ENGINEERING STUDY AND RECOMMENDATIONS

Replacement of Bridge No. 111/132
Whittier Street over Cocheco River

PREPARED FOR:

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December 2011
Revised - September 2012

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SECTION 1

Engineering Study Report

PURPOSE

The purpose of this engineering study is to explore and analyze options for the replacement of the Whittier Street Bridge over the Cocheco River, Bridge 111/132, in the City of Dover, New Hampshire. This work is being performed under the New Hampshire Department of Transportation (NHDOT) Municipally-Managed Bridge Aid Program, NHDOT Project # 15402.

This engineering study examines the following items specific to the new bridge: roadway alignment, pedestrian facilities, right-of-way impacts, proposed bridge width, proposed span length, hydraulics, subsurface investigations, substructure types, superstructure types, bridge architectural amenities, construction materials, removal of the existing bridge, permitting, and cost estimates. Recommendations of this engineering study are provided based on feasibility of construction and cost efficiency. The Louis Berger Group, Inc. (LBG) is using the directional convention as shown on the existing bridge plans prepared by Wesley E. Haynes to describe the existing and proposed bridges. The level of public involvement will be determined by the City in the preliminary plan phase.

EXISTING CONDITIONS

Historic

This site has been noted in Dover's history as both Whittier Falls and Whitcher's Falls, and bridges have stood here for over 115 years. The current stone masonry abutments date from before the 1890's and supported a single span metal truss bridge. The northwest wingwall appears to have been reconstructed after sustaining damage in the March 1, 1896 flood that resulted in the bridge being swept downstream to Whitcher's Falls. Newspaper articles at the time indicated the bridge sustained little damage and could be returned to its abutments.

(Photograph courtesy of the City of Dover Public Library)

Current

The existing Whittier Street Bridge was designed in 1962 by Wesley E. Haynes and carries a 21'-8" roadway and a 3'-8" sidewalk over the Cocheco River. Two 58'-6" continuous spans of four steel W33x130 rolled beams with 10"x¾" cover plates over the pier support a non-composite concrete bridge deck that varies from 7½" to 8¾" in thickness on a 4°-30' right-ahead skew. The overall bridge length is 120'-6" and the out-to-out deck width is 28'-2". The original steel pipe and cable bridge rail has been replaced with standard NHDOT 2-Bar and 3-Bar aluminum bridge and approach rails.

Reinforced concrete abutment beam seats and backwalls are supported on the stone masonry abutments and wingwalls of the previous Whitcher's Falls Bridge. Three of the four existing wingwalls are in a U-back configuration, while the northwest wingwall is flared at approximately 45 degrees. The stone masonry courses of this wingwall are not interlocked with those of the abutment, which is the main indication that this wingwall was constructed at a different time than the rest of the abutment. As the only the flared wingwall, it was likely constructed as part of the restoration after the 1896 flood. The foundations of the existing abutments and wingwalls are unknown, but subsurface explorations conducted as part of this Engineering Study suggest they are founded on either bedrock or on a layer of glacial till that overlays the bedrock.

The unusual center pier is comprised of a steel plate girder pier cap that extends through either side of a single rounded rectangular column shaft of reinforced concrete. The center portion of the steel pier cap is encased in the concrete column shaft except for the top of the top flange, which is used to support the bearings. The column is supported on a reinforced concrete footing that sits on an unreinforced concrete sub-footing bearing directly on bedrock.

DESIGN CRITERIA

General

The NHDOT *Bridge Design Manual*, 2000, as amended and the NHDOT *Highway Design Manual*, 2007, as amended will set the design criteria for bridge and roadway design elements respectively. The NGVD 1929 sets the vertical control for the project. In addition to these manuals, the following references will be used to develop the bridge and roadway design:

- NHDOT *Standard Specifications for Road and Bridge Construction*, 2010.
- NHDOT *Standard Plans for Road and Bridge Construction*, 2002, with supplements.
- AASHTO *A Policy on Geometric Design of Highways and Streets*, 2004 (Green Book).
- AASHTO *LRFD Bridge Design Specifications*, 5th Edition, 2010, with 2010 interims; referred to herein as AASHTO LRFD.
- ANSI/AASHTO/AWS D1.5 *Bridge Welding Code*, 2002.
- AASHTO *Manual for Bridge Evaluation*, 2nd edition, 2011 with interims.
- Federal Emergency Management Agency (FEMA), DHS, 44 CFR.
- City of Dover Sewer and Water design guidelines.
- NHDES Standards for design for Sewer and Wastewater Treatment.

