WATERVILLE BRIDGE
Pennsylvania Historic Bridges Recording Project
Spanning Swatara Creek at Appalachian Trail
Green Point vic.
Lebanon County
Pennsylvania

HAER No. PA-462

PHOTOGRAPHS

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HISTORIC AMERICAN ENGINEERING RECORD

WATERVILLE BRIDGE

HAER No. PA-462

Location:	Spanning Swatara Creek at Appalachian Trail, Green Point vicinity, Lebanon County, Pennsylvania. (Moved from Little Pine Creek at State Route 44, Waterville, Lycoming County, Pennsylvania.)
USGS Quadrangle:	Indiantown Gap, Pennsylvania (1969, photorevised 1977).
UTM Coordinates:	18/370150/4481980
Date of Construction:	1890; moved 1985.
Designer:	Berlin Iron Bridge Company (East Berlin, Connecticut).
Builder:	Berlin Iron Bridge Company (East Berlin, Connecticut).
Present Owner:	Pennsylvania Department of Conservation and Natural Resources.
Present Use:	Pedestrian bridge.
Significance:	The Waterville Bridge is an example of a lenticular truss, so named because of the lens-like shape of its curved upper and lower chords. It is representative of the Berlin Iron Bridge Company's trademark bridge type, based on the patent of William O. Douglas. This bridge also exhibits a Warren pattern of web bracing and a highly decorated portal. The process of moving the Waterville Bridge in 1985 is a notable example of how historically significant bridges can be preserved and adapted to new uses. The structure was listed in the National Register of Historic Places in 1988.
Historian:	Blythe Semmer, August 1997.
Project Information:	This bridge was documented by the Historic American Engineering Record (HAER) as part of the Pennsylvania Historic Bridges Recording Project - I, co-sponsored by the Pennsylvania Department of Transportation (PennDOT) and the Pennsylvania Historical and Museum Commission during the summer of 1997. The project was supervised by Eric DeLony, Chief of HAER.

Description

The Waterville Bridge formerly carried State Route 44 over Little Pine Creek in the village of Waterville, Lycoming County, Pennsylvania. The bridge is an example of the unusual lenticular, or parabolic, truss type that was a specialty of the Berlin Iron Bridge Company of East Berlin, Connecticut, who built this bridge in 1890 for the commissioners of Lycoming County.[1] At its new location over Swatara Creek in Swatara State Park, the bridge rests on new concrete abutments. Its twelve-panel, lens-shaped trusses measure 220'-9" long and are entirely pin-connected. The panel points are spaced 17'-6" apart and support a single-lane roadway 15'-5" wide. A Warren-pattern web reinforces the truss, and the diagonal members are laced box sections. These members are designed for compression but can carry both tension and compression forces. A central tension member runs the length of the bridge along the upper plane of the truss to brace the transverse struts against buckling. The diagonal web members also have transverse bracing due to the bridge's extreme length.

The top chord, end posts, and sway bracing members are all box-shaped sections with single lacing on the open side. Along the upper chord, joints occur at panel points. The lower parabolic chords are pin-connected eye-bars. The longitudinal deck girder is suspended from the truss by bent U-bolts. Since the web has a Warren pattern, panel points in the upper and lower parabolic chords do not align vertically. The deck is therefore suspended from a pin in the upper chord where there is no corresponding pin on the lower chord. Joints in the deck girders are not at the panel points, although they appear to be regularly spaced. There is lateral bracing on the underside of the deck. New steel deck beams and stringers were added during 1935 repairs to the bridge, and a new wooden wearing surface was added after the bridge's move in 1985. The lateral bracing is now welded to the deck structure.

The Waterville Bridge has a highly decorated portal. In addition to the ornament running across the portal, finials incised with a decorative design cap the end posts. There is a builder's plate in the center of each portal. The west end's plaque reads "Built by the Berlin Iron Bridge Company, East Berlin, Conn., Douglas and Jarvis Pat. Ap'l 16, 1878 and Ap'l 7, 1885." The last line refers to the patents granted to William O. Douglas for the lenticular truss. The plaque also credits Charles M. Jarvis, president of the Berlin Iron Bridge Company, although his name does not appear on the patents. The plaque on the east end of the bridge lists the names of the Lycoming County Commissioners responsible for the bridge's erection: A. P. Foresman, William S. Starr, and T. J. Strebeigh.

