APPENDIX II.

Catalog and Table of Contents of the Publications of the Michigan Geological and Biological Survey[1].

DOUGLASS HOUGHTON, State Geologist.

Reports from 1838-1846 were published with Legislative documents as follows: S. D. means Senate Document; H. D., House Document; J. D., Joint Document. State Geologist is abbreviated S. G., and State Geological Survey, S. G. S.

*1838. Report of a select committee of the Board of Regents of the University on the collection of the S. G.
H. D. Vol. I, p. 1-2; S. D. No. 1, p. 1. H. D. No. 55 is duplicate of No. 1. Statement of the expenditures on account of the S. G. S. for the year 1837.
H. D. No. 8. pp. 115-118; S. D. No. 21. (First annual account of the S. G.), pp. 315-318.
Report of the S. G. (first annual).
H. D. No. 24, pp. 276-317, separately, No. 14, pp. 1-39.
Communication from the S. G.
H. D. No. 46, pp. 457-460.

*1839. Report of the S. G., in relation to the improvement of State Salt Springs.
H. D. No. 2, pp. 39-45; S. D. No. 1, pp. 1-7.
Report of the committee on the S. G.'s report in relation to the improvement of the State Salt Springs.
H. D. No. 4, p. 123.
Report of the S. G. in relation to the iron ore, etc., on the school section in town five south, range seven west, in Branch county.
H. D. No. 21, pp. 342-344.
Second annual report of the State Geologist.
H. D. No. 23, pp. 380-507; S. D. No. 12, pp. 264-391.
Report of the Committee of the Senate on Manufacturers, to whom was referred the communication of the S. G. relative to salt springs and the salines of the State.
S. D. No. 3, pp. 85-86 (parallel to H. D. No. 4).
Communication from the S. G. relative to the S. G. S.
S. D. No. 25, pp. 463-466.

*1840. Report of S. G. relative to the improvement of the salt springs.
H. D. No. 2, Vol. I, pp. 18-23; S. D. No. 8, Vol. II, pp. 153-158.
Annual report of the State Geologist (third, map of Wayne county).
H. D. No. 27, Vol. II, pp. 206-293; S. D. No. 7, Vol. II, pp. 66-153, separately No. 8, pp. 1-120.
Report of the select committee to whom was referred the several reports of the S. G.
H. D. No. 46, Vol. II, pp. 455-461.
Report of the majority of the Committee on Finance on the communication and accounts of the S. G. for 1839.
Report of the minority of the Committee on Finance on the same subject.
Report of the select committee on S. G.'s report and accounts relative to improvement of Salt Springs, etc.
S. G.'s account for the year 1839, the same being the subject matter of the three preceding reports.
S. D. Nos. 15, 16, 17, 18, pp. 209-224.

*1841. Special message concerning State Salt Springs.
H., S. and J. D. No. 5, pp. 235-254.
Annual report of the S. G. (fourth).
H., S. and J. D. No. 11, pp. 472-607, separately H. D. No. 27, pp. 1-184.
Report of the S. G. relative to county state maps.
H. D. No. 35, pp. 94-98.

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[1]NOTE.—The greater part of the publications of the Michigan Geological and Biological Survey are distributed gratis to public libraries and exchanges, and also to citizens of Michigan on the payment of forwarding charges. A considerable number of copies of each publication are reserved for sale at the list price.

*Publication out of print.

*1842. Report of the S. G. relative to the State Salt Springs.
H. D. No. 2, pp. 15-21; S. D. No. 1, pp. 1-9.
Report of the select committee in relation to the report of the S. G.
H. D. No. 19, pp. 77-79.
Annual report of the S. G. (fifth).
J. D. No. 9, pp. 436-441.

*1843. Annual Report of S. G. (sixth).
J. D. No. 8, pp. 398-402.
Report of the S. G. relative to the State Salt Springs.
S. D. No. 9, pp. 402-408.

*1844. Annual report of the S. G. (seventh).
S. D. No. 11 (three pages).
D. Houghton undertook an arrangement with the Linear Survey of the U. S. Land Office by which a certain amount of geological work was done, which was never published by the State, the results of which appear largely in the township plats of the Land Office, and in the report of C. T. Jackson, 1849, U. S. S. Ex. D. No. 1, pp. 371-935, H. Ex. D. No. 5, Vol. 3, Part 3, including sub-reports of W. A. Burt and Bela Hubbard on the geology of the sub-divisions of the Linear Survey, First Session 31st Congress, and of Foster & Whitney, U. S. Geologists, Part I, H. Ex. D. No. 69, pp. 1-224 and 12 Plates, First Session 31st Congress; S. Ex. D. No. 2, Vol. 2, p. 147, Second Session 31st Congress; Part II, S. Ex. D. No. 4, Vol. 3, p. 3, Special Session 32d Congress.
The work of the Geological Survey was interrupted by the death of D. Houghton while actively engaged in explorations.

*1846. Report from Geological Department by S. W. Higgins, principal assistant.
J. D. No. 12, 22 pp.
Report of the joint committee relative to the Geological Survey.
J. D. No. 15, 8 pp.

A. WINCHELL, State Geologist.

*First Biennial Report of the Progress of the Geological Survey, embracing observations on the geology, zoology and botany of the Lower Peninsula by A. Winchell, 1860. 339 pp. 1 geological map.

Sketch of the history of the geology of Michigan.
Part I. (a) Physical structure of the Northwest and general sketch of the geology of Michigan—the formations, their character, extent, thickness, etc.; (b) Tables of deep borings, with exhibited geology; (c) Economic geology: ores, coal, paint material, gypsum, salt, salt wells, tables of analyses, production of salt, peat, wells, and springs; (d) Physical geography, topography, hydrography, meteorology.
Part II. Catalog of the mammals, birds, reptiles, and molluscs of Michigan by M. Miles, M. D., State Zoologist.
Part III. Catalog of the wild phaenogamous and acrogenous plants of Lower Michigan with botanical notes upon the distribution.

*Volume I. Upper Peninsula 1869-1873. Accompanied by an atlas.

Part I. Iron Bearing Rocks (Economic) by T. B. Brooks. 320 pp. 4 views, 20 Pls. and 29 Figs. (a) Historical sketch of discovery and development; (b) Geological sketch of the Upper Peninsula (where to explore); (c) Lithology, mineral composition and classification of rocks, (d) Geology of the Marquette iron region; (e) Menominee iron region; (f) Gogebic and Montreal river iron range; (g) Explorations; (h) Magnetism of rocks and use of the magnetic needle in explorations; (i) Method and cost of mining specular and magnetic ores; (j) Chemical composition and analyses; (k) Appendices: 1. Lithological descriptions of Huronian rocks and ores. 2. Catalog of state collection. 3. Microscopic determination and descriptions. 4. Discovery of iron ores. 5. Magnetic analyses. 6. Synopsis of mining laws of Michigan. 7. Metallurgical qualities, etc., of Lake Superior ores. 8. Structure of banded ores and jasper.
Part II. Copper District by Raphael Pumpelly. 144 pp. 11 atlas plates. (a) Age of copper bearing rocks; (b) Lithology; (c) Paragenesis and derivation of copper and associated minerals; (d) Correlation of rocks; (e) Descriptive cross-sections; (f) General structure and lithology.
Part III. Paleozoic Rocks of the Upper Peninsula by C. Rominger. (a) Limits and surface configuration; (b) General geology of the bed rock and the surface deposits; (c) The formations, their character, distribution, fossils, minerals and ores, etc.

*Volume II. Upper Peninsula 1869-1873. Appendices to Part 1, Volume I.

Iron Bearing Rocks (Economic) by T. B. Brooks. 298 pp., 20 Pls., 21 Figs.
Appendix A: Lithological descriptions of 259 specimens of Huronian and Laurentian rocks by A. A. Julien. B: Catalog of state collection of Huronian rocks and ores; C: Microscopic determinations and descriptions of 78 specimens by C. E. Wright; D: Relating to the discovery of iron ores by United States surveyors; E: Notes on rocks along the shores of Lake Superior near Marquette, from Mss. of Dr. Houghton; F: Iron ore dock at L'Anse; G: Population of the Upper Peninsula in 1870; H: Magnetic analyses and color of powder of Marquette ores by F. B. Jenney; I: Synopsis of mining laws by C. D. Lawton; J: Metallurgical qualities and richness of Lake Superior ores, etc., by H. B. Tuttle; K: Lamination, plication, and faulting of banded ore and jasper (Illus.)

*Publication out of print.

C. ROMINGER, State Geologist.

	Price.	Forwarding. Charges.
Volume III. Lower Peninsula. 1873-1876. Bound in paper.....	$3.00	$0 35

Part I. Geology of the Lower Peninsula by C. Rominger. 225 pp 4 Pls. 1 map (in pocket). (a) Geographical position and surface configuration of Lower Peninsula; (b) Geological structure; (c) Soils; (d) Palaeozoic rock series. 1. Helderberg group, 2. Hamilton group, 3. Black shales of Ohio, 4. Waverly group, 5. Carboniferous limestone, 6. Coal measures and (e) Appendices: A. Observations on the Ontonagon silver mining district, and the slate quarries of Huron bay by C. Rominger, and B. Report on the Salt Manufacture by S. S. Garrigues.
Part II. Paleontology. Fossil corals by C. Rominger. 161 pp. 55 Pls. This is "a carefully elaborated" and finely illustrated monograph on the indigenous corals of Michigan.
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Part II. The Menominee Iron Region by C. Rominger: Stratigraphy, character and distribution of iron bearing formations and associated rocks.

C. E. WRIGHT AND M. E. WADSWORTH, State Geologist.

See Vol. II and Vol. V, also the reports of the Commissioners of Mineral Statistics and the following entry:

*Report of the State Board of Geological Survey for 1891 and 1892. Also reports of Dr. Carl Rominger for 1881 and 1882; of C. E. Wright for 1885 to 1888, inclusive.

(a) Expenses of Survey from its inception to 1892; (b) Reports of Dr. Carl Rominger for 1881 and 1882, with notes on the iron bearing rocks in vicinity of Gogebic lake, Michigan; (c) of C. E. Wright for years 1885-8, with notes on the geology of the region between Marquette and L'Anse on magnetic belts, and on gas and salt wells in the Lower Peninsula; (d) of M. E. Wadsworth for 1888 to 1892 containing geological notes on the rocks between Iron River and Lake Gogebic and along the shore north of Marquette, on occurrences of gold west of Ishpeming, on granite, on the iron bearing country between the Marquette and the Menominee ranges, on the Marquette district, on the geological column, on gas and oil, salt wells, building stone, clay, slate, etc.; (e) Sketch of the geology of the iron, gold, and copper districts by M. E. Wadsworth: 1. Geological formations (a) Upper Peninsula, (b) Lower Peninsula; 2. Azoic (Archean) system: (a) Cascade formation on the oldest sediments or eruptives, (b) Republic formation: conglomerates, quartzites, dolomite, jaspilite and iron ore, (d) Holyoke formation: conglomerates, quartzites, graywackes, granite, diabase, melaphyre, etc.; 3. Chemical deposits of the Azoic; 4. Paleozoic system: Potsdam sandstone, Eastern sandstone, North Trap range, South Trap range; 5. Veins and copper deposits on Keweenaw Point; 6. Minerals and rocks of Michigan—varieties, analyses, microscopic characteristics, etc.; (f) Extracts from the annual reports of the State Geologist, L. L. Hubbard for 1897-8, containing notes on the geology of Tuscola county, etc.

L. L. HUBBARD, State Geologist.

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(a) Introduction relative to the use and meaning of geologic terms and names; (b) Granitic group; (c) Dioritic group; (d) Iron ore group: 1. Marquette region, 2. Menominee, 3. Gogebic, 4. Penokee-Gobegic, Wisconsin, 5. Vermillion range, Minnesota; (e) Arenaceous slate group; (f) Mica schist formation; (g) Keweenaw group. Part II. Geology of Lower Michigan with reference to deep borings. Edited from the notes of C. E. Wright by A. C. Lane. 102 pp. 73 Pls. and 1 map. (a) An introduction on the origin of salt, gypsum and petroleum by L. L. Hubbard; (b) General geological considerations and difficulties in correctly interpreting the structure and character of the rock formations from well borings; (c) Geological formations of the Lower Peninsula and their economic products: 1. Descriptions of the various formations, 2. Occurrence of economic products: coal, gypsum, salt, bromine and bromides, mineral waters, oil and gas, and 3. Methods of taking and testing samples from well borings; (d) Well sections and their preparation, and geological sections and their use; (e) Particular descriptions of deep borings; (f) Plates illustrating character, thickness, mineral, and water content, etc., of the rock strata penetrated in the various deep borings; (g) Cross sections showing major and minor structures of the Michigan Basin.		

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ALFRED C. LANE, State Geologist.

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*Publication out of print.

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*Annual Report for 1901. 304 pp. 15 Pls. and 7 Figs. (a) Notes on the progress of work in Tuscola, Saginaw, Bay, Alpena, Kent, Washtenaw, and Muskegon counties; (b) Preliminary report on Arenac county, by W. M. Gregory: 1. Introductory notes, 2. Limestone, 3. Gypsum, 4. Coal, 5. Water supply, water power, and flowing wells, 6. Clay and shales, 7. Agricultural resources; (c) Report on Alcona county: Surface geology by Frank Leverett, subsurface geology by A. C. Lane: 1. Climate, 2. Glacial deposits, 3. Lake history, 4. Economic resources: soils, marl, clay, water power, wells and borings, oil and gas possibilities, salt, water and mineral water, peat, etc.; (d) Distribution of the Plant Societies of Kent county, by B. E. Livingston; (e) Preliminary report on the surface geology of Lapeer county, by F. B. Taylor; (f) Economic geology of Michigan: 1. Relation to the industrial world. 2. Raw materials: water power, wood, oil and gas, iron, copper, sandstone, limestone, salt, precious metals, etc.; (g) Limestones: 1. Distribution, character and analyses of various limestone beds in the state, 2. Development of deposits; (h) Stratigraphy of the Traverse group of Michigan, by A. W. Grabau. 49 pp. Also contains valuable data concerning water supplies, limestones, shale and clay deposits in the regions of Little Traverse Bay and of Alpena (Thunder Bay to Presque Isle): (i) Deep wells and borings for Oil and Gas in Michigan: 1. Southwestern district, 2. Southeastern, 3. Port Huron, 4. Saginaw, 5. Northern part of state, 6. Lake Michigan shore; (j) Salt; (k) Meteorites; (l) Geothermal gradient; (m) Appendix; 1. The Port Huron oil field, 2. Wave cutting on west shore of Lake Huron, Sanilac county, by C. H. Gordon.		
*Annual Report for 1902. 26 pp. 1 geological map. Published in the Michigan Miner, Saginaw, January, 1903. (a) Preliminary report on the gypsum deposits of Michigan by G. P. Grimsley; (b) Field and laboratory tests of Bay county waters; (c) Notes on economic products: moulding sand, peat, limestone, road metal iron bearing rocks, water power, wells and deep borings, etc.		

*Publication out of print.

	Price.	Forwarding Charges.
*Annual report for 1903. 342 pp. 6 Pls. (soil, vegetation, and geologic maps) 10 Figs.		
(a) Relation of soils to natural vegetation in Roscommon and Crawford counties, by B. E. Livingston, 30 pp.: (b) Report on progress made in the Porcupine mountains; (c) Water supply of Lower Michigan, W. F. Cooper, 63 pp.: 1. Artesian well areas, 2. Springs and nonflowing wells, 3. Analyses of springs, 4. Topography and water power, 5. Water supply of Lenawee, Hillsdale, Branch, St. Joseph, and Cass counties, 6. Analyses of Lower Peninsula waters; (d) Waters of Upper Peninsula of Michigan, by A. C. Lane, 67 pp.: 1. Analyses of lake, river, mine and well waters, 2. Well records and deep borings, 3. Water bearing strata; (e) Limestone and limestone areas, analyses, etc., 25 pp.: (f) Building and road materials, 12 pp.: 1. Stone, 2. Brick, and 3. Cement; (g) Analyses; (h) Transmission of heat into the earth, by A. C. Lane, 43 pp.: 1. Mathematical calculation, 2. Grain of rock; (i) Theory of copper deposition, by A. C. Lane, 12 pp. 2 Figs.; (j) Tamarack mine cross section and the Keweenaw lodes, 19 pp.; (k) Deep borings for oil and gas, 21 pp.; (l) Peat; (m) Topographical survey; (n) Recent shore forms, etc.		
*Annual Report for 1904. 182 pp. 17 Pls., 5 Figs. 3 Maps.		
(a) Failure of wells along the Lower Huron river, Michigan, in 1904, by Myron L. Fuller, 29 pp.: 1. Water supplies of the Lower Huron river district, 2. Decline of water supplies of the wells, 3. Necessity of laws for regulating deep or artesian wells; (b) Geological reconnaissance along the north shore of lakes Huron and Michigan, by I. C. Russell. 122 pp. 15 Pls. 2 Figs.: 1. Introductory statement, 2. Outline of geological history, 3. Hardrock geology,—the formations, 4. Surface geology 5. Glacial deposits, 6. Fluvio-glacial deposits, 7. Beaches of former lakes, 8. Glacial lakes, 9. Topographic features of lake shores, 10. Lake and swamp deposits, sand dunes, and soils, 11. Recent changes of shore line; (c) Executive report, containing notes on substitutes for wood, clays and shales, sand-lime brick, cement, peat, coal, gold and oil; (d) Report of special committee for the Lake Superior region: 1. Successions and relations of formations obtaining in the various districts of United States and Canada, 2. The districts—Marquette, Penokee-Gogebic, Mesabi, Vermilion, Rainy Lake, Thunder Bay, Northern Lake Huron, etc., 3. Correlations, 4. The Laurentian problem, 5. Grain of Logan Sills; (e) Lake Superior gold mining; (f) Black River work; (g) Wells and borings.		
*Annual Report for 1905. 638 pp.		
Includes the following parts bound separately:		
*(a) An ecological survey in Northern Michigan by Chas. C. Adams.		
1. An ecological survey in the Porcupine Mountains and Isle Royale, by A. G. Ruthven:		
Part I. The Porcupine Mountains; History, topography, and geology; Biota considered by field stations; Summary, interpretations, and conclusions.		
Part II. Isle Royale; General geography; Biota considered by field stations; Summary and conclusions. 2. The ecological distribution of birds in the Porcupine Mountians, by Otto McCreary:		
Part I. The Lake Superior or slope of the first mountain ridge.		
Part II. Carp river valley.		
Part III. Hardwood forest south of Carp river.		
Part IV. Little Carp river valley.		
Part V. Summary.		
3. Ecological relations of the orthoptera in the Porcupine Mountains.		
4. Notes on the plants of the Porcupine Mountains and Isle Royale.		
5. Annotated list of molluscs of the Porcupines and Isle Royale, by Bryant Walker. 6. Spiders and insects from the Porcupines. 7. Cold blooded vertebrates of the Porcupines and Isle Royale. 8. Annotated list of the birds of the Porcupine Mountains and Isle Royale. 9. Notes on the mammals of the Porcupines and Isle Royale.		
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(d) Annual report of the State Geologist. Contains notes on the		

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origin of strontium, on wells, artesian and mineral waters, building material, marl, shale, sand lime brick, road metal, gypsum, paint, iron, and coal.		
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(c) A geological section from Bessemer down Black River by W. C. Gordon. 112 pp. 4 Pls. (1 map) 6 Figs. Bound in paper.		
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(e) Annual report of the State Geologist, containing notes on gold (placer) in Michigan, limestone, earthquakes, molding sand, clay, water and water supplies, coal, oil and gas, sand-lime brick, the biological and topographic surveys, etc.		
*Annual Report for 1907. 288 pp.		
Includes the following parts bound separately:		
(a) State Geologist's report containing notes on the topographic survey, on reforestation, leasing of state lands for oil and gas, etc., exploration, peat, coal and coal analyses, limestone, cement and lime, tests and analyses.		
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R. C. ALLEN, State Geologist.

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The Monroe Formation of Southern Michigan and Adjoining Regions by Professors A. W. Grabau and W. H. Sherzer. 248 pp., 32 Pls., 9 Figs.

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(a) Early history; (b) Newspaper and telegraph period; (c) The earthquakes; (d) Earthquakes connected with the mines of the Northern Peninsula.....	$0.21	$0.04

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The Keweenaw Series of Michigan, by Dr. A. C. Lane. 2 Vols. 983 pp. 15 Pls. (Maps included), Pls. VIII-XV in pocket, 69 Figs.