Vehicular and Pedestrian Loading

The bridge structure will be designed for HL-93 live loading as specified in the *AASHTO LRFD Bridge Design Specifications*. A pedestrian live load of 75 psf will be applied as appropriate. Design calculations will be performed by the Load and Resistance Factor Design method (LRFD). The structure will possess sufficient capacity pursuant to RSA 234:4 to be eligible for

State Bridge Aid funds. Plans and reports will use U.S. Customary units in accordance with NHDOT practice.

This design speed and the specific site characteristics of the project allow flexibility in bridge railing selection, which will be discussed in the bridge type studies and recommendations section. It has been determined through preliminary analyses that the minimum railing test level permitted for this bridge will be Test Level 2 (TL-2).

Roadway Design

The existing road profile adjacent to the bridge on the east end currently provides a K value of 15, equivalent to a design speed of 15 MPH. During the field visit it was noted that the speed of vehicles traveling this section of Whittier Street is noticeably higher than 15 MPH. The existing alignment of the road, from Hampshire Circle to Cassily Lane, has a shift in it to provide a nearly 90 (ninety) degree approach to the Cocheco River, thus inducing a kink in the alignment. A design speed of 35 MPH is desirable. A sidewalk is required to provide pedestrian access along this stretch of city roadway.

Hydraulic Criteria

The Whittier Street Bridge is considered to be on a secondary or off-system highway. Currently, the low chord of the existing structure (El. 54.0 ±) passes the 50-year flood elevation (El. 46.5) plus a minimum of one foot of freeboard, as described in the NHDOT Bridge Design Manual. Also the bridge low chord currently is approximately six feet (6') above the 100-year event elevation (El. 48.0) and above the 500-year event elevation (El. 53.5). The HYDROLOGIC AND HYDRAULIC STUDIES section of this report provides a more detailed discussion of the hydraulic criteria for the Whittier Street Bridge.

Seismic Analysis

According to AASHTO LRFD Article 4.7.4.2, seismic analysis is not required for singe-span bridges. The new Whittier Street Bridge will be a single span and was determined to be in Seismic Zone 1 in accordance with AASHTO LRFD Article 3.10. Connections between the bridge superstructure and the abutments will be designed for the minimum force requirements as specified in Article 3.10.9 and minimum support length requirements will be satisfied as specified in article 4.7.4.4.

Utilities Design

Several utilities, both public and privately operated, will be affected by the construction of the new bridge. There is currently a 6" natural gas main carried on the bridge. City standards for gas installation, along with applicable state and federal design guidelines will be used in utility design. There is no water or sewer line currently carried on the bridge, but a proposed water line will be carried on the new bridge.

Private utilities at the site include Verizon (telephone), Public Service of New Hampshire (electric), and Northern Utilities (natural gas). Construction and material specifications will be acquired from Northern Utilities during preliminary design. Overhead utility relocation by Verizon and PSNH will also be determined in preliminary design.

ROADWAY STUDIES AND RECOMMENDATIONS (SEE *FIGURES 1-2*)

Recommended Roadway Typical Section

The project limits extend from the southeasterly intersection of Whittier Street and Hampshire Circle, across the Cocheco River, to just past the intersection of Whittier Street and Whittier Falls Way, just short of Cassily Lane. Roadway stationing begins at the Hampshire Circle intersection and increases from west to east. The existing width of Whittier Street at the beginning of the project is approximately 28 feet. Currently there are no 4" solid white lines on either side of the bridge. The roadway width narrows to 25 feet at both ends of the bridge. The proposed roadway typical section consists of two 11-foot lanes with two 3-foot shoulders and a 5 foot wide sidewalk on the upstream side (north side) of the roadway. The proposed roadway width is 28 feet curb to curb and the overall width is 33 feet.

