CROTON HYDROELECTRIC PLANT
Croton Dam Road, at the Muskegon River
Croton vicinity
Newaygo County
Michigan

HAER NO. MI-81

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
Philadelphia Support Office
U.S. Custom House
200 Chestnut Street
Philadelphia, P.A. 19106

HISTORIC AMERICAN ENGINEERING RECORD

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HAER No. MI-81

Location:	Croton Dam Road, at the Muskegon River, Croton Vicinity, Newaygo County, Michigan UTM: A: 16.607960.4810040 to B: 16.608280.4810000 Quad: Croton, MI, 1:24,000
Dates of Construction:	1906-1908, 1915, 1930, 1991
Engineer:	William G. Fargo and others
Present Owner:	Consumers Power Company, 212 West Michigan Avenue, Jackson, Michigan 49201
Present Use:	Hydroelectric generating plant
Significance:	The Croton Hydroelectric Plant was one of the earliest large-scale hydroelectric generating plants in Michigan and was the site of major innovations in the transmission of high voltage electricity. Croton is also an early example of the work of William G. Fargo, a Jackson, MI civil engineer who specialized in the design of mid-sized hydroelectric plants in the Midwest in the early Twentieth Century. He pioneered in building earth embankment dams on foundations of soft soils, using hydraulic sluicing methods.
Project Information:	This documentation is the result of a May 9, 1994 consultation between Consumers Power Company (CPCo) and the State Historic Preservation Office (SHPO). This meeting took place in response to CPCo's desire to rehabilitate the plant spillway. As a result of the meeting, CPCo and the SHPO agreed to the recordation of the entire Croton Hydroelectric plant in accordance with Historic American Engineering guidelines. The documentation was completed in 1994 by Dr. Charles K. Hyde, Wayne State University, under contract to CPCo.

HISTORY AND SIGNIFICANCE

The Croton Hydroelectric Plant on the Muskegon River was one of Michigan's first large-scale electrical generating plants and was the site of significant engineering innovations, both in the construction of the plant and in the transmission of the electrical power generated there. Built by the Grand Rapids-Muskegon Power Company, a forerunner of the present-day owner, the Consumers Power Company, the Croton plant was designed to develop 14,400 horsepower with a hydraulic head of 40 feet. Croton had more than twice the 6,000 horsepower capacity of the Rogers Hydroelectric Plant (1906) built on the Muskegon River some seventeen miles above Croton by the same company. By contrast, the immense generating plant at Niagara Falls, New York (1895) developed 50,000 horsepower.

The Croton plant was the product of a long-term alliance of three talented Michiganians - William Augustine Foote (1854-1915), an Adrian native active in the electric power industry since 1886, chiefly as an entrepreneur and financier; his brother, James Berry Foote (1867-1924), an electrical engineering genius; and William Gilbert Fargo (1867-), a civil engineer from Jackson, Michigan, who began building hydroelectric plants for the Foote's in 1898. W.A. Foote became heavily involved in electrical utilities in Jackson, Kalamazoo, and Grand Rapids in the early 1890s and in 1904, bought one-third interest in the Grand Rapids-Muskegon Water Power Electric Company, which acquired virtually all the lands and riparian rights on the Muskegon River in June 1905. W.A. Foote helped reorganize and refinance the firm in April 1906, when a new corporate entity was established, the Grand Rapids-Muskegon Power Company. In March 1906, the company completed the Rogers Hydroelectric Plant, which developed 6,000 horsepower and supplied electricity to Grand Rapids, 55 miles away, and to Muskegon over a transmission line extending 68 miles. When the Rogers plant was completed, construction began at Croton, some 17 miles downstream from Rogers.[1]

