Coal Mine	Washburn Lignite Coal Co.... Wilton

McLEAN COUNTY

22. Bitumina Coal Mine	John Satterlund .....Washburn

MORTON COUNTY

30. Feland Coal Mine	Theodore Feland .....Sims

MOUNTRAIL COUNTY

42. White Earth Coal Mine ...	White Earth Coal Mining Co..... .....White Earth

STARK COUNTY

48. Lehigh Coal Mine	Consolidated Coal Co..... Dickinson
51. Zenith Coal Mine	Zenith Coal Company .....Zenith

WARD COUNTY

Name of Mine	Operator and Postoffice
60. Davis Coal Mine	Davis Coal Company .....Burlington
61. Diamond Coal Mine	Geo. Von Neida .....Kenmare
62. Forsythe Coal Mine	P. N. Forysthe .....Burlington
63. Hart Coal Mine	Harry Hart .....Kenmare
67. Kenmare Brick & Coal Company's Mine	Kenmare Brick & Coal Co., Kenmare
70. Little Minnie Coal Mine ...	Foxholm Coal Co. .....Foxholm
71. Lloyd Coal Mine	Lloyd Coal Company .....Burlington
72. McClure Coal Mine	McClure Coal Company .....Tasker
75. Scott Coal Mine	Scott Coal Company .....Burlington
77. Smith Dry Coal Mine	Smith Dry Coal Company....Kenmare
83. Wallace Coal Mine	J. S. Wallace .....Burlington

WILLIAMS COUNTY

95. Low Level Coal Mine	John Bruegger .....Williston
98. Noonan Coal Mine	Noonan Bros. ..... Noonan
102. Truax Coal Mine	C. N. Truax .....Noonan

MINES USING MINING MACHINES IN NORTH DAKOTA.

BURLEIGH COUNTY

Name of Mine	No. of Machines	Kind
21. Wilton Coal Mine	8	Jeffrey Chain Undercutting Machine.

STARK COUNTY.

48. Lehigh Coal Mine	3	Jeffrey Chain Undercutting Machine.

WARD COUNTY

77. Smith Dry Coal Mine	5	Pneumelectric Coal Puncher.

WILLIAMS COUNTY

95. Low Level Coal Mine	1	Ingersoll-Rand Pneumatic Coal Puncher.

FATALITIES AND ACCIDENTS.

Name	Mine	Post Office	Cause of Death	Cause of Accident	Date
Fritz Grittel	Blue Grass Coal Mine	Blue Grass*	Fall of roof	.....	Oct. 18
Vernon Butler	Lehigh Coal Mine	Lehigh	.....	Delayed shot	Nov. 10, 1910
R. Dorsymth	Lehigh Coal Mine	Lehigh	.....	Delayed shot	Nov. 19
Leon Alger	Low Level Coal Mine	Avoca	.....	Delayed shot	Nov. 19
J. V. Williams	Wilton Mine	Wilton	.....	Drilling into dynamite loaded hole	Nov. 23

*This property was not reported by this office.

DESCRIPTIONS OF THE COAL MINES.

ADAMS COUNTY.

1. *The Clermont Coal Mine.* The Clermont coal mine is leased and operated by the Peterson Bros. It is situated about two miles north of Haynes, and is located in a twelve to thirteen-foot bed of coal.

The roof is very good and the work is quite well done, though the entries are too large to be permanent. The rooms are turned off from the main entry and air is furnished by means of an air shaft. There is no water.

A shaft was used to deliver the coal to the surface at one time but has been abandoned in favor of the slope which was driven the summer of 1909.

February 2, 1910, the day the mine was visited, conditions were regarded as satisfactory, though a couple of days before a miner had been rather badly injured by a fall of coal.

2. *The Farmers' Coal Mine.* The Farmers Coal Company of Haynes own and operate this mine. It lies some three miles north of Haynes, and the coal at this point is about twelve feet in thickness. The coal is hauled up a sharp slope by a horse to a tipple, where the coal may either be dumped into storage bins or into wagons.

The roof of the mine is very good, but there is little system in the way the mine is laid out and worked. On February 2, 1910, when the mine was inspected, conditions were satisfactory as regards safeness.

3. *The Haynes Lignite Coal Mine.* The Brown Land Company of Mandan owns and operates a small mine, two and a half miles north of Haynes, on the same beds of coal that the other mines in this vicinity are located on.

A practical miner has charge of this property and it is the intention of the company to develop a permanent mine.

The coal is some twelve feet thick at this point and from eight to nine feet is mined. No water is encountered in the mine, and on February 2nd the conditions were found quite satisfactory.

4. *The Monroe Mine.* Monroe and Nippur lease a part of a school section for coal purposes, and operate the largest mine in the neighborhood. The coal is twelve to thirteen feet thick and is very black and hard and has the physical appearance of being a very excellent grade of lignite.

The roof is very good and little timbering is done. Nine feet of coal is mined, and wide rooms are driven. The system of mining adopted is not a good one for a permanent mining proposition, but at the time the mine was examined, it was safe.

BILLINGS COUNTY.

5. *The DeMores Mine.* The DeMores Estate owns this property, and it is leased to H. Kinmark of Medora, who operates it on a very small scale. The mine has about nine or ten feet of coal, and is free from water.

No particular system of mining is followed. An entry has been driven in and from this, rooms have been turned. The roof seemed very good, and no means of ventilation has been provided for, and is scarcely necessary, as but two men are employed.

January 28th, when this mine was inspected, it was found to be satisfactory for a mine operated on such a small scale.

6. *The Haas Coal Mine.* F. G. Haas has a small bed of coal cropping out in a small run and has opened it up for the purpose of mining coal. Some little coal was mined and then operations were closed through some difficulty with the government.

The bed as exposed lies under about six feet of clay and is from three to five feet thick. There is reported to be a bed of coal at a greater depth.

This is a very small working, and unless the lower bed should prove workable, will be of little value.

7. *The Rogers Coal Mine.* George Clark has opened up a bed of coal, the exact thickness of which is not known, that lies right at the surface of the ground. Six feet of it is mined. There is only a foot of dirt lying on top of the coal.

Very little coal is sold here, as it is some distance from the railroad and there are several other small mines in the vicinity.

BOWMAN COUNTY.

8. *The Scranton Coal Mine.* The Scranton coal mine is owned and operated by the Consolidated Coal Company of Dickinson. It is located in the town of Scranton, where a short spur runs up to the mine. The coal is hauled up the slope to the tipple by a horse.

This mine has about nineteen feet of solid coal and about sixty per cent is recovered. Ten feet of coal is mined in the rooms when driving them, and then on the way back, most of the roof coal is shot down. Very little attempt is made to rob the pillars.

A windmill furnishes power to keep the mine dry, and an air shaft supplies plenty of air on ordinary days. A gasoline engine has been placed in the mine, and connections made to an ordinary tank pump for use on days when there is no wind. An exhaust fan has been made from an ordinary threshing machine blower to help create a draft on days when the air shaft does not furnish sufficient air. It is said to work very satisfactorily.

A carefully laid out system is being followed in the mining operations, and on the day the mine was inspected everything was found to be in very good condition.

BURKE COUNTY.

9. *The Anderson Coal Mine.* The Anderson mine, owned by Andrew Anderson, is located about four and one-half miles from Columbus, and is on a bed of coal that lies very near the surface.

The overlying clay is stripped off easily, and the coal loosened up with dynamite.

There is but little water, which is disposed of by a hand pump.

10. *The Anderson Mine.* This property is owned by Nels Anderson and leased to Iver Christianson. From fifteen to twenty feet of clay is removed by scrapers, exposing an eight-foot bed of coal.

Some undermining is attempted in the winter months. Mr. Anderson has purchased a steam shovel with the intention of stripping the coal with it, but experienced such delay in transporting the machine to the mine, that it was not being used in 1909.