Sidewalk Recommendations

An existing three and a half foot coping with a vertical granite curb is located on the downstream side of the bridge. LBG is proposing a five foot wide sidewalk on the upstream side of the bridge. There are two primary reasons for placing the sidewalk on the north side of Whittier Street: first, it will connect two pieces of existing sidewalk that currently are not connected; second, placing the sidewalk on the south side would negatively impact the residence located at the SW corner of the bridge. On the east side of the Cocheco River, the proposed sidewalk will extend beyond the new bridge and will connect to the existing sidewalk currently ending at Cassily Lane. On the west side, the new sidewalk will connect with the existing sidewalk where tip-downs and a crossing have been provided in front of the Cedar Cove development. The construction of a sidewalk for the roadway and bridge is also consistent with the CWDAC and City's desire to promote pedestrian activity, as well as to provide connections from Whittier Street to City parks in the vicinity, such as Dover Cassily Community Garden.

Whittier Street Alignment Alternatives and Recommendations

The engineering study has determined that by raising the existing road profile at the bridge by four (4) to six (6) feet, the minimum sag design K value can be increased to 42, equivalent to a design speed of 30 MPH. A straight tangent from Hampshire Circle to Cassily Lane that removes the jog in the current alignment is proposed for the new road alignment. These two improvements are a significant improvement to the current alignment. A vertical alignment utilizing a K value of 49, equivalent to a design speed of 35 mph, was investigated but rejected due to the increased cost, greater impacts produced to adjacent properties, impacts to the wetland area at the northeast corner of the bridge, and the negative impact to the design and construction of the bridge due to the location of vertical curves on the bridge structure.

Two alignments were investigated at a conceptual level:

Option 1 consists of an alignment that provides a horizontal tangent through the bridge matching into an existing curve on the east side and an existing tangent on the west side. This alignment provides:

- A tangent horizontal geometry from Hampshire Circle through the proposed bridge to Cassily Lane.

- An adequate K value for a speed limit of 30 MPH versus the current K-value that provides a profile adequate for 15 MPH.
- Minimizes impacts on the properties and wetlands adjacent to the project.
- Improved headlight distance.

Disadvantages of this alignment are:

- Re-grading of the front of the property at the SE corner of the bridge (46 Whittier Street) will be required.
- Utility poles will need to be relocated

Option 2 Maintains the existing horizontal alignment while raising the profile of the road. This alignment provides:

- No utility pole relocation.

Disadvantages of this alignment are:

- Inadequate roadway geometry which results in a permissible speed significantly less than the 30 MPH preferred design speed.
- Limited headlight distance approaching the bridge
- Significantly greater impacts to 46 Whittier Street adjacent to the bridge
- Retains the existing kink in the roadway alignment

LBG recommends **Option 1** because it provides adequate geometry to provide a design speed of 30 MPH while minimizing impacts to adjacent properties.

RELATED ISSUES, STUDIES AND RECOMMENDATIONS

Right-of-Way Impacts from the Preferred Alternative

The Preferred Alternative will impact several parcels:

Tax Map E Lot 66 will have temporary slope impacts.

Tax Map 33 Lot 1 will have temporary slope impacts.

Tax Map E Lot 67A will have temporary slope impacts.

Tax Map 34 Lot 20B will have temporary slope impacts.

Maintaining Pedestrian Bridge Access during Construction

The existing pedestrian crossing will be closed during construction.

Pedestrian Considerations

The construction of a sidewalk on the north side of Whittier Street is recommended. This will provide a continuous sidewalk from Cassily Lane to Whittier Falls Way where the community trail is located, across the bridge to the Cedar Cove development and then across the road to the existing sidewalk in front of the Dover Housing Authority Complex.

Trail Connection Considerations

The proposed sidewalk on the north side of Whittier Street will extend beyond the new bridge and will connect the existing sidewalk coming from Hampshire Circle Housing with the Dover Community Trail, both located on the south side of Whittier Street, and another existing sidewalk located on the north side of Whittier Street in between Whittier Falls Way and Cassily Lane. Crosswalks are recommended and locations will be determined as the design progresses.