William G.Fargo, the consulting engineer for the Croton project, had designed hydroelectric plants for several Michigan utilities since the late 1890s and had an early association with the Foote brothers. Fargo, a native of Jackson, had initially planned a career in landscape architecture, but found the field financially unrewarding and in 1890, launched a surveying and civil engineering practice in Jackson instead. In 1895, he established the Fargo Engineering Company in Jackson and soon specialized in the design of hydroelectric plants using dams built on soft earth (versus bedrock) foundations. His first significant project for the Foote brothers was the Trowbridge Dam on the Kalamazoo River in Allegan County, Michigan, which Fargo built in 1898-1899. Power from Trowbridge was transmitted to Kalamazoo, some 24 miles away, at an unprecedented pressure of 22,000 volts.[2]

Fargo Engineering specialized in the design and construction of small and mid-sized low-head hydroelectric plants in the Midwest. Between 1895 and late 1921, Fargo designed a total of 61 hydroelectric plants, with 44 of these in Michigan, and all except nine in the Midwest. The firm also designed nine steam-powered generating plants. Fargo's work for the utilities which eventually became the Consumers Power Company accounted for roughly two-thirds of Fargo's Michigan projects. He was also a contributor to Engineering News and other national engineering publications, an indication of the innovative nature of his hydroelectric plant designs.[3]

Croton was also the site of significant breakthroughs in the transmission of electricity at high voltages. The Foote brothers wanted to reduce the power loss that resulted from long-distance transmission by increasing the line voltage from the level of 72,000 volts used on the Rogers line to the unprecedented pressure of 110,000 volts. The Rogers line used pin-insulators 14 inches in diameter, the largest size that could be economically produced, mounted on wooden poles. These insulators were the best the electrical industry had developed at the time, but they were not adequate to carry the projected voltage from Croton.

J.B. Foote discovered in the course of a visit to the General Electric plant in Schenectady, New York, that E. M. Hewlett and Harold W. Buck were experimenting with a new insulator design. The Hewlett-Buck system utilized five porcelain discs or "bells," each 10 inches in diameter, suspended from one another by wire and attached to the transmission tower. J.B. Foote tried this design but found that the hardware connecting the insulators tended to break the porcelain discs. He solved the problem by annealing a piece of line wire, threading it through the insulators, and attaching it to the discs with Crosby clips. At the time of this design breakthrough, the Hydro-electric Power Commission of Ontario, Canada, was planning to build a 66,000 volt transmission system, but upon hearing of the success of the Croton line, designed a similar system to carry 110,000 volts.[4]

There were other significant innovations besides the new insulator design. To carry the transmission line, the Footes used three-legged steel towers which rose to a point, commonly called "windmill" towers because they were first designed to support farm windmills. These towers were manufactured by the Aermotor Company of Chicago, which initially supplied the towers to farmers, but later became a major supplier to electrical utilities. The Foote brothers preferred to use No. 2 stranded medium-hard copper wire as the conductor on this line, but because manufacturers were not able to produce that size, they instead used six strands of No. 10 medium-hard copper wire cabled around a hemp center.

When considered as an interrelated cluster of innovations, the insulators, towers, and conductors were not only immediately significant in enabling the Croton transmission line to operate at unprecedented high voltages, but these innovations also permitted subsequent increases in transmission voltages. Three years after Croton was completed, the Foote interests opened a 140,000 volt transmission line from Cooke Dam on the Au Sable River to Bay City, a distance of 125 miles.[5]

The Croton hydroelectric plant went into full service in July 1908 and aroused international interest in its design and operations. Dozens of foreign visitors including engineers from England, Russia, France, Italy, Japan, and India, came to view the plant. Dr. Charles Steinmetz, the "wizard of Schenactady," conducted corona tests on the Croton transmission line in the Fall of 1908. Croton not only attracted the attention of the international engineering community, but it also appealed to the imagination of the general public. In September 1907, when the plant was still under construction, the Foote brothers promoted three railroad excursions from Grand Rapids to the construction site, involving more than 700 participants in all, including bankers, manufacturers, government officials, and ordinary citizens. They were given a grand tour of the dam and powerhouse, and were treated to an elaborate dinner followed by expensive cigars. At the conclusion of the last dinner on September 11, 1907, a group of fifty citizens from Holland, Michigan, sang the "Song of Croton Dam," composed for the occasion by H. Vander Ploeg of Holland and sung to the tune of "Marching Through Georgia."[6] The song's lyrics reflect the enthusiasm generated by the Croton Dam:

Sing a song of Croton Dam,
The biggest in the State.
Where the water sizzles thru
And things are up to date.
Sing it with a hearty cheer
As long as you can make.
While we are riding to Croton.