11. *The Domrese Coal Mine.* The Domrese mine is a stripping mine owned by H. J. Domrese, and located about four miles east of Larson. The coal has a very shallow overburden, which it is not difficult to remove.

Such water as accumulates is pumped out by a windmill pump. The surface is rolling prairie, and the mine is located in a slight hollow between two ridges.

12. *The Fenster Mine.* The Fenster mine, owned and operated by the Fenster Bros., is situated about a mile and a half from the Soo siding called Atcoal, and some three miles west of Larson.

Here on the edge of a very low set of hills defining the edge of a bottom, or alkali flat, coal is found at a shallow depth.

The top is stripped and the coal shipped to a great extent to the towns along the line that are not adjacent to mines.

13. *The Gille Coal Mine.* The Gille mine was operated the year of 1908 by Mr. Miller, and for the year 1909 it was leased by J. S. Greenup.

This mine is situated about five miles south of Columbus, and is in a slight draw where the overburden is not over eight feet ten inches thick.

This has been well worked out, however, and now there is from fifteen to twenty feet of earth to remove.

14. *The Greenup Coal Mine.* The Greenup mine is what was known and reported two years ago as the Pratt mine, J. S. Greenup having obtained possession of it.

This property is but a short distance from the Gille mine, and on the same bed of coal.

It is kept free from water by the use of a small gasoline engine and a rotary pump.

15. *The Hall Coal Mine.* The Hall mine is one of the very small mines located in a ravine where the coal outcrops.

The main entry has been driven for about one hundred and fifty feet, and rooms worked off from this.

Little if any system is adopted in carrying on the work and it will doubtless have to be abandoned after a year or so and operations started at a new point.

On November 30, 1909, I found conditions at this mine fairly good as regards safety.

16. *The Mackee Coal Mine.* The Mackee mine is found about twelve miles west of Portal and a few hundred feet south of the international boundary line.

Here the coal was found outcropping along the border of Short creek. The mine is located on the south side of the creek.

All the coal is removed in mining, and very careful and adequate timbering is done in all parts of the mine.

Due to the long haul now required to deliver the coal at the tipple, a shaft and hoist is to be installed during the summer of 1910.

17. *The Vick Coal Mine.* Herman Vick owns and operates this mine. It is a surface mine, the coal occuring at depths of from six to eight feet.

The overburden is scraped away in the summer time, and the coal loosened up with dynamite. It is then ready to be sold to any one who should come that way.

This property is located about six miles from Columbus, and in a very shallow sort of a coulee.

BURLEIGH COUNTY.

18. *The Eckman Mine.* Oscar Eckman owns and operates a mine in a bed of coal thirteen feet thick and under a forty-five foot overburden.

The coal is hauled up a steep slope by means of a team and long cable. Coal is blasted off the solid, and no particular plan of mining is followed, but conditions on December 20, 1909, were found generally satisfactory.

19. *The Lind Mine.* The Lind mine is owned and ably operated by Mrs. A. C. Lind. It is located about two miles east of Wilton, and on a twelve-foot bed of lignite of which about seven feet is mined. There is about fifty feet of overburden, and the coal is delivered through a slope, being hauled up by a team at the surface.

Tamarack props are used in the rooms, no timbering is done in the entries, and little system is adopted in the plan of work, but the mine appeared safe, and was well ventilated by a furnace and airshaft on December 20, 1909.

20. *The Peterson Mine.* This mine is owned by Charley Peterson, and is operated on a small scale. There is eleven feet of coal at this point, and very little timbering is required, as a four-foot roof of coal is left.

The mine is dry, and air is furnished by means of an air shaft and furnace. Coal is delivered at the surface by means of a team attached to a cable, which extends to the foot of the slope.

December 20, 1909, conditions at this mine were satisfactory.

21. *The Wilton Coal Mine.* The Wilton coal mine, located about one mile east of Wilton, and operated by the Washburn Lignite Coal Company, is the largest and most completely equipped mine operating in the state.

The overburden at the shaft is fifty feet thick, and the coal averages about sixteen feet, of which about eighty-five per cent is finally recovered.

The most up-to-date methods of handling coal are used in every respect. Brest undercutting machines are used, as well as electric haulage, a two-cage hoist and boxcar loaders. An electric plant is operated in connection with the mine, which furnishes Wilton with light, and the mine with light and power. A sixteen foot blower fan furnished the ventilation, which is divided in two splits. In all parts of the mine the air seemed to be sufficient. Drainage is furnished by the use of four electric pumps, delivering water to a main pump from which a No. 5 steam pump lifts it to the surface.

Formerly a brick plant was operated in connection with the mine, but this has been idle for the last two years.

Mr. A. W. Pollock is superintendent of the mine. In the winter months two hundred men are employed in this mine. In the summer about sixty. During the winter of 1909 and 1910 a shortage of cars was complained of.

January 21, 1910, when the property was inspected, conditions were satisfactory in all respects.

M'LEAN COUNTY.

22. *The Bitumina Mine.*—This mine is the property of John Satterlund of Bismarck, and is operated by Edward Kugler. Some trouble has been experienced in getting a permanent entry, but at the place it is now situated, it is thought to be secure enough to be permanent.

The coal is delivered at the tipple by a steam wound drum. The tipple is being built with the idea of having some storage capacity also.

There is no timbering excepting room props. A steam pump takes care of the water, while the ventilation is secured by an air shaft.

December 17, 1909, conditions were quite satisfactory at this place.

23. *The Duchene Black Diamond.*—J. J. Duchene owns and operates a coal mine west of Garrison. This is a small property,

the coal bed being but three feet thick. There is five feet of earth on top of the coal, which is removed with scrapers.

A ditch drains the workings.

24. *Long and Arvidson Mine.*—This mine is operated by Goldley and Isaackson. It is located near Turtle Lake. The coal bed, which is four feet thick, has an over burden of forty feet.

The coal outcrops, and is reached by a drift. Tamarack three piece sets, with plank logging are used in the entries, and props and caps in the rooms.

25. *The Love Coal Mine.*—I. E. Love operates a coal mine a part of the year near Turtle Lake. The coal is found at a depth of about thirty-one feet. The bed is seven feet thick, and of this, five and one-half feet is mined.

A steam pump is used to drain the mine, and a steam wound hoist is used to elevate the coal to the surface. Ventilation is secured by the use of an air shaft.

Tamarack and cedar are used in timbering, and a three piece set is placed every three feet in all entries.

26. *The Younguist Mine.*—This mine is operated by the Barlow Bros. They have driven an entry and were ready to turn some rooms. The coal at this point is about nine feet thick, and a two foot coal roof is left.

This mine has only recently been opened and is dry. No ventilation had yet been provided, nor was greatly needed.

Conditions were satisfactory December 17, 1909.

MERCER COUNTY.

27. *The Haatvit Coal Mine.*—This property is leased from the state and John Haatvit runs a small surface mine. The market is local and there is only a small output.

28. *The Janson Mine.*—B. Janson leases a piece of coal land from the state, and conducts a small mine. Eight feet of overburden is scraped away, exposing four feet of coal. The water which is present is ditched out. The output is very small.

29. *The Schmidt Coal Mine.*—The land on which this mine is located is leased from the state. The coal bed here is but three feet thick, and the overburden of nine feet is scraped off. The output is very small at this point.

MORTON COUNTY.

30. *The Feland Mine.*—The Feland mine, owned and operated by Theodore Feland, is one of the old mines of the state, and is located at Sims. In the early eighties an attempt was made to use this coal on Northern Pacific construction work, and some two hundred miners were employed. Now the only mine operating is the Feland, and it is nearly worked out.