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(a) Popular description of major geological structures of Lake Superior Basin, the stratigraphy, etc.: 1. The Keweenaw fault and other faults, 2. The general character and succession of the beds, 3. Sources of copper, 4. Agents of metamorphism, 5. Resultant minerals, 6. Shear zones and shoots, 7. Surface geology, 8. Distribution of float copper; (b) Nomenclature and chemical relations of the Keweenawan rocks; (c) Microscopic petrography—the minerals and textures; (d) The grain of igneous rocks; (e) Detailed stratigraphy as shown by the mines and outcrops.
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(f) Temperature of the copper mines; (g) Mine waters; (h) Copper formation; (i) Comparison with similar deposits; (j) The development of the copper mines and their geological relations, by A. H. Meuche; (k) Appendix: Recent developments, geological questions, and bibliography.....	2.65	.35

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Surface Geology of the Northern Peninsula of Michigan, with notes on agricultural conditions and water power, by Frank Leverett, 91 pp. 8 Pls. 7 Figs. (Plate I is a large scale surface geology or soil map). Bound in paper, cloth backs.

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(b) The Iron Mining Industry of Michigan, by R. C. Allen, 103 pp., 7 Figs. (including maps): 1. Introduction—importance and permanency of industry, the iron formation and character of the ores, 2. Important features of iron mining industry—exploration, royalties, values, ownerships and reserves, prices and price determinations, transportation, ore sampling and analyses, 3. Recent developments; Menominee range—Menominee district, Calumet trough, Metropolitan trough, Crystal Falls district, Iron River district; Gogebic range; Marquette range and Gwinn district, 4. Statistical tables—shipments (1855-1911) by districts, cargo analyses, prices, freight rates and mine values, list of mines with location, ownership, sales agents, etc.

(c) Pig Iron Industry in Michigan, by Prof. A. E. White, 35 pp. 3 Pls.: 1. Introduction—production, history and development of the industry, 2. Details regarding blast furnaces of Michigan: Charcoal furnaces; Coke furnaces, 3. The J. T. Jones' Step Process for the metallization of low grade iron ores.

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(h) Gold in Michigan, by R. C. Allen: 1. Discovery in Michigan, 2. The Ropes and other mines, 3. Mining companies, 4. Placer gold.

(i) Oil and gas in Michigan, by R. A. Smith: 1. Exploration, 2. Anticlinals, 3. Oil fields and districts: Port Huron field; Southeastern district; Southwestern district; Western district; Central part of state: Northern part of Southern Peninsula; Northern Peninsula, 4. Tables of deep borings showing the several horizons, their depth, thickness, etc.

(j) Directory of the mineral producers of Michigan.

(k) Miscellaneous statistical tables—pottery, mineral waters, clay, sandstone, lime, limestone, sand and gravel, sand-lime brick, brick and tile, summary of mineral products.

(l) Appendix—Production and value of mineral products of Michigan for 1911.

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Surface Geology and Agricultural Conditions of the Southern Peninsula, by Frank Leverett. Chapter on Climate, by C. F. Schneider. 144 pp. 15 Pls. (3 maps), 16 Figs.

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(b) Climatic conditions: 1. Seasonal and annual means, 2. Temperature, 3. Frosts, 4. Precipitation, 5. Drought, 6. Sunshine, 7. Winds, 8, Relative humidity, 9. General climatic data.

(c) Glacial features: 1. Features due to early stages of glaciation,

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(d) Lake features and history: 1. Introductory statement, 2. Lake Chicago, 3. Lake Maumee, 4. First Lake Saginaw, 5. Lake Arkona, 6. Later Lake Saginaw, 7. Lake Whittlesey, 8. Lake Warren, 9. Lake Wayne, 10. Lake Elkton, 11. Beginnings of Lake Erie and Lake St. Clair, 12. Lake Algonquin, 13. Nipissing Great Lakes.

(e) Agricultural conditions: 1. General notes, 2. Conditions by counties (in tabulated form).

Publication 10, Biological Series 3. 1911.

The Herpetology of Michigan, by A. G. Ruthven, Crystal Thompson and Helen Thompson. 190 pp. 11 Pls. 55 Figs.

(a) The Herpetology of Michigan; (b) General introduction; (c) The Amphibians by Crystal Thompson and Helen Thompson: 1. Literature, 2. Methods of study, collecting and preserving specimens, 3. Description of species, 4. Glossary; (d) The Reptiles, by A. G. Ruthven and Frances Dunbar: 1. Literature, 2. Methods of study, collecting and preserving specimens, 3. Description of species, 4. Glossary, 5. General bibliography; (e) Memoranda towards Bibliography of the Archaeology of Michigan, by Harlan I. Smith..... $0.80 $0.10

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Geological Report on Arenac County, by W. M. Gregory. 145 pp. 7 Pls. 18 Figs.

(a) Historical and geographical introduction; (b) Previous geological work; (c) Climate; (d) The geological column; (e) Geology of the Palaeozoic formations; (f) Pleistocene or glacial geology; (g) Water resources: Pt. I. Hydrology, Pt. II. Hydrography; (h) Altitudes or elevations; (i) The soil and soil products; (j) Economic resources and raw materials: sand and gravel, the sand soil products, the jack pine flora, clay, gypsum, limestone, coal, water resources, and the soils.. .50 .10

Publication 12, Geological Series 9. 1911.

Geological Report on Wayne County by W. H. Sherzer. 388 pp. 32 Pls. 22 Figs.

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(f) Directory of mineral producers in Michigan for 1912.....	$0.60	$0.10

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The Occurrence of Oil and Gas in Michigan, by R. A. Smith, 281 pp., 3 Pls., 19 Figs.

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(b) Introduction. 1. Object and plan of the report. 2. Acknowledgments.

(c) The Michigan Basin. 1. Major structure. 2. Minor structure. 3. The geological section and formations described.

(d) Geological factors controlling the occurrence of oil and gas. 1. The anticlinal theory. 2. Forms of oil and gas reservoirs. 3. Generalizations concerning the application of the anticlinal theory. 4. Rock pressure and its causes. 5. Surface indications of oil and gas.

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(f) The southeastern district. 1. Rock structures. 2. Relation of surface signs to oil and gas horizons. 3. Explorations and records of wells in Monroe, Lenawee, Hillsdale and Wayne counties. 4. Local structures Wyandotte and Stony Island anticlines. 5. Explorations and records of wells in Washtenaw, Oakland, Macomb and St. Clair counties. 6. Local structures in Macomb and eastern St. Clair counties. 7. Conclusions.

(g) The Saginaw oil field. 1. The Saginaw Valley Development Company. 2. The Saginaw anticline. 3. The explorations. 4. The oil horizons. 5. Favorable area for exploration. 6. Character and composition of the oils.

(h) Central Michigan. 1. Geographic and geologic relations. 2. Explorations and records of wells in Bay, Saginaw, Genesee, Midland, Gratiot, Isabella, Gladwin, Mecosta, Kent, Ionia. Barry, Eaton, Ingham, Jackson and Calhoun counties. 3. Local geology in Livingston, Shiawassee and Clinton counties. 4. Explorations and records of wells.

(i) The southwestern district. 1. Occurrence of oil in the vicinity of Allegan. 2. Character of the formations and local structures. 3. Explorations and records of wells at Allegan. 4. The local structures in Berrien, Cass, St. Joseph and Kalamazoo counties—the Berrien Springs syncline and the anticline near Niles. 5. The oil horizons. 6. Explorations and records of wells.

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(l) Northern Peninsula. 1. The Paleozoic area. 2. The Wisconsin section. 3. Explorations and records of wells in eastern Wisconsin and Menominee and Delta counties. 4. Occurrence of oil and asphalt in the Trenton limestone. 5. Explorations and records of wells in Schoolcraft, Mackinac and Chippewa counties and on Manitoulin Island, Ontario.

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Brine and Salt Deposits of Michigan, by Chas. W. Cook, 181 pp., 15 Pls., 47 Figs.

(a) Introduction. 1. Distribution. 2. Physical properties of salt. 3. Previous work.

(b) Historical account. 1. Governmental development. 2. Private initiative.

(c) Theories of the origin of salt deposits. 1. Volcanic. 2. Evaporation—the Ochsenius and Walther's. 3. Dome.

(d) Brine theories. 1. Original sea water. 2. Solution.

(e) Geology of the brine and rock salt formations and the character and origin of the brines and rock salt. 1. Parma. 2. Marshall. 3. Berea Grit. 4. Dundee. 5. Upper Monroe or Detroit River Series. 6. Salina. 7. Summary.

(f) Salt manufacture. 1. Wells—well drilling machinery, boring and pumping methods. 2. Preliminary treatment of brines. 3. Methods of evaporation—direct heat and steam.

(g) Character, production and value of salt in Michigan.

(h) Geology, production and operating companies by counties. 1. Saginaw. 2. Bay. 3. Huron. 4. Macomb. 5. Iosco. 6. Midland. 7. Gratiot. 8. Manistee. 9. St. Clair. 10. Mason. 11. Wayne. 12. Isabella.

(i) Appendix A. Bibliography of Michigan salt deposits.

(j) Appendix B. The salt inspection law.....	.60	.10

Publication 16, Geological Series 13. 1913.

Mineral Resources of Michigan for 1913 and prior years.

(a) The Michigan Copper Industry in 1913 by R. E. Hore. 1, General conditions. 2. Profits and losses. 3. Cost of mining. 4. Wages paid. 5. Exploration. 6. New construction. 7. Earnings and dividends. 8. Summary of mining operations for 1913 by mines. 9. Statistical tables of production and value of copper. 10. Summaries of financial statements of mining companies.

(b) The Iron Ore Reserves of Michigan by R. C. Allen. 1. A. brief description of the iron bearing formations—relation to other formations; thickness, deformation and alteration; the formation of the ore bodies; depth to which iron ore occurs. 2. Importance of the iron mining industry in Michigan. 3. Permanency of the industry—mining at deep levels, development of unexplored lands, opening of abandoned mines, utilization of low grade ores, and recent estimates of Michigan iron ore reserves. 4. Royalty and ownership. 5. Value of iron ore in Michigan in 1913. 6. Statistical tables on production and value of iron ore, on iron ore reserves, mining costs and appraised value of mines, prices of ore, freight rates, iron ore shipments by mines, ranges and counties. 7. List of active iron mines with location, ownership, depth of bottom levels and number of men employed.

(c) Non-metallic Minerals by R. A. Smith. 1. Limestone—general business conditions, description of the limestone formations, location and character of the principal deposits, statistical tables of production and value. 2. Lime—general business conditions and statistical tables. 3. Sandstone—general character of the sandstones of Michigan, causes of the decline of the sandstone industry, statistical tables. 4. Shale—Uses of shale and location of shale resources. 5. Trap rock—location of the trap rock deposits, growth of the industry, statistical tables. 6. Grindstones and scythestones—location of the grit or grindstone quarries and method of quarrying. 7. The Michigan Slate Industry by O. R. Hamilton—location and description of the black slate deposits of Baraga county, attempted development, former production and value of slate. 8. Sand and gravel —growth of the industry, difficulty of obtaining complete statistical data, the use of sand and gravel for concrete aggregates, statistical tables. 9. Salt—general trade conditions, seats of the industry, extent of the salt beds, statistical tables. 10. Cement—growth of the industry in Michigan, increased price in 1912-1913, future outlook, statistical tables. 11. Gypsum—growth of the industry in Michigan, present developments, extent and distribution of the gypsum resources, statistical tables. 12. Clay—character and uses of the clays of Michigan, statistical tables. 13. Pottery—trade conditions and statistical tables. 14. Brick and tile—general trade conditions, character of the brick and tile products in Michgan, statistical tables. 15. Sand-lime brick—growth and importance of the industry in Michigan, location of the plants, statistical tables. 16.

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Publication 17, Geological Series 14. 1912-1914.

Biennial Report of the Director of Michigan Geological and Biological Survey, by R. C. Allen, 104 pp., 1 map.

(a) Organization of the Geological and Biological Survey; 1. Expenditures; 2. Employees.
(b) Powers and duties of the Board of Geological Survey.
(c) Functions of the Geological Survey; 1. Distribution of reports; 2. Correspondence and conferences; 3. Cooperation with the Board of State Tax Commissioners in the appraisal of mines and mineral lands; 4. Reports of the State Geologist to the Board of State Tax Commissioners; 5. Cooperation with the Michigan Securities Commission; 6. Cooperation with the Public Domain Commission.
(d) Progress of the Geological Survey of Michigan; 1. Geological work in the Gwinn Iron Bearing District; 2. On the east end of the Menominee Iron Range; 3. Resurvey of the Gogebic Iron Range between Wakefield and Lake Gogebic; 4. Laboratory studies of Pre-Cambrian rocks in the district between Lake Gogebic and Iron River; 5. Monograph on the copper ore deposits of Michigan; 6. Report of the geology of Limestone Mountain; 7. Report on the brine and salt deposits of Michigan; 8. Report on the occurrence of oil and gas in Michigan; 9. Geologic investigation of the limestone resources of Michigan; 10, Studies of the Dundee, Traverse, and Marshall formations; 11. Study of the physiography of Michigan inland lakes; 12. Geologic and physiographic studies of Mackinac Island; 13. Annual report on mineral resources and statistics of mineral production.
(e) Progress of the topographic survey of Michigan; 1. Object of the survey; 2. Expenditures for cooperative topographic survey of Michigan; 3. Plan of cooperation in topographic mapping; 4. Report of topographic surveys July 1, 1912, to July 1, 1914. 5. Table of progress of the topographic survey in the United States.
(f) Progress of the Biological Survey of Michigan; 1. Plan of work; 2. Field work for 1913 and 1914; 3. Publications; 4. Recommendations.
(g) Recommendations to the Legislature relative; 1. To a proposed increase in appropriations for topographic mapping—need for and uses of topographic maps, appropriations for the Topographic Survey; 2. To the investigation of water powers, drainage, etc.; 3. To the need of a soil survey of Michigan—organization of a Soil Survey, recommendations; 4. To the regulation of the drilling and care of deep borings—harmful results of unregulated deep drilling, proposed regulations; 5. To the relation of the Geological and Biological Survey to the conservation of the birds and wild animals of the state; 6. To the proposed work of the Biological Survey—report of the Committee on Policy of the Biological Survey, plan of work, and nature of publications.
(h) Catalog and tables of contents of the publications of the Michigan Geological and Biological Survey, 1838-1914..... .10 .06

Publication 18, Geological Series 15. 1915.

Part I. Contributions to the Pre-Cambrian Geology of Northern Michigan and Wisconsin, by R. C. Allen and L. P. Barrett. 152 pp., 12 Pls., 11 Figs.
Part II. The Geology of Limestone Mountain and Sherman Hill in Houghton county, Michigan, by E. C. Case and W. I. Robinson. 29 pp., 5 Figs.
Part I. Contributions to the Pre-Cambrian Geology of Northern Michigan and Wisconsin.
(a) Introduction and acknowledgments.
(b) A revision of the correlations of the Huronian group of Michigan and the Lake Superior region; 1. Correlation of the Animikie series as Middle Huronian; 2. Correlation of the Huronian group in the Gogebic and Marquette districts; 3. Correlation of the Vulcan (iron bearing) series with the Negaunee (iron bearing) series—Marquette and Crystal Falls districts; 4. Correlation of the Negaunee series with the Vulcan series of the Sturgeon trough, Felch Mountain district, Calumet trough, and Menominee range; 5. Correlation of the Ironwood (Animikie) of the Gogebic range with the Vulcan (Middle Huronian) series of the Crystal Falls-Iron River-Florence-Menominee district on the basis of similar relations to intrusive granite; 6. General remarks on the correlation of the Animikie series with the Middle Huronian.

	Price.	Forwarding Charges.
(c) A revision of the sequence and structure of the Pre-Keweenaw formations of the eastern Gogebic iron range; 1. Introductory statement—summaries of the geology based on earlier work and of the writers' conclusions; 2. Archean system; 3. Algonkian system: Lower Huronian—Sunday quartzite and Bad River limestone; Middle (Animikie) Huronian—introductory statement, relation to other formations, geology of the Palms and Ironwood formations, Middle Huronian extrusives, basic extrusives, Presque Isle granite; Upper Huronian—The Copps formation; Keweenawan series—Relation to adjacent formations, Keweenaw(?) gabbro; 4. Structure of the Gogebic range east of Wakefield—Keweenawan series, Copps formation, and Middle Huronian series. (d) Geology of the Marenisco range; 1. Introductory statement; 2. Archean system—northern area, southern area, relations to adjacent rocks; 3. Middle Huronian (Animikie) series—graywacke-quartzite, iron formation, slate formation, igneous rocks. (e) Geology of the Turtle Range; 1. Introduction; 2. Successions on the Turtle range; 3. Archean; 4. Huronian group—Lower and Middle; 5. Igneous rocks. (f) Geology of the Manitowish Range; 1. Results of diamond drilling; 2. General summary. (g) Geology of the Vieux Desert district—conclusions. (h) Geology of the Conover district; Petrographic description of the Conover slates. (i) The Paint slate and the Wolf Lake granite, gneiss, and schist; 1. The Paint slate formation; 2. Petrographic descriptions of the Paint slate; 3. Summary statement; 4. Granites, gneisses, and schists of the Wolf Lake area; 5. Relations of the Wolf Lake granite and mica schist to the Paint slate. (j) Correlation and structure of the Pre-Cambrian formations of the Gwinn iron bearing district; 1. Previous geological work; 2. Recent studies; 3. Location, topography, etc.; 4. Notes on the structure of the Gwinn synclinorium; 5. Archean system; 6. Algonkian system: Middle Huronian—Gwinn series; Upper Huronian—Princeton series; 7. Keweenawan series (?); 8. Paleozoic; 9. Correlation of the Gwinn and Princeton series. (k) Evidence of the Middle-Upper Huronian unconformity in the quartzite hills of Little Lake Michigan; 1. Structure of Little Lake hills; 2. The Lower (Gwinn) series—arkose and conglomerate; 2. Upper (Princeton) series—conglomerate, quartzite and quartz slate; 3. Notes on the correlation. (l) Relative to an extension of the Menominee iron range eastward from Waucedah to Escanaba, Michigan; Conclusions. Part II. Geology of Limestone Mountain and Sherman Hill in Houghton county, Michigan. (a) Location and topography. (b) Previous geological work. (c) Stratigraphy and correlation of beds; 1. Mid-Devonian; 2. Niagaran; 3. Middle or Upper Richmond; 4. Upper part of Lower Richmond; 5. Lower Richmond; 6. Galena (Stewartville or Upper Galena); 7. Decorah (Upper Blue); 8. Upper Black (Upper buff); 9. Potsdam (Jacobsville). (d) Structure. (e) Geological history—The fault between Big and Little Limestone..	$0.90	$0.10

Publication 19, Geological Series 16. 1914.

Mineral Resources of Michigan for 1914 and prior years. 359 pp., 18 Pls., 24 Figs.

Part I. Metallic minerals.
(a) Michigan Copper Deposits, by R. E. Hore, 161 pp., 18 Pls., 23 Figs.; 1. Location of the copper mines; 2. Structural features of Keweenaw Point—general geology, structure of Keweenawan series, faulting; 3. The copper bearing rocks—the Keweenaw rocks, classifications and descriptions; 4. Nature of the copper deposits—mode of occurrence, conglomerate lodes, amydgaloid lodes, sandstone lodes. Epidotic beds, cupriferous felsite, fissure veins, paragenesis of copper and calcite, sulphide veins, arsenides and sulphides of copper, arsenic in the copper, copper oxide, silicate and carbonate minerals, accessory minerals containing fluorine, boron, or tungston, silver in Michigan copper deposits; 5. Geology and development of the copper deposits or lodes and production of copper,—Adventure No. 4 lode, Algomah, Allouez conglomerate, Ashbed lode, Atlantic, Baltic, Calumet conglomerate, Central mine vein, Forest lode, Hancock lodes (No. 3 and No. 4), Indiana lode, Isle Royale, Kearsarge, Lake,—East lode, Mass mine lodes, Evergreen lode, Butler, Ogima, and Knowlton lodes, Michigan lodes, Minesota lodes, Nonesuch lode, Osceola, Pewabic, Phoenix mine vein, Superior lode, Superior "West" lode, Winona production of the several lodes in 1912; 6. Origin of the deposits—views of geologists, deposition of copper by solutions of ferrous salts, deposition of copper from chloride solutions, conclusions of R. E. Hore as to the origin of the deposits.

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(b) The Copper Industry in 1914, by Walter E. Hopper, 35 pp. 1. General review: the strike of the copper miners, effects of the strike on production and mining costs, losses, effects of the European war—loss of foreign markets, closing of copper mines, disorganization of the domestic copper markets, recovery of the copper market at the close of 1914, disasters in the copper country—fires and boiler explosions; 2. Construction work—restriction by strike of 1914; 3. Mine casualties: 4. Sanitary conditions; 5. The Copper Handbook—removal of publication office from Houghton to New York City; 6. The Douglass Houghton memorial at Eagle River; 7. Details of operations of the mining companies in 1914; 8. Statistical tables by R. E. Hore and W. E. Hopper.

(c) Iron Ore—Statistical tables, by R. C. Allen and O. R. Hamilton, 22 pp.

Part II. Non-Metallic Minerals, by R. A. Smith.

(a) Coal in Michigan, 23 pp.: 1. Michigan Coal Basin—location and extent, surface features, accessibility, geology, character and thickness of the coal measures, occurrence of the coal, quality, analyses; 2. Development, history of coal mining, mining conditions, methods of mining; 3. Markets; 4. Production and statistical tables.