CHORUS: Hurrah! Hurray! We shout for Croton Dam.
Hurrah! Hurrah! The biggest dam what am.
And so we shout the chorus of the dam
That gives us light,
As we are riding to Croton.

(CONTINUED)

How the water dashed o'er
  The dam that fills the creek.
How it surges through the gates
  That sends it on its work
How the wheels are turning as
  The water rushes through
While we are riding to Croton.

CHORUS

Oh, the power, the light, the heat
  That dam does furnish us.
Oh, the industries that hum
  That feel the electric touch.
Oh, the cities that are built
  Where'er that power is used
While we are marching to Croton.

CHORUS[7]

PHYSICAL DESCRIPTION

Proceeding from east to west, the Croton Hydroelectric Plant consists of four distinct segments - an earth embankment dam, a reinforced concrete and brick powerhouse, a reinforced concrete spillway, and a concrete and brick substation. These segments will be individually described in the subsections of this report.

NOTES

[1]George Bush, Future Builders: The Story of Michigan's Consumers Power Company (New York, 1973), pp. 87-89, 102-104, and 475; E. Hardy Luther, "Early Developments in High Voltage Transmission," Michigan History, LI (Summer 1967), pp. 102-103; and Memorial Society of Michigan, In Memorium: Founders and Makers of Michigan (Detroit, 1938), pp. 27-29.

[2]Bush, Future Builders, pp. 74-79; Who's Who In Engineering: A Biographical Dictionary of Contemporaries (New York 1925), p. 666; and Herbert S. Case, editor, Official Who's Who in Michigan (Munising, MI, 1936), p. 125.

[3]Fargo Engineering Company, Power, Hydro-Electric and Steam: An Outline of the Engineering and Construction Activities of Fargo Engineering Company, Jackson, Michigan (Jackson, November 1921), pp. 3, 4, 33; William G. Fargo, "Some Examples of Concrete Mixing and Delivery Plant," Engineering News, Vol. 55, May 31, 1906, pp. 605-606; Fargo, "Experience With Steel Sheet Piling in Hard Soils," Engineering News, Volume 57, April 4, 1907, pp. 374-375; and Fargo, "Hydraulic Excavation and Dam Building at the Croton and Lyons Dams in Michigan," Engineering News, Volume 58, (24 October 1907), pp. 429-431.

[4]J.B. Foote, "The History of the Evolution of the High Voltage Tower Transmission Lines of the Consumers Power Company," The Au Sable News (September 1921), pp. 10-12.

[5]Luther, "Early Developments in High Voltage Transmission," pp. 103-105.

[6]Ibid., p. 104.

[7]"Last Excursion to Croton Dam the Largest of the Three: More Than 250 Enjoyed the Trip, Despite Bad Weather: Great Interest Shown by the Manufacturers and Bankers - Visitors From Holland and Other Cities Went Along," Grand Rapids Herald, 11 September 1907, p. 7.

SOURCES OF INFORMATION

A. Engineering Drawings: The Consumers Power Company Engineering Department, 1945 West Parnall, Jackson, MI 49201, has over one hundred sheets of drawings produced by Fargo Engineering between 1906 and 1920. This collection of drawings is likely to be preserved well into the future.