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[1] Another lenticular truss was documented during the Pennsylvania Historic Bridges Recording Project - I; see U.S. Department of the Interior, Historic American Engineering Record (HAER) No. PA-468, "Nicholson Township Lenticular Bridge," 1997, Prints and Photographs Division, Library of Congress, Washington, D.C. There are about six lenticulars extant in Pennsylvania and around fifty in the U.S., according to research by Dr. Mark M. Brown, project historian.

The Lycoming County commissioners' bridge book records the Waterville Bridge's date of erection as August 1889, although the builder's plate bears the date 1890.[2] Construction may not have been completed until 1890. According to the Lycoming County bridge book, the Berlin Iron Bridge Company was a popular choice for bridge construction in the county during the last two decades of the nineteenth century. The listing that precedes the Waterville Bridge in the Cummings Township section of the bridge book is also a Berlin bridge, built in November 1884 over Big Pine Creek at Pine Bottom at a cost of $9,660.00.[3] The 1884 bridge is described as wrought iron, the material typically used by the Berlin Iron Bridge Company. Most of their lenticular trusses were wrought iron, as they did not commonly use steel until 1894.[4] The Waterville Bridge is also probably wrought iron but could include steel members.

The Waterville Bridge did not undergo major repairs until it came under the state's control in 1931. In 1935, new steel stringers and floor beams were added, and the weight limit was raised from six to thirteen tons as a result. Fire damaged an end post of the truss in October 1958. Minor accidents took their toll on truss members, but none were replaced.

Moving the Bridge

The Waterville Bridge served the Little Pine Creek crossing until it was determined inadequate for the amount of traffic traveling State Route 44 in the 1970s. In 1980, the division administrator of the Federal Highway Administration submitted a Eligibility Documentation Report to the National Register of Historic Places in Washington, D.C., in anticipation of replacing the bridge at this crossing. He requested the opinion of Carol Shull, the Acting Keeper of the National Register, because of a difference of opinion between the local historical society and the Bureau of Historic Preservation, the state historic preservation office for Pennsylvania.[5] The Lycoming County Historical Society and Museum stated in letters on 14 September 1970, and 7 November 1979, that the replacement of the Waterville Bridge would have no detrimental

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[2]Another Berlin Iron Bridge Company bridge located in Lycoming County was documented by the Pennsylvania Historic Bridges Recording Project - 1; see HAER No. PA-460, "Upper Bridge at Slate Run," 1997, Prints and Photographs Division, Library of Congress, Washington, D.C. The Upper Bridge is a 196'-0" lattice truss bridge spanning Pine Creek above Slate Run in Lycoming County. The same county commissioners were responsible for the construction of both bridges in 1890, according to the builder's plates.

[3] Lycoming County, Pennsylvania, *Bridge Book* (Lycoming County Courthouse, Williamsport, Pennsylvania), 10.

[4] Victor C. Darnell, "Lenticular Bridges from East Berlin, Connecticut," *IA: The Journal of the Society for Industrial Archaeology* 5, No. 1 (1979): 21.

[5] Donald E. Hammer, to Carol Shull (Acting Keeper of the National Register), 8 August 1980 (Waterville Bridge National Register file, Commonwealth of Pennsylvania Historical and Museum Commission, Bureau of Historic Preservation, Harrisburg, Pennsylvania).

effect on the historic character of the Pine Creek valley.[6] However, the State Historic Preservation Officer, Ed Weintraub, contended that "this bridge is a particularly rare type of parabolic truss bridge using a Warren truss framework. In my opinion ... the bridge is eligible for listing in the National Register of Historic Places."[7] The Waterville Bridge was officially determined National Register-eligible on 3 September 1980. The Keeper of the National Register commented briefly, "Built in 1890 by the East Berlin Iron Bridge Company, one of the principal late nineteenth-century manufacturers of iron bridges, the Waterville Bridge meets the National Register criteria as an important example of a lenticular truss bridge. It is significant as a rare instance of a lenticular truss bridge with a Warren configuration for the web members."[8] Although the determination of eligibility was not intended to stop the replacement of the Waterville Bridge, it did dictate that the bridge would fall under the protective regulations of Section 106 of the National Historic Preservation Act of 1966, which state that projects using federal funding must make efforts to mitigate their effect on historic properties listed in or eligible for the National Register. The Federal Highway Administration's involvement indicates that federal funding was planned for this project.

