

FINAL DESIGN REPORT
State Project No. 0147-0062
Bridge No. 04805
Forge Hill Road over Pachaug River
Voluntown, Connecticut

PROJECT LOCATION:

Bridge No. 04805 is a 20-foot-long single-span structure that carries Forge Hill Road over Pachaug River in the Town of Voluntown, Connecticut.

DESCRIPTION:

The 20' wide roadway over the bridge is classified as a Rural Local Road and the estimated Average Daily Traffic (ADT) is 651 vehicles per day with 2% truck traffic (Year 2022).

The bridge superstructure is comprised of a reinforced concrete slab and bituminous concrete wearing surface supported by concrete abutments on spread footings, which are presumed to be founded on soil. The bridge was built in 1920, and the west bridge rail was repaired in 2022 due to collision damage. After the 2022 repairs, the bridge is currently stop sign-controlled on both sides with alternating, one-way traffic. The bridge does not support a sidewalk or underground utilities.

The Deck, Superstructure and Substructure are rated to be in Fair (5), Poor (4), and Fair (5) condition respectively based on the Inspection Report dated August 10, 2022.

The existing bridge is classified as an intermediate structure based on a 5.5 square mile watershed and operates in open flow with no underclearance based on the water surface elevation at the approach section (1 foot min. recommended/standard) and provides 0.6 feet of freeboard (1 foot min. recommended/standard) for the 100-yr design storm. The bridge is located between two dams, Beach Pond Dam upstream and Still Waters Pond Dam downstream. The existing 19.7-foot clear hydraulic opening is less than 1.2 times the Bankfull Width (25'-0" BFW) of the channel, which is estimated to be 30 feet. Though the existing bridge is not classified to be scour critical by the 2022 Inspection Report, which is based on the Comparative Scour Analysis Report dated 1998, scour analysis of proposed bridge alternates along with a review of the subsurface soil strata indicates that the existing bridge is likely to be scour critical.

DESIGN CLASSIFICATIONS AND STANDARDS:

Functional Classification:	Rural Local Road
Type of Roadside Development:	Rural
Federal-Aid System:	Off-System
Roadway Configuration:	(2) 11' Travel Lanes, No Shoulders
Proposed Improvement Type:	Spot Improvement - 3R (Non-Freeway)
Design Traffic Volume:	651 (2022)
Pavement Type:	Bituminous Concrete
Control of Access:	Control by Regulation
Design Standards:	CTDOT: Highway Design Manual (2023) Bridge Design Manual (2003)
	AASHTO: A Policy on Geometric Design of Highways & Streets (2018) LRFD Bridge Design Specifications (2012)

DESIGN FEATURES - FORGE HILL ROAD:

<u>Design Element</u>	<u>Standard</u>	<u>Existing</u>	<u>Proposed</u>
<u>Highway</u>			
Design Speed (Posted)	25 mph	<25 mph	25 mph
Travel Lane Width	9-12 ft.	10-11 ft.	11 ft ¹
Shoulder Width	0-4 ft.	0 ft.	0 ft.
Cross Slope Travel Lane	1.5% to 2%	0% to 6.7%	2% to 4% ²
Cross Slope Shoulder (W<4 ft.)	Same as Adjacent Travel Lane		
Stopping Sight Distance	155 ft.	170 ft.	160 ft.
Minimum Radius	190 ft.	76 ft.	85 ft. ³
Superelevation Rate (e _{max})	6.0%	N/A	N/A
Maximum Grade	13.0%	10%	8.6%
Sag Vertical Curve (K Value)	14	29	35.1
Crest Vertical Curve (K Value)	12	N/A	N/A
<u>Bridge</u>			
Bridge Width (Curb to Curb)	18 ft.	20 ft.	22 ft.
Minimum Vertical Clearance:	N/A Bridge over Waterway		

¹ The existing roadway contains no pavement markings

² 4% max designed to aide in cornering along tight radius

³ Substandard radius due to bridge and property constraints

DESIGN FEATURES – WYLIE SCHOOL/NORTH SHORE ROAD:

<u>Design Element</u>	<u>Standard</u>	<u>Existing</u>	<u>Proposed</u>
<u>Highway</u>			
Design Speed (Posted)	25 mph	<25 mph	25 mph
Travel Lane Width	9-12 ft.	10-11 ft.**	10 ft ¹
Shoulder Width	0 ft. to 4 ft.	0 ft.	0 ft.
Cross Slope Travel Lane	1.5% to 2%	0% to 6%	2%
Cross Slope Shoulder (W<4 ft.)	Same as Adjacent Travel Lane		
Stopping Sight Distance	155 ft.	60 ft.	87 ft. ²
Minimum Radius	190 ft.	138 ft.	150 ft. ³
Superelevation Rate (e _{max})	6.0%	N/A	N/A
Maximum Grade	13.0%	7%	7.25%
Sag Vertical Curve (K Value)	14	16	20
Crest Vertical Curve (K Value)	12	N/A	N/A

¹ The existing roadway contains no pavement markings

² SSD limited by grading/vegetation and guiderail

³ Substandard radius due to regulated areas and property constraints

EXCEPTIONS TO DESIGN STANDARDS:

Based on Highway Design Manual Section 3-2.02, formal Design Exceptions for substandard geometric criteria are not anticipated as part of this project. Of the three controlling criteria that might trigger a Design Exception for a 3R Spot Improvement Project, underpass width and vertical clearance standards are not applicable for a bridge over a waterway. The third controlling criteria, proposed roadway width over the bridge (curb to curb), will meet both FHWA and CTDOT design requirements.

As noted above, according to a review of the controlling design criteria identified in the CTDOT Highway Design Manual for a Rural Local road, 3R (Non-Freeway), Spot Improvement project, the following roadway geometric elements will not meet the current 3R Design Standards; however, they will either match or be an improvement compared to existing conditions:

- K-value of sag vertical curve (North Shore Road)
- Minimum Horizontal Radius (all 3 roadways)
- Stopping Sight Distance (all 3 roadways)
- Cross Slope (Forge Hill Road)
- Intersection Sight Distance (Driveway)

RIGHTS OF WAY:

This design will result in the following property impacts, see plans for specific applications.

- Partial Takes
- Drainage Right of Way
- Temporary Construction Easement
- Right to construct Driveway
- Right to Grade
- Right to Install Sedimentation Control System
- Slope Easement

GEOTECHNICAL:

Based on geotechnical investigations conducted by Freeman Companies as a subconsultant to CHA Consulting, the existing bridge abutment and wingwall footings are likely founded on soil comprised of a mixture of sand and varying amounts of silt and gravel overlying Glacial Till, weathered bedrock, and bedrock, which is approximately 20 feet below the roadway. The footings for Bridge No. 04805 are assumed to be founded on material susceptible to scour in the absence of As-Built plans.

The geotechnical report created by Down To Earth Consulting, a subconsultant to Benesch, states that the proposed abutments and associated wingwalls should be supported on drilled micropiles socketed into sound bedrock. It also states that the proposed temporary bridge may be supported on conventional, shallow footings founded below the miscellaneous fill stratum and be supported on 12 inches of compacted bedding placed on undisturbed, natural sand and gravel.

HYDRAULICS AND DRAINAGE:

While the bridge section is curbed, there is no curbing present along Forge Hill Road within the vicinity of the project site. Runoff along the roadway within the project limits generally sheet flows off the road or is collected by one of the following systems. There is a culvert inlet located approximately 150 feet south of the bridge at the west edge of roadway that collects runoff from the west half of the roadway to the south. This flow is conveyed under the road through a reinforced concrete pipe (RCP) to a depression between the east edge of road and adjacent driveway. This depression is drained through a reinforced concrete pipe (RCP) and conveyed

northerly under the driveway to an outlet that discharges south of the Pachaug River, upstream of the bridge. There is also a drainage swale along the north shoulder of Wylie School Road (west of the intersection) that collects runoff from the north side of the roadway and the area north of the roadway. This swale discharges to a 15" RCP which conveys the flow below the roadway and into Pachaug River downstream of the bridge.