(b) Limestone; 1. Growth of industry; 2. Location of quarries; 3. Statistical tables.

(c) Lime; 1. Slow growth of industry; 2. Unfavorable location of kilns; 3. Quality of lime; 4. Production, 5. Statistical table.

(d) Sandstone; 1. Decline of industry; 2. Cause; 3. Statistical table.

(e) Trap Rock; 1. Unfavorable location of deposits and quarries; 2. Statistical table.

(f) Grindstones and Scythestones; 1. Location and character of the grit stones; 2. Location of quarries.

(g) Sand and Gravel; 1. Decrease in production in 1914; 2. Extent of sand and gravel resources; 3. Statistical table.

(h) Salt; 1. Production and rank of state in 1914; 2. Former center of industry—Saginaw Valley; 3. The salt producing districts; 4. Rapid development of industry in Wayne county; 5. Mining of rock salt; 6. Manufacture of bromine, bromides, and calcium chloride; 7. Occurrence of the rock salt deposits; 8. Depth; 9. Probable extent; 10. Statistical tables.

(i) Cement; 1. Growth of industry; 2. Raw material; 3. Production; 4. Distribution; 5. Market prices; 6. Statistical tables.

(j) Gypsum Deposits in Michigan, 8 pp.; 1. Occurrence and development; 2. Character, extent, and thickness of the beds; 3. The gypsum bearing formation; 4. The gypsum bearing districts—the Grand Rapids-Grandville, the Alabaster-Turner district (Iosco and Arenac counties), and the St. Ignace; 5. History of gypsum industry; 6. Production and disposition of product; 7. Statistical tables.

(k) Clay: 1. Character and occurrence—brick and tile, pottery, and slip clays; 2. Developments; 3. Uses—brick and tile, pottery, glazing.

(l) Pottery: 1. Growth of industry; 2. Character of products; 3. Sources of raw material; 4. Statistical tables.

(m) Brick and Tile Products: 1. Raw materials; 2. Production; 3. Rank of state; 4. Development of common brick industry near Detroit; 5. Drain tile and sewer-pipe; 6. Statistical tables.

(n) Sand-lime Brick: 1. Factors affecting the growth of the industry; 2. Production; 3. Rank of state; 4. Statistical table.

(o) Mineral and Spring Waters: 1. Fluctuating production and causes; 2. General decline of industry; 3. Table of production.

(p) Natural Gas: 1. Sources—surface deposits, bed rocks; 2. Surface gas wells—Macomb, Oakland, Washtenaw, and Manistee counties; 3. Rock wells—Port Huron oil field; 4. The gas and oil bearing strata; 5. Statistical table.

(q) Petroleum; 9 pp.: 1. The Port Huron field—discovery of the Petrolia Oil Springs fields in Ontario, the C. A. Bailey and G. B. Stock explorations, the development companies, records of the recent test wells, the Port Huron anticline, the surface deposits and surface gas, the rock formations, the oil bearing formation; 2. Explorations at Cadillac, Wexford county; 3. H. R. Ford test well at Dearborn, Wayne county,—plan to drill to the depth of 5,000 feet or to the pre-Cambrian granite.

(r) Quartz: 1. Production and uses; 2. Location of mines and mills.

(s) Mineral Paints: 1. Raw materials; 2. Producers.

(t) Relative to Potash deposits in Michigan: 1. Studies on the Devonian and Silurian formations in Michigan, by A. W. Grabau; 2. Possibilities for the occurrence of potash salts in the lowest rock salt beds in southeastern Michigan; 3. Uses of potassium salts; 4. Importance of a reliable source; 5. Investigations by the U. S. Geological Survey and the U. S. Bureau of Soils; 6. Occurrence, extent, and depth of the rock salt beds in Michigan.

(u) Summary table of the production and value of mineral products in Michigan, 1910-1914.

(v) Appendix—Directory of the producers of non-Metallic minerals in Michigan for 1914.

(w) Index..... $0.90 $0.10

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Publication 20, Biological Series 4, 1915.

Miscellaneous Papers on the Zoology of Michigan. 179 pp. 28 Pls. 3 Figs.

(a) Observations on the fishes of Houghton county by Thomas L. Hankinson. 12 pp. 8 Plates, 1 Fig. 1. Local distribution of fish—Stonington, South Twin, North Twin, Kratt and Bear Lakes. 2. Habitat and distribution in South Twin Lake. 3. Conclusion. 4. List of species.

(b) An ecological study of the fish fauna of the Douglas Lake region (Michigan) with special reference to the mortality of the species by Roy J. Colbert. 13 pp. 1 Fig.

(c) Dragon Flies of the Douglas Lake region (Michigan) by Arthur T. Evans. 20 pp. 2 Plates.

(d) Reptiles and amphibians of Monroe County by Crystal Thompson. 3 pp. List of species.

(e) Results of the Mershon expedition to the Charity Islands, Lake Huron: Coleoptera, by A. W. Andrews. 42 pp. 1. Habitat distribution of the coleoptera. 2. List of species.

(f) Results Shiras expeditions to Whitefish Point, Michigan: Fishes, by T. L. Hankinson, 161 pp. 17 Plates. 1 Fig. 1. General description of region. 2. Fish habitats. 3. List of species. 4. Hypothetical list of species. 5. Summary and conclusion. 6. Bibliography.

Publication 21, Geological Series 17.

Mineral Resources of Michigan with statistical tables of production and value of mineral products for 1915 and prior years. 402 pp. 8 Pls. 15 Figs.

Part I. Metallic Minerals.

(a) Michigan Copper Industry in 1915 by W. E. Hopper, 55 pp.: 1. General review. 2. Exploration and development work. 3. Construction work. 4. Dividends. 5. Mine casualties. 6. Details of operations of the mining companies in 1915. 7. Statistical tables.

(b) Iron Industry—Statistical Tables, by R. C. Allen and O. R. Hamilton. 1. Iron ore shipments by districts. 2. Summary of iron ore shipments by ranges and counties. 3. List of active iron mines. 4. Iron ore reserves of Michigan. 5. Appraised value of Michigan iron mines. 6. Value of Michigan iron ore shipments in 1915. 7. Costs, profits, losses, and assessments, iron mines of Michigan.

Part II. Non-Metallic minerals by R. A. Smith.

(a) Limestones of Michigan. 209 pp. 8 Pls. 15 Figs. 1. Origin of limestone. 2. Classification and varieties of limestones. 3. Uses of limestone and lime. 4. Geology of limestone formations—geologic distribution and character of pre-Cambrian and Paleozoic limestones and marl or bog lime deposits. 5. Distribution, character, and development of limestone deposits by counties.

(b) Miscellaneous non-metallic minerals. 1. Coal—growth in production, cost of mining, markets, methods of mining; statistical tables. 2. Limestone industry—growth of industry, character of the deposits, and statistical tables. 3. Lime industry—growth, statistical table. 4. Sandstone—decline of industry, statistical table. 5. Grindstones and scythestones—occurrence and development. 6. Sand and gravel—occurrence and development, statistical tables. 7. Salt—growth of industry, occurrence and extent of salt deposits, statistical tables. 8. Cement—growth of industry, statistical tables. 9. Gypsum—growth of industry, occurrence of beds, statistical tables. 10. Clay—Classes, quality, occurrence and uses. 11. Pottery—growth of industry, classes of products, statistical table. 12. Brick and tile products—raw materials, nature of product, statistical tables. 13. Sand lime brick—growth of industry, statistical table. 14. Mineral and spring waters—decline of industry, statistical table. 15. Natural gas—occurrence, statistical table. 16. Petroleum—occurrence and production. 17. Trap rock—occurrence and development, statistical table. 18. Shale—occurrence and development. 19. Graphite—occurrence of graphitic slates, development. 20. Quartz. 21. Mineral paints. 22. Summary table of production and value of mineral products in Michigan, 1911-1915.

(c) Appendix. Directory of producers of non-metallic minerals in Michigan in 1915.

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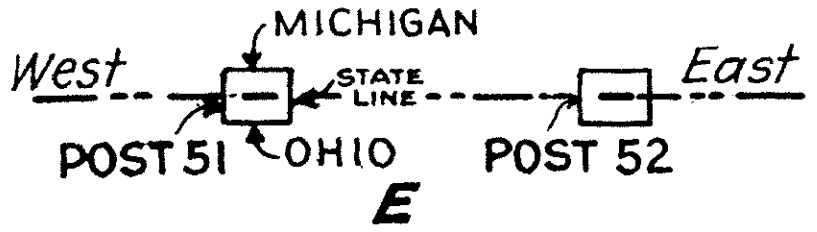
Publication 22, Geological Series 18, 1914-1916.

Biennial Report of the Director of the Michigan Geological and Biological Survey by R. C. Allen, pp. 118, Pls. 15.

(a) Organization of the Geological and Biological Survey. 1. Tables of expenditures. 2. Employees of the Board of Geological Survey, July 1, 1914 to July 1, 1916.
(b) Progress of the Geological Survey.
(c) Co-operative work. 1. With the Board of State Tax Commission. 2. The Public Domain Commission. 3. The Michigan Securities Commission. 4. The Mackinac Island State Park Commission.
(d) Geological work. 1. Geological map of Michigan. 2. Report of Michigan limestones. 3. Studies of the pre-Cambrian rocks of the Northern Peninsula. 4. Studies of the Devonian formations. 5. Of the Mississippian formations. 6. Of the Paleozoic formations of the Northern Peninsula. 7. Of the physiography of Michigan inland lakes. 8. Mineral statistics.
(e) Progress of the Topographic Survey: 1. Expenditures of the Co-operative Topographic Survey of Michigan. 2. Importance of the Topographic Survey to the development of the state.
(f) Progress of the Biological Survey: 1. Report of the Chief Naturalist.
(g) Retracement and permanent monumenting of the Michigan-Ohio boundary: 1. Part I. Report of commissioners. 2. Part II. Report of engineer. 3. Part III. Basis of Ohio-Michigan boundary dispute. 4. Bibliography of the Ohio-Michigan boundary dispute. 5. Appendix I. Distribution of reports of the Geological Survey. 6. Appendix II. Catalog and table of contents of the publications of the Michigan Geological and Biological Survey.

DESIGN FOR
STONE MONUMENTS
OHIO - MICHIGAN
STATE LINE
JULY 1915



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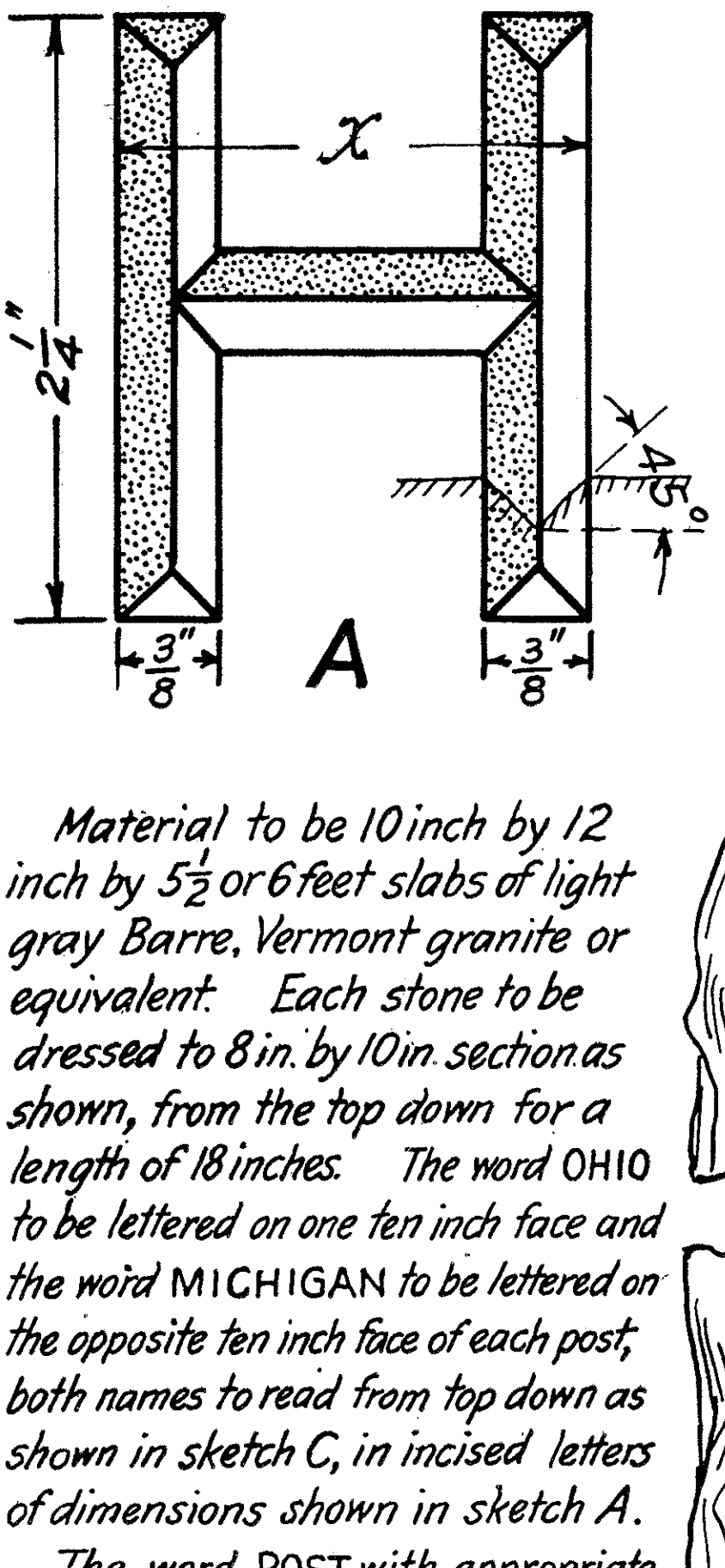
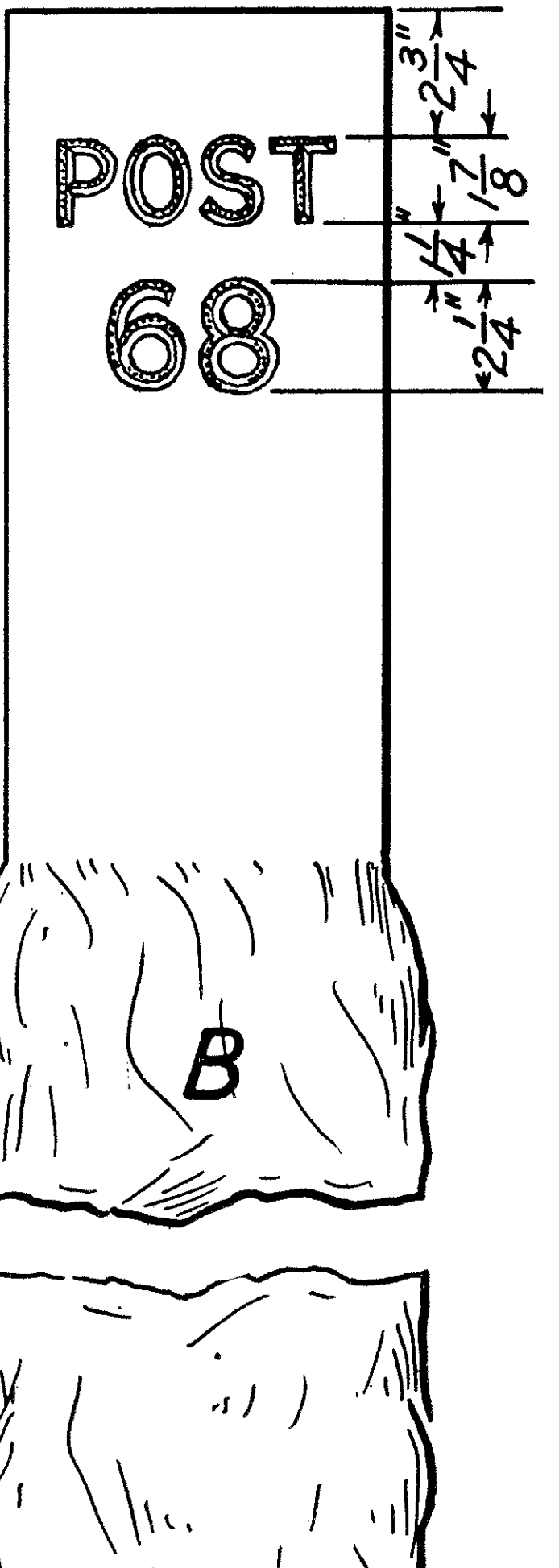
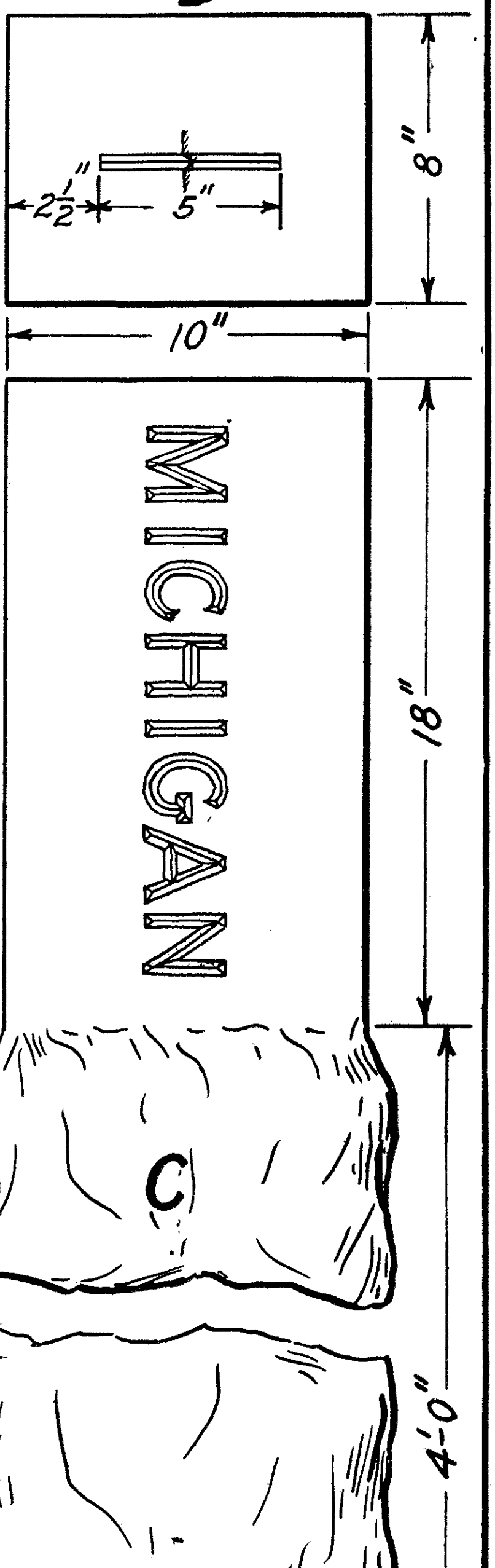






Material to be 10 inch by 12 inch by 5½ or 6 feet slabs of light gray Barre, Vermont granite or equivalent. Each stone to be dressed to 8 in. by 10 in. section as shown, from the top down for a length of 18 inches. The word OHIO to be lettered on one ten inch face and the word MICHIGAN to be lettered on the opposite ten inch face of each post, both names to read from top down as shown in sketch C, in incised letters of dimensions shown in sketch A.

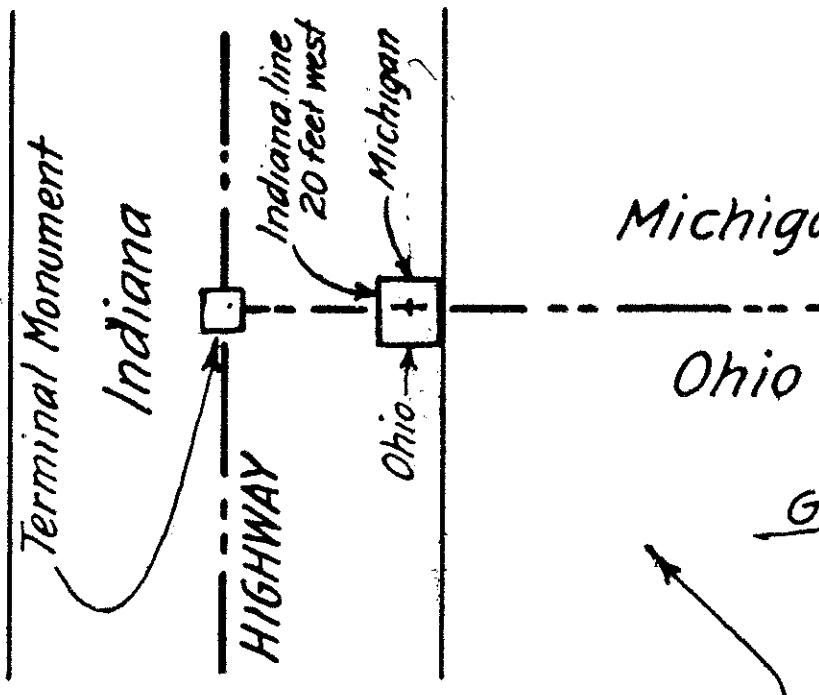
The word POST with appropriate consecutive number from 1 to 75 to appear in incised letters and figures on 8 in face as shown in sketch B.

