Pennsylvania State Historic Preservation Office
PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION

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DEPARTMENT OF TRANSPORTATION

PA State Historic Preservation Office (PA SHPO) &

PA Department of Transportation (PennDOT)

Methodology for 2021 Reinforced Concrete Thru Girder Bridge Reevaluation

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Introduction

The PennDOT Historic Bridge Inventory and Evaluation, one of the earliest comprehensive inventories of historic highway bridges in the country when it was completed in 2001, identified bridges that meet the criteria for National Register of Historic Places (National Register) listing. This inventory considered all reinforced concrete thru girder bridges included in the 2001 inventory and in PennDOT's Bridge Management System (BMS2)[1] built between 1909 and 1945[2] with an opening greater than 20 feet.[3]

As part of mitigation for the replacement of the SR 1017 bridge over Kistler's Creek in Kempton, Berks County (MPMS 10588), A.D. Marble & Company undertook the cleanup of data and prepared contextual information on the reinforced concrete thru girder bridges. That effort was completed in February 2021 (Appendix A). This study identified 90[4] reinforced concrete thru girder bridges through the statewide bridge survey and BMS2. Forty-two (42) of these bridges are extant and 48 have been demolished as of February 2021, for a 54% loss[5] in the populations of reinforced concrete thru girder bridges. In consideration of this loss, PennDOT, in consultation with the Pennsylvania State Historic Preservation Office (SHPO), is now updating that inventory and evaluation with a focus on reinforced concrete thru girder bridges.

The methodology is based on continuing the approach outlined in a *Historic Context for Common Bridge Types in Pennsylvania* (1998) and the *Pennsylvania Historic Bridge Inventory and Evaluation* (A.G. Lichtenstein, 1999) with some updates and/or revisions based on recent scholarship. Several historic bridge inventories have been completed since 2001, most notably Indiana (2009) and Maryland (2011). These and other useful publications, including NCHRP's *A Context for Common Historic Bridge Types* (2005), were consulted in the refinement of the

[1] PennDOT's Bridge Management System or "BMS2" is a database used by PennDOT and FHWA that stores, updates, and reports on the physical and operating characteristics of road related structures in Pennsylvania, with bridges being the largest category of structures. BMS2 provides information such as location, features carried/crossed, owner, maintenance responsibility, posting status, structural capacity, load rating, inspection condition information, underwater inspection information and proposed/completed maintenance items. The database is updated daily.

[2] The bridge update does not apply to concrete bridges that became common types after 1945 and are therefore addressed by the ACHP Program Comment for Common Post -1945 Concrete and Steel Bridges.

[3] Pursuant to Stipulation II.D.1 of the Section 106 Federal Aide Programmatic, it is agreed by the signatories that most bridges less than 20 feet in length are categorically considered not individually eligible for the NRHP. The exceptions to this are covered bridges, stone arch bridges, and closed spandrel concrete arch bridges, which the parties to the agreement agreed could, under certain circumstances, possess individual significance. For consistency, bridges in BMS2 field 5E01 with a "Y – long enough" was used to determine which bridges were greater than 20 ft. in structure length.

[4] A.D. Marble initially included 92 bridges in their study. Four of these bridges were identified by the statewide survey as reinforced concrete thru girders, but A.D. Marble concluded they were a bridge type other than a reinforced concrete thru girder bridge. These four bridges were omitted from this study bringing the number of bridges to 88. Two (2) slab/girder hybrid bridges that were evaluated in the concrete slab reevaluation were added to this study for a final number of 90 bridges reevaluated.

[5] Many of these bridges are locally owned and their removal may not have been federally funded.

methodology.[6] The methodology is consistent with the 2017 metal truss bridge inventory update[7] which developed a point system for a consistent and replicable approach to determine the eligibility of a bridge regardless of its type, materials, features, or age. The methodology is a continuation of the point system outlined in the 2019 concrete arch bridge reevaluation[8] and the 2020 reinforced concrete slab bridge reevaluation and adapts the point system to assess eligibility of the reinforced concrete thru girder population.

As part of the update effort, bridges were only evaluated for National Register significance under Criterion C for engineering significance or relative to having high artistic merit. Population loss numbers were examined to understand rarity across the state and in regions (PennDOT engineering districts were utilized as representing a region[9]). In addition, evaluation criteria were developed for reinforced thru girder bridges based on the point system developed for the 2017 metal truss bridge reevaluation.

Bridges determined not eligible for the National Register during this inventory update: lack integrity due to alterations; are part of a remaining population that includes earlier and more complete examples; or are late examples of designs which do not possess engineering significance in Pennsylvania. Of the 41 remaining reinforced concrete thru girder bridges, 30 bridges are recommended not individually eligible after the bridge inventory evaluation.

Six (6) reinforced concrete thru girder bridges were identified as eligible or listed in the National Register during the 2001 statewide inventory. The 2021 reevaluation found that only four (4) of these bridges remain (a 20% loss in the eligible/listed population). The 2021 reevaluation identified 7 additional bridges as eligible for the National Register, bringing the number of eligible and listed reinforced concrete thru girder bridges to a total of 11.

In 2020, reevaluation of the reinforced concrete slab bridges identified two slab bridges described in BMS2 as "reinforced slab supported by reinforced concrete through-girder system" (Bridge Key # 2459 and # 8189). Upon further investigation of inspection reports, Mike Cuddy, a historic bridge engineer, concluded that these bridges are concrete encased steel thru girder bridges with an integral reinforced concrete slab and represent experimentation of early engineers to see how versatile and economical reinforced concrete could be, especially when experimenting with span lengths that exceeded what was normally anticipated for slab bridges. These

[6] The evaluation system is based on the application of National Register Criterion C. Although bridges may be eligible for the National Register under any of the National Register criteria, only Criterion C was considered for this reevaluation. Evaluation of significance under National Register Criterion A was not undertaken but notes were made when a need for evaluation of potential historic significance under Criterion A was identified. It was not practical or feasible to evaluate bridges for associative value under Criterion A or B as part of this effort. Criterion A assessments, including contributing status to historic districts, will be ongoing, and generally undertaken on a case-by-case basis during future Section 106 project reviews.

[7] https://www.penndot.gov/ProjectAndPrograms/Cultural%20Resources/Documents/metal-truss-survey-update-methodology-12-21-17.pdf.

[8] https://www.penndot.gov/ProjectAndPrograms/Cultural%20Resources/Documents/Historic%20Concrete%20Arch%20Bridge%20Methodology.pdf.

[9] PennDOT divides the Commonwealth into eleven Engineering Districts (Districts 1-6, 8-12) which are responsible for the state-maintained transportation network in that region.

bridges represent a distinctive method of construction that is rare. The reevaluation of the reinforced concrete thru girder bridge identified five additional slab/girder bridges (Bridge Key # 5907, # 8270, # 8216, # 8234, and # 28445). Because the concrete slab and girder reevaluations used different metrics to award points for early example of bridge type and early example in the statewide population and regional rarity, it was determined that all seven (7) of these combination slab/girder bridges would be evaluated under the same criteria as a subtype of the reinforced concrete thru girder bridge. Of these seven (7), three (3) of the combination slab/girder bridges are recommended eligible and are included in the 11 total eligible and listed reinforced concrete thru girders.