BRIDGE TYPE STUDIES AND RECOMMENDATIONS

General

The Bridge Rehabilitation alternative is not being considered due to the substandard width and poor alignment of the roadway. The existing bridge is too narrow for the traffic volume and the existing substructure components (stone abutments and concrete pier stem with structural steel pier cap) do not lend themselves to economical extension to support a widened superstructure. Also, a rehabilitated and widened bridge would not address the safety issues with the existing vertical alignment.

Bridge superstructure options considered were a single-span with steel plate girders (Alternates 1 and 2) and a single-span steel truss (Alternate 3). Two-span superstructure options were not considered due to potential permitting, hydraulic, and environmental impacts associated with excavation and installation of a new pier in the Cocheco River. The existing pier is not wide enough to carry the proposed superstructure width and the required retrofit for widening and matching the proposed re-alignment is not feasible. The existing pier will be removed to streambed level minimizing impacts. Precast concrete girder superstructures were not considered to be a viable option for the site due to a span length of 160 feet.

Superstructure

As discussed previously, the bridge will carry two eleven foot lanes, two three foot shoulders and a five foot sidewalk on the upstream side. The total bridge width will be 36’-0”. See *Figures 4, 5 & 6* for cross section views of the bridge.

The superstructure for the proposed alignment over the Cocheco River will have no skew. Based on bridge length and profile, the west end will be fixed and receive an elastomeric plug type joint while the east end will have expansion bearings and will receive a strip-seal type joint. See *Figure 3* for a Plan and Profile of the bridge.

Two steel plate girder alternatives were evaluated. The use of five steel plate girders is proposed for Alternate 1. Five is the minimum number of girders typically used by NHDOT. The five girder arrangement is used as a long-term maintenance measure to facilitate phased deck replacement and future widening, if necessary. Girder spacing will be 7'-9" for the 36'-0" section. The proposed girder spacing would utilize an 8-½" thick cast-in-place concrete deck overlaid with barrier membrane and a 2-½" thickness of bituminous pavement. LBG will propose a precast deck panel option for the cast-in-place deck.

Alternate 2 proposes the use of four steel plate girders. Significant cost savings can be realized by eliminating a girder and a set of bearings. Girder spacing will be 10'-0" for the 36'-0" section. With the larger girder spacing, more load will be applied to each girder resulting in a deeper section. The proposed profile is such that the required increase in girder depth still clears the Q100 water surface. Even with the increased girder size, the overall structural steel quantity required will be less. The proposed girder spacing would utilize an 8-½" thick cast-in-place concrete deck as in Alternate 1, so no additional concrete would be required. A precast deck panel option will be proposed for Alternate 2, also. Given the fact that the bridge will be closed during construction for the proposed project, it could likely be closed for any future deck replacement work required. With that in mind, the four girder alternative was worthy of evaluation.

Alternate 3 proposes using a pre-fabricated galvanized steel truss bridge system. These bridge systems can be very economical in some locations. The truss system would employ steel stringers spaced at approximately 8'-0" to support an 8" cast-in-place concrete deck. The steel stringers are bolted to steel floor beams which transfer the bridge loads to the trusses. The truss system has an out-to-out width of over 38 feet which will require extending the length of the abutments.

Bridge Mounted Utilities

The Whittier Street Bridge will carry utilities across the Cocheco River in addition to traffic and pedestrians. The existing gas line currently hangs under the existing bridge superstructure and will be carried by the proposed bridge. The City will add the piping for a 12" water line on the proposed bridge to provide additional capacity to the existing system by connecting the capped ends on each side of the river. Conduit for future telephone and cable lines will also be attached to the bridge.

For the steel girder options, the proposed utilities will be supported within the bays on typical K-type cross frames above the bottom flange.

For the steel truss option, the proposed utilities will be supported on steel brackets attached to the outside of the trusses. The water line would run on the outside of the north truss and the gas line on the outside of the south truss. Conduit for future telephone and cable lines can be paired with either the water line or gas line.

Reuse of Existing Abutments

The existing abutments are rated as "FAIR" in the NHDOT bridge inspection report dated 12/07/2010. Cracked stones were evident along with failing mortar joints and the concrete caps and backwalls had cracks and spalls. The existing abutments are not wide enough to carry the proposed bridge width and would need extensive rehabilitation and reconstruction if reused.