The proposed drainage system was designed using a 10-year design storm in accordance with CTDOT Drainage Manual. The watershed areas for the site are less than 200 acres; therefore, the Rational Method will be used to determine the design discharge. Times of concentration were estimated using the TR-55 methodology as recommended by the Connecticut DOT. These times were used to determine rainfall intensity rates from the NOAA Atlas 14 Point Precipitation Frequency Estimates. For pavement drainage, the minimum time of concentration was assumed to be 5 minutes.

Runoff coefficients have been developed using Section 6.9 Rational Method of the CTDOT drainage manual. Natural Resources Conservation Service (NRCS) Web Soil Survey was used to determine Hydrologic Soil Groups. Both gutter flow and pipe flow have been performed using Hydraflow Storm Sewers program.

The proposed site drainage systems will completely replace the existing systems. The catch basins and associated piping network will ultimately discharge to the same general location as the existing outlets thus maintaining similar flow patterns to the existing roadway drainage. The proposed outfalls at proposed culvert ends will require erosion protection consisting of straight concrete end-walls and riprap splash pads.

The proposed bridge will have a low chord elevation of 276.3 which will improve the freeboard from 0.6 feet to 0.7 feet at the roadway low point, located north of the bridge at the intersection of Forge Hill Road with Wylie School Road and North Shore Road. The proposed bridge will be under a pressure flow condition with no underclearance (same as existing condition) for the 100-year storm.

ENVIRONMENTAL:

The Pachaug River flows below Bridge No. 04805 in an east to west direction. The bridge is located within the Pachaug River subregional drainage basin (#3600) of the Pachaug regional drainage basin (#36). The bridge is located within Special Flood Hazard Zone AE with a base flood elevation of 278-feet according to FEMA Flood Insurance Rate Map #09011C0254G (effective date July 18, 2011).

The project is located in a Natural Diversity Database (NDDDB) area per the December 2022 mapping. NDDDB filing #93331 has identified the Eastern Hognose snake as a species of concern for this project.

Additional key points related to Bridge No. 04805 include:

- The project site is not located in an Aquifer Protection Area.
- The Northern Long-eared Bat and the Monarch Butterfly are species that may potentially be affected by activities at this location.
- Wetlands are associated with the watercourse that flows under the bridge.

Preliminary coordination for this project has been initiated with Connecticut Department of Energy and Environmental Protection (CTDEEP) Fisheries Division. Based on Fisheries division sampling conducted in the vicinity of the Project Site, the fisheries community is composed of primarily lentic and warmwater species. The reach of the Pachaug River that contains the Project Site is connected to the tributary stream Blivens Brook which is designated as cold-water habitat basin and contains wild brook trout. CTDEEP Fisheries' recommendations for the project include avoiding any concrete or leachate or wash water from entering the channel and any unconfined in-water work be restricted to the periods between June 1 and September 30.

PERMITS:

The following permits are anticipated for the project:

- CTDOT FMC-MOU
- Town of Voluntown Inland Wetlands & Watercourses Permit
- US Army Corps of Engineers – General Permit – PCN

PUBLIC UTILITIES:

There are no utilities carried by Bridge No. 04805, but there are overhead utilities present in the vicinity of the bridge. Relocation of the overhead utilities will be required prior to the construction of this project. A preliminary layout of the proposed utilities has been included in the plans. The final layout will be determined once coordination with utility companies is completed.

MAINTENANCE AND PROTECTION OF TRAFFIC:

Construction duration is anticipated to be approximately two construction seasons. The proposed construction will be accomplished by providing a 14-foot wide temporary bridge located approximately 13 feet west of the existing bridge. The temporary roadway through the project site will be designed to accommodate passenger vehicles, standard school buses, Town emergency vehicles, and typical vehicle/boat trailer combinations with alternating one-way traffic using temporary signalization. There will be a truck-only detour of Forge Hill Road. It will be a 7.4-mile detour to the north located entirely within the town of Voluntown which will be implemented throughout the duration of construction utilizing state and local roads. Access to adjacent properties will be maintained at all times during construction.

COST AND SCHEDULE

The estimated construction cost of the project is \$4,485,000 and the anticipated construction duration is approximately 16 months (two construction seasons).