The coal here is about six and a half feet thick, of which about six feet is mined. The entries are not timbered except in the places where the roof is weak; and props are used in the rooms.

At the present time the haul is some twenty-six hundred feet. There is very little water in the mine, and air is furnished by means of an air shaft. A spur from the Northern Pacific enables the coal to be emptied from the mine cars into the box cars.

January 25th, when the mine was inspected, the condition of this property was very good.

31. *The Hebron Brick Company's Mine.*—The Hebron Fire and Pressed Brick Company conduct a mine to supply coal for the firing of their brick. It is located about five miles northeast of Hebron, on the side of a hill in which their clay pit is also located.

The main entry to the mine and particularly the slope, is timbered in a very satisfactory manner. The rooms require a considerable amount of timbering, as the roof is not a good one.

They are driven about twenty feet wide, and three rows of props with good caps are used.

There is practically no water in the mine, and a sufficient ventilation is furnished by an air shaft.

January 26, 1910, the day that the mine was visited, active operations were being suspended as the brick yard needed no more coal, but everything was found to be satisfactory.

32. *The North Star Coal Mine.*—The North Star mine is owned by Havens and Murray, of Hebron, but is leased by H. T. Wadeson.

The mine is located a short distance from the Hebron Fire and Pressed Brick Company's mine, and on presumably the same coal bed.

This mine has a poor roof and requires careful and costly timbering to hold it in place. The chief reason seems to be because the top four feet of the bed consists of alternating layers of clay and poor coal.

The slope is timbered with four piece sets and some trouble is experienced in keeping the top from settling. There is no water in the mine and the air is furnished by an air shaft.

The day the mine was visited, January 26, 1910, everything was found in good order.

MOUNTRAIL COUNTY.

33. *The Blake Mine.*—The Blake mine is about five and one-half miles south-west of Stanley, located on a bed of coal that outcrops on the west side of Knife Creek. This mine is the nearest mine to Stanley, and has the thickest seam of coal in the immediate neighborhood.

Several entries have been driven and lost, but the entry now being driven is being carefully timbered and will be permanent. There is, just to the north of the entry, an area where a little stripping has been possible.

34. *The Elgers Mine.*—The Elgers mine, owned by Andrew Elwshire, is about seven miles southwest of Stanley, and is located on what is probably the same bed of coal as the Blake and Kale mines. There is a bed of coal consisting of a four foot seam, and one foot clay parting, and a foot of coal and slack. The four foot seam is the one which furnishes all the coal.

The overburden of fifteen to twenty feet of clay is stripped, and the coal pried up in blocks.

35. *The Gamble Mine.*—The Gamble Mine is found about nine miles northwest of White Earth on a branch of the White Earth creek. The mine is on a bed of coal that outcrops at the foot of the rather sloping hills that mark the eastern edge of the creek bottoms. The coal is found under eight feet of clay, which is stripped off, allowing access to the coal.

36. *The Heinemeyer Coal Mine.*—This coal mine is located on school land leased from the state by C. J. Heinemeyer. This mine is a very small one, there being three feet of coal covered with twlve feet of overburden. The water is ditched away. The mine is only operated for a short period each year.

37. *The Kale Mine.*—The Kale mine is located but a short distance from the Blake mine at the head of a coulee, where three small drains join, and extensive stripping has been done. Mr. Hartman intends to begin undermining sometime during 1910, as the overburden cannot be profitably stripped any longer.

38. *The New Mine.*—The New mine, is operated by Peter Tovson, is about nine and one-quarter miles northwest of White Earth, located a short distance from the Gamble mine, and on the same bed of coal.

Stripping has been carried on here for some time, but the increasing thickness of the overburden necessitates the undermining, which has just been begun, the main entry being some ten feet in

A striking similarity in the cross sections of coal here and at the White Earth coal mine, situated three miles south of White Earth, is noted.

39. *The Papke Coal Mine.*—The Papke mine, owned by Emma E. Papke, is ten miles almost straight south of Stanley, in the east bluffs of the Knife Creek. Here the coal is found under the first little bench, a few hundred feet from the bluffs proper, and the twelve feet of overlying clay is stripped.

The coal mined is divided by a seven inch clay parting into an upper and lower strata. The lower is better coal, selling for $2.00, while the upper, not quite so good, is sold for $1.20.

Work will probably be discontinued on this when the overburden becomes too thick to strip, as a bed of this thickness could hardly be undermined profitably.

40. *The Porger Mine.*—On the face of a bluff on the west side of the White Earth river, a six foot bed of coal outcrops, and in this, George Porger has opened up a small mine. An entry has

been driven in a considerable distance, and from this small rooms have been turned. There was little ventilation in the workings, but sufficint for the number of men employed.

On November 24, 1909, the conditions about the mine were fairly satisfactory.

41. *The Robinson Coal Mine.*—The Robinson Bros.' mine is found in a deep coulee about fourteen miles south of White Earth. Here is about eleven feet of coal under a hundred foot cover. The lower five feet of coal is separated from the rest by a sixteen inch clay parting and is the best coal. Above the parting six feet of coal occurs, the top two feet of which is not very good coal.

There is found at some distance above this bed, another which is supposed to be some two or three feet thick. The mine supplies a local demand, and was not operated during the season of 1908.

The portion of the mine where stripping was being done was safe enough, but the underground works were in rather poor condition on November 21st.

42. *The White Earth Coal Mine.*—The White Earth coal mine is owned by a company incorporated as the White Earth Coal Mine and Brick & Tile Company, and is situated on the east bluffs of the White Earth Creek about three miles from White Earth. Considerable financial trouble has been experienced by the company, and its management is now in the hands of Richard Slater.

All the coal is mined, the roof of clay being well propped. There is a hoist for hauling loaded cars up a steep slope to the top of the bluff, but this is not being used at present. The mine is well equipped with steel track and in good condition to make a big output.

Conditions were satisfactory on November 21, 1909.

OLIVER COUNTY.

43. *The Flint Coal Mine.*—The Flint coal mine is located near Hannover. It is owned and operated by Mrs. Henregetta Flint. This is a surface mine and only worked in a small way. Ten feet of earth has to be removed in order to get at the three feet of coal which is the thickness of the bed at this stripping.

During the summer teams and scrapers are used in removing the overburden, and the coal is loosened with picks.

RENVILLE COUNTY.

44. *The Christoferson Coal Mine.*—The Christoferson coal mine is located about a mile north of the town of Carpio, and a little west. Christ Christoferson is the owner and operator. A very neat and well conducted little mine is found here. The timbering is well done and the top of all the entries are carefully lagged.

Conditions were first rate on December 8, 1909.

45. *The Jewell Coal Mine.*—The Jewel mine is owned and operated by Gus Vahl. It is located on the east side of the Des Lacs river and near the town of Donnybrook. The coal bed in which this mine operates is but three feet or so thick, and there is much dead work in all the entries and in the rooms where it is desired to lay track. Much of the output of this mine is sold on contract before it is mined, and insures steady work for the miners employed at all times during the year.

Very little water troubles, and such as collects is hauled from the sump in barrels. The main entry is well timbered, but there is no timbering done in the cross entries at all. Props and caps are used in the rooms as often as, in the miners' judgment, they are required.

On December 8, 1909, the day I visited this mine, five men were employed. The air was good and the mine is fair condition.

46. *The Spring Farm Coal Mine.*—Hawkins and Collins lease this mine from Peter Tehelka. The mine is located four miles from Carpio, on the west side of the Des Lacs river. The mine is in a rather run down condition, and it is said that the workings will be abandoned in the summer of 1910.

The coal here is about two feet six inches thick, and much dead work is required to get a roadway.

The first part of the main entry is timbered with jack pine and tamarack. On December 8, 1909, when the mine was inspected, conditions were unsatisfactory.