Also, the ability to evaluate reutilization of the existing abutments to ensure a 75-year design life for the structure will be difficult due to a number of unknowns, such as the walls physical dimensions, structural capacity, scour susceptibility, and seismic performance. Therefore, new abutments are recommended to be constructed behind the existing abutment locations. The existing abutments can be removed prior to constructing the new abutments or left in place to aid in water diversion during construction of the new abutments and removed later.

The stone blocks from the existing abutments can be used for rip-rap at this site or can be removed and stored for use at a proposed location by the City.

Substructure Layout

The abutment type which provides the shortest span without impact to the Cocheco River is a full height option, with the abutment faces set close to parallel to the faces of the existing stone masonry abutments of the previous bridge. Wingwalls for the proposed bridge will be U-back walls placed parallel to the proposed roadway. This layout matches the existing bridge on all corners, except for the northwest corner. A U-back wing on the northwest corner allows the bridge stone fill (scour protection) to follow the river bank more uniformly and ties in better with the roadway side slope grading.

Foundations – General

Recommended foundation types for the new Whittier Street Bridge are based on the foundation investigation report prepared by Ward Geotechnical Consulting, PLLC. The recommendations are a result of a boring program, described in more detail under the Boring Layout and Logs sections below. The elevation of bedrock at the bridge site is the controlling factor for the foundation types selected. Bedrock depth at the proposed abutments is within five to six feet of the riverbed elevation at the west and east banks. The proposed footings will be supported on bedrock. The bedrock is slightly weathered and slightly to moderately fractured. Rock Quality Designation (RQD) values ranged from 23% to 75%. Due to the variability of the rock quality and the impracticality of removing all fractured rock, conservative values for bearing resistance are recommended. Footings bearing on bedrock will be designed using a service limit state nominal bearing resistance of 20 ksf. A strength and extreme limit state nominal bearing resistance of 60 ksf will be used. A resistance factor of 0.45 will be used for the strength limit state and a resistance factor of 1.0 will be used for the service and extreme limit states.

East Abutment

Bedrock was encountered at the east abutment at approximately 21 to 22 feet from the ground surface, between elevation 36.2 and 37.7. The recommended foundation type for the full-height east abutment and wingwalls is cast-in-place concrete spread footing on rock founded at elevation 36.0. This results in an approximate abutment height of 29.5 feet. The relatively shallow bedrock elevation, coupled with the ability to open-cut the excavation with minimal dewatering requirements, makes spread footings the most appropriate and cost-effective choice for foundation type.

West Abutment

Bedrock was encountered at the west abutment, at approximately 21 to 24 feet below existing ground, at elevation 35.2 to 38.0. The recommended foundation type for the full-height west abutment and wingwalls is cast-in-place concrete spread footing on rock founded at elevation 35.0. This results in an approximate abutment height of 25.6 feet. The relatively shallow bedrock elevation, coupled with the ability to open-cut the excavation with minimal dewatering requirements, makes spread footings the most appropriate and cost-effective choice for foundation type.

Bridge Railing Considerations

The NHDOT standard 2-bar and 3-bar plain finish aluminum railing with balusters is proposed for the steel girder option. This railing is currently on the existing bridge and appears with and without balusters on other bridges throughout the City. Aluminum railing has been used successfully around the State as an option with minimal cost increases over standard T2 and T4 railing types.

For the truss option, T101 rail is shown, which is the standard rail used on prefabricated trusses. T101 rail meets crash test requirements for the proposed design speed. Additional steel tubes will be attached to the truss on the sidewalk side for pedestrian safety requirements.

Substructure Facades

Re-use of the existing granite blocks for new abutments and wingwalls is possible but has some disadvantages. The existing blocks are approximately 2 feet thick, and if used as a façade would require increased wall thicknesses and therefore, increase costs.

If the City would like to replicate the existing granite masonry abutment walls, the proposed abutments and wingwalls can be constructed to have the appearance of a stone façade. The façade could be created with actual stone blocks, similar to the Washington Street Bridge, or by using a concrete form liner. Form liners can create a variety of patterns on the surface of the concrete walls including stone blocks or random field stones. The stones can also be colored to more closely resemble actual stones by painting the individual stones or placing a dye in the concrete mix.