Research

In preparation for this inventory update, background research included an examination of the following sources and consultation with the following people:

- PennDOT's *Historic Context for Common Bridge Types in Pennsylvania* (1998)
- PennDOT's *Pennsylvania Historic Bridge Inventory and Evaluation* (1999)
- NCHRP's *A Context for Common Historic Bridge Types* (2005)
- Indiana *Historic Bridge Inventory: Volume* I: National Register Eligibility Results (2009)
- *Historic Highway Bridges in Maryland: 1631-1960, Historic Context Report* (1995)
- 1927-1928 plans in the *Standards for Old Bridges Volume 1*
- Methodology for 2017 Metal Truss Bridge Reevaluation
- Methodology for 2019 Concrete Arch Bridge Reevaluation
- Reinforced Concrete Slab Bridge Reevaluation
- Mike Cuddy, Historic Bridge Engineer, Transystems
- PennDOT Historic Bridge Survey database (2001)
- PennDOT Bridge Management System (BMS2)
- PA SHPO files related to bridges, including survey records, Historic American Engineering Record forms, nominations for National Register listing, and determinations of eligibility
- Google Maps/Google Earth.

Methodology for Reinforced Concrete Thru Girder Bridge Reevaluation

While the 2020 methodology used to reevaluate the slab bridges was streamlined from the earlier methodologies for the metal truss and concrete arch bridge reevaluations, there are fewer reinforced concrete thru girders to evaluate and many retain a higher level of integrity than the slabs, therefore, these bridges did not use the streamline methodology and each reinforced concrete thru girder bridge was evaluated in the same manner consistent with the metal truss bridge and concrete arch bridge reevaluation.

All reinforced concrete thru girder bridges were evaluated and points were awarded to bridges with the following features:

- Built before 1914 (early example of type)
- Built as an encased steel girder with integral reinforced concrete slab (method of construction)
- Built with a continuous design (a distinctive type)
- Early example in statewide population (Built in 1916 or earlier)
- Earliest example in each district
- Regionally Rare
- Exceptional span length (59 ft. or greater)
- Exceptional overall length (130 ft. or greater)
- Skew greater than 45 degrees
- Multiple spans
- Work of a master

A bridge must receive a minimum threshold of 13 points to be recommended eligible. Since the maximum number of points that can be awarded to bridges with high artistic value is 9 points, any bridge that was awarded a minimum of 4 points was also evaluated for artistic value.

Any bridge that received the minimum threshold of 13 points to be recommended eligible was then reevaluated for integrity using the point application for integrity.[10]

[10] This chart is based on the 2019 Concrete Arch Bridge evaluation.

Reinforced Concrete Thru Girder Point System

Category	Item	Subtype – Thru Girder	Subtype – Slab/Thru Girder	Points to Assign
1. Distinctive characteristics of type, period, or method of construction	A. Built before specified year	1914	1914	7
	B. Method of Construction	None noted	Concrete encased steel girder with integral reinforced concrete slab	7
	C. Distinctive type and/or uncommon type or Only known example in the state	Continuous Design	Continuous Design	7
	D. Early example in the state	1916	1916	7
	E. Early standard plan in the state	None noted		3
	F. Earliest example in PennDOT district	Earliest example in each district		4
	G. Rare – PennDOT Dist. (≤ 3 bridges)	Rare in Dist. 5,6,12 None in Dist. 1 or 4		3
2. Variation, evolution, and/or transition of a type	A. Exceptional length – main span	59 feet or greater		3
	B. Exceptional length – overall	130 feet or greater		3
	C. Special feature/ innovations - important or unusual	Skew more than 45 degrees Multiple spans		3
	D. Special feature/ innovations – highly important or unusual	None noted		4
	E. Outstanding technological achievement	Two or more examples of 2C above		7
3. High artistic value	A. Selected ornamentation	One example of ornamentation to include non-standard decorative railing, panel parapet, added decorative posts to parapet, pyramidal topped posts, bridge plaque, and rounded parapet ends giving a Moderne style		3
	B. Two or more examples of ornamentation or architectural treatment in overall design	Two of more examples from 3A above		6
4. Work of a Master	A. Prolific or Important Designer/Builder/Engineer	Frank H. Shaw, bridge engineer in Lancaster		3

Criterion C Point Application for Integrity[11]

The *Reinforced Concrete, Through Girder Bridges Contextual Information* compiled by A.D. Marble (Appendix A) notes four primary character defining features of the concrete thru girder bridge. The most notable is the monolithic deck/floor slab and girder system, with the girders visible from underneath. This is the key defining feature of a reinforced concrete thru girder bridge as the deck slab rests between the girders, creating a parapet wall above the deck, giving the bridge its form. Remaining primary features include the deck slab, which is carried between the girders, the girders, which serve as integrated railing or parapet system, and the recessed feature.

Few alterations can be made to a concrete thru girder bridge because of its monolithic and integral slab and girder system. Most integrity issues come from loss of original material through spalling, or repair of spalling through the application or coating that covers ornamentation. Other integrity issues include inappropriate repair or replacement of wingwalls and functional and safety improvements not in accordance with the SOI standards, such as attachment of guide rails to the parapet.

The chart below is used to evaluate the integrity of multiple bridge types (concrete arches, slabs, and girders) and examples provided may not be applicable to the reinforced concrete thru girder bridges. Please note the following in the chart below:

- in kind replacement refers to Secretary of the Interior's Standards for Rehabilitation, Standard 6: Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence. In character replacement is differentiated by being similar in size, material, detailing, and is visually compatible and does not detract from the overall historic appearance.
- Spalling that removes ornamentation was added for the concrete girder evaluation.

[11] Adopted from the Concrete Arch Bridge reevaluation and used for the concrete slab and concrete girder bridge reevaluation. Note that some features and examples may pertain to other bridge types and not girder bridges.

Level of Integrity Loss	Treatment	Treatment Details	Score
Level 0	Replacement in kind	Replacement in kind of primary and/or secondary character defining features and ornamentation such as: • Parapet, balustrade • Decorative features: lighting, brackets, medallions	-0
	Alterations/Additions	Application of coating/patching that does not cover ornamentation or with in kind replacement of ornamentation: • Scoring of spandrel wall or arch • Rustication	-0
Level 1	Replacement not in kind	Replacement of character defining features and ornamentation not in kind but in character such as: • Replacement of paneled parapets with solid parapet • Replacement of historic lighting with modern lighting that replicates historic feel	-1
	Alterations/Additions	Limited application of patch coating that covers decorative features or ornamentation • Large areas of spalling or loss of material (See level 3 Loss for spalling that results in the loss of ornamentation such as paneling detail)	-1
Level 2	Alterations/Additions	Removal of secondary character defining features and ornamentation such as: • Lighting • brackets	-2
	Two or more examples from the Level 1 Integrity loss category		-2