B. Historic Views: Four historic views are in the office building at the Croton Hydroelectric Plant.

C. Bibliography

2. Secondary and Published Sources:

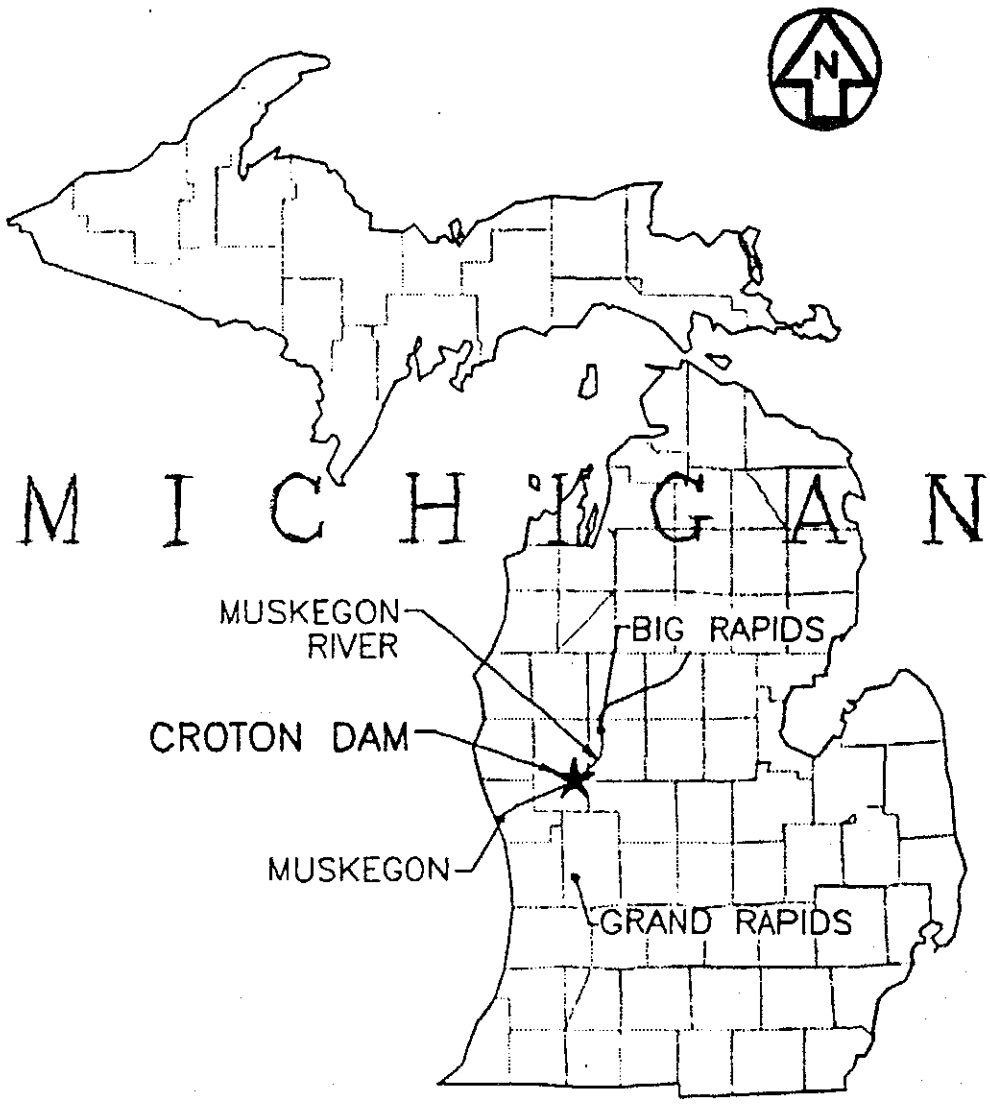
Fargo, William G., "Experience With Steel Sheet Piling in Hard Soils," Engineering News, Volume 57, No. 14 (4 April 1907), pp. 374-375.

Fargo, William G. "Hydraulic Excavation and Dam Building at the Croton and Lyons Dams in Michigan, Engineering News, Vol. 58, No. 17 (24 October 1907), pp. 429-431.

Schuyler, James Dix, "Recent Practice in Hydraulic-Fill Dam Construction," American Society of Civil Engineers, Transactions, Vol. 58 (June 1907), pp. 196-277.