However, the Determination of Eligibility Documentation concurred with inspection reports that stated the Waterville Bridge was structurally and functionally inadequate for the traffic on State Route 44.[9] When PennDOT decided to replace the Waterville Bridge, the agency made it known that the lenticular truss was available for re-use at another site. The Bureau of Facility Design and Construction of the Pennsylvania Department of Conservation and Natural Resources was developing a state park in Lebanon County along the Appalachian Trail. Ultimately, a crossing for the Trail over Swatara Creek would be required, and using a historic bridge was a unique way to provide one.[10]

Using the engineering services of both the Bureau of Facility Design and Construction and PennDOT, the bridge was disassembled and moved to Swatara State Park in Lebanon County, at a crossing similar to Little Pine Creek. All funding came from state agency budgets: PennDOT financed disassembly, reassembly, and moving, while the Bureau of Facility Design

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[6] Determination of Eligibility Documentation (Waterville Bridge National Register File), appendices. The Lycoming County Historical Society and Museum was not alone in its determination that the Waterville Bridge was not of great historical value. The Lycoming County Planning Commission and the Pine Creek Task Force, a group formed by the Pennsylvania Department of Environmental Resources to protect the environment in the Pine Creek area, voiced similar opinions. All favored the replacement of the bridge.

[7] Ed Weintraub, to Donald Hammer, 23 June 1980 (Waterville Bridge National Register file).

[8] Determination of eligibility notification, 30 September 1980 (Waterville Bridge National Register file).

[9] Determination of eligibility notification, 8.

[10] Gene Comoss (director, Bureau of Facility Design and Construction, Pennsylvania Department of Conservation and Natural Resources), telephone conversation with author, 22 August 1997.

and Construction paid for construction of new abutments, deck replacement, and painting.[11] The members were numbered for identification and individually cleaned by sandblasting. Some members were reinforced by welding steel plates at weakened spots. None of the truss members were replaced, though, and the deck width was kept the same. The bridge was given a new wooden deck, and the members were repainted according to the recommendations of nineteenth-century bridge engineer J. A. L. Waddell: compression members are dark gray and tension members are a light blue-gray.[12]

The Lenticular Truss

After the Civil War, dramatic growth in manufacturing extended to the production of bridges. Bridge companies began to specialize in particular truss types, marketing their product to county commissions and town governments. Competition for business revolved around the price of the bridge and the company's advertising prowess as well as their possession of unique truss designs. The Berlin Iron Bridge Company of East Berlin, Connecticut, was known for the construction of wrought-iron and steel lenticular trusses in New England and New York during the last three decades of the nineteenth century. The lenticular truss was particularly competitive as a highway bridge because it was easy to assemble in the field and used less material than other truss types, thus reducing cost. Berlin's signature truss was based on the patent of William O. Douglas.[13]

William O. Douglas was granted U.S. Patent No. 202,526 for the lenticular truss form on 16 April 1878. Douglas was not the first to employ the parabolic shape, nor the first to do so in the U.S. Lenticular trusses had been used in France, England, and Germany in the mid-nineteenth century, and two other American patents had been issued for the truss type. Edwin Stanley was given a patent in 1851, and Horace Hervey and Robert Osborne received theirs four years later.[14] The lenticular truss developed out of the bowstring arch bridge, where the deck of the bridge is supported by a parabolic upper chord and a straight lower chord. The lenticular form makes both the upper and lower chords parabolas, and forces are balanced between them. Light bracing between the upper and lower chords sufficiently stabilizes the truss and preserves the strength of its parabolic shape. The lenticular truss was easy to fabricate, required few working drawings, and was usually entirely pin-connected, making it a natural choice for highway bridges.

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[11] Comoss, telephone conversation.

[12] Waterville Bridge National Register file.

[13] For more information on Douglas and his patents for lenticular bridges, see U.S. Department of the Interior, HAER No. MA-105, "Tuttle Bridge," 1990, Prints and Photographs Division, Library of Congress, Washington, D.C.

[14] Darnell, "Lenticular Bridges," 19.