Level 3	**Alterations/Additions**	**Removal of Character defining features such as:** • **parapet (without addition of new parapet or guide rails)**	**-3**
		Application/addition of ornamentation not in character such as: • Non-historic scoring pattern	-3
		Functional and Safety Improvements not in accordance with the SOI Standards • Minor widening that does not obscure construction method (arch and spandrel wall are still visible) • Application of coating that obscures ornamentation (Spalling that results in the loss of ornamentation such as paneling detail)	-3
	Two or more examples from the Level 2 Integrity loss category		-3
Level 4	Replacement not in kind	Inappropriate replacement of parapet that is not in character such as: • Replacement of balustrade with solid parapet • Alteration of parapets by infilling balustrade with concrete	-5
	Additions/Alterations	Strengthening not in accordance with the SOI Standards: • Strengthening of spandrel walls through application of tie rods that are visually prominent	-5
		Functional and Safety Improvement not in accordance with the SOI Standards • Major widening that doubles the size of the deck or more without obscuring the original construction method (arch and spandrel walls are visible) • Attachment of guide rails to the spandrel wall	-5
	Two or more examples from the Level 3 Integrity loss category		-5

Level 5	Additions/Alterations	Functional and Safety Improvement not in accordance with the SOI Standards • Any widening that either doubles the size of the deck or obscures the original construction method (arch and spandrel walls are not visible) • Application of coating that obscures outstanding ornamentation	**-7**
	Two or more examples from the Level 4 Integrity loss category		-7
Level 6	Additions/Alterations	Strengthening not in accordance with the SOI • Removal of concrete support structures and replacement with metal • Enclosing open spandrel with concrete	-10
	Two or more examples from the Level 5 Integrity loss category		-10

Results of Reinforced Concrete Thru Girder Bridge Reevaluation

The Reinforced Concrete Thru Girder Bridge Reevaluation resulted in eleven bridges being recommended as eligible for listing in the National Register of Historic Places. This includes four bridges that are slab/girder combination bridges. Of these eleven bridges, four bridges were determined eligible in the 2001 statewide bridge survey. This section presents the eleven bridges recommended eligible for listing in the National Register of Historic Places as a result of the 2021 Reinforced Concrete Thru Girder Bridge Reevaluation.

Bridge Name:	SR 1053 Peartown over Cocalico Creek
County:	Lancaster
Municipality:	West Cocalico
PennDOT District #:	8
Bridge Key #:	21483
PA-SHARE #:	Resource # 2004RE05459
Year Built:	1909
History:	This bridge was determined eligible in the 2001 statewide bridge inventory. It is the oldest reinforced concrete thru girder bridge in the survey. PennDOT's Bridge Management System notes this bridge is concrete continuous. It is assumed this means the bridge is a continuous design and points were awarded for an unusual method of construction. The bridge has two spans with paneled girders serving as parapets. The 2001 statewide bridge inventory notes this is built by County Engineer F. H. Shaw who favored this design and used it throughout the Lancaster area and reports this bridge as an early prototype example of a reinforced concrete thru girder by Shaw and contractors Nelson & Merydith of Chambersburg.
Reevaluation Recommendation:	Remain eligible
Total Points:	34
Points Received:	Received 34 points for: • Early example of type (built before 1914) • Unusual method of construction (continuous design) • Early example in statewide population (built before 1916) • Earliest example in District 8 • Multiple spans • Select ornamentation (paneled girders/parapet) • Work of a Master (Frank H. Shaw)

Points Deducted:	No points deducted for loss of integrity
Photograph:	 Source: PennDOT Inspection Report
Photograph:	 Source: PennDOT Inspection Report

Bridge Name:	PA 616, SR 0616 over South Branch Codorus Creek
County:	York
Municipality:	Shrewsberry
PennDOT District #:	8
Bridge Key #:	37606
PA-SHARE #:	Resource # 2004RE08322
Year Built:	1910
History:	This bridge is a skewed example of a reinforced concrete thru girder bridge. This early bridge exhibits paneled girders which act as parapets. The bridge was strengthened in 1970 by the placement of H piles with steel cap beams under the bridge. The 2001 statewide survey notes that this strengthening does not affect the bridge's appearance or integrity of original design because they are reversible and do not distract from the bridge's engineering significance. The bridge is structurally associated with the National Register listed Northern Central Railway Bridge 182+42 stone arch bridge. (Bridge Key # 37605, Resource # 1982RE00541)
Reevaluation Recommendation:	Remain eligible
Total Points:	20
Points Received:	Received 20 points for: • Early example of type (built before 1914) • Early example in statewide population (built before 1916) • Exceptional skew • Select ornamentation (paneled girders/parapet)
Points Deducted:	No points deducted for loss of integrity

Photograph:	 Source: PennDOT Inspection Report
Photograph:	 Source: PennDOT Inspection Report

Photograph:	 Source: PennDOT Inspection Report

Bridge Name:	T-422 County Bridge #E TR 422 over Limestone Run
County:	Montour
Municipality:	Limestone
PennDOT District #:	3
Bridge Key #:	28451
PA-SHARE #:	Resource # 2004RE04238
Year Built:	1913
History:	This bridge exhibits girders with incised paneled that serve as parapets. The bridge is an early example of a reinforced concrete thru girder bridge and is the earliest reinforced concrete thru girder in District 3. The 2001 statewide bridge survey notes that this bridge is built by Nelson & Merydith, a instate bridge builder.
Reevaluation Recommendation:	Eligible
Total Points:	21
Points Received:	Received 21 points for: • Early example of type (built before 1914) • Early example in statewide population (built before 1916) • Earliest example in District 3 • Select ornamentation (incised girders/parapet)
Points Deducted:	No points deducted for loss of integrity • Application of coating/patching that does not cover ornamentation (Level 0 Integrity Loss)
Photograph:	 Source: PennDOT Inspection Report

Photograph:	 Source: PennDOT Inspection Report

Bridge Name:	SR 1017 (LR 06172) Stumps Bridge over Kistler Creek
County:	Berks
Municipality:	Albany
PennDOT District #:	5
Bridge Key #:	4982
PA-SHARE #:	Resource # 2004RE00179
Year Built:	1913
History:	This bridge was determined eligible in the 2001 statewide bridge evaluation as one of the largest examples of its type in the region and as the earliest example in the county. This 2 span bridge exhibits girders with decorative panels that serve as parapets and are topped with pipe railing. This early bridge is rare in District 5 which has three or less reinforced concrete thru girder bridges.
Reevaluation Recommendation:	Remain eligible
Total Points:	26
Points Received:	Received 27 points for: • Early example of type (built before 1914) • Early example in statewide population (built before 1916) • Earliest example in District 5 • Regionally Rare (District 5) • Select ornamentation (paneled parapet/girders)
Points Deducted:	Deduction of 1 point for Level 1 Integrity Loss: • Large areas of spalling (Level 1 Integrity Loss)
Photograph:	 Source: PennDOT Inspection Report

Photograph:	 Source: PennDOT Inspection Report
Photograph:	 Source: PennDOT Inspection Report