47. *The White Ash Coal Mine.*—This mine is leased from Door Carrol, of Carpio, by Gustafson and Riechman. It is one of the smaller mining properties, working in a bed of coal of some two and a half feet thick. Considerable clay has to be removed to clear gangways. There is no water and an air shaft furnishes the ventilation. The mine is situated about five miles up the Des Lacs River valley from Carpio.

December 8, 1909, the day the mine was visited, conditions appeared quite satisfactory. Three men are employed, and the mining is all by hand.

48. *The Lehigh Coal Mine.*—The Consolidated Coal Company of Dickinson, owns and operates this mine. It is located at Lehigh, on the Northern Pacific.

The coal bed here is about fourteen feet thick of which about seven feet is mined. The rooms are driven twenty-five feet wide and two hundred and fifty feet deep, and often they are driven to full size, the props are drawn and most of the roof is stripped of coal. The eight foot pillars are not recovered.

Such water as accumulates is pumped out by means of an electric pump. A seven foot electric driven steam exhaust fan furnishes ample ventilation. Undercutting is done by Jeffries chain breast undercutting machines, three being in operation in the mines. A well equipped power house furnishes power for the mine. Some

of the haulage is over three-quarters of a mile, and against a one per cent grade. The intention is to install electric haulage in the near future.

Provision is made for loading two box cars at the same time. J. M. Brady is superintendent. The mine was found in excellent condition throughout on January 27, 1909.

49. *The Missouri Slope Company Mine.*—The Missouri Slope Company mine is the name applied to a small mine conducted by the Dickinson Brick Company. It is situated on the banks of the Heart River, about four miles east from Dickinson.

The coal is nine feet thick and about seven feet is taken out. In the summer time the coal is taken to the brick company's yard and in the winter is sold to the local trade.

A good roof is found here and the cost of mining is not high. The mine is flooded by the spring high waters, and as the coal dips away from the outcrop, it has to be pumped out after the river has gone down.

C. Edbaugh is the foreman of the mine, and conditions were not bad on January 27, 1910.

50. *The Riley Coal Mine.*—The Riley mine consists chiefly of a big outcrop of coal on the banks of the Heart River at Lehigh. Mr. Riley allows those choosing to mine coal the privilege of mining it here on payment of a thirty-five cent per ton royalty.

Several rooms have been driven into the face of the outcrop, no regular system of mining having been adopted. The deepest of these rooms is about two hundred and fifty feet.

51. *The Zenith Coal Mine.*—The Zenith Coal Company of Duluth, owns and operates this mine. Henry Truelson is the president and general manager of the company.

During the summer of 1909 the work at the old mine north of the track was discontinued and operations begun on the new mine, located just on the south side of the railroad. Here a one thousand foot slope of five per cent grade has been built to give access to the coal which is from eighteen to twenty-two feet thick at this point.

The coal bed dips to the northwest, and there is an abundance of water in the mine which requires a steam pump to keep down. The rooms are driven twenty-five feet wide, and seven to eight feet is taken out on the way in, and coming back the props are removed and a larger part of the roof coal is recovered.

A completely enclosed tipple of roomy dimensions has been built, and box cars are loaded at the mine. An air shaft furnishes the ventilation. Props are used in the rooms and the slope is carefully timbered. No timbering is necessary in the entries. Aside from being wet, this mine was found in excellent condition January 27, 1910.

52. *The Baden Coal Mine.*—The Baden coal mine is operated by Jonas Johnson. It is situated a mile down the Des Lacs valley

from Baden. The coal here is about two and a half feet thick, under about one hundred and ten feet of overburden. The mine is dry. An air shaft furnishes the necessary amount of ventilation, and the timbering consists of posts of tamarack and cedar placed in the rooms. The entries are about five by five feet, considerable dead work being done. No timbering has been done in there and as the roof was not very good, the conditions of the mine could not be pronounced satisfactory on December 9, 1909.

53. *The Bertelson Coal Mine.*—The Bertelson mine, owned and operated by Mr. Bertelson, is one of the larger mines of the Kenmare district. It is located about six miles north of Kenmare, and on the bank of the Des Lacs lake.

There is an entry driven into the coal about thirty feet above the level of the lake, and back on the top of the hills a shaft one hundred and forty feet has been sunk to the coal, permitting of two methods of coal delivery and of exit, should occasion demand.

The timbering and up keep of this mine is of the best. The timbering is carefully and adequately done, the main entry being lagged on the top and sides, and all the entries lagged on top.

The freezing of the lake permits haulage on the ice to Kenmare. From three to six and eight sleighs are coupled together and two teams take from six to sixteen tons to market.

On the date of examination, December 6, 1909, I found conditions at the mine satisfactory in every respect.

54. *The Broughton Coal Mine.*—This mine is owned by C. B. Cummings and operated by Thomas Cyrus. The coal runs from two to four feet in thickness, and is under one hundrd and fifty feet of clay.

A small drift has been driven in the side of a steep coulee, and is timbered with three piece sets and lagged.

This is one of the smaller workings, and the mine is only open a part of the year.

Conditions were satisfactory at the time the property was visited on December 9, 1909.

55. *The Carpio Coal Mine.*—This mine was leased from Jacob Karstensen by Adams and Lorenz. There is four feet of coal altogether, but separated by a fifteen inch clay parting into sixteen and thirty-two inch seams.

As the work progressed it was found that the roof was becoming more difficult to hold, close timbering and lagging being required to make it safe.

A traction engine with one drive wheel locked and a drum attached to the other one was used to haul the coal up the slope. The track was made by nailing iron pipe, one inch in diameter to wooden work. A steam pump was used for draining the mine. December 10, 1909, things were generally satisfactory.

56. *The Colton Coal Mine.*—This property is owned and operated by L. D. Colton of Burlington. The coal is delivered at the surface by a one hundred and twelve foot shaft. A well appointed tipple was arranged in such a way that considerable coal could be stored in the chutes.

There is no water in the mine, and ventilation is secured by means of an air shaft. The top of the air shaft a few feet above the surface of the ground, is fitted with a funnel arranged so as to always face the wind, thus forcing the air down the air shaft and up the hoisting shaft. There is about nine feet of coal here and seven of it is mined. A very good hoisting engine and geared drum with a suitable wire cable make it possible to do rapid and safe hoisting.

57. *The Coulee Coal Mine.*—This property was opened up in the fall of 1909. A drift was driven in the side of the hill at the bottom of a deep coulee, and a three foot bed of coal was encountered. The roof was very poor and the timbering had to be both strong and close.

On December 9, 1909, the main entry was being driven and no rooms had been turned. Conditions as regards safety were fair.

58. *The Conan Coal Mine.*—D. A. Conan owns a small mine which in 1909 was leased to J. Morrison. This mine is located in a nine foot seam of coal on the east side of the Mouse River, and about two miles from Burlington. The mine is worked only in a very small way. The water is both ditched and pumped out. Cottonwood and tamarack are both used for props in the rooms. On December 11, 1909, conditions were satisfactory.

59. *The Crosby Coal Mine.*—The Crosby coal mine, run by John Crosby, is situated on the north side of the lake and in a five foot six inch bed of coal. This mine has some water which is ditched to a small sump and bailed out. On the date of inspection, water was being encountered on the face of the main entry and on both cross entries, showing that the coal dipped in three ways at that point.

60. *The Davis Coal Mine.*—This property is owned and operated by the Davis Coal Company. It is situated a mile east of Burlington, at a siding called Davis. This is one of the larger mines, and is equipped and run in a very commendable manner. The stub entry system of mining is used. There is very little water.

A steam wound hoist hauls the loaded cars up the slope, from which they run over the platform scale and go to the tipple, from which box cars are loaded. The coal is screened, the screenings being used under the boilers at the power plant, and also at the Minot electric plant. A very well constructed furnace and air shaft furnishes a very good ventilation. A brick plant is run in connection with the mine. G. B. Wilson is superintendent of the company's works at Davis.