The cost of for a stone veneer (NHDOT Item 570.2) is approximately $50 per square foot. A non-color stone pattern created with a concrete form liner is approximately $5 per square foot. Colored form liner facades are approximately $10 per square foot. The substructure area to which these treatments would be applied is approximately 2100 square feet. The resulting associated costs are as follows:

- $ 105,000 for a stone veneer.
- $ 10,500 for a plain concrete form liner.
- $ 21,000 for a colored concrete form liner.

BORING LAYOUT AND LOGS

General

Team member Ward Geotechnical Consulting, PLLC (WGC) engaged New Hampshire Boring, Inc. to conduct a five-day boring program for the project from April 27th through May 3rd, 2011. The locations of the thirteen borings drilled during this five-day program are detailed in the attached geotechnical report prepared by WGC. Refer to *Appendix C*.

Boring Program

Borings B101 through B109 were drilled near the east and west abutments of the proposed bridge, respectively, to obtain subsurface information for foundation design. Five of these borings were advanced to bedrock (or boulder) and bedrock samples were cored with sample lengths ranging from 5 to 11.3 feet. The borings were drilled using cased wash boring drilling techniques. Split spoon sampling with standard penetration tests (SPTs) were conducted at depth intervals of approximately 5 feet in the overburden soils.

Borings B110 through B113 were drilled in areas of the approach roadways along Whittier Street. These borings were drilled to depths ranging from 4 to 6.5 feet below the existing ground surface. Continuous split spoon samples with SPTs were obtained in these borings.

Subsurface Conditions

No bedrock outcrops were observed at the site while the boring program was conducted. Soil types appearing at each abutment include asphalt, fill (gravelly sand, silty sand, sandy silt, gravel, cobbles and boulders), silty sand, sandy silt, glacial till and bedrock.

For soil layer thickness and other subsurface information at boring locations, see the attached report.

Groundwater

Groundwater observation wells were not installed in the boring holes. Based on site observations, the groundwater level at the boring locations is typically 2 to 4 feet above the water level in the river.

HYDROLOGIC AND HYDRAULIC STUDIES

Existing Conditions

The hydrologic analysis for the Cocheco River used in the May 2005 Strafford County Flood Insurance Study (FIS) was prepared by the U.S. Soil Conservation Service in 1979 using SCS TR-20 software. The FIS hydraulic analysis for the Cocheco River in Dover was performed using the SCS WSP-2 step-backwater computer program (United States Army Corps of Engineers - USACE, 1991). Whittier Street is located at the upper limits of the detailed FIS study for this reach of the Cocheco River. Upstream of Whittier Street, a section of nearly 6 miles of the river with a vertical drop of over 60 vertical feet is not included in the FIS study. Detailed study resumes just below the Isinglass River confluence in the City of Rochester.

LBG contacted FEMA to obtain the original computer files or backup calculations, but they are no longer available. The following information describes the existing conditions regarding the structures and flood data in reference to the NGVD 1929 datum. LBG has modeled the existing and proposed bridge using HEC-RAS software, with flow rates obtained from the FEMA Study. Flows using five methods were computed and compared with the study flow. The elevations obtained from the FEMA study results closely match the elevations from the LBG analysis for the 50, 100 and 500 year event.

Table 1: Hydrology summary

Method	10-Year (cfs)	50-Year (cfs)	100-Year (cfs)	500-Year (cfs)
SCS TR-20 (from FEMA FIS)	6,330	11,140	13,560	19,110
NEHL / AWM Methods:	6,400	11,500	n/a	n/a
USGS Method:	8,174	13,797	17,150	n/a
FHWA 5 - Parameter Equation:	5,982	10,704	12,674	n/a
Average:	6,722	11,785	14,461	19,110
Used:	6,330	11,140	13,560	19,110

The Cocheco River is designated as a Zone AE special flood hazard zone (associated with detailed hydraulic study) downstream of the Whittier Street Bridge and Zone A Flood Hazard area upstream.