Bridge Name:	On TSR 999 Trout Run Road over Trout Run
County:	Clearfield
Municipality:	Goshen
PennDOT District #:	2
Bridge Key #:	11654
PA-SHARE #:	Resource # 2004RE01973
Year Built:	1914
History:	This bridge was determined eligible in the 2001 statewide bridge evaluation as one of the oldest and most complete examples in northern Pennsylvania (Districts 1, 2, 3 & 4), and one of the oldest of six identified examples from 1914 to 1919 in Clearfield County. This bridge exhibits girders with decorative panels that serve as the parapet and a bridge plaque. This is the earliest example of a reinforced concrete thru girder bridge in District 2. The bridge rests on stone abutments which may have been from an earlier bridge.
Reevaluation Recommendation:	Remain eligible
Total Points:	17
Points Received:	Received 17 points for: • Early example in statewide population (built before 1916) • Earliest example in District 2 • Multiple ornamentation (paneled parapet/girders and bridge plaque)
Points Deducted:	No points deducted for loss of integrity

Photograph:	 Source: PennDOT Inspection Report
Photograph:	 Source: PennDOT Inspection Report

Photograph:	 Source: PennDOT Inspection Report

Bridge Name:	T481 Black Rock Rd over West Branch Octoraro Creek
County:	Lancaster
Municipality:	Colerain
PennDOT District #:	8
Bridge Key #:	21869
PA-SHARE #:	Resource # 2004RE08677
Year Built:	1921
History:	This bridge is an example of a skewed reinforced concrete thru girder bridge. This multiple span bridge exhibits girders with decorative panels that serve as parapets.
Reevaluation Recommendation:	Eligible
Total Points:	13
Points Received:	Received 13 points for: • Exceptional Skew • Multiple Spans • Select ornamentation (paneled parapet/girders)
Points Deducted:	No points deducted for loss of integrity • Patching or coating that does not cover ornamentation (Level 0 Integrity Loss)

Photograph:	 Source: PennDOT Inspection Report
Photograph:	 Source: PennDOT Inspection Report

Bridge Name:	McDowell Lane over Chartiers Creek[12]
County:	Washington
Municipality:	North Strabane
PennDOT District #:	12
Bridge Key #:	35315
PA-SHARE #:	Resource # 2004RE03338
Year Built:	1943
History:	This 3-span bridge is the only reinforced concrete thru girder bridge located in District 12 making it the earliest in the region and regionally rare. The bridge is a continuous design which is a distinctive and uncommon type. This multiple span bridge exhibits girders with decorative panels that serve as parapets.
Reevaluation Recommendation:	Eligible
Total Points:	22
Points Received:	Received 23 points for: • Distinctive and Uncommon type (Continuous Design) • Earliest example in District 12 • Regionally Rare (District 12) • Exceptional span length (Span 59 ft or greater) • Multiple Spans • Select ornamentation (paneled parapet/girders)
Points Deducted:	Deduction of 1 point for Level 1 Integrity Loss: • Large areas of spalling (Level 1 Integrity Loss)

[12] This bridge was demolished shortly after finalization of the reevaluation.

Photograph:	 Source: PennDOT Inspection Report
Photograph:	 Source: PennDOT Inspection Report

	 Source: PennDOT Inspection Report

Slab/Girder Combinations

The 2020 reinforced concrete slab reevaluation identified two bridges (Bridge Key # 2459 and 8189) as a slab/girder combination. The 2021 reinforced concrete thru girder reevaluation identified five additional slab/girders. Further research concluded that slab/girder combination bridges represent experimentation of early engineers to see how versatile and economical reinforced concrete could be, especially when experimenting with length. Slab/girder combinations bridges represent a distinctive method of construction that is rare. It was determined to evaluate all seven of the slab/girder combination bridges using the same methodology. The bridges were evaluated under the reinforced concrete thru girder bridge methodology and the following four slab/girder bridges were recommended eligible for listing in the National Register of Historic Places. Note that both Bridge Key # 2459 and 8189 were recommended eligible under the 2020 reinforced concrete slab reevaluation as well.

Bridge Name:	Timberland Ave over Saw Mill Run Creek
County:	Allegheny
Municipality:	Pittsburgh
PennDOT District #:	11
Bridge Key #:	2459
PA-SHARE #:	Resource # 2004RE00031
Year Built:	1909
History:	This bridge is not a typical slab or girder bridge. It is listed in BMS2 as having a span design of "other" and inspection reports describe it as a "reinforced slab supported by reinforced concrete through-girder system." It is one of two bridges found in the 2001 statewide inventory of slabs with this description in BMS2. The other is Bridge Key # 8189. Through investigation of inspection reports, Mike Cuddy, a historic bridge engineer, concluded that these two bridges are concrete encased steel thru-girder bridges with an integral reinforced concrete slab and represent experimentation of early engineers to see how versatile and economical reinforced concrete could be especially when experimenting with span lengths that exceeded what was normally anticipated for slab bridges. The bridge looks like it has been closed for a long time and appears to carry a utility line. This bridge was previously determined eligible in the 2001 statewide inventory. This bridge was also determined eligible under the concrete slab bridge reevaluation.[13] This is both an early and complete example of a concrete slab/girder bridge with an unusual method of construction.

[13] This bridge received 24 points in the slab evaluation for early example of type, unusual method of construction (concrete encased steel girder with integral reinforced concrete slab), early example in statewide population, and earliest example in District 11. One point was deducted for a Level 1 Integrity loss (large areas of spalling or loss of material).

Reevaluation Recommendation:	Remain eligible
Total Points:	20
Points Received:	Received 21 points for: • Early example of type (built before 1914) • Unusual method of construction (Concrete encased steel girder with integral reinforced concrete slab) • Early example in statewide population (built before 1916)
Points Deducted:	Deduction of 1 point for Level 1 Integrity Loss • Large areas of spalling (Level 1 Integrity Loss)
Photograph:	 Source: PennDOT Inspection Report

Photograph:	 Source: PennDOT Inspection Report

Bridge Name:	Boot Jack Road Over Conestoga River
County:	Lancaster
Municipality:	Caernarvon
PennDOT District #:	8
Bridge Key #:	21854
PA-SHARE #:	Resource # 2004RE00952
Year Built:	1914
History:	This bridge is an early example in the state. The bridge has select ornamentation with paneled parapets and thick concrete above the paneling. The bridge is the work of a master having been built by F. H. Shaw, a prolific Lancaster County bridge engineer. The bridge has some small areas of spalling and has been coated, however the application does not cover ornamentation and the spalling is minimal, therefore 0 points are deducted for integrity loss. The bridge rests on stone abutments which may date to an earlier bridge.
Reevaluation Recommendation:	Eligible
Total Points:	13
Points Received:	Received 13 points for: • Early example in statewide population (built before 1916) • Select ornamentation (paneled parapet with thicker concrete section above) • Work of a Master (Frank H. Shaw)
Points Deducted:	No points deducted for loss of integrity • Application of coating/patching that does not cover ornamentation (Level 0 Integrity Loss)
Photograph:	 Source: PennDOT Inspection Report

Photograph:	 Source: PennDOT Inspection Report
Photograph:	 Source: PennDOT Inspection Report