On December 13, 1909, the mine was found in first class condition.

61. *The Diamond Coal Mine.*—The Diamond mine is located about a mile and a half east of Kenmare on the main line of the Soo, where a tipple is so arranged that coal may be dumped directly into the cars for shipment. The coal bed at this point is found to be about five feet six inches in depth, so all the coal is removed in mining. The clay roof requires careful timbering to keep it in place. The mine is dry and the work is being carefully done.

62. *The Forsythe Coal Mine.*—P. N. Forysthe owns and operates a mine located about a mile up Paradise Creek from Paradise siding. Most of the coal taken out is shipped. The bed is from seven to eight feet thick, and all of it is mined. A steam pump is used to remove the water from the mine. The entries are driven about five by six feet, and no timbering is done in them. Tamarack props and caps are used in the rooms. December 11, 1909, conditions at this mine were satisfactory.

63. *The Hart Coal Mine.*—The Hart mine, owned by Harry Hart, is found a mile east of Kenmare on the main line of the "Soo." The mine is well located with reference to shipping facilities. It is on the same bed of coal as the Diamond mine, about a quarter of a mile further east and like conditions prevail at both mines.

This mine has been operated for a number of years, and the working faces are a considerable distance from the mouth of the entry. On December 1, 1909, when at this mine, I found conditions fairly good, and the mine work well conducted.

64. *The Hot Blast Coal Mine.*—This mine has been operated for a number of years by different parties. At the date of inspection, McIntosh and Hodgson were working the property. No scheme or plan of any definite nature is followed, the timbering is not adequately done, and at best, the mine could hardly be termed other than unsafe. As there is a considerable haul, it is probable that the workings will be abandoned in the spring of 1910.

On date of examination, December 9, 1909, there were but two miners at work.

65. *The Hunewell Coal Mine.*—The Hunewell mine is one of the older mines of the state, having been operated for a number of years. A ten to eleven foot bed of coal is found here, and an excellent roof is easily obtained by leaving from three to four feet of coal to support it.

The main entry is timbered for some distance back under the hill until well into the solid coal, after which no timbering in the entries is done, and all timber used is the props and caps in the rooms.

Such water as is present, accumulates in a sump, and is pumped from there by an ordinary hand pump.

On the date of examination, December 11, 1909, I found conditions at the mine quite satisfactory.

66. *The Ingison Coal Mine.*—This mine is owned by J. W. Ingison, and is operated on the double entry system. In working out the rooms, a different plan is followed than is usually adopted. The room neck is driven in about a hundred feet and then is widened out to a width of thirty feet, and the work brought back toward the entry. This is in effect a sort of retreating long wall. The wall being thirty feet long, with the roadway in the middle and at right angles to it.

In this case the roof is very good, and extensive timbering is not required to keep the roof in a fairly safe condition in regard to the miners working on the face of the wall.

On December 4th, 1909, when the mine was visited, I found the air fairly good and the mine in a pretty good condition.

67. *The Kenmare Brick and Coal Company's Mine.*—This property is managed by E. Chase, for the Kenmare Brick and Coal Company. Controlling interest in the concern is held by Levi Lewis of Minneapolis. The mine is located two and a half miles east of Kenmare, on the west side of Lake Des Lacs, and is reached by a spur of the "Soo." The company does not pay a great deal of attention to the sale of coal, brick making being its more important work. The coal is but four feet thick at this point, necessitating considerable dead work in all the road ways.

A well appointed power house that furnishes light for the company's buildings and power for the brick making machinery is run in connection with the mine.

On December 2, 1909, the day I visited this property, I found everything in first class shape and order. The timbering was being done especially well in all the entries and rooms, and the air was first rate. Fifteen men were employed at this time.

68. *The Knorr Coal Mine.*—This mine is owned and operated by G. J. Knorr, and is located some distance from Sawyer. It is in a small valley, and the drift opens into the coal almost immediately. There is fourteen feet of coal here, and from ten to eleven feet is mined. This is a very small property and on the date of inspection but two men were employed. The air, which is furnished by an air shaft, was good, and the mine in a safe condition on December 15, 1909.

69. *The Leeson Coal Mine.*—The Leeson mine is owned by J. J. Leeson. It is a surface mine and from five to fifteen feet of overburden has had to be removed to expose the coal, which is fourteen feet thick.

At this mine there is evidence of a fault. The line of faulting being as sharply cut as though it had occurred in firmer material than clay. The fourteen foot bed of coal ended as abruptly as though cut by a knife, and the coal next the plane of the fault

was highly polished and the scratches on it showed the direction of the slipping.

70. *The Little Minnie Coal Mine.*—The Little Minnie mine is owned and operated by D. J. Lloyd. It is situated about one and a half miles south of Foxholm, on the west side of the Des Lacs River, and a spur of the "Soo" enables the cars to be loaded for shipping at the mine.

The coal at this point is eleven feet thick, and of a good quality. There is considerable water which is collected at a sump, and from there it is removed by a steam pump.

The coal is delivered at the top of the slope by a steam wound drum. This drum consists of a traction threshing engine securely blocked in place with one driver locked and the other removed, in place of which a drum has been affixed to which the cable is attached.

Props and caps are used in the rooms, and no timbering is done in the entries except in the slope. On December 10, 1909, I found this mine in good order in most respects.

R. P. Jones was superintendent of the mine.

71. *The Lloyd Mine.*—The Lloyd mine is operated by the Paradise Mining Company, which is controlled by D. J. Lloyd. The mine is situated about a mile from the side track called Paradise, up a valley, also called Paradise. The mine lies on the north side of the valley and the drift only had to be driven a short distance before striking the coal. The overlying clay is very firm and makes a good roof, enabling the operators to remove all of the nine foot bed of coal. The main entry only is timbered, a coal roof being left in the cross entries. Tamarack props are used in the rooms. Ventilation is supplied by a furnace and air shaft, and the water is removed from the sump by a gasoline engine and pump, which is located outside the mine.

On December 11th, when the mine was visited, conditions were generally satisfactory.

72. *The McClure Coal Mine.*—The McClure coal mine is owned by the McClure Coal Company, of which G. E. McClure is the general manager, with the main office at Minot. The mine is located at Tasker, with side track facilities allowing loading for shipment from the mine cars.

An inclosed trestle some four hundred to five hundred feet long has been built from the mine entrance to the tipple. The main entry is timbered at intervals of four and one-half feet with three piece sets. Tamarack being used principally. Tamarack props are also used in the rooms. About six hundred feet from the entrance of the main entry, a parting has been built, which is carefully and amply timbered.

Mules are used both in gathering and in hauling out to the trips. This mine has been operated for several years, and there is said to be about five miles of track in the mine at the present time. A

pump has been arranged to handle such water as gathers. A steam driven box car loader is used, and a daily output of considerably more than a hundred tons is possible.

At the time of visiting this mine, on December 10, 1909, everything in regard to the mine and its management was found first class. W. E. Bryant was the superintendent of the mine.

74. *The Red Flag Coal Mine.*—The Red Flag mine is owned and operated by G. Knowles. It is located fourteen miles from Velva. This is what is termed a surface mine, some six to ten feet of clay having to be stripped off before the coal is exposed.

This bed is about eight feet thick, and appears to be a very good grade of coal. This mine is one of the smaller ones and is only operated a part of the time.

At the time of inspection, December 15, 1909, the coal that had been stripped was nearly all sold, so an entry was being started, the idea being to undermine a little while it was cold and the ground frozen.