The elevation of the existing bottom chord is approximately 54.0'. The 100-year water surface elevation is approximately 48 feet at the existing Whittier Street bridge. The 50-year water surface elevation is approximately 46.5 feet at the existing Whittier Street bridge. The gas line is located under the deck on the downstream side. The existing bridge currently also clears the 500-year event, as shown on the FIS maps.

The structures in the City of Dover crossing the Cocheco River from downstream to upstream include Washington Street Bridge (lower – newly rebuilt), Washington Street Bridge (upper), Pedestrian Bridge, Mill building, Cocheco Falls (Central Ave) Dam, Central Ave Bridge, Chestnut Street Bridge, Old B&M RR Bridge, Downeaster RR Bridge, Fourth Street Bridge, Whittier Street Bridge, Spaulding Turnpike (Route 16) Bridge, Watson Dam, and Watson Road Bridge. The Cocheco River below the Washington Street bridges is tidal influenced. The Cocheco River flows to the Piscataqua River which flows to the Atlantic Ocean between Kittery, ME and Portsmouth, NH.

Whittier Street Bridge is located near the downstream end of a white water rapids reach of the Cocheco River, just before it enters the Cocheco Falls (Central Avenue) Dam reservoir River reach.

The bridge is known to have been flooded in 1896, newspaper accounts indicate an ice dam and incomplete repairs to the western abutment as possible contributing factors to this incident. Following reconstruction, no further flooding of the bridge has been recorded.

Proposed Conditions

Under proposed conditions, the bridge top finish grade elevation will be raised approximately 4.5 feet vertically but deeper girders are required for a single span. LBG also proposes the removal of the existing pier by cutting it down to the streambed level. This will return the bridge to its pre-1962 single span type configuration. River velocities in the vicinity of the bridge range from 6 feet per second in the 10-year storm to 13 feet per second in the 100-year flood event.

Five Girder Alternative

The low chord elevation varies from 53.08' to 57.83', compared to the existing elevation of approximately 54.0'. This will provide even greater clear opening than currently exists below the bridge girders.

The freeboard (distance from the water surface elevation to the lower end of the bottom of the girder) is 7.1 feet in the 50-year storm, 5.8 feet in the 100-year storm event. The 500-year storm event submerges the low (west) end of the girder by 4 inches but has 4.4 feet of freeboard at the higher (east) end.

Four Girder Alternative

The low chord elevation varies from 52.41' to 57.16', compared to the existing elevation of approximately 54.0'. This will provide even greater clear opening than currently exists below the bridge girders.

The freeboard (distance from the water surface elevation to the lower end of the bottom of the girder) is 6.4 feet in the 50-year storm, 5.1 feet in the 100-year storm event. The 500-year storm event submerges the low (west) end of the girder by 1.0 foot but has 3.7 feet of freeboard at the higher (east) end.

Due to moving the abutments back, the removal of the central pier and the raising of the average structural low chord, the hydraulic opening will increase. A Letter of Map Revision (LOMR) would be required if the flood elevation increases by more than 6 inches as a result of the project.

Scour Protection

There are several types of scour that may require evaluation, including contraction scour, abutment scour, bed scour and general scour. The abutments of this bridge are set on bedrock not susceptible to scour. The proposed hydraulic opening is similar but slightly larger than existing, so no change in conditions is expected. The existing bridge has no history of scour problems.

Contraction scour occurs when the channel is suddenly narrowed. At the proposed bridge, the abutment locations generally match the stream banks, and therefore, contraction scour is minimal. There are also no piers utilized in the proposed bridge structure, and therefore *pier scour* is also not a concern. The existing pier foundation is to remain and the pier stem will be removed to streambed level. *Abutment scour* occurs when the abutment obstructs the flow. The proposed concrete abutment footings are expected to be founded on bedrock, which is not susceptible to localized scour.

Bed scour is the change in elevation of the bottom of the channel over time associated with sediment transport. It is either in a state of aggradation or degradation (i.e. the raising or lowering in elevation, respectively). *General scour* can be caused by increased velocities from the passing of a flood or erosion from a bend, variable downstream control, or other stream changes. Scour at the proposed bridge should be restricted to general scour.