Schuyler, James Dix. Reservoirs for Irrigation, Water-Power and Domestic Water Supply, With An Account of Various Types of Dams and the Methods, Plans and Cost of Their Construction. Second Edition. New York, 1909.

LOCATION MAP



CROTON, MICHIGAN QUADRANGLE, 1:24,000

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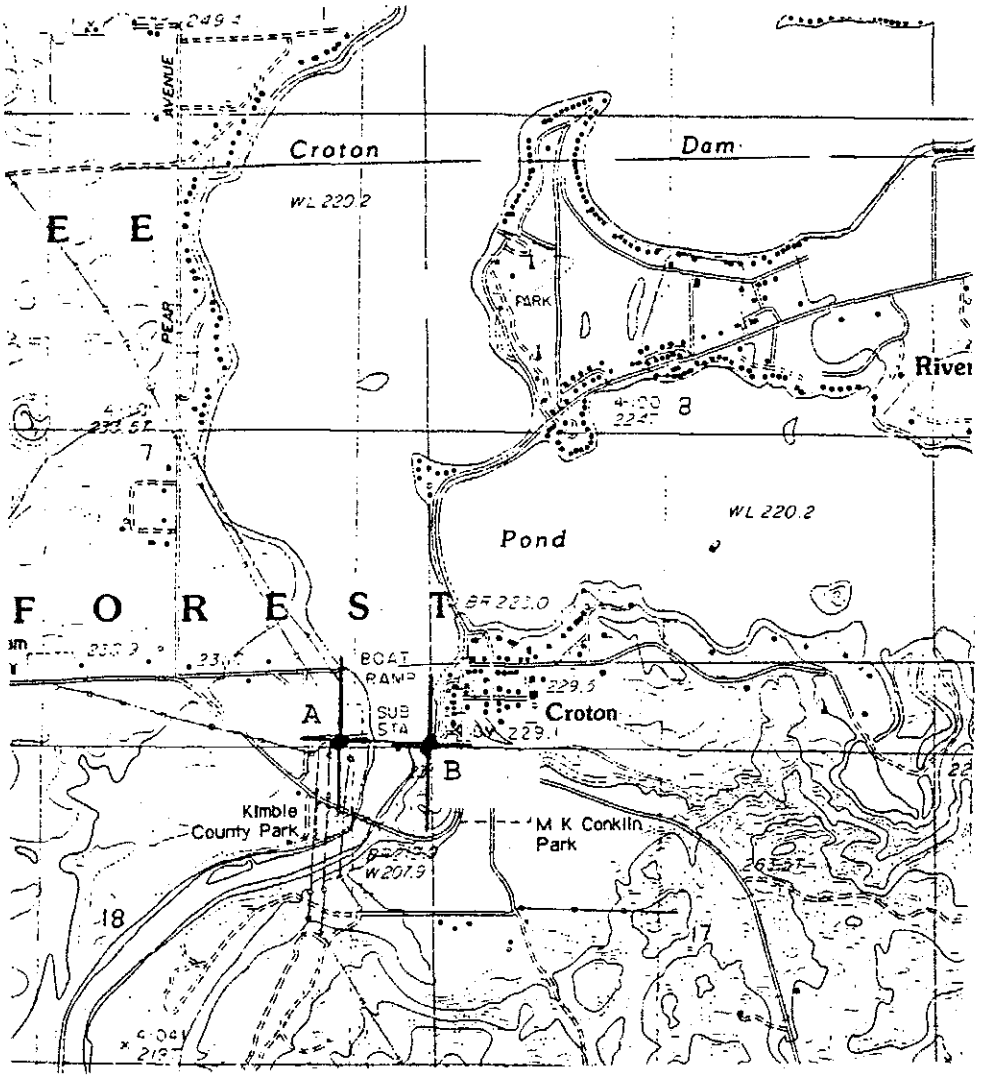