Bridge Name:	T-463 Etna Furnace over Roaring Run
County:	Blair
Municipality:	Catharine
PennDOT District #:	9
Bridge Key #:	5907
PA-SHARE #:	Resource # 2004RE04819
Year Built:	1914
History:	This bridge is identified in the 2001 statewide bridge survey and in BMS2 as a slab, but inspection reports describe the bridge as a concrete slab and concrete girder structure. This is one of 7 bridges identified in the concrete slab and the girder reevaluation as a concrete slab girder hybrid. During the concrete slab reevaluation, Mike Cuddy, a historic bridge engineer, concluded that these bridges represent experimentation of early engineers to see how versatile and economical reinforced concrete could be especially when experimenting with span lengths that exceeded what was normally anticipated for slab bridges. Two of these bridges were identified in the concrete slab reevaluation and were awarded points as a method of construction. Five additional bridges were identified in the concrete girder reevaluation. All seven bridges were reevaluated using criteria under the girder revaluation. This bridge has a bridge plaque. It was noted in the 2001 Statewide Bridge Survey that this bridge has raised panel parapets with pyramidal topped posts placed on the shallow cantilevered deck section. There is a shear detail where the deck meets the abutments, which the survey called a common period design, however this was not seen often in the reevaluation and therefore was awarded points for multiple ornamentation.
Reevaluation Recommendation:	Eligible
Total Points:	23
Points Received:	Received 23 points for: • Unusual method of construction (Concrete encased steel girder with integral reinforced concrete slab) • Early example in statewide population (built before 1916) • Multiple ornamentation (paneled girders/parapet with pyramidal topped posts, bridge plaque)
Points Deducted:	No points deducted for loss of integrity

Photograph:	 Source: PennDOT Inspection Report
Photograph:	 Source: PennDOT Inspection Report

Photograph:	 Source: PennDOT Inspection Report

Bridge Name:	T-578 Shuler Road over Little Buffalo Run
County:	Butler
Municipality:	Clearfield
PennDOT District #:	10
Bridge Key #:	8189
PA-SHARE #:	Resource # 2004RE11244
Year Built:	1915
History:	This is the second slab/girder hybrid bridge identified and evaluated under the concrete slab reevaluation. It is recorded in BMS2 as having a span design of "other" and inspection reports describe it as a "reinforced slab supported by reinforced concrete through-girder system." The bridge was determined eligible in the concrete slab reevaluation.[14] Under the concrete girder reevaluation, the bridge continues to be an early example of concrete slab/girder hybrid bridge, an unusual method of construction.
Reevaluation Recommendation:	Eligible
Total Points:	16
Points Received:	Received 17 points for: • Unusual method of construction (Concrete encased steel girder with integral reinforced concrete slab) • Early example in statewide population (built before 1916) • Select ornamentation (bridge plaque)
Points Deducted:	Deduction of 1 point for Level 1 Integrity Loss: • Large areas of spalling (Level 1 Integrity Loss)

[14] This bridge received 13 points in the slab evaluation for unusual method of construction (concrete encased steel girder with integral reinforced concrete slab), earliest example in District 10, and select ornamentation (Bridge Plaque). One point was deducted for a Level 1 Integrity loss (large areas of spalling or loss of material.

Photograph:	 Source: PennDOT Inspection Report
Photograph:	 Source: PennDOT Inspection Report

Photograph:	 Source: PennDOT Inspection Report

APPENDIX A: Reinforced Concrete, Through Girder Bridges Contextual Information

Prepared by A.D. Marble, February 2021

Introduction

The purpose of this contextual information is to provide a framework to assist the Pennsylvania State Historic Preservation Office (PA SHPO) and Pennsylvania Department of Transportation (PennDOT) in their efforts to complete a National Register of Historic Places (National Register) eligibility reevaluation of Pennsylvania's reinforced concrete, through girder bridges. As part of the data gathering, searches of PennDOT's Bridge Management System (BMS2) were conducted in September and December 2020, and February 2021, which revealed that only 40 of these bridges remain extant throughout the state; nine are maintained by PennDOT, while 31 are maintained locally by counties or municipalities. This is a drastic decrease from A.G. Lichtenstein & Associate's (herein, Lichtenstein & Associates) statewide bridge inventory (1999), which identified 89 bridges of this type throughout the state, although it should be noted that 14 of those are classified as a different bridge type (e.g., concrete slab, concrete T-beam) in BMS2.[15] The data presented in the Excel-format bridge matrix accompanying this document was collected from PennDOT's BMS2 system, bridge inspection reports and photographs, Lichtenstein & Associates' bridge inventory, and CRGIS. The matrix includes a separate sheet for extant and demolished bridges, as well as a third sheet for those that Lichtenstein & Associates identified as reinforced concrete, through girder bridges but are classified as a different bridge type in BMS2. The remainder of the context summarizes information gathered from a variety of sources, as listed in the bibliography.

Important Technology/Features

Reinforced concrete, through girder bridges (also denoted as "thru-girder") are a type of reinforced concrete slab bridge, which finds its origins in prehistory, with early examples using stone. The advent of concrete and steel reinforcement bars (commonly known as "rebar"), two separate but important technological advances, brought about the subsequent development and construction of reinforced concrete bridges. The combination of portland cement and advances in steel reinforcement bars allowed engineers to create the poured-in-place reinforced concrete, through girder bridges, which could perform well under both compressive and tensile stresses.

Concrete has long been used as a building material; the Romans are thought to be the inventors of the material, though their formula was different than modern concrete (Wayman 2011). Portland cement was initially

[15] Although the Lichtenstein study was begun in the 1990s, it was not completed until 2001. Each of the 89 reinforced concrete, through girder bridges identified by Lichtenstein & Associates was searched for in PennDOT's BMS2 database. The "Structure Home" page for each of these 14 bridges, as well as available inspection reports, classified them as a different bridge type. See "Not Through Girders" sheet of the Excel Matrix for more information. It should also be noted that BR Key #8189, T-578 over Little Buffalo Run in Butler County, was reevaluated in 2020 as part of the Concrete Slab Bridge Reevaluation as it was classified in BMS2 as "other" but referred to in inspection reports as a "reinforced slab supported by reinforced concrete through-girder system."

invented in England. Portland cement differs from natural rock cement in that it is made from artificial sources of lime, gypsum, and other materials and is then heated to a higher temperature than that used in making natural rock cement (Edison Coatings, Inc.). In the United States, the Copley Cement Company, established in 1866 in Lehigh County, Pennsylvania, began to experiment with producing portland cement from rocks in their quarry in the early 1870s. The portland cement the Copley Cement Company was making was harder and stronger than the natural rock cement being produced around the country and less expensive than the portland cement that was imported from England and Germany. The Copley Cement Company's production process was refined, and American-made portland cement was available for purchase in 1875 (Harakal).

Roughly a decade later, Ernest L. Ransome, a noted California engineer, patented the first deformed steel reinforcement bar in 1884. The Ransome bar was a square twisted rod designed to create more surface area for adhesion. Different kinds of deformations in the steel bars were tested to see which allowed better adhesion between the concrete and metal to create a stronger bond. Edwin Thatcher, a civil engineer who specialized in steel-reinforced concrete construction, patented an improved reinforcing bar in 1899. The Thatcher bar had "longitudinally oriented cross-shaped deformations integrally formed on the upper and lower surface" (P.A.C. Spero & Company 1995:146-147). Adding steel rebar to portland cement allowed for stronger design loads, as well as longer spans, than unreinforced concrete. Laying out a system of rebar in the concrete during the pouring process allowed the steel's stronger tensile strengths to supplement the portland cement's lack of tensile strength, while the natural acidity in the cement protected the steel from carbonization and deterioration (Ronacrete 2020).