The words STATE LINE on opposite 8 in. face of each post in appropriate sized letters reading horizontally. Top face of each post to be incised with 5 inch groove as shown on sketch D. Relative positions of letters and figures on each post shown in sketch E.

SPECIFICATION FOR INTERMEDIATE POSTS

WESTERN TERMINAL AND WITNESS MONUMENTS

OHIO-MICHIGAN STATE LINE JULY 1915

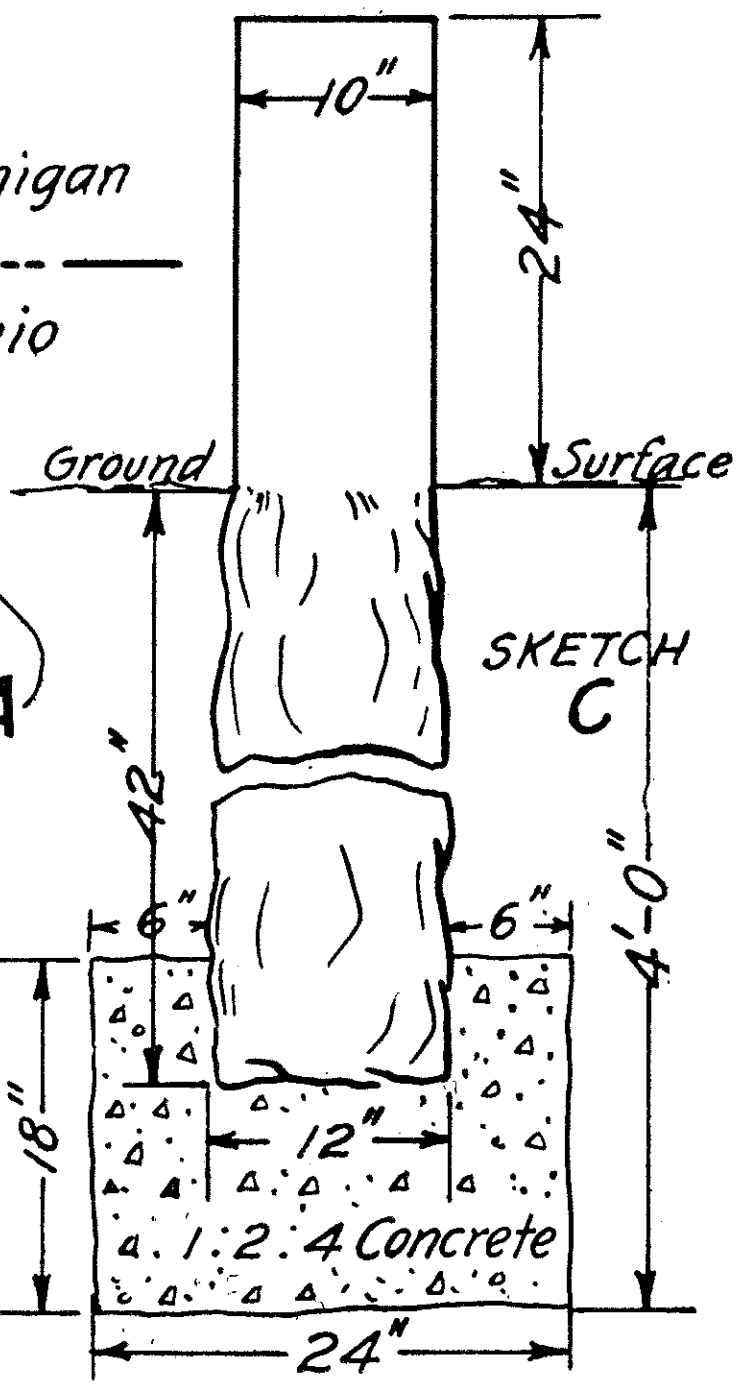


POSITION SKETCH **A**

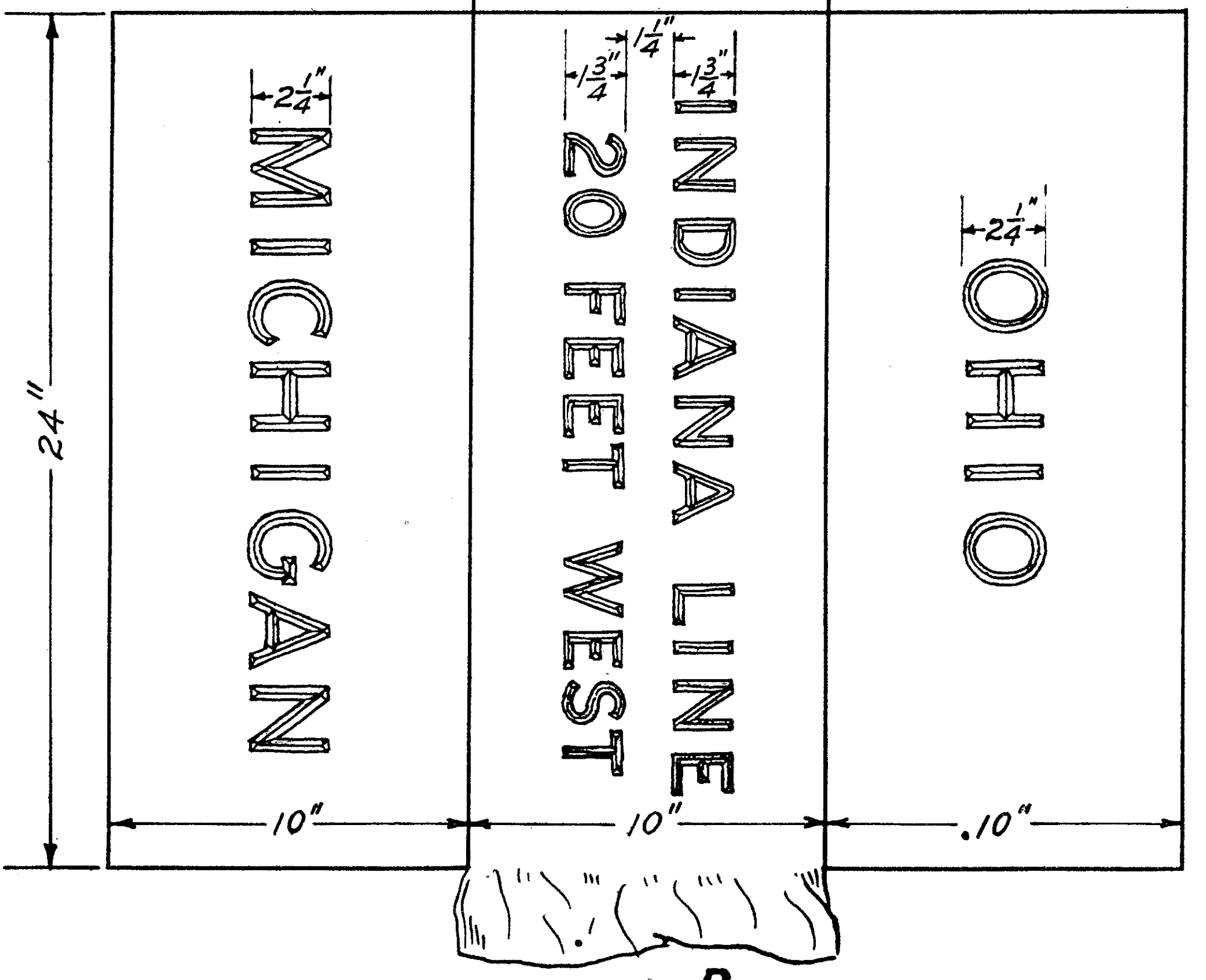
Material to be of Barre, Vermont, or equivalent light gray granite.

One terminal monument 12"×12"×36" rough stone set below surface of ground at position shown in sketch **A**. One witness monument 12"×12"×5'-6" slab, dressed to 10"×10" for 24 inches down from top and lettered as shown in sketch **B**.

Witness monument to be set in concrete base as shown in sketch **C**.



SKETCH **C**



SKETCH **B**

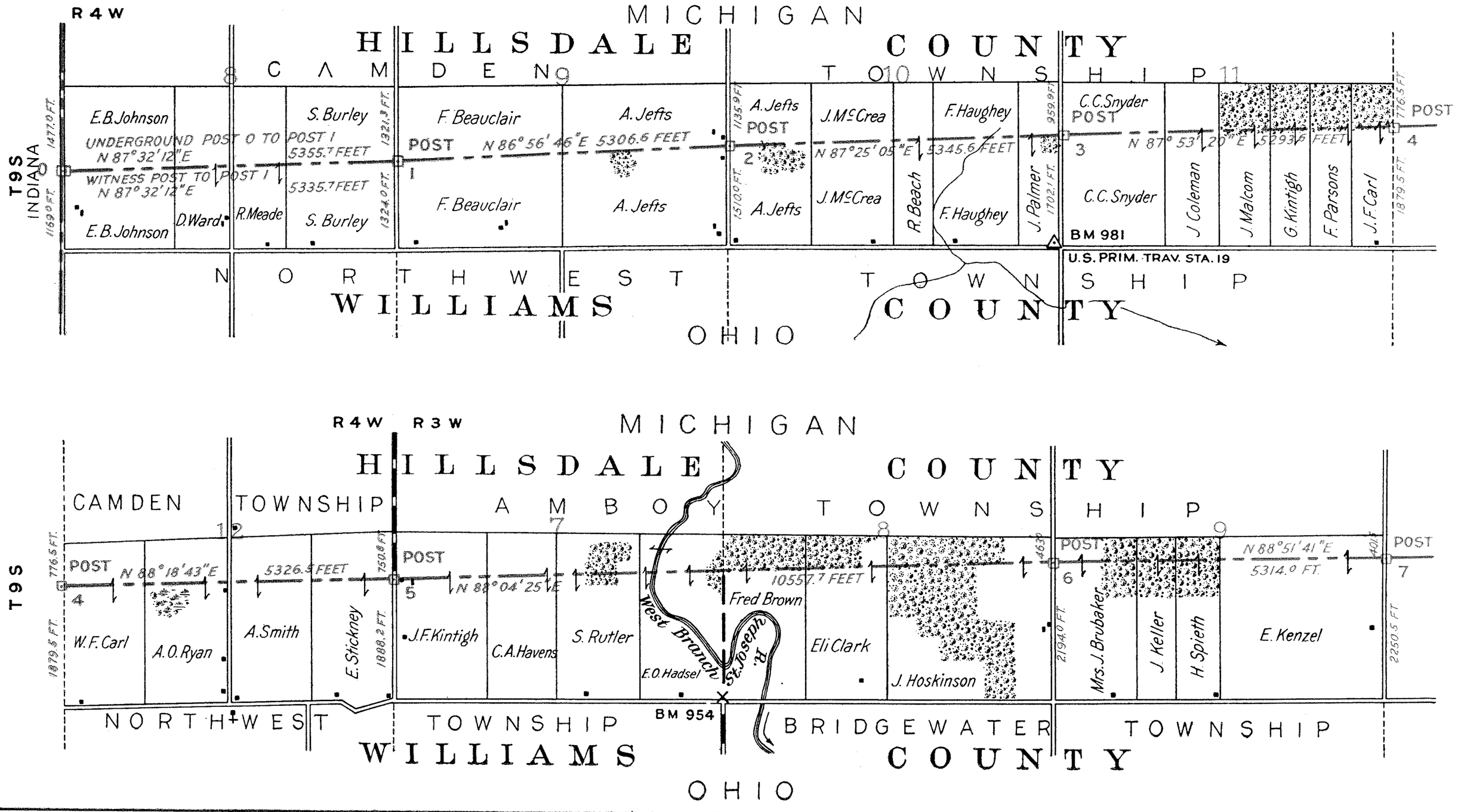
SPECIFICATION FOR WESTERN TERMINAL MONUMENT

Map No. 1

R.C. Allen, State Geologist
Michigan Geological Survey

OHIO-MICHIGAN BOUNDARY RETRACEMENT

C. E. Sherman, Inspector
Ohio Topographic Survey



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Columbus, O.-1916.

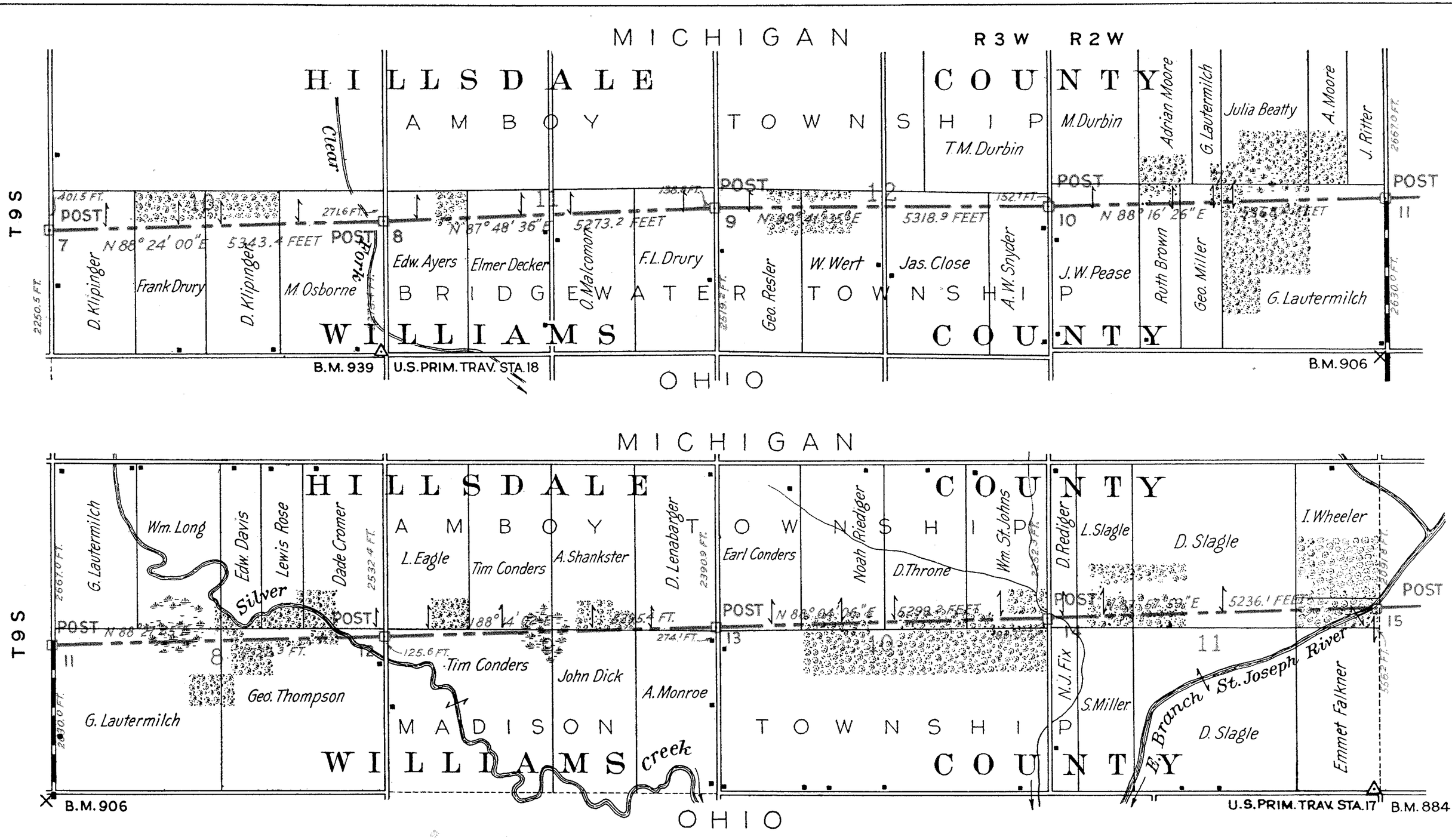
Surveyed in 1915 by S.S. Gannett, Geographer
U.S. Geological Survey

Map No. 2

R.C. Allen, State Geologist
Michigan Geological Survey

OHIO-MICHIGAN BOUNDARY RETRACEMENT

C.E. Sherman, Inspector
Ohio Topographic Survey



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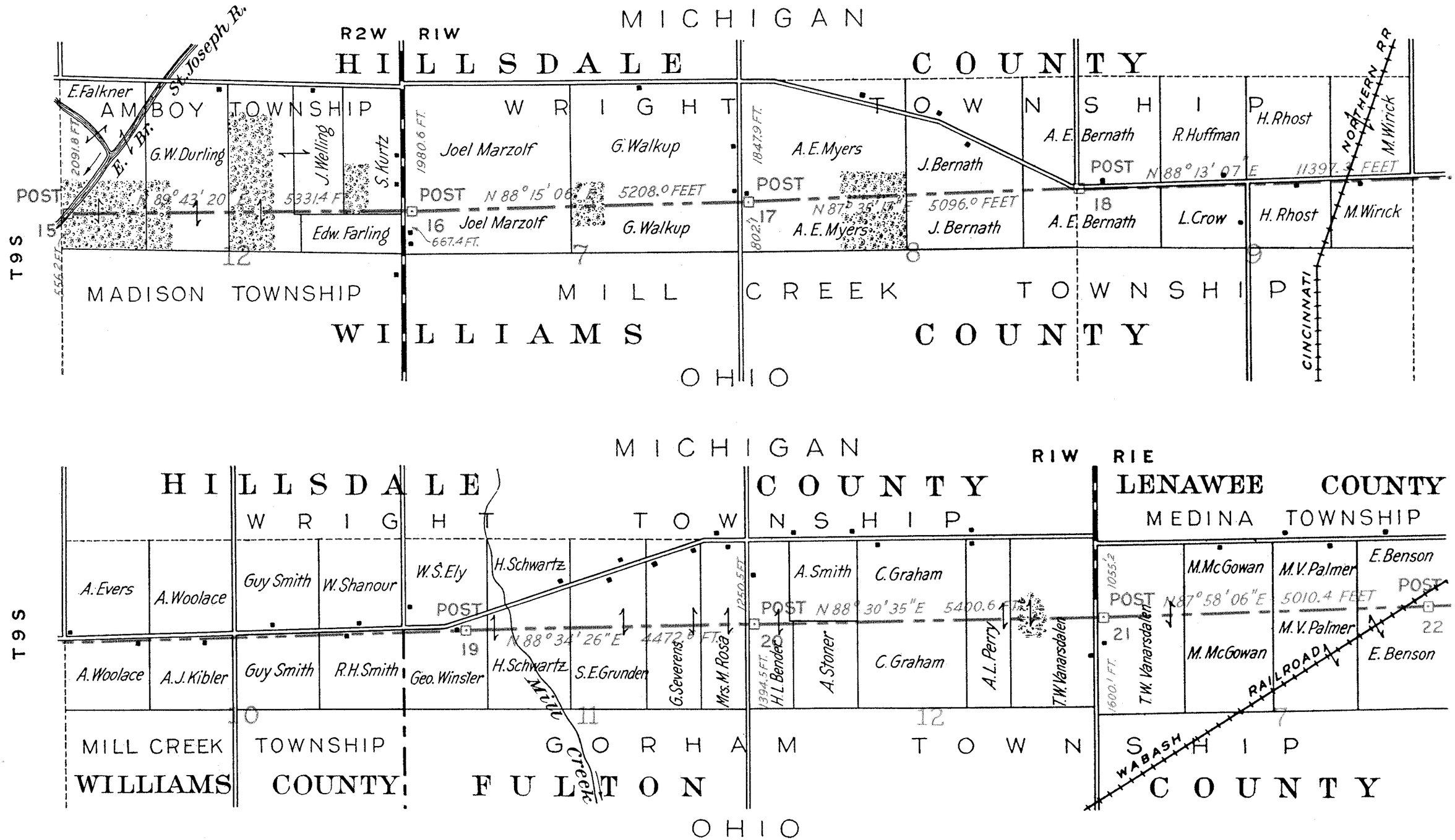
Map No. 3