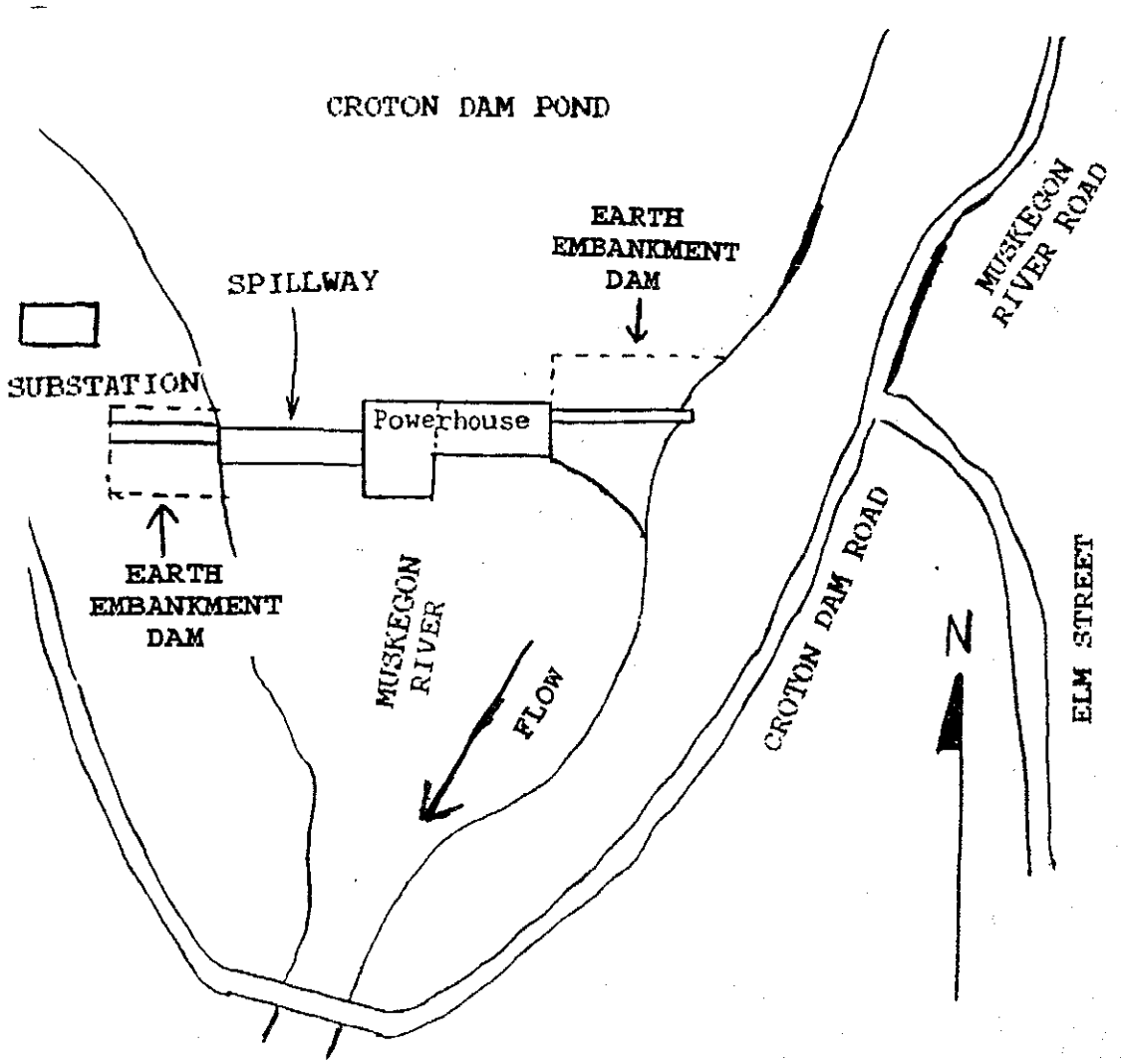


GENERAL SITE PLAN



ADDENDUM TO:
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Croton vicinity
Newaygo County
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HAER MI-81
HAER MICH,62-CROTO.V,1-

FIELD RECORDS

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National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001