75. *The Scott Coal Mine.*—The Scott coal mine is owned and operated by the Scott Coal Company. The mine is located about a mile up Paradise Valley, and about that distance from the sidetrack of the Soo, called Paradise. It is just on the opposite side of the valley from the Lloyd mine, and undoubtedly on the same bed of coal.

The main entry is timbered back to the coal, after which no timbers are used except for props in the rooms. The clay over the coal is very firm, and all the coal is removed in mining.

There is some water is some portions of the mine, but this troubles very little. Air is supplied by an air shaft, and natural means. The company has built a narrow gage track from the mine to the shipping spur at Paradise, and the mine cars are run down on this and dumped into the freight cars.

December 11, 1909, when the mine was visited, conditions were found generally satisfactory in all respects. Some sixteen men were at work. Mr. Scott conducted the affairs of the mine, while H. N. Graves acted as foreman underground.

76. *The Scotty Coal Mine.*—The Scotty mine is the property of Andrew Barrie, and is operated by him. The mine is located in a coulee that runs into the Mouse River valley a short distance below the town of Burlington. The coal bed is ten feet thick and is reached by means of a shaft, some thirty-two feet deep. The hoist is worked by steam power, a traction engine having been arranged with a drum on one of the drivers for this purpose.

A safety arrangement has been adopted which covers the mouth of the shaft when the cage is down. Tamarack props are used in the rooms, no timbering being done in the entries. There is no water in the mine whatever. Ventilation is secured by means of an air shaft.

December 11, 1909, everything about the mine was found to be in good condition.

77. *The Smith Dry Coal Mine.*—The Smith Dry Coal Mine is owned and operated by the Smith Dry Coal Company of Minneapolis. Fred Smith is general manager of the property and has active charge of the mining operation. The mine is located a mile and a half from Kenmare, on the east side of Lake Des Lacs, on a coal bed of five and one-half feet in thickness.

Timbering is done principally with jack pine and tamarack posts. The nature of the roof requires that all the entries shall be carefully protected with timber.

The mine is thoroughly equipped with all modern coal mining appliances. An electric seven ton motor is used for hauling out the trips. Undercutting of the clay is done with Pneumelectric coal punchers, and the trips are pulled onto the tipple by an electric hoist. An automatic register registers the weight of each car as it crosses the platform. A Phillips crossover dump empties the coal directly on a shaker screen. This screen has ninety square feet of screen surface. The coal that passes over this passes down a chute to the box car, where an Ottumwa box car loader takes care of it.

The screenings collect in a small mine car which, when loaded, is drawn up the slope by the electric hoist and dumped into chutes that supply the power plant boilers.

A power plant is run in connection with the mine that supplies light and power to Kenmare.

78. *The Soo Coal Mine.*—The Soo mine has been operated a number of years, and each year under different management. It is owned by H. L. Laughlin, and is leased by C. A. Buie.

At the time this mine was visited, December 6, 1909, the boiler was disabled and it was not possible to go underground. Surface indications were not encouraging. The boiler did not appear trustworthy, and an ordinary manila rope about an inch in diameter was used on the hoist.

The depth of the shaft is one hundred and twenty feet. The coal is said to be from four feet six inches to six feet six inches thick. The mine is dry. At the time this mine was visited there were sx miners waiting for operations to resume.

79. *The Spencer Coal Mine.*—The Spencer mine is leased from William Spencer by E. E. Spitzer. It is a small mine working in a bed of coal of not greater thickness than three feet. A neat little four by four entry, well timbered, has been driven in some distance, and some rooms turned from this. It has no air shaft, and there are only two or three miners working at it. The market is entirely local.

80. *The Stafford Coal Mine.*—This mine is owned by the Stafford Land Company, and is managed by C. C. Stafford. Here the

coal bed runs all the way from eighteen feet to six feet in thickness, and the thicker part of the deposit seems to lie nearer the outcrop.

In the first place the rooms were made fourteen feet wide with an eight foot pillar between, but as the work progressed and the character of the roof discovered, the pillars were narrowed and the rooms widened and so rooms twenty to twenty-five feet in width with pillars three and four feet in thickness stand with no signs of any caving. The roof is undoubtedly one of the best in the state. No timbers are used except in the first hundred feet or so of entry. The mine is perfectly dry. The coal is shot off the solid.

On the date on which the mine was visited, the conditions at the mine seemed satisfactory, though it seemed impossible that a clay roof could stand unsupported as well as this one did.

81. *The Strong Coal Mine.*—Joseph Strong leases this mine from A. W. Ditmer. This mine is located twelve miles southwest of Velva, and is in a shallow coulee. There is twelve feet of coal here, and heretofore this has been a surface mine, but as the overburden has become too great to permit its being removed, undermining has been begun.

A very firm roof permitting a fifteen foot entry to be driven in a hundred feet or so, and from which other rooms of ten feet in width have been turned, is found at this mine. The farmers who come to get loads of coal, drive up to the entrance and back their wagons into the entry to the face, and here are loaded, after which they drive out. No timber is used.

December 15, 1909, when this mine was visited, the coal was being shot off the solid and a fifteen foot room turned off a fifteen foot entry, and the roof still stood up. There were three men working in this mine at that time.

82. *The Vadneis Coal Mine.*—The Vadneis mine is owned and operated by the Vadneis Bros. It is located on the north side of the coulee from the Kenmare Brick and Coal Company's mine. The coal bed is about three feet eight inches thick, and of good quality. The main entry is timbered very well, and is in good shape. The air seemed sufficient. The mine is very dry. Both hand mining and blasting off the solid is practiced.

December 2, 1909, when I visited this property, conditions were fair.

83. *The Wallace Mine.*—This mine is owned by L. D. Davis, and is leased by J. S. Wallace, who operates it. The mine is situated almost directly in the town of Burlington, and but a few rods from the Soo railroad.

A pump operated by a gasoline engine keeps the mine drained. No timbering is required in the entries, and props are used in the rooms.

Mr. Wallace introduced a new method of mining in this state, which is used here. The stub entry system, as it is termed. The

stub entry is driven off the double entries, ten feet wide, and two hundred feet long. From this, rooms are turned off on both sides, beginning at the back end and the pillars drawn, this being a retreat system.

Air is kept at the face of the works by the use of brattices. Air is furnished by an air shaft and furnace, the main entry being the back air course.

December 11, 1909, when the property was visited, conditions at the mine were excellent.

84. *The Westergaard Mine.*—This property is owned by A. K. Westergaard. It is one of the smaller mines situated north of Kenmare on the east side of Lake Des Lacs. The drift opens on the lake shore. From here a track has been laid up the side of the bluffs, and a hoisting engine installed, which allows the mine cars to be pulled up to the top of the banks and emptied directly into wagons.

A very neat and efficient sort of a home made hoist is used. The mine is free from water, and on the date of inspection, December 2, 1909, was found to be quite satisfactory.

WILLIAMS COUNTY.

85. *The Black Diamond Coal Mine.*—The Black Diamond mine, owned by the Williston Lignite Coal and Power Company, is on the same bed of coal as the Williston lignite mine, and is about four and three-quarter miles from Williston. The bed of coal is some ten feet thick and is of good quality. There are no clay partings and the mine is dry.

The stub entry system of mining is being employed here, and is proving satisfactory. A carefully planned scheme has been worked out and the mine is being developed along these lines.

Ventilation is secured by means of an air shaft, and when needed, a fire is built beneath it to aid in obtaining a draft.

The mine has a good roof of some two and a half to three feet of coal and is well timbered, giving ample support for the clay above and protection to the employes.

86. *The Camp Creek Coal Mine.*—This property is leased from the state by E. E. Ryal, and is operated on a very small scale for his own convenience, there being but from two to ten feet of earth on top of the coal. This is stripped off and six feet of coal is thus exposed. Such water as collects is ditched out of the pit.