R.C. Allen, State Geologist
Michigan Geological Survey

OHIO-MICHIGAN BOUNDARY RETRACEMENT

C.E. Sherman, Inspector
Ohio Topographic Survey



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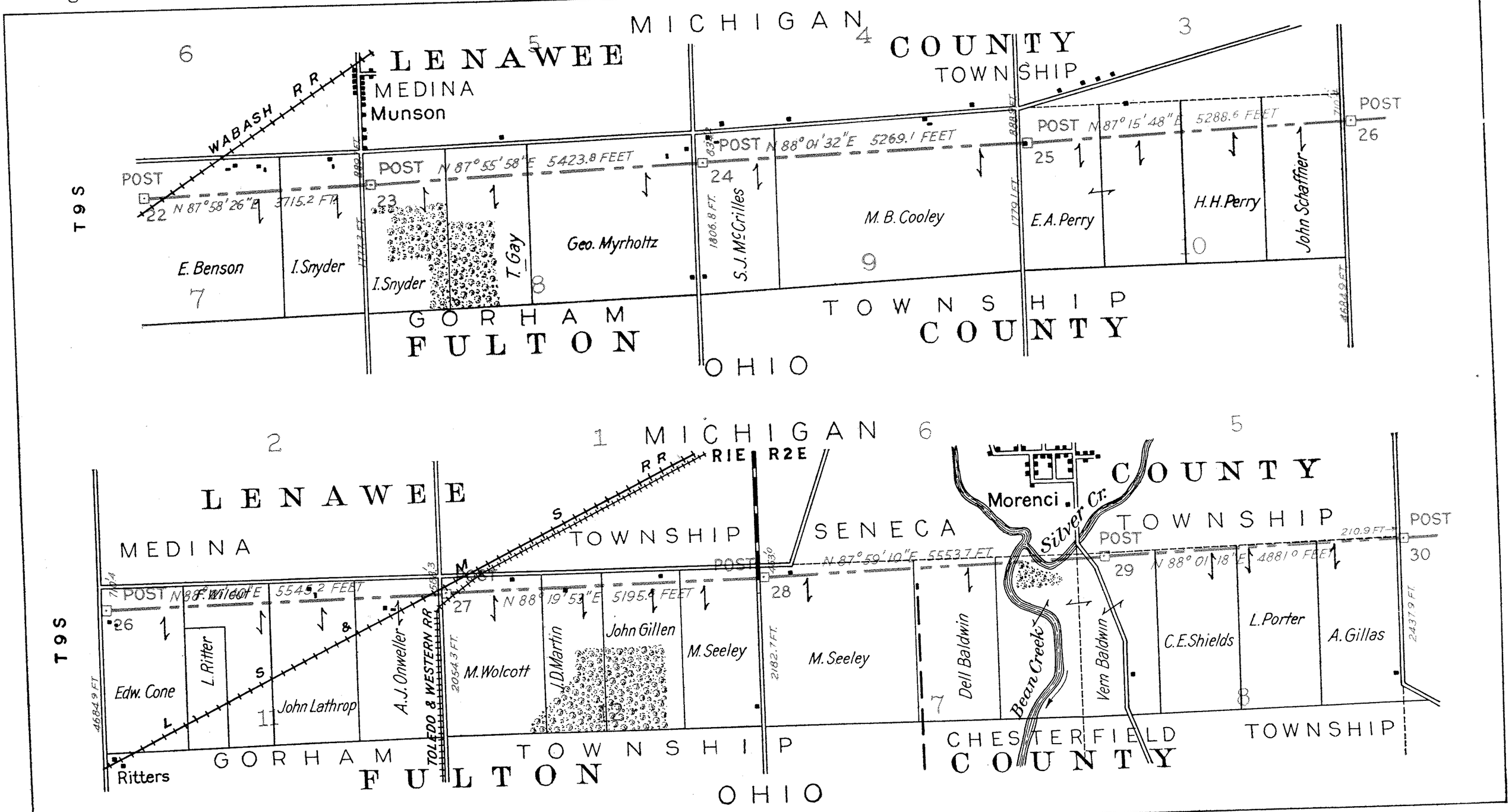
Map No. 4

R.C Allen, State Geologist
Michigan Geological Survey

OHIO-MICHIGAN BOUNDARY RETRACEMENT

C.E.Sherman, Inspector
Ohio Topographic Survey



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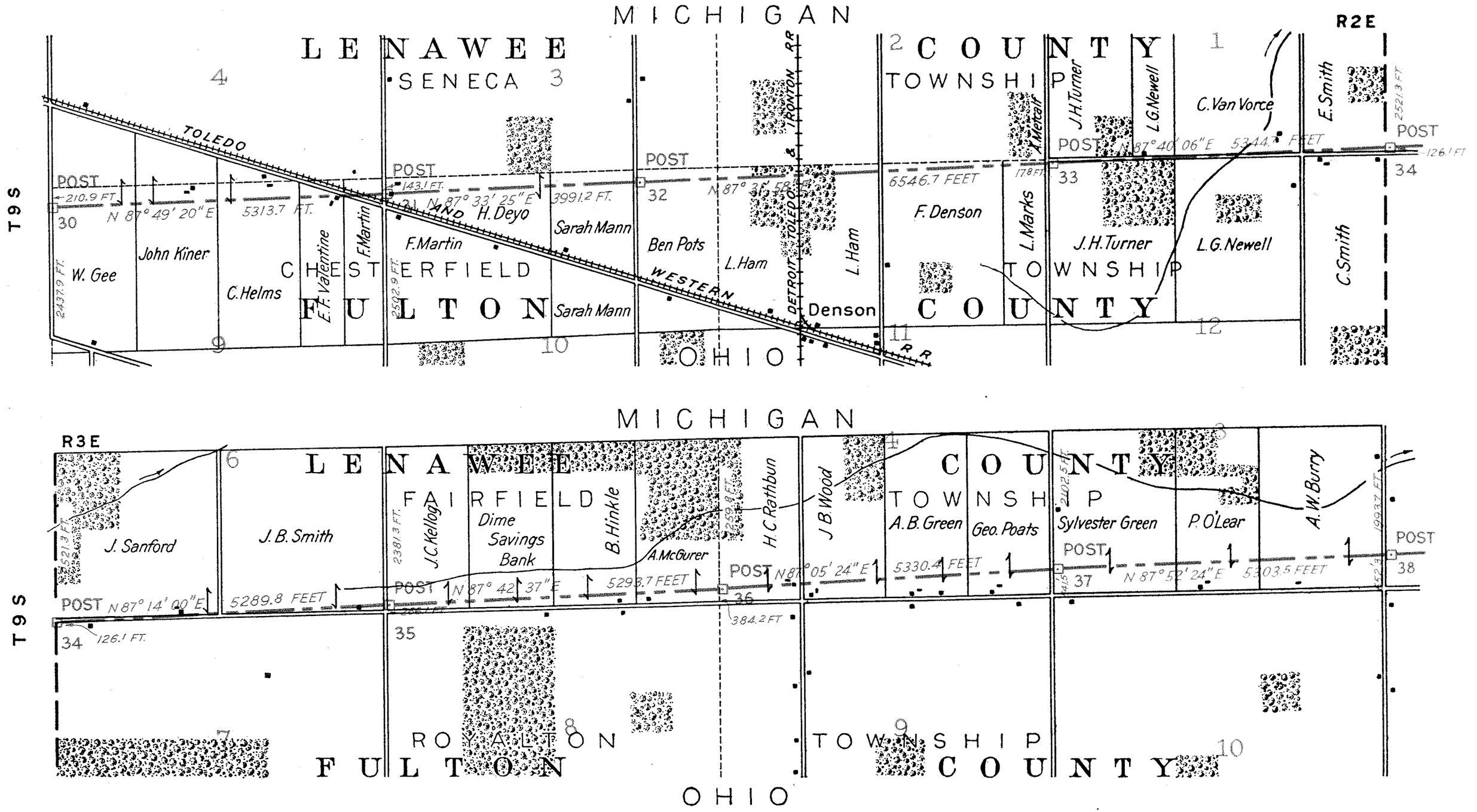
Map No. 5

R.C. Allen, State Geologist
Michigan Geological Survey

OHIO-MICHIGAN BOUNDARY RETRACEMENT

C.E. Sherman, Inspector
Ohio Topographic Survey



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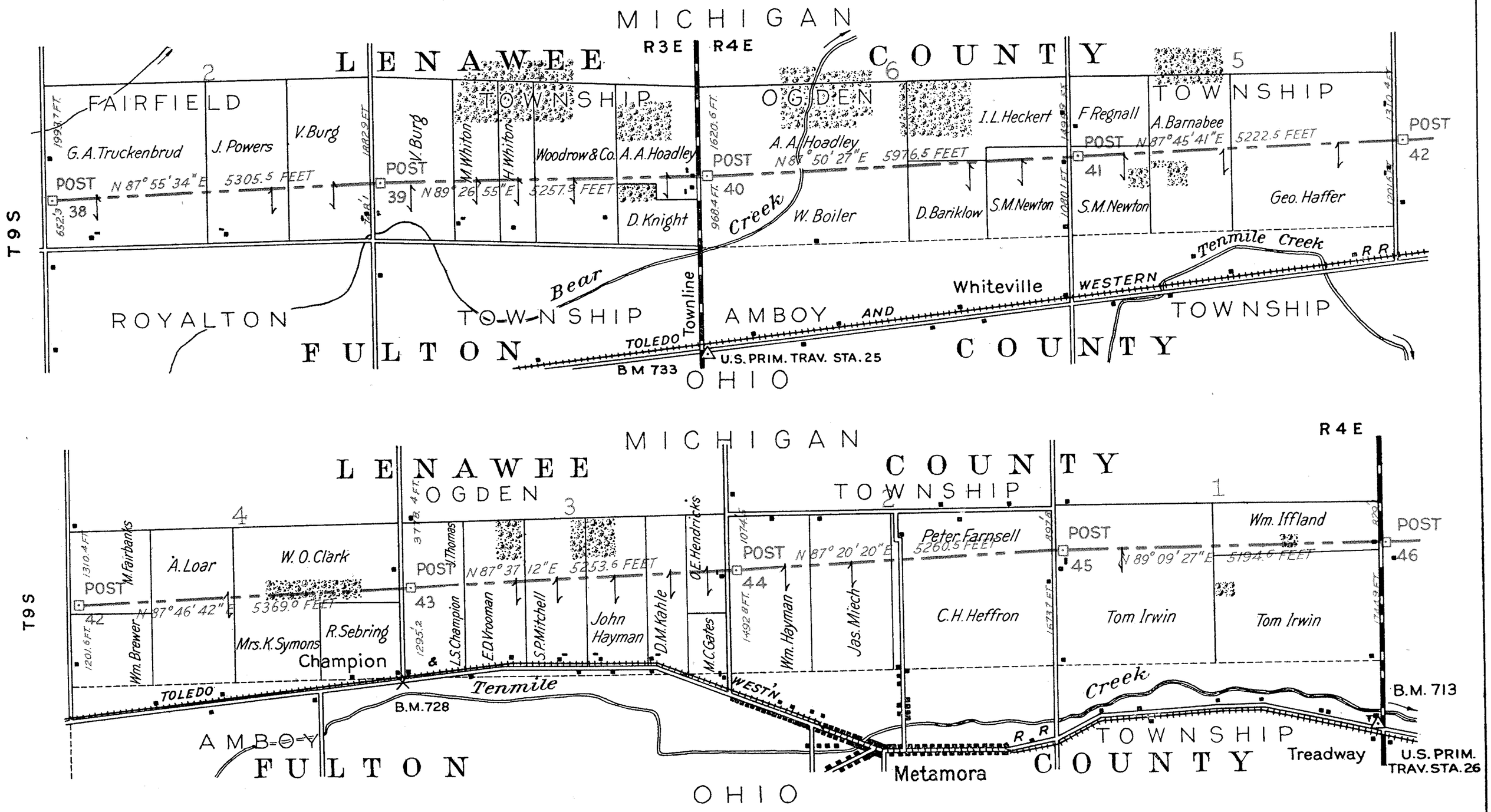
Map No. 6

R.C. Allen, State Geologist
Michigan Geological Survey

OHIO-MICHIGAN BOUNDARY RETRACEMENT

C.E. Sherman, Inspector
Ohio Topographic Survey



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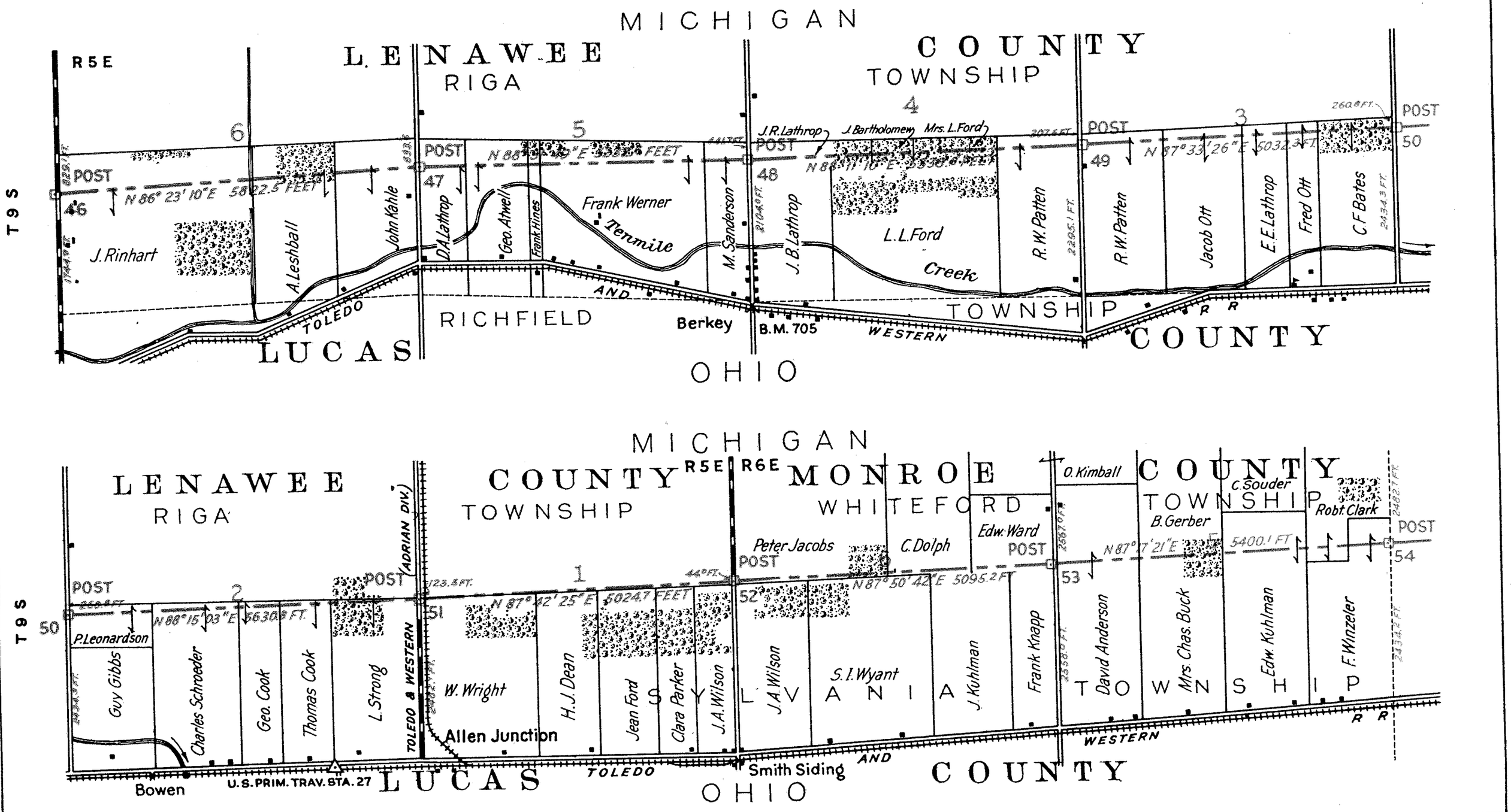
R.C. Allen, State Geologist
Michigan Geological Survey

OHIO-MICHIGAN BOUNDARY RETRACEMENT

C.E. Sherman, Inspector
Ohio Topographic Survey



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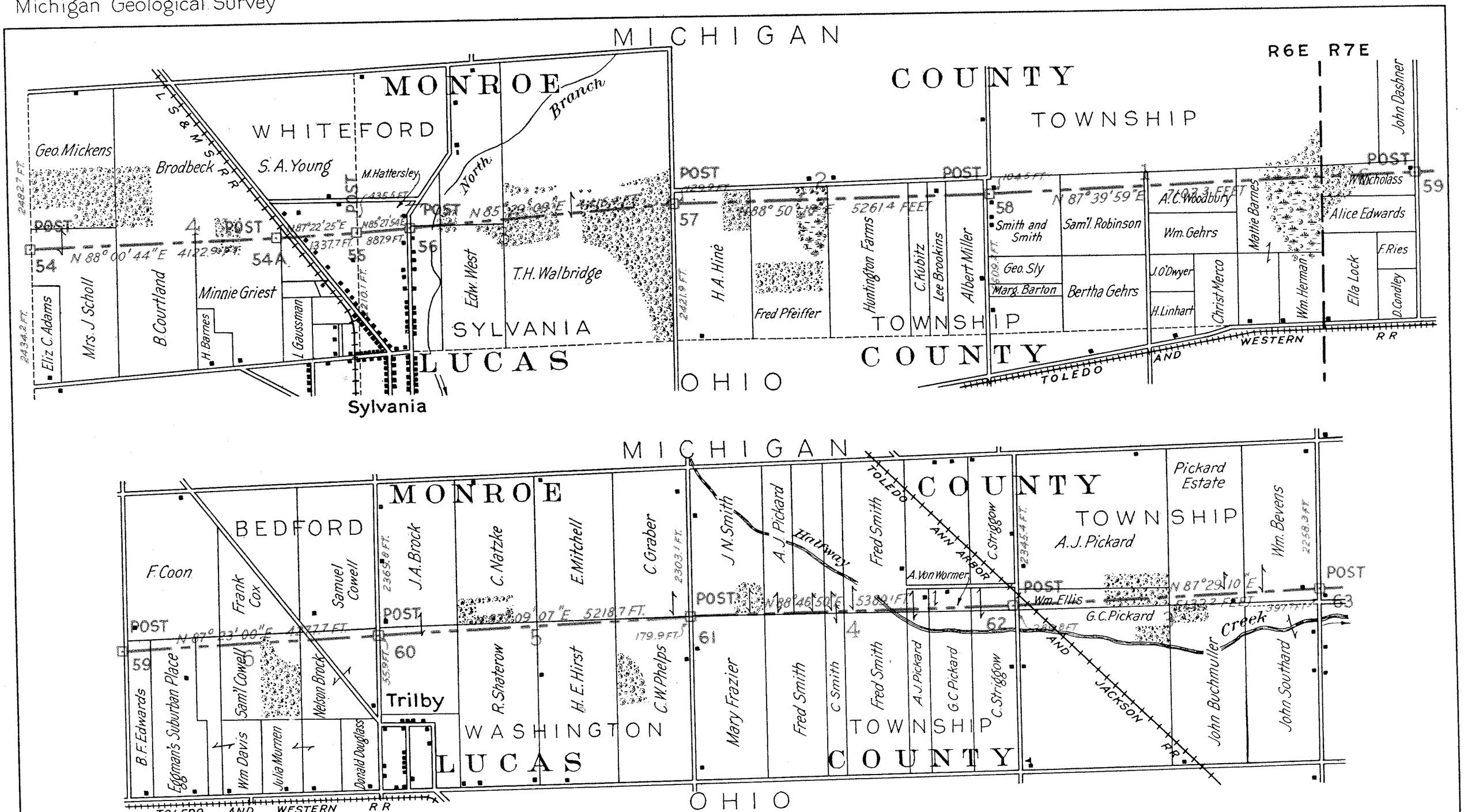
Michigan Geological Survey

OHIO-MICHIGAN BOUNDARY RETRACEMENT

C.E. Sherman, Inspector
Ohio Topographic Survey



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Columbus, O.-1916.