Early Development and Construction

Reinforced concrete bridges were still a relatively new technology when through girder bridges began to appear in the early 1900s. The first reinforced concrete bridge in the United States was the arched San Francisco Alvord Lake Bridge in 1889, designed by Ernest Ransome (Brinckerhoff 2005:3-56; Harrison 2019). The first "reinforced" concrete girder bridge in the country was built in Pittsburgh, Pennsylvania, in 1898. This 28-foot-long bridge located on Evergreen Road in Pittsburgh, was designed by F. W. Patterson, Allegheny County engineer and member of the League of American Wheelmen. The bridge was not a through girder type, but rather a series of steel I-beams encased in concrete with a jack-arch floor, a design that would help pave the way for through-girder and slab bridges. Research was unable to confirm whether it remains extant. Additionally, concise details of how the technology made its way to Pittsburgh could not be located through research, although it is presumed that F.W. Patterson, as an engineer, was cognizant of such technological developments (Frame 1988:D-6; Historic Documentation Company Inc. 2010:2.2-2.3; *Pittsburgh Press* 1897:3). The increased understanding of economical and practical placement of steel reinforcement bars within concrete structures led to the rise in the use of slab, T-beams, and girder bridges around the turn of the twentieth century. The type of bridge design used in a specific location was ultimately chosen based on factors like overhead clearance, span length, traffic accommodation, and ease and economy of construction. Reinforced concrete, through girder bridges, "represent the experimentation that characterizes the early days of reinforced concrete bridges" (Lichtenstein & Associates 1997:13). Through girder bridges are relatively simple to construct and were most frequently used to cross small spans. They are differentiated from other reinforced concrete bridges in the way the floor slab is carried *between* the girders, which act as parapet walls/railings giving the bridge an H-shaped cross-section (Frame 1988:D-8). Unfortunately, because of their constrained design, they are hard to alter (Brinckerhoff 2005:3-93; Frame 1988:D-8).

By 1928, George A. Hool, an authority on reinforced concrete bridge construction, advised that "from the standpoint of economy, the thru girder bridge should not be built except where insufficient head-room or other local conditions prevent the use of the deck girder [T-beam]" (Lichtenstein & Associates 1998b:1). Despite Hool's advice, through girder bridges experienced their height of popularity from 1920 through 1939, even though Lichtenstein & Associates wrote that they were "one of the least successful standardized reinforce[d] concrete bridge types developed during the first decade of the 20th century" (Frame 1988:D-8; Chase 2015:57; Lichtenstein & Associates 1998b:1). Their popularity was largely driven by the expanding highway and railroad systems across the United States (Chase 1995:57; Brinckerhoff 2005:2- 26). After World War II, through girder bridges largely fell out of fashion for heavily traveled roads as the highway system across the country continued to expand. This was partly due to the fact that the width of through girder bridges is generally limited to 25 feet and cannot be easily altered after original construction, whereas other types of bridges allowed for wider roadways, as well as future widening, to accommodate more traffic (Frame 1988:D-8). Through girders also fell out of favor as new technology like steel I-beams and precast concrete slabs rose to prominence; the latter were more cost-efficient because they did not require the framework and scaffolding needed for the through girder bridges to be cast in place (Chase 2015:57). Despite their loss in popularity, reinforced concrete, through girder bridges continued to occasionally be used on smaller, less-traveled rural roads (Frame 1988:D-8).

In Pennsylvania, reinforced concrete, through girder bridges were built across the state in the first half of the twentieth century with at least one located in 25 of the state's 67 counties (Lichtenstein & Associates 1999). The earliest reinforced concrete, through girder bridges in Pennsylvania appear to have been built in Lancaster County (BR Key #21483 and #22059) and Allegheny County (BR Key # 2459) in 1909 (Lichtenstein & Associates 1999; PennDOT var.).[16] A high incidence of the bridge type appeared in Lancaster County prior to 1925 (24 examples surviving as of 1997-1999), 20 of which were designed by the county engineer, Frank H. Shaw; only eight of these bridges remained extant in 2020. Butler County also had a high incidence of this bridge type, with 16 identified by Lichtenstein & Associates; eight remained extant as of 2020. Several through girder bridges also appeared in Blair County (six), Clearfield County (five), Berks County (five), Montour County (three), and York County (three). The other 18 counties appear to have only constructed one or two reinforced concrete, through girder bridges. While the vast majority of the bridges were constructed in 1931 or earlier, the newest, which is still in use, was constructed in 1943 by Washington County to carry S.R. 7220 over Chartiers Creek (BR Key #35315; Lichtenstein & Associates 1999; PennDOT).

Major Engineers/Builders Associated with Reinforced Concrete, Through Girder Bridges

Few companies operating in the early twentieth century had the distinction of being statewide engineering firms, contractors, and/or builders. Counties, townships, cities, and boroughs that built the majority of the

[16] Lichtenstein & Associates also include BR Key #42700, Dark Hollow Road over Tohickon Creek in Bucks County, constructed in 1906, on their list of reinforced concrete, through girder bridges, although PennDOT's BMS2 system indicates it was a concrete solid spandrel arch bridge, which appears to be confirmed by the photos available in CRGIS. The bridge was demolished ca. 2004 (Lichtenstein & Associates 1999; PA SHPO var.; PennDOT var.).

reinforced concrete, through girder bridges within the state generally utilized their government-appointed engineers to design the structures and issued calls for construction bids in regional newspapers.[17] Often, a plaque describing the date of construction, the county commissioners, county clerk, engineer of record, and/or the builder/contractor was placed onto the finished bridge.

Because only about half of the through girder bridges identified in the late 1990s remain extant, Lichtenstein & Associates' master bridge inventory (1999) was reviewed to develop a list of major engineers and builders of this bridge type.[18] Four engineers were listed as the designers of two or more through girder bridges; only one, James B. Long, designed bridges in more than one county. Similarly, five construction companies have been identified as having constructed two or more through girder bridges, only two of which built through girder bridges in multiple counties: Ferro Concrete Company (Cumberland, Indiana, and Lancaster counties) and Nelson & Merydith (Lancaster and Montour counties). A list of the four engineers and five contractors that constructed two or more bridges of this type is provided below; information about the engineer/company is provided when possible.

Engineers:

Frank H. Shaw

Frank H. Shaw served as the county engineer, as well as water superintendent, of Lancaster County (*Lancaster New Era* 1911:2; U.S. Bureau of the Census 1910). He is known to have designed 20 through girder bridges in Lancaster County that date from 1909 to 1925, six of which are extant (Lichtenstein & Associates 1999; BR Key #22013, #21378, #21964, #21913, #21854, #21483).

James B. Long

James Blair Long was an engineer from Norristown (U.S. Bureau of the Census 1920; *Lewisburg Journal* 1927:1). He served as county engineer for Adams County (*New Oxford Item* 1920:3). Long is best known as the engineer of record on the multi-arched concrete Columbia-Wrightsville Bridge that spans the Susquehanna River, linking York and Lancaster counties (Semmer 1997:4). Long designed two through girder bridges: one in Union County (1919) and one in Adams County (1922). The S.R. 1005 Latimore Creek bridge in Adams County is his only extant through girder bridge (Lichtenstein & Associates 1999; BR Key #174).