87. *The Coulter Coal Mine.*—The Coulter mine, owned by Coulter Bros., of Williston, is being operated by Otis Turcotte at present. The coal outcrops on the west side of Sand Creek, and is from four and one-half to five feet thick. The overburden is of sand, and therefore the mine has a poor roof, requiring close timbering. The trade is entirely local, being confined to those who come to the mine for their coal.

88. *The Dougherty Coal Mine.*—The Dougherty mine is located southeast of the Truax and Noonan mines, and on the opposite side of the coulee.

At the entrance to the mine there is evidence that at one time the coal bed was on fire. The miners have to shear before blasting, as it is not profitable to attempt to blast off the solid.

89. *The Good Coal Mine.*—The Good mine is leased by T. E. Good from the state. It is located about four miles north of Williston on the west side of the Muddy River. This mine was operated for a time by stripping, but as the overburden became thicker, undermining has commenced. The coal is eleven feet thick and about seven feet is mined.

90. *The Government Coal Mine.*—The Government mine is about one and one-half miles northeast of Williston, and situated on a bed of coal outcropping along the northwest side of a low range of hills which define the eastern edge of the bottoms of the Big Muddy.

Government borings indicate that there are three distinct beds of coal, each thick enough to possess commercial value. The first vein is nine feet thick and found at a depth of forty-five feet. Fifty feet beneath this is another vein nine feet in depth, in which the mine is located, and ninety feet beneath this another bed of about equal thickness is found.

The present intention of the government is to continue mining in the lower bed until the coal is recovered to a point beneath the outcrop of the upper bed, after which mining will be begun on the upper bed. All of the upper bed within the property limits will be mined, after which operations may be resumed on the lower bed.

The roof of this mine is not very good, and requires constant and careful timbering to prevent loss of rooms by falls of clay. In the rooms all the coal is removed, but in the entries two and a half feet of coal is left.

An arrangement to aid in ventilation has been built at the entrance of the mine. When the wind blows from the north and northwest there is a good circulation of air, but when it blows from the southeast there is a tendency to create a suction at the entrance of the tunnel which nearly neutralizes the effect of the air shaft. By building a big shield at the entrance of this mine this difficulty has been obviated. The wind strikes the shield and is turned downward and into the tunnel.

Since this mine has been operating, it has been the policy of the engineers in charge to drive the entry work as far as it was desired toward the limits of the property, and to work on a retreating scheme, robbing the pillars and letting the roof fall.

This of course makes the coal expensive at first, but blocks out a great quantity of coal that can be mined cheaply and safely later

on, and in the long run is deemed the most economical method of exploiting a mine.

Two systems of mining are being tried out, namely, the stub entry system and the cross entry system. The stub entry system requires less entry work but requires considerable bratticing work to secure sufficient ventilation. The result of this will illustrate the system most advantageous for the conditions which exist at this mine, and as these conditions are common in the majority of mines, of the state, the outcome will be of considerable interest and importance.

91. *The Head Coal Mine.*—The Head coal mine, owned by P. G. Head, is the newest mine near Williston, having just recently been opened. It was not possible to ascertain the exact thickness of the coal as at no place was the roof and floor exposed, but it is from nine to ten feet thick.

The entrance of the mine is on the west side of a rather sharp little coulee tributary to Sand Creek, and runs under the west bank. The surface is nearly level prairie back for a mile or so, and the bed may be of some considerable extent.

The water, which is quite abundant, is ditched out to the coulee. The main entry has been driven in to about seventy feet, and no rooms or cross entries turned.

There is a two to four inch clay parting about eighteen feet from the bottom of the seam.

92. *The Hess Coal Mine.*—Mr. C. A. Hess leases a quarter section of land from the state for coal purposes and operates a very small mine. All of the five to seven foot bed of coal is removed. The mine is conducted for the local use, and very little is sold.

93. *The Johnson Coal Mine.*—The Johnson mine is situated near Hoffland, on school land, and some coal is sold. Timbering is done with cottonwood, and three piece sets are used in the entries and props in the rooms. The mine is a small one.

94. *The Larsen Coal Mine.*—The Larsen mine is located on the northwest quarter of section sixteen, township one hundred and fifty-five, range on hundred and two, and is owned by the state.

It is leased by J. J. Larsen, who mines just a small amount of coal for his own use by stripping the overburden off and thus exposing the coal.

95. *The Low Level Coal Mine.*—The Low Level mine of Avoca, owned by John Bruegger of Williston, is located on a bed of coal thought to be the bottom bed of this locality. The mine entrance is some three hundred feet from the Great Northern Railroad, and a sidetrack has been put in at this point. The coal bed is about ten feet thick and about eight feet is mined. It dips to the north about one per cent. There is an abundance of water, which has to be pumped out at about the rate of four hundred gallons a minute, day and night. A Fairbanks Morse duplex steam pump being used for this purpose.

There is a well equipped engine house, containing a hoisting engine and an Ingersoll Rand air compressor and two boilers. A steam wound hoist is employed to pull the cars up the slope and onto a trestle which leads to a tipple emptying directly into the freight cars. As the loaded cars come up onto the level trestle they are disconnected, and run down to the weighing platform by hand, while empties are connected to the cable and run into the mine by gravity.

Compressed air is employed to run an Ingersol Rand punch undercutting machine, which is being used with success, and enables much larger quantities of coal to be loosened up by the shots. Two shots frequently loosening up from fourteen to sixteen cars of coal.

A double entry system is being followed out, and a sufficient number of rooms turned to permit of a larger daily output.

96. *The Moorman Coal Mine.*—The Moorman mine is located eight miles from Wheelock in a southeasterly direction, in a deep coulee known locally as Hungry Gulch. This mine which is a small one, is so inaccessible that it only supplies a local trade. It requires a four horse team to pull a partial load out of the gulch. The coal deposit here is about seven feet in thickness, and is about twenty or thirty feet above the level of the small creek.

97. *The Morrow Coal Mine.*—The Morrow mine is located on school land not far from the post office of Epping. It is a surface mine, there being a fifteen foot overburden, which is stripped. The water is ditched out of the pit. The coal here was five feet and ten inches thick.

98. *The Noonan Coal Mine.*—The Noonan mine, operated by the Noonan Bros., is located about a mile from the town of Noonan, on a shallow coulee that runs in a northeasterly direction.

There are two methods of delivering coal at the surface. One by an entry driven in on the coal where it outcrops on the side of the coulee, and one by a shaft situated back about twenty rods from the edge of the coulee. There is an eight foot bed here and the coal seems of a very good quality. The entries do not require much timbering, and props are used in the rooms. The shaft which has recently been made, is five feet eight inches by five feet ten inches, and is cribbed with two by four inch pieces. The total depth from the surface to the bottom of the coal is forty-two feet. They have a steam wound hoist at the shaft.

99. *The Old Nelson Coal Mine.*—This mine is located on school land and is leased by Monroe Beard, who mines only a very small amount of coal for local use. The coal is about ten feet thick and occurs at a depth of about twenty-six feet. Water is kept out of the mine by a gasoline engine and a pump.

100. *The Parker Coal Mine.*—The Parker mine is located about a half mile down the coulee from the Truax and Noonan mines. It is on probably the same bed of coal, though at this point it is

but six feet thick. This mine is a new one, and has only opened up. So far it consisted of only the beginning of the main entry.

101. *The Reynolds Coal Mine.*—The Reynolds mine is a new mine that is just being opened. The entry has been driven one hundred and fifty feet or so, and several rooms turned to furnish immediate coal. It has a rather poor clay roof which may improve as the work is extended further back under the hill.

102. *The Truax Coal Mine.*—E. M. Truax owns coal bearing property not far from the town of Noonan, and but a short distance from the Noonan mine. C. N. Truax operates a mine at this point. It was not possible at the time the mine was visited to go underground, but about the mine, conditions prevail as at the Noonan mine, both being in the same bed of lignite, the thickness varying but little.