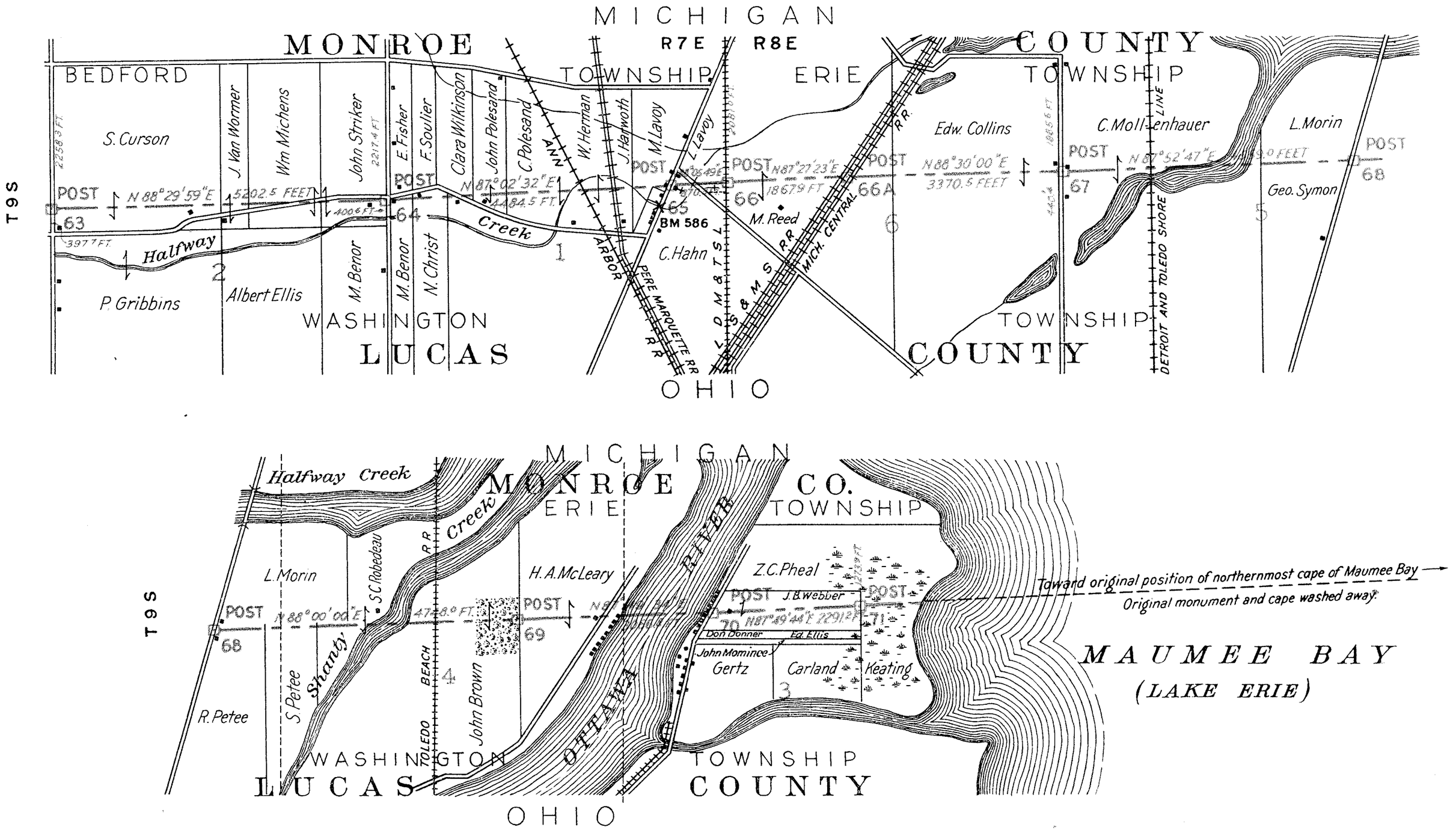
Surveyed in 1915 by S.S. Gannett, Geographer
U.S. Geological Survey

Map No. 9

R.C. Allen, State Geologist
Michigan Geological Survey

OHIO-MICHIGAN BOUNDARY RETRACEMENT

C.E. Sherman, Inspector
Ohio Topographic Survey



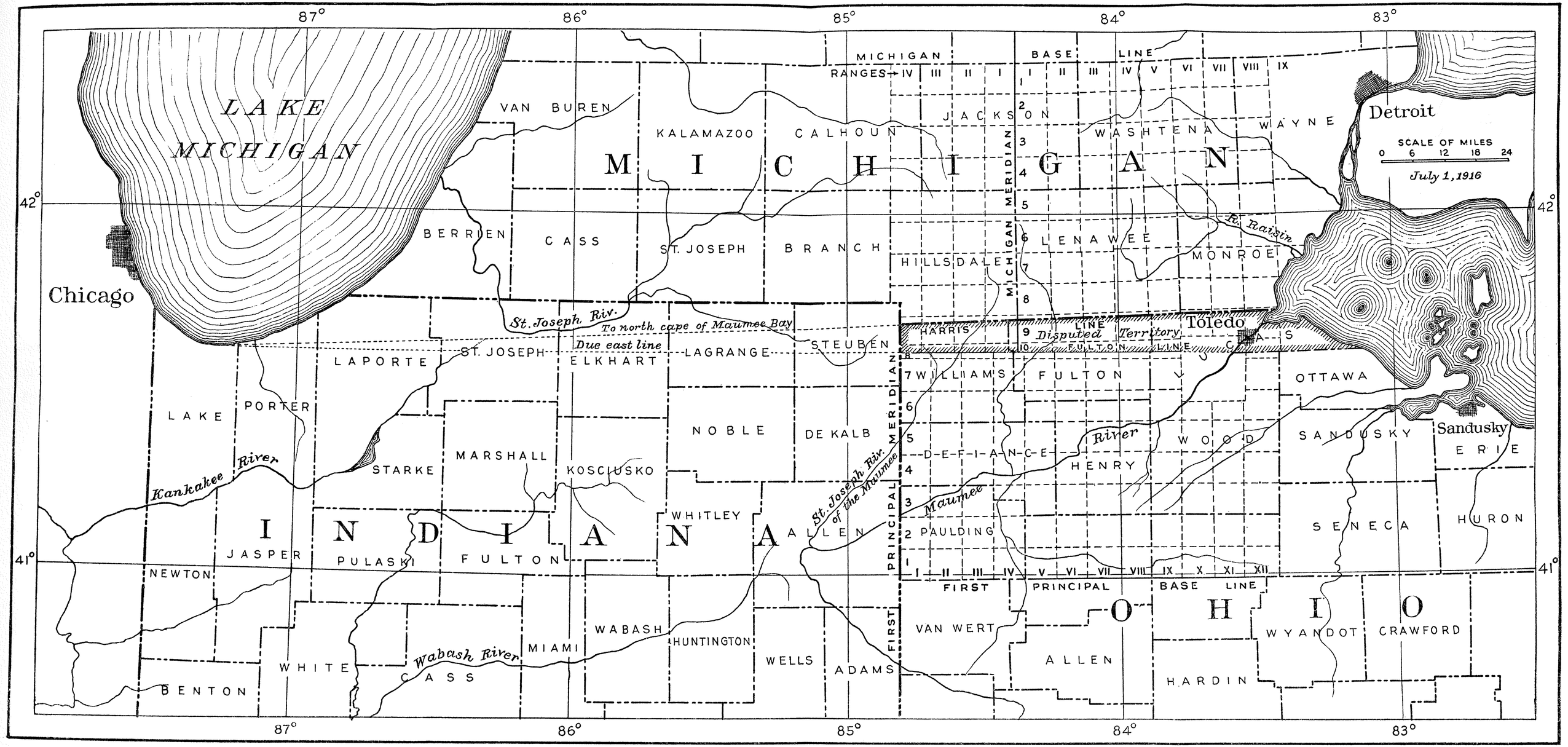
Drawn by W. D. Turnbull, C.E.
Columbus, O.-1916.

Surveyed in 1915 by S.S. Gannett, Geographer
U.S. Geological Survey

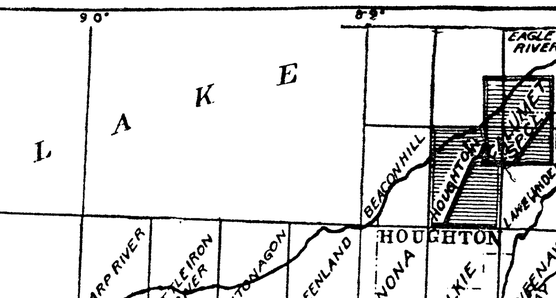
R.C. Allen, State Geologist
Michigan Geological Survey

OHIO-MICHIGAN BOUNDARY RETRACEMENT

C.E. Sherman, Inspector
Ohio Topographic Survey



MAP SHOWING DISPUTED AREA AND ACTUAL RELATIVE POSITIONS OF LAKES ERIE AND MICHIGAN. (COMPARE WITH MITCHELL'S AND HUTCHINS' MAPS)



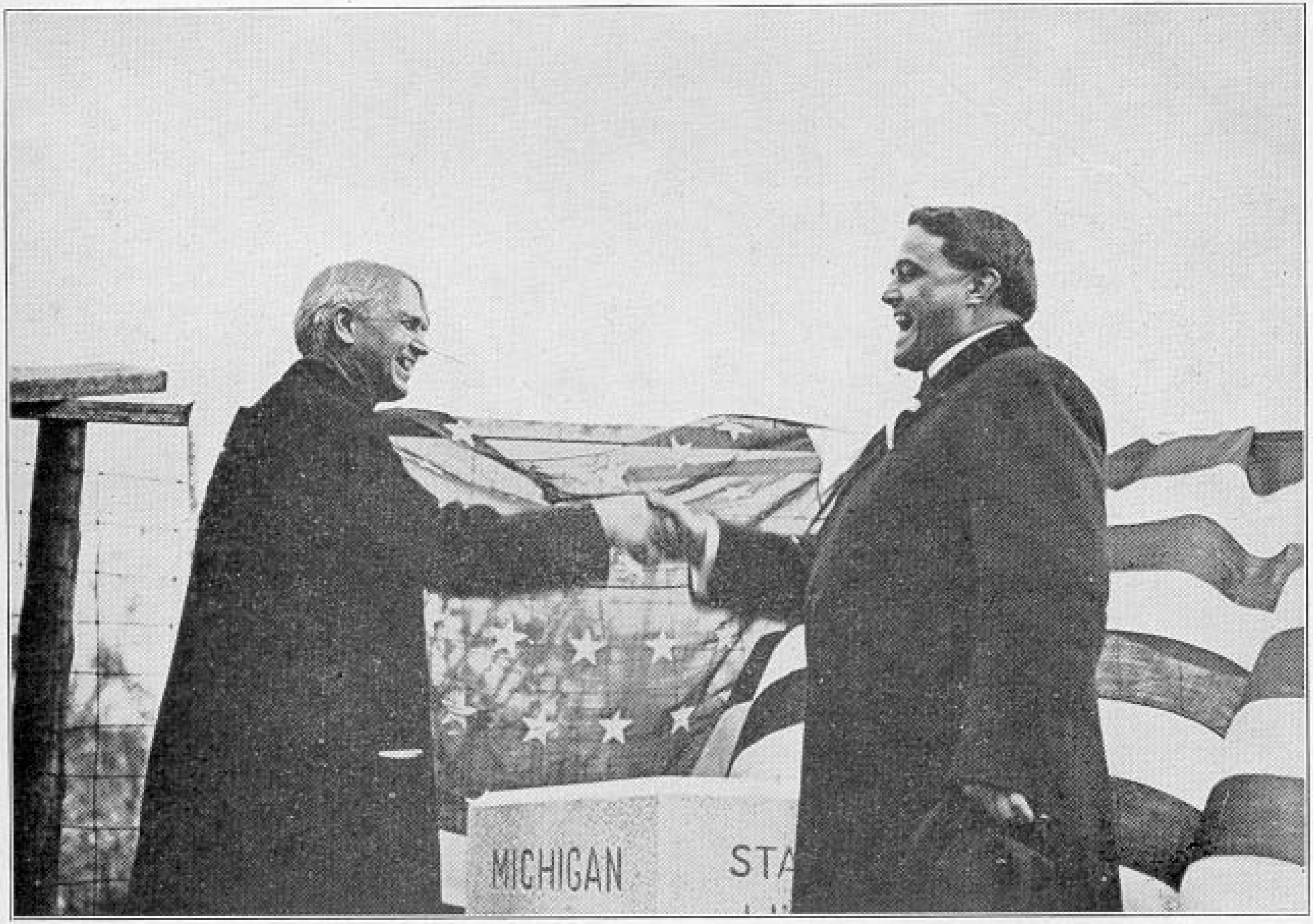
TOPOGRAPHIC SURVEY OF MICHIGAN PROGRESS MAP, 1916.

SCALE MILES

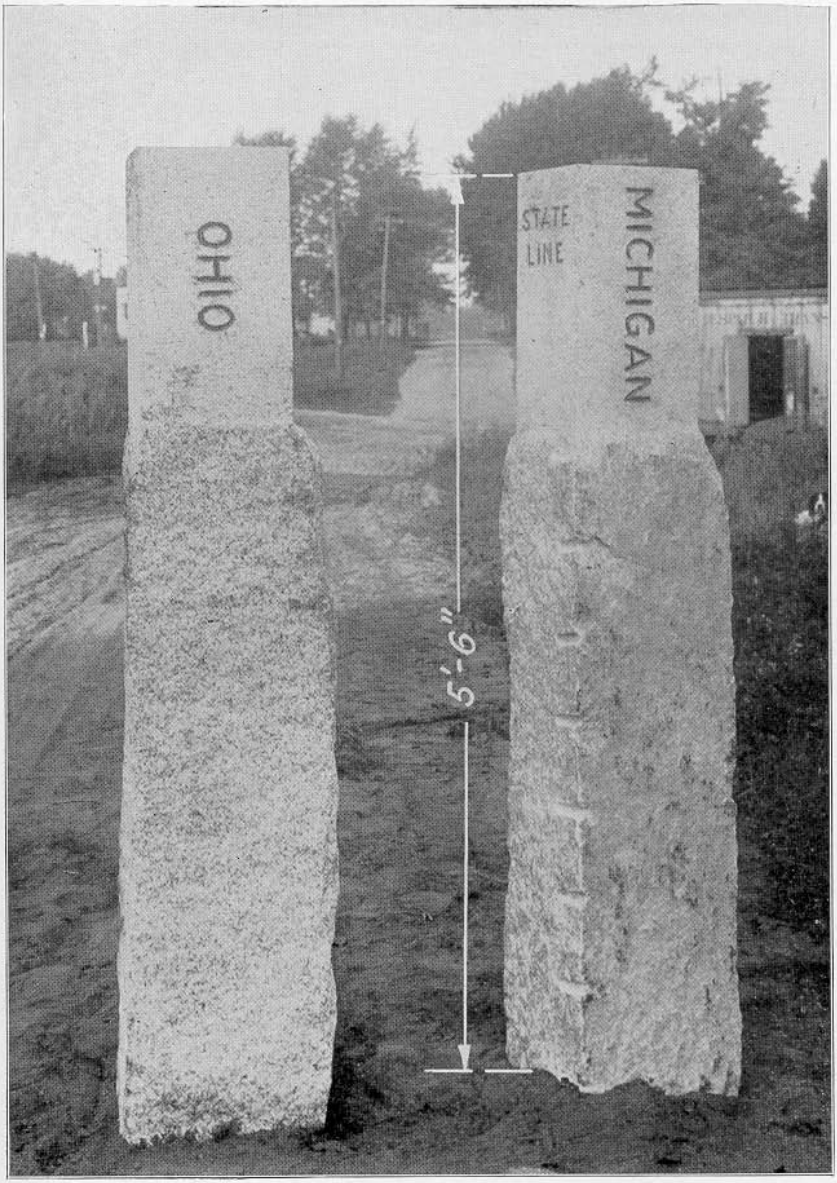
QUADRANGLES IN WHICH SURVEY IS IN PROGRESS

QUADRANGLES IN WHICH SURVEY IS COMPLETED

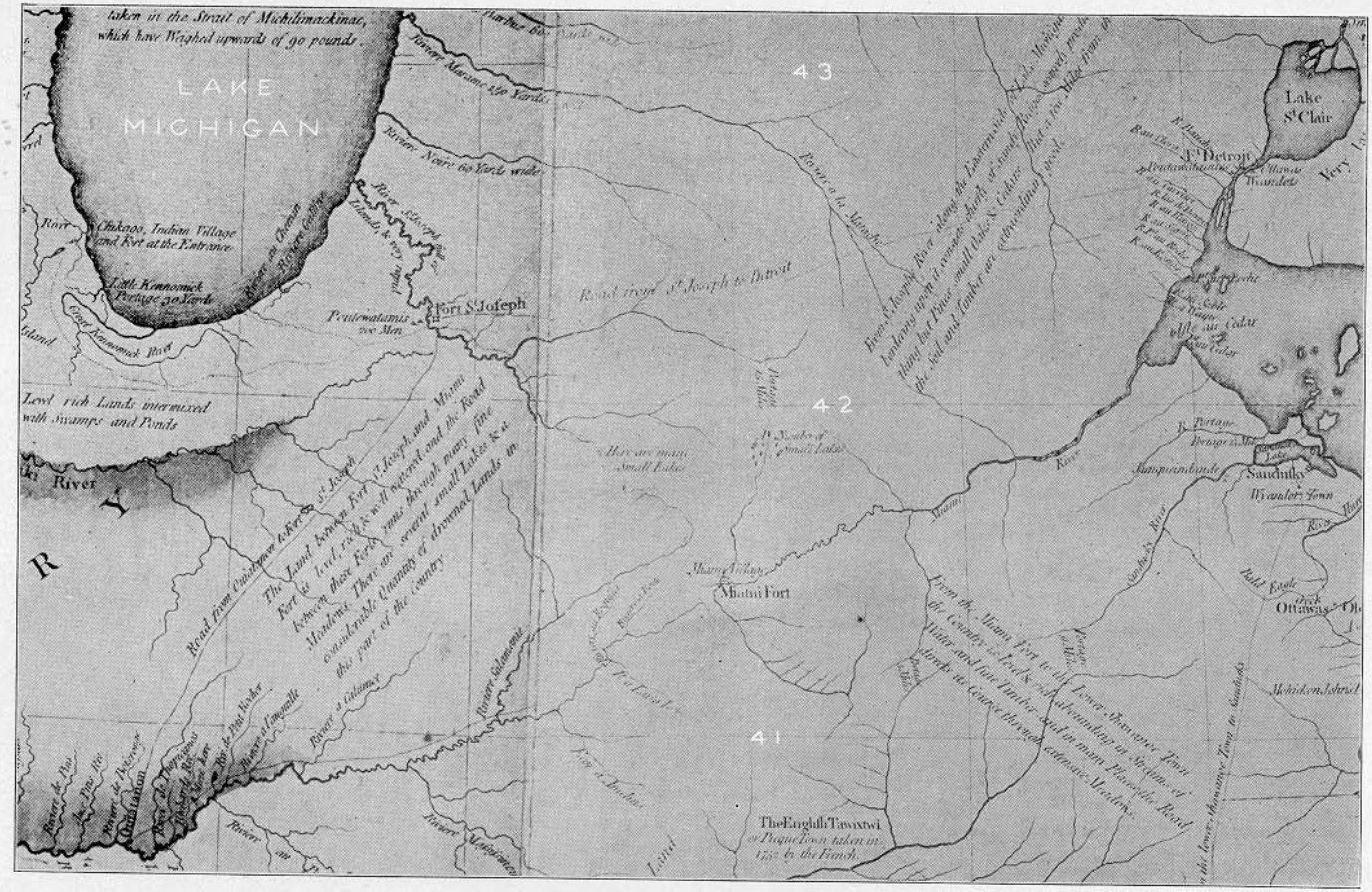
QUADRANGLES REMAINING TO BE SURVEYED



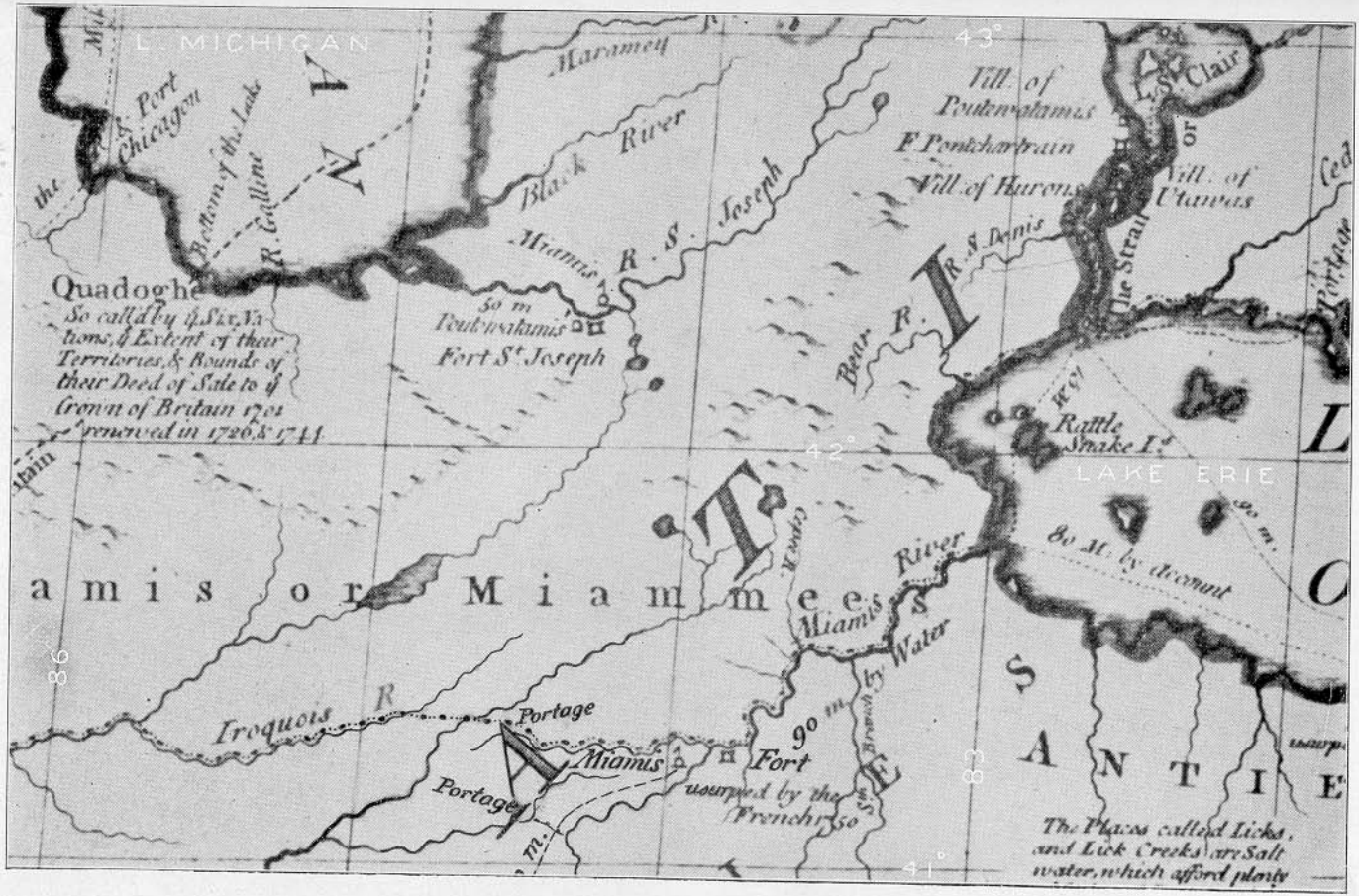
Governor Ferris Nov. 24, 1915 Governor Willis