Walter Frick

Walter Frick was elected city engineer of Carbondale in 1890. He served in that capacity for at least three, three-year terms (Kingsley 1897:232). By 1903, he moved to Lewisburg and was elected borough engineer on May 2, 1910, and served in that capacity until his resignation on November 5, 1945 (*Lewisburg Journal* 1903:1, 1910:1,

[17] Although Lichtenstein & Associates' master bridge inventory indicates that nearly half of the reinforced concrete, through girder bridges extant in 1997-1998 were maintained by PennDOT, it is likely that many of those were designed and constructed at the local level, and later transferred to PennDOT's jurisdiction. For example, of the 24 bridges listed in Lancaster County, 20 were designed by F.H. Shaw, the county engineer (A.G. Lichtenstein & Associates 1999).

[18] Seventy-five is the number of through girders remaining from Lichtenstein & Associates list after the 14 that are classified as a different bridge type in BMS2 are subtracted.

1945:5). He is known to have designed two reinforced concrete, through girder bridges in Union County. The S.R. 7027 over Sweitzer Run bridge (BR Key #33599) in Limestone Township is his only extant bridge of this type. It differs from the other 39 extant through girders by featuring incised rectangular panels on the exterior faces of the parapets, and a concave-like profile on the inner faces (Lichtenstein & Associates 1999; PennDOT var.).

R.B. McKinnon

R.B. McKinnon was a civil engineer and surveyor working in York County (*York Dispatch* 1911:1). He also severed as York's city engineer from about 1900 through 1914 (*The York Daily* 1900:3; *York Dispatch* 1915:2). McKinnon is known to have designed two through girder bridges, both located in York County. Both bridges are small (33 and 34 feet long, respectively), built in 1927, and still extant (Lichtenstein & Associates 1999; BR Key #38059, #38230).

Contractors:

Nelson & Merydith

Nelson & Merydith was a bridge-building company based out of Chambersburg, Pennsylvania, that was founded as Nelson & Buchannan in 1883 by Thomas M. Nelson and Andrew Buchanan. The firm was one of the most popular in Pennsylvania, designing and/or constructing bridges for county and municipal governments from the late 1880s to the mid-1910s. Nelson & Buchanan was renamed when Thomas Nelson's son, Alexander Nelson, and Edward Merydith took over in 1906. The company continued to operate independently through the 1910s and built a large body of standardized reinforced concrete bridges (Lichtenstein & Associates 1998 c:2). Nelson & Merydith were identified as contractors on five through girder bridges built from 1908 to 1913, and they worked with Frank H. Shaw on three of those bridges. They built two bridges in Montour County and three in Lancaster County. Only the S.R. 7205 bridge over Limestone Run in Montour County remains extant (Lichtenstein & Associates 1999; BR Key #28451).

J. Miller Eschelman

J. Miller Eschelman was a concrete construction contractor working in Lancaster County and surrounding areas. Eschelman built five through girder bridges, all of which were located in Lancaster County. The bridges were built between 1917 and 1923, and were all fairly large in size, ranging from 59 to 86 feet in length. All of the bridges have been demolished (Lichtenstein & Associates 1999).

J.D. Fleming

Joseph D. Fleming was a contractor working in and around Butler County. Fleming built four through girder bridges, all located in Butler County. They were small- to moderately sized bridges, ranging from 25 to 38 feet long, and were built from 1911 to 1915; none of the bridges remain extant (U.S. Census of the Bureau 1930; Lichtenstein & Associates 1999).

Ferro-Concrete Company (Harrisburg)

The Ferro-Concrete Company, named after the original name for reinforced cement, "ferrocement," was a company based in Harrisburg specializing in concrete construction. The company was started in August 1907 with offices in the Union Trust Company building. The firm was comprised of George H. Dunham, John F.

Whittaker, and D. L. Diehl (The Constructor; *Harrisburg Telegraph* 1908:3). The bridge inventory by Lichtenstein & Associates (1999) lists the Ferro-Concrete Company as the contractor for three bridges across the state, one each in Cumberland, Indiana, and Lancaster counties. All the bridges have been demolished.

W. H. Drawbaugh

Walter. H. Drawbaugh, of Dover, Pennsylvania, was a contractor working in Adams and York counties from about 1918 to about 1940 (*York Daily Record* 1923:7; *Harrisburg Telegraph* 1918:4; *Gettysburg Times* 1940:1). Drawbaugh was the contractor for the 1922 S.R. 1005 bridge over Latimore Creek in Adams County (BR Key #174). He also served as contractor for the 1927 S. R. 7229 bridge over Tributary Conewago Creek in York County (BR Key #38230). Both of these bridges are extant.

Standardization

Standardization of bridge designs increased through the late-nineteenth century and into the early-twentieth century as professionally trained engineers and architects emerged (Lichtenstein & Associates 1997:12). While some states, such as Wisconsin and Illinois, adopted the reinforced concrete, through girder bridge as a standard design, Pennsylvania's State Highway Department preferred T-beams and slabs as early standard designs (Lichtenstein & Associates 1997:11-13, 1998b:2). None of the reinforced concrete, through girder bridges identified as part of the research for this effort were confirmed to have been designed by the State Highway Department.[19] At the local level, bridge design and construction in rural areas was often the domain of appointed or elected county commissioners (larger bridges) or township supervisors (smaller bridges and culverts), while more populous counties had elected or appointed county engineers who managed bridge design and construction. Smaller, rural townships and municipalities did not frequently have the budget to hire bridge-building companies and engineers (Lichtenstein & Associates 1998a:27).

Due to the nature of design of the reinforced concrete, through girder bridge type, the basic shape and construction methods of the superstructure generally remained consistent throughout the state; most variations among the examples lie in the piers (when multiple span), abutments, and wingwalls, as well as the parapet design, which tend to have some form of recess to help reduce the parapets' weight (NCDOT 2020). As implied above, research indicated that Pennsylvania's State Highway Department (later, Department of Transportation) never developed a standard plan for the reinforced concrete, through girder bridge type (PennDOT 1983, 2019a, 2019b). Lancaster and Butler counties are the only two counties that appear to have embraced the bridge type, constructing at least 24 and 16, respectively. Butler County appears to have developed a standardized plan, as seven of the eight extant bridges reflect the same parapet design of a simple, rectangular box form with a recessed rectangular outline on the inner and outer faces. The extant bridges in Lancaster County, however, reflect a variety of parapet designs, perhaps indicating experimentation rather than standardization. Overall, the

[19] Two bridges classified by Lichtenstein & Associates as through girders, S.R. 3012 over Blair Gap Run (BR Key # unknown) and S.R. 1038 over Pittsburgh & Shawmut Railroad (BR Key #3156), were designed by the State Highway Department. However, Lichtenstein & Associate's eligibility summary for S.R. 3012 over Blair Gap Run refers to the bridge as a concrete slab, and their eligibility summary for S.R. 1038 over Pittsburgh & Shawmut Railroad notes the bridge is a combination of steel through girder, concrete T-beam, and deck girder spans. Inspection reports were unable to be located for either of these bridges so their designs could not be confirmed. Based on Lichtenstein & Associates' summaries, which do not identify the bridges as through girders, they are not being considered in this discussion.

extant through girder bridges do exhibit some regional and local variations in the design of the parapets. As with those in Butler County, through girder bridge parapets in Bedford, Lawrence, Montour, and Washington counties tend to have recessed rectangular outlines in the parapet, while those in the other 12 counties tend to exhibit full recessed rectangular panels. There was some local variation in the size of the rectangular panels as well. Adams, Berks, Clearfield, Lancaster, and Union counties featured larger rectangular panels, the heights of which extended nearly the full height of the parapet; the recessed panels on the bridges in Chester, Huntingdon, Lebanon, and York counties were shorter, at roughly one-third to one-half the height of the parapet. The through girder in Adams County features one long rectangular panel; all others tend to have multiple rectangular panels (or outlines), dependent upon the length of the bridge.