The Waterville Bridge exhibits a Warren pattern of web trussing, which was an efficient way to add strength on longer trusses. The longest lenticular truss ever built by the Berlin Company was a 288'-0" through truss at Raymondville, New York, which also used Warren web trussing.[15] More material was necessary to stabilize the bridge.[16]

One objection to the lenticular truss was a lack of stiffness, which was caused by the deck being suspended by hangers. Lateral bracing along the top of the truss could help stabilize the bridge. However, a problem arose in lenticulars of shorter spans, because the end posts were only approximately one half the height at mid-span. In these bridges, lateral bracing along the top chords would be stopped at the first panel point so that the placement of the portal would allow sufficient vertical clearance for vehicles crossing the bridge. Therefore, the stiffness of the chords and end posts became critical to the truss' stability.[17]

William O. Douglas was granted a second patent (No. 315,259) for the lenticular truss bridge on 7 April 1885. Bridge historian Victor Darnell describes the second patent as

> aimed at a less expensive system of bracing.... The struts of the bracing system were to be replaced by rods, and the truss action replaced by the tension of the two lines of rods. In short spans, about seventy-five feet or less, the ties would be bolted to the abutments. In longer spans, the tension would be resisted by an inclined strut that was connected to the first interior panel point of the bottom chord.[18]

The revised design had no real advantage and was not widely used by the Berlin Company as it reduced the truss' lateral stiffness.[19]

The New England states had high concentrations of Berlin bridges, and those in Pennsylvania were concentrated near New York, with the exception of three in Philadelphia.[20] All but one of the lenticular trusses constructed by the Berlin company were for highways. Very few were built after 1895 because demand for the metal truss bridges declined and the company increasingly turned its attention to constructing steel-framed industrial buildings.[21]

An heir to the Berlin, Connecticut, tradition of tinware manufacturing dating to the eighteenth century, the immediate predecessor of the Berlin Iron Bridge Company was the

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[15] Darnell, "Lenticular Bridges," 26.

[16] Darnell, "Lenticular Bridges," 21.

[17] Robins Fleming, "Early Parabolic Truss Bridges Gradually Disappearing," *Engineering News-Record* 100 (10 May 1928): 749.

[18] Darnell, "Lenticular Bridges," 21.

[19] Darnell, "Lenticular Bridges," 21.

[20] Darnell, "Lenticular Bridges," 27.

[21] Determination of Eligibility Documentation, 13.

Corrugated Metal Company, formed in 1873. The firm manufactured corrugated iron for buildings. Gradually the company began making iron roof trusses to support the corrugated iron sheets. This endeavor led to their involvement in bridge building. The firm was facing financial ruin in 1877 when S. C. Wilcox became president. The Corrugated Metal Company obtained exclusive rights to the Douglas patent soon after this crisis was averted. The company was reorganized and began to profit from bridge construction, particularly from lenticular trusses built for use on roadways. The name was changed to the Berlin Iron Bridge Company in 1887, reflecting this new emphasis. Charles M. Jarvis took over as president at Wilcox's death in 1886 and remained president until the firm joined with twenty-five other companies to form the American Bridge Company in 1900.[22]

As early as 1928, the lenticular truss was recognized as a vanishing artifact of American bridge-building when an article on the disappearing parabolic truss appeared in *Engineering News-Record.* The article was written by Robins Fleming, an engineer for the American Bridge Company who had previously designed lenticular trusses for Berlin. Though he mentions European parabolic bridges, Fleming does not acknowledge the only lenticular bridge built in the U.S. by someone other than the Berlin Iron Bridge Company. The Smithfield Street Bridge in Pittsburgh is the longest lenticular truss ever built in this country, at 720'-0" in two spans, excluding the length of approaches. Gustav Lindenthal, the engineer of the Smithfield Street Bridge, responded to Fleming's article with an indignant letter to the editor. Lindenthal cited examples of the use of the parabolic truss in Germany in 1857 and in England in 1859, saying that "it is obvious that the American patent was worthless."[23] Although the Berlin Iron Bridge Company did not have an exclusive claim to the construction of lenticular trusses, they popularized this efficient and unusual truss type.

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[22] Darnell, "Lenticular Bridges," 24.

[23] Gustav Lindenthal, letter to the editor, *Engineering News-Record* 100 (10 May 1928): 789.

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APPENDIX: Suggestions for Future Research

Some questions arose during the research and writing for the report on the Waterville Bridge that, due to limitations in the scope of the Pennsylvania Historic Bridges Recording Project - I, could not be answered. Scholars interested in this bridge are encouraged to pursue the following:

1. On the last day of the project, plans and a description of the moving process for the Waterville Bridge were obtained from the Bureau of Facility Design and Construction. These documents are included in the historians' field notes and are an important source of information that should be more fully explored.

2. Although contract documents and specifications were not available from Pennsylvania state government agencies, the Susquehanna Supply Company, contractor for the bridge relocation, might be able to supply this information.

3. Many of the people involved in the bridge move are still professionally active at this writing in 1997. Scholars interested in a more detailed exploration of any aspect of the Waterville Bridge relocation project are encouraged to mine this valuable resource.