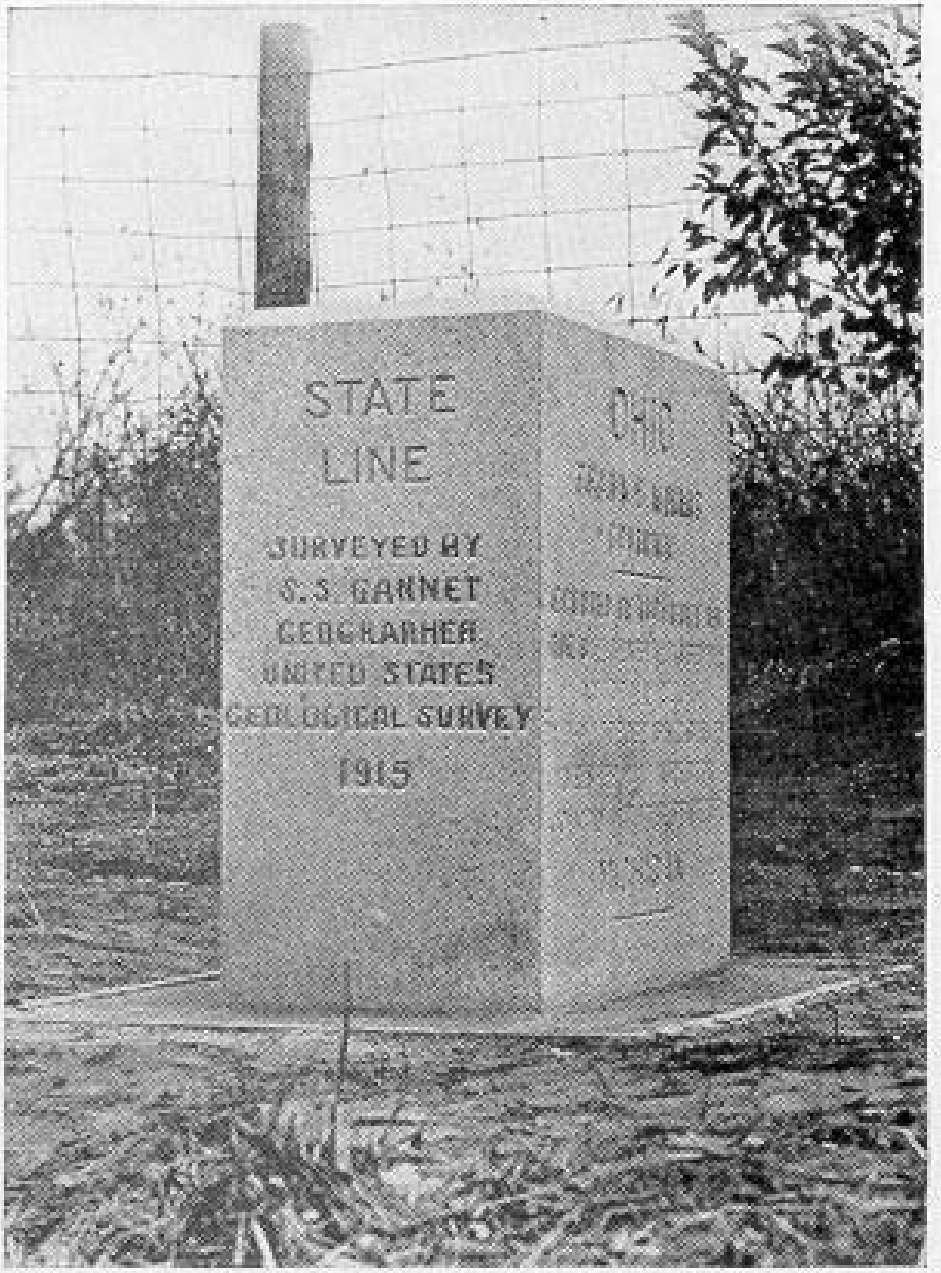
Intermediate Monuments



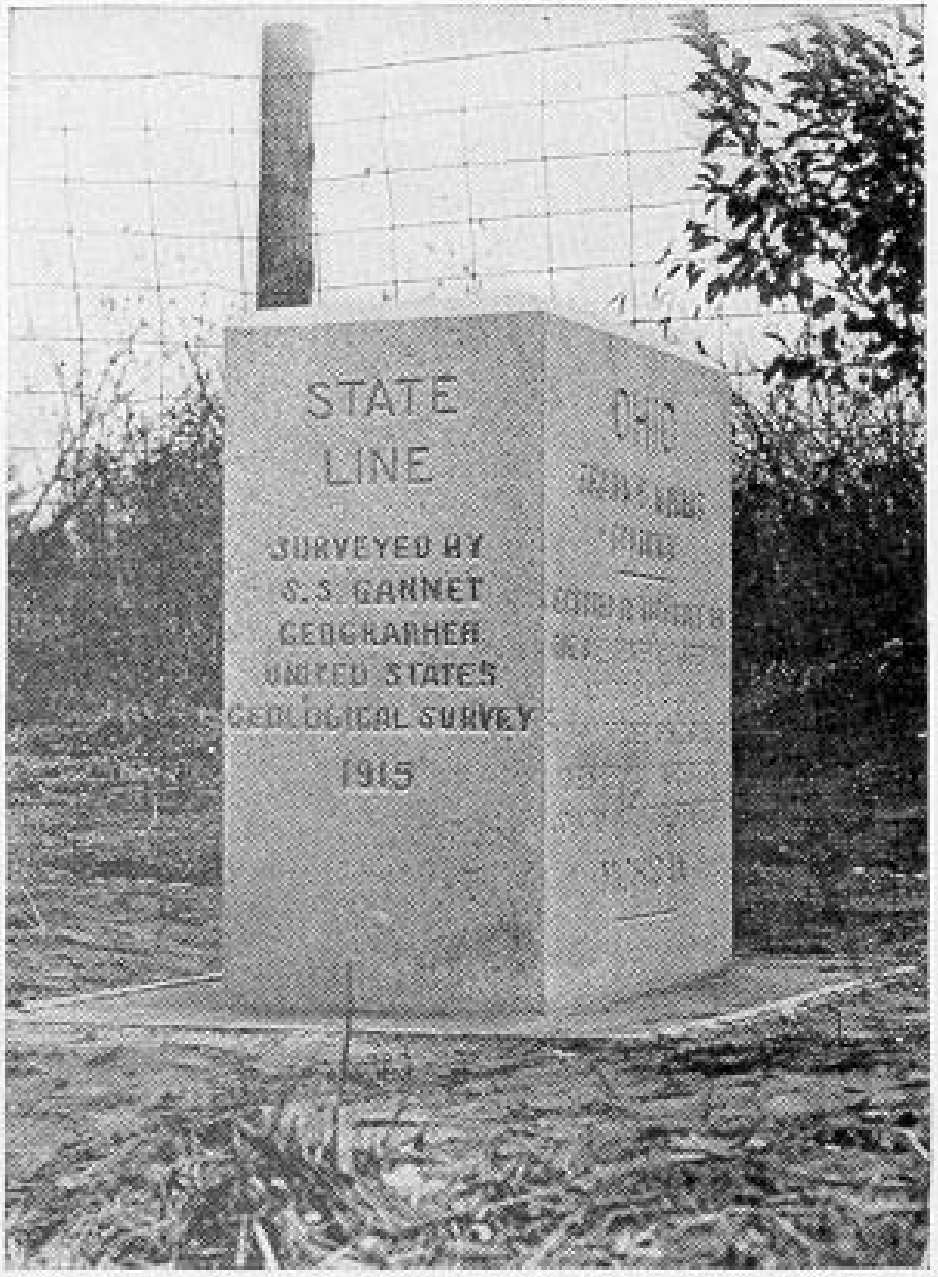
Photograph of a portion of Hutchins' Map, 1778.



Photograph of a portion of Mitchell's Map, 1755.



Views of Post 70 near Eastern Terminus



Views of Post 70 near Eastern Terminus

EXPENDITURES OF THE BOARD OF GEOLOGICAL SURVEY.

1914-1915 and 1915-1916. (Fiscal years ending June 30th.)

Work.	Total.	Salary.	Subsistence.	Travel.	Assistance.	Property.	Office.	
							Permanent	Incidental.
Topographic survey, 1914-1915 and 1915-1916	$13,960 86	$6,565 89	$4,642 09	$2,555 24	.....	.....	$85 47	$112 17
Appraisal of mines, 1914-1915 and 1915-1916	11,192 62	9,678 56	497 33	402 79	.....	.....	317 71	296 23
General and miscellaneous office and correspondence work, etc., 1914-1915 and 1915-1916	9,268 50	8,322 78	25 68	78 78	$17 00	$120 86	370 26	333 14
Michigan-Ohio Boundary line re-survey, 1915-1916	4,006 31	2,262 53	622 24	416 88	24 50	635 98	.....	44 18
Biological Survey, 1914-1915 and 1915-1916	2,805 87	2,696 38	1 75	16 34	12 25	.....	.....	79 15
Geological Survey of west end of the Marquette range, 1915-1916	2,458 44	1,606 86	263 30	332 43	48 40	40 80	4 00	162 65
Geological Survey of east end of Gogebic range, 1914-1915	2,156 14	1,520 83	282 95	160 89	36 10	13 00	15 50	144 87
Mineral statistics, 1914-1915 and 1915-1916	2,028 20	1,742 19	3 65	9 00	5 16	.....	13 22	254 98
Study of limestones, 1914-1915 and 1915-1916	1,610 48	1,220 17	66 60	66 50	104 70	3 10	3 53	145 88
Geological survey of Silver Mountain, 1915-1916	923 12	576 25	172 06	148 78	.....	.....	.....	26 03
Geological study of the Devonian formations, 1914-1915 and 1915-1916	636 66	539 00	.....	.....	.....	.....	.....	97 66
Geological study of the Marshall and Coldwater formations, 1915-1916	431 19	183 25	168 00	38 24	.....	.....	.....	41 70
Physiography of Michigan inland lakes, 1914-1915 and 1915-1916	390 51	189 68	.....	165 55	.....	.....	.....	35 28
Geological survey of Mackinac Island, 1915-1916	251 95	150 00	29 97	56 83	.....	.....	.....	15 15
Gage reading on Escanaba river, 1914-1915 and 1915-1916	72 90	72 90	.....	.....	.....	.....	.....	.....
Total	$52,211 75	$37,327 27	$6,775 62	$4,448 25	$248 11	$813 74	$809 69	$1,789 07
July 1, 1916:								
Unexpended balance, general appropriation	167 71							
Unexpended balance, special appropriation	847 40							
Unexpended balance, Michigan-Ohio appropriation	4 22							
Unexpended balance, topographic survey appropriation	4,979 53							
Total	$58,210 61							

CLASSIFIED LIST OF EXPENDITURES OF THE BOARD OF GEOLOGICAL SURVEY FOR THE FISCAL YEARS 1914-1915 AND 1915-1916.

Number of voucher.	Name.	Classification.	Total.	Salary.	Subsistance.	Travel.	Assistance.	Property.	Office.	
									Permanent.	Incidental.
16, 46, 65, 80, 98, 135, 150, 49, 117.	Adams Express Co.	Transportation Co.	$68 22							$68 22
77	Adder Machine Co.	Supply house	1 00							1 00
459, 490, 505, 528, 550	Allen, H. J.	Rodman	403 56	$172 56	$231 00					
1, 5, 17, 19, 31, 28, 36, 40, 51, 67, 82, 106, 59, 117, 136, 152, 153, 64, 170, 67, 2, 10, 22, 28, 37, 12, 35, 50, 62, 14, 63, 78, 84, 47, 97, 104, 50, 111, 54, 55, 16, 56, 59, 156	Allen, R. C.	Director, State Geologist and Appraiser of Mines	7,911 76	6,957 90	341 97	$600 89			$11 00	
12, 66, 92, 116 130, 182, 56, 88, 121, 148	Allen Printing Co.	Supply house	41 42						18 47	22 95
16, 18, 50	Alverson, Miles C.	Rodman	73 11	70 00		3 11				
18, 25, 45, 102, 114, 169, 185, 190, 36, 59, 72, 102, 130, 141, 153	American Express Co.	Transportation Co.	76 37							
14	Andrews, A. W.	Naturalist	75 00	75 00						76 37
85	Arbaugh Co., F. N.	Supply house	3 70					$3 70		
40, 49, 95, 126, 17, 61, 127, 128, 149, 152	Auditors, State Board of	Supply house	66 62						1 09	65 53
521	Baker, C. E.	Liveryman	12 00			12 00				
518	Baker, John S.	Liveryman	15 00			15 00				
10	Baldwin, Dell	Teamster	25 50				$24 50	1 00		
8, 15, 16, 18, 22, 37, 39, 54, 57, 85, 110, 120, 139, 156, 172, 2, 6, 13, 16, 21, 24, 31, 32, 38, 41, 44, 82, 99, 114, 132, 56, 64, 70	Barrett, L. P.	Assistant Geologist	2,664 67	2,210 00	217 58	233 09		4 00		
485	Bartow and Enright	Liverymen	43 00			43 00				
461, 489, 508, 530	Bateson, Geo. R.	Rodman	218 94	101 94	117 00					
39, 73, 125, 179, 30, 68	Beauchamp, Regis	Gage reader	72 90	72 90						
402	Bemis, E. L.	Topographic Aid	64 03	29 03	35 00					
467	Benham, Clyde	Liveryman	36 00			36 00				
9, 15, 25	Bergeron, John	Liveryman	84 50				84 50			

430, 434, 462, 468, 492, 507, 519, 522, 525, 531, 537, 562, 563, 565, 566	Bibbee, E. C.	Topographic Aid	933 22	461 94	398 94	73 03			
50, 57	Bludeau, Geo. G.	Bookbinder	114 57					114 57	
22	Bottner, L.	Map agent	1 68						1 68
28, 133	Bovee, F. N.	Photographer	5 75						5 75
68	Brennan, P.	Provision house	83 01		83 01				
2, 8, 13, 21, 27	Brown, Floyd B.	Compassman	128 62	94 67	8 30	25 65			
531, 551	Bunge, Wm. H.	Rodman	65 17	30 67	34 50				
362	Burney, Alfred E.	Topographic Aid	46 69	24 19	22 50				
327, 332, 359, 357, 362, 363, 368	Burney, H. E.	Junior Topographer	307 45	170 20	115 20	22 05			
429, 459, 490, 505, 528, 550	Burrell, F. E.	Rodman	424 84	181 59	243 25				
3, 6	Campbell, C. Alfred	Chainman	191 50	100 00	91 50				
42, 109	Carlton Supply Co.	Supply house	32 58					29 70	2 88
488, 515, 568	Chamberlin, Geo. L.	Liveryman	166 50			166 50			
47, 96, 86, 90	Chicago Press, University	Publishers	24 25					8 00	16 25
6, 189	Chilson, McKinley & Co.	Publishers	10 00					10 00	
	Christie, Wm. J.	Rodman	85 00	40 00	45 00				
7, 10, 6, 41, 90, 143, 70, 105, 145	Citizens Telephone Co.	Telephone Co	87 45						87 45
21, 63, 105, 75	Clear-Bauer Co.	Cartage Co	23 87						23 87
60, 127	Com. Env. & Box Co.	Supply house	16 82						16 82
142	Commercial Service Co.	Supply house	2 70						2 70
460, 491, 506, 529, 552	Coy, Richard S.	Rodman	350 42	162 92	187 50				
100	Crowell Co., Thos. T.	Publishers	1 65					1 65	
432, 461, 466, 487, 513, 538	Culbert, C. M.	Liveryman	290 75			290 75			
327, 357, 362, 368	Davis, C. M.	Rodman	162 52	110 02	52 50				
119	Demaray, D. E.	Binder	13 00					13 00	
20	Detroit Coin Wrapper Co.	Supply house	1 50						1 50
106	Diamond Drill	Publishers	8 00						8 00
4, 8	Dietz, C. A.	Liveryman	262 50			262 50			
27, 47, 51, 58, 59, 77, 91, 129, 147, 181, 187, 19, 74, 136, 60, 76	Dietzgen Co., Eugene	Supply house	163 04				8 12	28 60	126 32
11, 25, 88	Dodge, C. K.	Botanist	400 00	400 00					
61, 74, 103, 113, 128, 145, 80, 73, 85, 122, 146	Dudley Paper Co.	Supply house	77 00						77 00
124	Dunbar, Francis J.	Slide manufacturer	16 61					16 61	
76	Dyer Jenison Barry Co.	Bonding Co	5 00						5 00
132	Economic Geology	Publishers	3 00					3 00	
75, 81, 4, 10, 14, 17, 26, 28, 61	Ehlers, Geo. M.	Paleontologist	365 49	159 25	168 00	38 24			

CLASSIFIED LIST OF EXPENDITURES OF THE BOARD OF GEOLOGICAL SURVEY FOR THE FISCAL YEARS 1914-1915 AND 1915-1916.—*Continued.*

Number of voucher.	Name.	Classification.	Total.	Salary.	Subsistance.	Travel.	Assistance.	Property.	Office.	
									Permanent.	Incidental.
147	Elbe File & Binder Co	Supply house	$6 26						$6 26	
123, 138	Eng. & Mining Journal	Publishers	12 00						12 00	
	Folland, Christopher	Rodman	42 50	$20 00	$22 50					
520, 539	Furst Livery Co	Liveryman	27 00			$27 00				
3, 5, 6, 9, 11, 13, 15	Gannett, Samuel S.	Geographer	1,588 54	1,225 00	216 00	59 85		$87 69		
94	General Land Office	Supplies	6 00							
58	Golden Rule Sup. House	Supply house	5 00					6 00		
72, 38	Grabau, A. W	Paleontologist	450 00	450 00					5 00	
65	Graham, Jane	Copyist	3 75				$3 75			
514	Granger, C. B	Liveryman	70 00			70 00				
29, 18, 32, 75	Gurley, W. & L. E	Instrument dealers	28 31					15 00		$13 31
71, 84	Hagle, Maud	Copyist	8 50				8 50			
461, 489, 486, 508, 530, 535, 551	Hain, E. L	Assistant topographer	834 23	576 00	226 62	31 61				
430, 462, 492, 507, 525, 531, 562, 563	Hall, M. F	Topographic aid	569 59	259 84	309 75					
1, 17, 28, 36, 53, 54, 55, 56, 57, 58, 60, 61, 62, 63, 66, 68, 12, 20, 30, 37, 42, 45, 46, 48, 49, 51, 52, 64, 72	Hamilton, O. R	Mining engineer	5,421 58	4,800 00	390 81	240 77				
87, 90	Hankinson, T. L	Biologist	200 00	200 00						
402	Harris, George	Rodman	51 69	21 94	29 75					
469, 523	Hawes, E. K	Liveryman	16 50			16 50				
43	Heikkinen and Cayanus	Provision house	13 28		13 28					
328, 334	Hicks, Wm. R	Rodman	51 61	51 61						
465	Hinkley Brothers	Liverymen	47 50			47 50				
165	Hobbs, W. H	Member Bd. of Advisers	2 58			2 58				
	Hodges, Guy	Rodman	42 50	20 00	22 50					
56, 72, 87, 122, 176, 26, 67, 116, 69	Hopper, W. E	Geologist	525 06	500 00	3 25	11 65	10 16			
79	Hotchkiss, W. O	Geologist	6 00					6 00		