Summary of Extant Population

As noted in the introduction, searches of PennDOT's BMS2 database revealed that only 40 reinforced concrete, through-girder bridges remain in service throughout the state with just 17 counties having at least one, as compared to the 75 through girder bridges identified among 25 counties in the late 1990s. As of 2020, Lancaster and Butler counties had the most reinforced concrete, through girder bridges with eight each; two in Lancaster County were maintained by PennDOT, and the other 14 were locally maintained. Clearfield County retained four (two maintained by PennDOT and two locally maintained), Blair and York counties each had three, two of which in each county were locally maintained; Allegheny and Montour counties each had two locally maintained through girder bridges, and the remaining 11 counties each had only one. Those in Adams, Berks, and Huntingdon counties are maintained by PennDOT; the single reinforced concrete, through girder bridge in each of Bedford, Chester, Lawrence, Lebanon, Montgomery, Montour, Northampton, Union, and Washington counties are all maintained locally. The extant bridges range in date from 1909 (S.R. 1053 over Calico Creek in Lancaster County; BR Key #21483) to 1943 (S.R. 7220 over Chartiers Creek in Washington County; BR Key #35315). All but seven of the bridges are single span, with total lengths ranging from 27 feet to 63 feet. Four of the bridges are two-span, with total lengths from 66 feet to 116 feet; two are three-span, one with a total length of 136 feet and the other with a total length of 143 feet, and one is four-span. The longest of the bridges is the four-span, S.R. 7207 bridge over Swatara Creek (constructed in 1924; BR Key #22862) in Lebanon County, which has a total length of 214 feet. Brinkerhoff (2005:3-93) noted that through girders were best suited for spans ranging from 15 to 40 feet; several of Pennsylvania's examples, however, push this limit for a single span. Fifteen of the bridges have individual spans greater than 40 feet in length, which appears to indicate that although the bridge type was never widely popular, engineers did experiment with its parameters relative to length.[20] The two shortest, T-463 over Roaring Run (1914; BR Key #5907) in Blair County and T-318 over Beaver Run (1924; BR Key #28445) Montour County, are 27 feet in length. The widest of the 40 bridges is S.R. 23 over Upper Merion & Plymouth Railroad in Montgomery County; however, this 36-foot-wide bridge is a combination through girder/T-beam bridge, which is the likely reason for its abundant width relative to the typical 25foot width of through girders. The widest true through girder is S.R. 7205 over W. Octoraro Creek in Lancaster County, which has a width of 25.5 feet, just above the maximum recommended width.

Prior to this reevaluation of reinforced concrete, through girder bridges, five of the extant bridges were determined eligible for listing in the National Register. Due to the loss of several reinforced concrete, through

[20] These fifteen bridges are not relegated to one or two counties but are scattered all over the state.

girder bridges, as well as the age of the previous statewide inventory, these eligibility determinations may change upon completion of this reevaluation. S.R. 1008 over Trout Run in Goshen Township, Clearfield County (BR Key #11654), was determined eligible as one of the oldest and most complete examples in northern Pennsylvania (PennDOT Districts 1-0, 2-0, 3-0, and 4-0) and as one of the oldest examples from 1914 to 1919 in Clearfield County. S.R. 1017 over Kistlers Creek in Albany Township, Berks County (BR Key #4982), is significant as one of the largest examples of its type and the earliest example in Berks County. S.R. 1053 over Cocalico Creek in West Cocalico Township, Lancaster County (BR Key #21483), is an early example by contractors Nelson & Merydith of Chambersburg and is one of the two earliest extant examples Lancaster County and among the five oldest pre-1910 examples in the state. S.R. 0616 over South Branch Codorus Creek in Shrewsbury Township, York County (BR Key #37606), is the oldest and most complete example in southeastern Pennsylvania (PennDOT Districts 6-0 and 8-0). It is also one of the two oldest examples in York County. T578 over Little Buffalo Run in Clearfield Township, Butler County (BR Key #8189) was determined eligible in 2020 as part of the reevaluation of concrete slab bridges; it had been determined not eligible as a through girder bridge as part of the Lichtenstein & Associates survey.

Character-Defining Features

As with buildings, there are a wide variety of designs, forms, and materials, used in the construction of bridges; thus, each bridge type (e.g., metal truss, concrete through girder) will have different character-defining features critical for conveying its historical significance. An individual reinforced concrete, through girder bridge would need to retain those specific features, as defined below, to be considered eligible for listing in the National Register.

Speaking of concrete girder bridges in general, Brinckerhoff (2005:3-94) states,

> "Concrete girders possess moderate significance...if they retain their character- defining features, which include a monolithic deck and girder system, parapet or railing when integrated (e.g., through girders) and abutments, and floor beams, piers, and wingwalls, when present."

PA SHPO's "Draft Secretary of Interior's Standards for Bridges in Pennsylvania" (2018:19), offers some refinement of Brinckerhoff's statement through its general discussion of concrete bridges, noting,

> "The primary character defining features of concrete bridges are the structural system (such as open or closed arches, t-beam, slabs, girders, rigid frame, and box beams). For concrete bridges with aesthetics in mind, decorative features can be considered among the primary character defining features that should be preserved, repaired, or replaced during rehabilitation. Secondary character defining features include abutments, piers, and wing walls."

Based on the above statements, as well as a review of photographs for the extant bridges throughout Pennsylvania, it is recommended that reinforced concrete, through girder bridges should retain the following character-defining features in order to portray their significance:

Primary Features

A monolithic deck/floor slab and girder system, with the girders visible from underneath, as that is the key defining feature of a through girder bridge—the deck slab rests between the girders, creating a parapet wall above the deck;

- A deck slab carried between the girders;
- Main girders that serve as an integrated railing/parapet system; and
- Recessed panels, or other design features, that represent a reduction in dead load (not just an aesthetic feature).

Secondary Features

- Abutments;
- Piers; and
- Wingwalls, when present in the original design.

While not recommended as character-defining features, it is suggested that additional consideration be given to those bridges that retain their plaque naming the engineering firm and/or contractors, and/or those that retain visible form marks on the underside of the deck, demonstrating their cast-in-place construction.

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