The coal bed does not outcrop, but a slope was driven in a coulee where the overburden was the lightest. The coal is hauled up the slope by a cable, horse power being used.

Cedar posts are used for timbering, one row being placed in the rooms. Little timbering being done in the entries.

103. *The Williston Lignite Coal Mine.*—The Williston Lignite coal mine, owned by D. A. Powell, is located on a bed of coal outcropping in the bluffs that line the east side of the Missouri river, and is some five miles from Williston.

At this point the coal bed is about ten feet thick and contains no clay partings and is perfectly dry.. There is said to be another bed of coal of considerable thickness between forty and fifty feet beneath this bed now being worked. A two and a half to three foot coal roof is left which, with the timbering done, makes a very reliable sort of roof. In some instances rooms fifteen feet wide and over have stood for a number of years after the room was abandoned and the props removed.

There is little if any dip to the bed and no accurate idea could be obtained as to its extent. Back from the east of the edge of the bluffs at a distance of about a quarter of a mile some deep coulees and hilly land is found which might break up the continuity of the bed in that direction.

PREVENTION OF MINE EXPLOSIONS.

Because of the numerous mine accidents which have occurred during the last few years the United States government secured the services of three foreign experts to study the conditions found here in coal mining especially in regard to mine explosions, and to prepare a report stating how they might be improved. This commission consisted of Victor Watteyne, Inspector-General of Mines, Belgium, Carl Meissner, Councillor for Mines, Germany, and Arthur Desborough, H. M. Inspector of Explosives, England. Their report was published recently as Bulletin No. 369, U. S. Geological Survey, and several portions are printed herewith:

SELECTING THE EXPLOSIVES TO BE USED.

(1) We recommend that the government of the United States examine the explosives now and hereafter used in mining, with a view of eliminating the more dangerous explosives and to improving and standardizing such exposives as may be considered most suitable for such use, these to be designated by the government "permissable explosives."

The term "permissable explosives" is suggested for the reason that no explosives are entirely safe, and all of them develop flame when ignited; and we advise therefore against the use in the United States of the terms "safety explosives" or "flameless explosives," as these terms may be misunderstood and this misunderstanding may endanger life.

(2) We recommend that the operators and miners of coal use only such explosives as are included in a list of "permissable explosives," when the same has been published by the government, in all mines where there is risk of igniting either dust or gas, selecting that one which their own experience indicates can be used to the best advantage under local conditions.

(3) We recommend that investigations be conducted to determine the amount of charge of such "permissable explosives" which may be used to the best advantage under different conditions with a view to reducing danger to the minimum.

CARRYING THE EXPLOSIVES INTO THE MINE.

(1) All explosives should be made into cartridges and placed in closed receptacles before being carried into the mine, and the quantity carried into the mine during one day by any miner should be limited as nearly as practicable to the quantity needed by him for use during that day. Handling loose explosives and making them into cartridges by an open light in the mine should be prevented.

(2) Detonators or caps should be handled with great care, and should be carried only by a limited number of responsible persons.

USE OF EXPLOSIVES IN THE MINE.

(1) Shooting in or off the solid should not be practiced.

(2) The depth of the shot hole should be less by at least six inches than the depth of the cutting or mining. The use of very deep shot holes should be avoided as unnecessarily dangerous.

(3) The overcharging of shots (the use of a larger charge than is required to do the work satisfactorily) should also be avoided as unnecessary and dangerous. The proper standardization of explosives used in coal mining will greatly facilitate the carrying out of this recommendation.

(4) Shots should never be tamped with fine coal or material containing coal. Clay or other suitable material should be supplied and used for this purpose.

(5) The firing of two or more shots in one working place, except simultaneously by electricity, should not be allowed until a sufficient interval has elapsed between the firings to permit an examination of the working place in order to see whether any cause of danger has arisen.

(6) Believing that such will be one of the greatest advances which can be made in safeguarding the lives of the miners, we recommend the adoption of a system of electric shot firing, in all mines where practicable, by which all shots in the mine, or in each ventilation district of the mine, may be fired simultaneously, at a time when all miners and other employes are out of the mine.

USE OF ELECTRICITY.

(1) Electricity in mining operations offers so many advantages and has been so generally adopted, that no reasonable objection can be made to its use under proper restrictions. The electrical equipment, however, should be installed, maintained and operated with great care, and so safeguarded as to minimize danger from fire or shock. The fact that the effectiveness of some insulating materials is soon destroyed in most mines should not be lost sight of.

We recommend the following precautions: For distribution underground the voltage should not exceed 650 direct current or 500 alternating current, these voltages being intended for transmission to machinery operating at 500 volts direct current and 440 volts alternating current, respectively. Even lower voltages are preferable. The trolley wires should be installed in such manner as to render shocks least likely; that is, placed either high enough to be beyond easy reach or to one side of the track and properly protected.

Where current at a potential of more than 650 volts is employed for transmission underground, it should be transmitted by means of a completely insulated cable; and where a lead or armored covering is used, such covering should be grounded.

In all mines having electric installation special precautions should be taken against the setting on fire of coal or timber. Inclosed fuses or cut-outs are recommended, and each branch heading should be so arranged that the current may be cut off when necessary.

PRECAUTIONS AGAINST MISCELLANEOUS ACCIDENTS.

(1) In all new construction, shaft lining and superstructures about the entrance of the shaft (or slopes or drifts) should be built as far as practicable of noncombustible materials.

About the entrances to mines, every possible precaution should be taken to prevent fires or the injury of the equipment for ventilation and haulage. Ventilating fans should be placed to one

side of the mine opening, and hinged doors or light timbering should render easy the escape of the explosive force in direct line of the shaft or slope.

Proper precautions should be taken for immediately preventing the entrance into the mine of heat and gases and for facilitating the escape of men in case of surface or shaft fires.

(3) In all new mines, and in all old mines as far as practicable, suitable man roads should be provided for the men separate from the main haulage roads.

(4) In connection with the system of ventilation it is recommended that in the more frequented roads connecting the intake with the return air courses, two doors be provided, these doors to be placed at such a distance apart that while one is open the other is closed.

(5) In view of the large number of accidents from falls of coal or roof, under the existing practice with single props, more attention should be given to the introduction in mines where the roof is bad of better systems of timbering, such as have been long in use with economy and safety in many well managed mines.

(6) In undercutting coal by hand, the premature fall of the coal should be prevented by sprags or other suitable supports.

MINE SUPERVISION AND INSPECTION.

(1) We cannot too strongly emphasize the fact that thorough discipline about the mine is absolutely essential to safety, and that thorough discipline can be brought about only through the hearty co-operation of the operators, the miners and the state.

(2) We are of the opinion that the responsibility for safety in the mine should primarily rest with some person, such as the manager or superintendent, clothed with full authority; and that such person can greatly facilitate the attainment of safety through the employment of a sufficient number of foremen, and also of one or more inspectors whose special duty it shall be to see that the regulations are strictly enforced.

(3) The state cannot exercise too much care concerning the experience, technical training and selection of its inspectors. Their positions should be made independent of all considerations other than that of efficiency; and their continuance in the service should be coexistent with good behavior and proper discharge of official duty.

TRAINING FOR MINE FOREMEN, INSPECTORS, ETC.

We are of the opinion that the cause of both safety and efficiency in coal mining in the United States would be greatly aided through the establishment and maintenance in the different coal regions

of special schools for the training of fire bosses, mine foremen, superintendents and inspectors. The instruction in such schools should be practical rather than theoretical.

The work of these schools would supplement most effectively that of the colleges already established in many parts of the country for the more thorough training of mining engineers.