7, 40, 76	Hubbard, Bela	Geologist	99 43		11 25	88 18			
66, 81	Hyde, Jos	Compassman	29 88	26 67	50	2 71			
524	Hyman, Charles	Liveryman	6 00			6 00			
7, 97, 115, 131, 151, 167, 186, 129, 63, 154	Ihling Bros. Everard Co	Supply house	36 95						36 95
144	Imes, Lewis	Photographer	9 00						9 00
86	Iron River-Stambaugh Rep.	Publishers	1 50						1 50
78, 91	Iron Trade Review	Publishers	8 00					8 00	
3, 6	Jackson, R. B	Rodman	153 50	80 00	73 50				
402	Johnson, A. B	Rodman	60 81	25 81	35 00				
429, 433, 459, 484, 509, 512, 532, 553, 569, 573	Jones, Oscar	Topographic engineer	877 38	283 98	174 75	418 65			
429, 459, 490, 505, 528, 550	Jones, S. G	Rodman	431 05	184 30	246 75				
402	Kavanagh, A. J	Junior topographer	84 06	50 81	33 25				
43	Kelly Brothers	Supply store	29 70		29 70				
328	Kendrick, Geo. F	Rodman	31 94	31 94					
5, 22, 23	Kenton Store Co	Provision house	194 47	194 47					
429, 459, 490, 505, 528, 550	Krise, Wm. Earl	Rodman	412 68	176 43	236 25				
46	Kurtz, Langbein & Swartz	Supply house	3 33					3 33	
361, 365, 366, 370	Lamb, W. E	Liveryman	141 50			141 50			
	Lau, Louis	Rodman	42 50	20 00	22 50				
460, 491, 506, 529, 552	Laughlin, Howard S	Rodman	360 08	168 08	192 00				
327, 329, 358, 357, 362, 367, 369, 389, 390, 391, 400	Lee. L. L	Assistant topographer	1,355 04	757 98	344 93	252 13			
3, 6	Linton, L. L	Recorder	241 50	150 00	91 50				
7	Lloyd Brothers	Monument Mfgs	450 00				450 00		
107	Longstreet Lbr. Co	Lumber dealers	3 60					3 60	
21	McDonald, R	Exploration manager	68 51		68 51				
11, 32, 46, 44	McGraw-Hill Book Co	Publishers	33 85					33 85	
16, 18, 42, 44, 48, 78, 2, 11, 13, 21, 34, 66, 74	McKone, Don T	Rodman	432 11	346 67	19 70	65 74			
6, 26, 34, 178, 188, 15, 16, 29, 35, 43, 93, 139, 62	Michigan Drug Co	Supply house	127 46				91 64	35 82	
49, 83, 80	Mich. Engineering Society	Publishers	15 00						15 00
89	Mich. Press Clipping Bu'au	News bureau	4 00					4 00	
8, 33, 43, 93, 148, 162, 183, 21, 34, 47, 60, 95, 120, 137	Mich. State Tel. Co	Telephone Co	73 21						73 21
108	Michigan, University of	Educational institution	104 70			104 70			
30, 110	Mining Journal	Publishers	4 00						4 00
8, 149	Mining World	Publishers	6 00						6 00
65	Monroe Sales Co	Supply house	250 00					250 00	

CLASSIFIED LIST OF EXPENDITURES OF THE BOARD OF GEOLOGICAL SURVEY FOR THE FISCAL YEARS 1914-1915 AND 1915-1916.—*Continued.*

Number of voucher.	Name.	Classification.	Total.	Salary.	Subsistance.	Travel.	Assistance.	Property.	Office.	
									Permanent.	Incidental.
501	Muck, E. G.	Provision house	$51 29		$51 29					
460, 470, 491, 506, 517, 529, 534, 554	Muldrow, Robert	Topographic engineer	1,074 17	$766 17	211 75	$96 70				
334, 336	Murphy, J. J	Rodman	20 64	20 64						
	Nelson, Alfred	Rodman	42 50	20 00	22 50					
184, 126	Newcombe, F. C	Member Bd. of Advisers	5 21			5 21				
13	Novy, Frank	Naturalist	82 00	82 00						
	Null, II, H. Harrison	Rodman	42 50	20 00	22 50					
27	Nystrom & Co., A. J	Supply house	58 80							
327, 333, 360, 357, 364, 368	Opdyke, Alfred L	Topographic aid	236 40	125 00	110 00	1 40			$58 80	
23	Penton Publishing Co	Publishers	3 50						3 50	
	Phillips, R. H	Rodman	85 00	40 00	45 00					
160	Polk & Co., R. L	Publishers	8 00							
191, 143, 155	Postal Telegraph Co	Telegraph Co	4 41						8 00	
10	Povah, H. W. Alvah	Botanist	182 00	182 00						$4 41
52	Presquele Mining Co	Exploration Co	44 25		44 25					
64, 78	Proudfit Loose Leaf Co	Supply house	13 75							
536, 557	Raymond, B. C	Liveryman	37 50			37 50			13 75	
164	Reighard, J	Member Bd. of Advisers	2 58			2 58				
142, 159, 177, 79, 14	Reuter, Carl H	Agent	75 00							
	Richardson, G. R	Rodman	42 50	20 00	22 50					75 00
5	Richmond, Marian	Office assistant	6 00				$6 00			
4, 2, 15, 24, 37, 55, 71, 86, 111, 121, 140, 157, 175, 13, 25, 41, 53, 66, 83, 101, 115, 134, 56, 64	Richmond, Mrs. K. V	Stenographer	1,780 00	1,780 00						
70	Rogers Leather Gds. Store	Supply house	8 50						8 50	
331, 337	Russell and Masten	Liverymen	106 00			106 00				
9, 24, 163, 3, 19, 150	Ruthven, A. G	Chief naturalist	805 66	800 00	50	5 16				

328, 330, 335, 334, 400	Sadler, C. L.	Topographic engineer	594 03	414 83	162 32	16 88				
4	Sawyer, Mrs. M. M	Office assistant	6 00				6 00			
	Saxon, Wm., Jr	Rodman	42 50	20 00	22 50					
367, 389	Schultz, Wm., Jr	Rodman	123 68	57 68	66 00					
2, 13, 221, 31, 66	Schweitzer, Jos	Cook	270 00	270 00						
2, 3, 29, 32, 33, 34, 66, 73	Scott, I. D.	Geologist	433 85	239 68	2 85	185 07				
	Senseney, H. S.	Topographer	63 75	37 50	26 25					6 25
17	Sherman, C. E.	Inspector	200 00	200 00						
3, 6	Sherman, R. B.	Rodman	134 50	70 00	64 50					
108	Sherzer, W. H.	Member Bd. of Advisers	3 40		35	3 05				
555	Silver, Glen C	Liveryman	108 00			108 00				
42	Smith Bros., L. C	Typewriter Mfgs	9 00							9 00
1, 2, 4, 17, 20, 28, 36, 52, 68, 83, 107, 118, 137, 154, 171, 69, 82, 11, 23, 39, 51, 64, 79, 98, 112, 131, 56, 64	Smith, R. A.	Geologist	3,553 88	3,384 66	72 20	90 40				
3, 6	Sorensen, F. G.	Chainman	112 33	58 33	54 00					3 62
463, 510, 511, 533, 556	Sowersby, J. C.	Liveryman	380 00			380 00				
77	Sparks, M. F.	Tent manufacturer	23 10					23 10		
504, 71	Sponsler, O. L.	Biologist	200 00	200 00						
	Staack, J. G.	Topographic engineer	105 37	79 12	26 25					
39	State treasurer	Insurance fund	53 48							53 48
489, 508, 516, 530	Stone, Harry H	Rodman	168 67	78 67	90 00					
92	Supt. Public Documents	Supplies	3 70						3 70	
73	Taylor, Frank B	Geologist	150 00	150 00						
18	Terry Engraving Co	Engravers	105 99					105 99		
26, 35	Thompson, Crystal	Naturalist	200 00	200 00						
38, 66	Tobin, James	Cook and compassman	110 00	110 00						
99	Toerring Co., C. J.	Supply house	2 35							2 35
89	Tomlinson, W. Harold	Slide manufacturer	11 50					11 50		
89	Transeau, E. N	Biologist	150 00	150 00						
19	Turnbull, W. D.	Draftsman	50 25	50 25						
9, 44, 134, 158, 69, 77	U. S. B. P. Paper Co	Supply house	52 42						3 50	48 92
1, 17, 28, 36, 53, 54, 55, 57, 60, 62, 63, 66, 12, 20, 30, 37, 42, 45, 48, 51, 56, 64	Vance, E. E.	Draftsman	2,400 00	2,400 00						
161, 125	Walker, Bryant	Member Bd. of Advisers	7 00			7 00				
76	Wagenvoord & Co	Binders	1 25						1 25	
118	Washington Loose Leaf Co	Supply house	15 00						15 00	
45, 29	Wellborn, W	Copyist	17 45	17 45						

CLASSIFIED LIST OF EXPENDITURES OF THE BOARD OF GEOLOGICAL SURVEY FOR THE FISCAL YEARS 1914-1915 AND 1915-1916.—*Concluded.*

Number of voucher.	Name.	Classification.	Total.	Salary.	Subsistance.	Travel.	Assistance.	Property.	Office.	
									Permanent.	Incidental.
460, 491	Wellington, C. F	Rodman	$159 52	$74 02	$85 50					
9, 19, 30, 48, 81, 104, 166, 180, 18, 33, 48, 57, 71, 94, 124, 144, 151.	Western Union Co	Telegraph Co	66 66							$66 66
461	Whitmore, Morris T	Rodman	122 77	56 77	66 00					
3, 1, 3, 13, 14, 23, 36, 38, 53, 62, 69, 79, 84, 88, 109, 112, 119, 123, 138, 141, 155, 173, 174, 192, 74, 12, 20, 24, 31, 40, 45, 52, 55, 65, 80, 81, 96, 100, 103, 113, 140, 56, 64, 67	Wight, Harry R	Secretary	3,107 70	2,400 00					$47 64	660 06
402	Wilson, J. H	Assistant topographer	115 97	70 97	45 00					
564, 567	Winn, Edward	Liveryman	24 00			$24 00				
403	Wolverine Auto Co	Transportation Co	63 00			63 00				
17	Wood, Frank E	Supply agent	4 00							
12, 27	Wood, N. A	Naturalist	200 00	200 00						4 00
8, 35, 75, 101, 146, 168, 54, 87. 135.	Wynk'p Hallen'k C'r'd Co.	State printers	115 56						28 50	87 06
429, 431, 459, 490, 505, 528, 550	Yoakum, B. H	Topographic aid	499 34	235 22	252 00	12 12				
Total			$52,211 75	$37,327 27	$6,775 62	$4,448 25	$248 11	$813 74	$809 69	$1,789 07
Unexpended balance July 1, 1916			5,998 86							
Total			$58,210 61							

EMPLOYEES OF THE BOARD OF GEOLOGICAL SURVEY FOR THE FISCAL YEARS JULY 1, 1914 TO JUNE 30, 1915 AND JULY 1, 1915 TO JUNE 30, 1916.

Name.	Position.	Amount of salary received.	Period of time employed.	How employed.					
				Mineral statistics.	Geology.	Appraisal of mines.	Topography.	Biology.	Michigan-Ohio boundary.
Allen, H. J	Rodman	$172 56	4 months, 10 days				*		
Allen, R. C	Director, State Geologist, Appraiser of Mines	6,957 90	2 years		*	*	*	*	*
Alverson, Miles C	Rodman	70 00	2 months		*				
Andrews, A. W	Naturalist	75 00	Contract					*	
Barrett, L. P	Assistant Geologist	2,210 00	2 years		*	*			
Bateson, Geo. R	Rodman	101 94	2½ months				*		
Beauchamp, Regis	Gage Reader	72 90	1 year, 1 month, 6 days		*				
Bemis, E. L	Topographic Aid	29 03	20 days				*		
Bibbee, E. C	Topographic Aid	461 94	6 months				*		
Brown, Floyd B	Compassman	94 67	2 months, 11 days		*				
Bunge, Wm. H	Rodman	30 67	23 days				*		
Burney, Alfred E	Topographic Aid	24 19	15 days				*		
Burney, H. E	Junior Topographer	170 20	2 monhts, 22 days				*		
Burrell, F. E	Rodman	181 59	4½ months				*		
Campbell, C. Alfred	Chainman	100 00	2 months						*
Christie, Wm. J	Rodman	40 00	2 months				*		
Coy, Richard S	Rodman	162 92	4 months, 3 days				*		
Davis, C. M	Rodman	110 02	2½ months				*		
Dodge, C. K	Botanist	400 00	Contract					*	
Ehlers, Geo. M	Paleontologist	159 25	2 months, 22 days	*					
Folland, Christopher	Rodman	20 00	½ month				*		
Gannett, Samuel S	Geographer	1,225 00	3½ months						*
Grabau, A. W	Paleontologist	450 00	Contract		*				
Graham, Jane	Copyist	3 75	16 hours					*	
Hagle, Maud	Copyist	8 50	16 hours and contract					*	

EMPLOYEES OF THE BOARD OF GEOLOGICAL SURVEY FOR THE FISCAL YEARS JULY 1, 1914 TO JUNE 30, 1915 AND JULY 1, 1915 TO JUNE 30, 1916.—*Concluded.*

Name.	Position.	Amount of salary received.	Period of time employed.	How employed.					
				Mineral statistics.	Geology.	Appraisal of mines.	Topography.	Biology.	Michigan-Ohio boundary.
Hain, E. L.	Assistant Topographer	$576 00	2 months, 8 days				*		
Hall, M. F.	Topographic Aid	259 84	6 months				*		
Hamilton, O. R.	Mining Engineer	4,800 00	2 years		*	*			*
Hankinson, T. L.	Biologist	200 00	Contract					*	
Harris, George	Rodman	21 94	17 days				*		
Hicks, Wm. R.	Rodman	51 61	1 month, 9 days				*		
Hodges, Guy	Rodman	20 00	½ month				*		
Hopper, W. E.	Geologist	500 00	2 years	*	*				
Hyde, Jos.	Compassman	26 67	½ month		*				
Jackson, R. B.	Rodman	80 00	1 month, 18 days						*
Johnson, A. B.	Rodman	25 81	20 days				*		
Jones, Oscar	Topographic Engineer	283 98	1½ months				*		
Jones, S. G.	Rodman	184 30	4 months, 18 days				*		
Kavanagh, A. J.	Junior Topographer	50 81	21 days				*		
Kendrick, Geo. F.	Rodman	31 94	22 days				*		
Krise, Wm. Earl	Rodman	176 43	4 months, 12 days				*		
Lau, Louis	Rodman	20 00	½ month				*		
Laughlin, Howard S.	Rodman	168 08	2 months, 8 days				*		
Lee, L. L.	Assistant Topographer	757 98	6 months				*		
Linton, L. L.	Recorder	150 00	2 months						*
McKone, Don. T.	Rodman	346 67	6½ months		*				
Muldrow, Robert	Topographic Engineer	766 17	4 months				*		
Murphy, J. J.	Rodman	20 64	16 days				*		
Nelson, Alfred	Rodman	20 00	½ month				*		
Novy, Frank	Naturalist	82 00	Contract					*	

Null, H. Harrison	Rodman	20 00	½ month				*		
Opdyke, Alfred L	Topographic Aid	125 00	2½ months				*		
Phillips, R. H	Rodman	40 00	1 month				*		
Povah, H. W. Alvah	Botanist	182 00	Contract					*	
Richardson, G. R	Rodman	20 00	½ month				*		
Richmond, Marian	Office Assistant	6 00	6 days		*				
Richmond, Mrs. K. V	Stenographer	1,780 00	2 years	*	*		*	*	*
Ruthven, A. G	Chief Naturalist	800 00	2 years					*	
Sadler, C. L	Topographic Engineer	414 83	2 months, 9 days				*		
Sawyer, Mrs. M. M	Office Assistant	6 00	6 days		*				
Saxon, William, Jr	Rodman	20 00	½ month				*		
Shultz, William, Jr	Rodman	57 68	1½ months				*		
Schweitzer, Jos	Cook	270 00	4½ months		*				
Scott, I. D	Geologist	239 68	2 months, 3 days		*				
Senseney, H. S	Topographer	37 50	½ month				*		
Sherman, C. E	Inspector	200 00	Contract						*
Sherman, R. B	Rodman	70 00	1 month, 12 days						*
Smith, R. A	Geologist	3,384 66	2 years	*	*	*			
Sorensen, F. G	Chainman	58 33	1 month, 5 days						*
Sponsler, O. L	Biologist	200 00	Contract					*	
Staack, J. G	Topographic Engineer	79 12	½ month				*		
Stone, Harry H	Rodman	78 67	2 months				*		
Taylor, Frank B	Geologist	150 00	Contract		*				
Thompson, Crystal	Naturalist	200 00	Contract					*	
Tobin, James	Cook and Compassman	110 00	1 month, 11 days		*				
Transeau, E. N	Biologist	150 00	Contract					*	
Turnbull, W. D	Draftsman	50 25	8 days						*
Vance, E. E	Draftsman	2,400 00	2 years	*	*	*	*	*	*
Wellborn, W	Copyist	17 45	6½ days	*					
Wellington, C. F	Rodman	74 02	1 month, 27 days				*		
Whitmore, Morris T	Rodman	56 77	1 month, 13 days				*		
Wight, Harry R	Secretary	2,400 00	2 years	*	*	*	*	*	*
Wilson, J. H	Assistant Topograher	70 97	22 days				*		
Wood, N. A	Naturalist	200 00	Contract					*	
Yoakum, B. H	Topographic Aid	235 22	4 months, 21 days				*		

Date.	Name and Address of Company.	Report by.
1914.		
Nov. 17	Regal Collieries, Ltd., Taber, Alberta, Canada	R. C. Allen.
Jan. 9	Lake Superior Land Co	R. C. Allen.
1915.		
June 16	White Pine Extension Copper Co	R. C. Allen.
July 31	Central Michigan Clay Products Co., Williamston, Michigan	R. C. Allen.
Sept. 24	Cheboygan County Limestone Products Co., Mackinaw City, Michigan	R. A. Smith.
1916.		
Jan. 24	Minook Gold Dredging Co., Seattle, Wash	L. P. Barrett.
April 3	Assets Realizing Mines Corporation	R. C. Allen.
April 25	Jerome Victor Extension Copper Co. of Arizona	R. C. Allen.
April 27	Butte-Elk Park Extension Mining Co. of Montana	R. C. Allen.
May 5	Plattville Consolidated Lead & Zinc Mining Co., Beloit, Wisconsin	R. C. Allen.
May 9	Silica Brick Co., Detroit, Mich	R. A. Smith.
June 9	Breitung Hematite Mining Co., Ltd	R. C. Allen.
June 29	Fullers Earth Company of America	R. C. Allen.

EXPENDITURES OF THE CO-OPERATIVE TOPOGRAPHIC SURVEY OF MICHIGAN.

Year.	By the State of Michigan.	By the United States Geological Survey.
1903	$800 00	$800 00
1905	2,000 00	2,000 00
1906	3,000 00	3,000 00
1907	3,000 00	3,000 00
1908	2,000 00	2,000 00
1909	2,000 00	2,000 00
1910	2,000 00	2,000 00
1911	2,000 00	2,000 00
1912	2,000 00	2,000 00
1913	2,500 00	2,500 00
1914	2,500 00	2,500 00
1915	15,000 00	15,000 00
1916	15,000 00	15,000 00

STATEMENT OF EXPENDITURES MICHIGAN-OHIO JOINT BOUNDARY LINE RESURVEY.

July 1, 1915-June 30, 1916.

Michigan Appropriation.

Payee.	Total.	Salary.	Subsistence.	Travel.	Assistance.	Property, permanent.	Office, incidental.	Miscellaneous.
Allen, R. C	$79 67		$25 50	$54 17				
Baldwin, Dell	25 50				$24 50	$1 00		
Campbell, C. Alfred	191 50	$100 00	91 50					
Dietz, C. A	262 50			262 50				
Gannett, Samuel S	1,588 54	1,225 00	216 00	59 85		57 22	$30 47	
Jackson, R. B	153 50	80 00	73 50					
Linton, L. L	241 50	150 00	91 50					
Lloyd Brothers	450 00					*450 00		
Sherman, C. E	200 00	200 00						
Sherman, R. B	134 50	70 00	64 50					
Sorensen, F. G	112 33	58 33	54 00					
Terry Engraving Co	108 49					105 99		
Turnbull, W. D	50 25	50 25						
Total	$3,598 28	$1,933 58	$616 50	$376 52	$24 50	$614 21	$30 47	
Appropriation	$3,600 00							
Balance	1 72							
	$3,600 00	$3,600 00						

*Granite monuments.

Campbell, C. Alfred	$412 50	$292 50	$120 00					
Dietz, C. A	113 65			$113 65				
Gannett, Samuel S	927 38	678 33	84 00					$165 05
Jackson, R. B	61 67	31 67	30 00					
Linton, L. L	399 00	277 50	121 50					
Loyd Brothers	1,073 30					*$1,073 30		
Schlesinger, A. M	150 00	150 00						
Sherman, C. E	99 98		11 50	43 00	$30 71		$14 77	
Sherman, R. B	61 67	31 67	30 00					
Sorensen, F. G	61 67	31 67	30 00					
Stambaugh, A. A	150 00			150 00				
Turnbull, W. D	88 88	88 88						
Total	$3,599 70	$1,582 22	$427 00	$306 65	$30 71	$1,073 30	$14 77	$165 05
Appropriation	$3,600 00							
Balance	30							
	$3,600 00	$3,600 00						

*Granite monuments.