To protect the abutments from ice or debris damage and any unforeseen potential scour, a 3-foot thick layer of stone fill will be placed along the toe of the abutments, except in the case where the bedrock surface limits the thickness. Sizing of the stone will be performed at preliminary design stage.

ENVIRONMENTAL CONSIDERATIONS AND PERMITTING

General

The following is a synopsis of historical and environmental permitting needed to meet federal, state and local regulations for the project, based on the preferred alignment and bridge structure type.

Protection of Historic Resources

LBG will conduct background research, consulting the files at New Hampshire Division of Historic Resources (DHR) and City of Dover to determine if there are any recorded historic resources (e.g. buildings, structures, or districts) or any archaeological sites in, or immediately adjacent to, the project area. Prior to the preliminary plan submission LBG will submit a Request for Project Review (RPR) form to the DHR.

Required Permits

The following is a synopsis of state and local regulators that have been contacted for the project and a discussion of the appropriate permits.

- The use of federal funding requires the preparation of a Categorical Exclusion (CE)

Document. All necessary data will be gathered for submission of the CE to the NHDOT. Items to be completed include air quality, endangered species, floodways, noise, right-of-way, Section 4(f)-USDOT Act of 1966, Section 6(f)-The Land and Water Conservation Fund Act of 1965, water quality, hazardous waste, NH Designated River, invasive plants, Coastal Zone Consistency Review, Essential Fish Habitat, Asbestos Containing Material, Conservation Land Stewardship Program, wetlands and historical or archaeological resources-Section 106 of the National Historic Preservation Act of 1966. Each corresponding agency has been, or will be, contacted to obtain the required clearances or conditions for the project, which will be incorporated into the CE Document. LBG will coordinate with the NHDOT and the FHWA to provide the information necessary for submission of the CE document.

- Based on preliminary geotechnical findings, the construction of the proposed abutment foundations and wing walls will require excavation along the edges of the Cocheco River. Approval by NHDES as a “minimal impact” or “minor impact” Wetlands Permit will be required depending on the extent of any temporary cofferdams needed for the bridge/ roadway construction.

- Shoreland Protection permit will be required due to proposed work within the 50 foot shoreline buffer.

- A stream assessment based on NHDES stream crossing rules will need to be completed prior to the Preliminary Plan submission. LBG has calculated the recommended bridge length based on the bankfull widths and the proposed bridge will exceed the minimum recommended by NHDES Stream Crossing Guidelines.

- A Major Impact Permit from NHDES will be required based on a Tier 3 stream crossing.

- Parcels E-67 and 34-20B are both included under the Dover Conservation list. Work at parcel E-67 will remain within the right of way and therefore no further requirements apply. Work at parcel 34-20B, which is owned by the City of Dover, will likely encroach outside of the right of way and further action will be required.

<u>Conditionally Required Permits</u>

- Section 403 of the Clean Water Act stipulates that the project must be constructed in accordance with Title 1342 – the National Pollution Discharge Elimination System (NPDES).

    - If the land area disturbed by the contractor is in excess of one acre, the general contractor selected as the winning bidder will be required to submit a U.S. Environmental Protection Agency (EPA) Notice of Intent (NOI) for a Construction General Permit, and maintain a Storm Water Pollution Prevention Plan (SWPPP) on site. The project is expected to exceed this threshold.

    - If any new drainage or modifications to existing drainage discharges are proposed, they will have to be designed in accordance with the storm water treatment provisions of the NPDES and the MS-4 permit on file for the City of Dover. This section of the Cocheco River (NHIMP600030608-04) was listed in

2008 as impaired for Aquatic Life with regard to pH, and for Primary Contact Recreation due to Escherichia coli.

  - Construction dewatering, if required, (associated with bridge abutment construction) triggers another General Permit.

- Section 404 of the Clean Water Act gives the USACE authority to review any wetlands impacts generated by the project. The Cultural Resources meeting with NHDOT and other resource agencies will review the project's NHDES Dredge & Fill Application and determine if the Whittier Street Bridge over the Cocheco River is eligible under the State General Permit or if an Individual Permit is required. If an Individual Permit is required LBG will produce wetlands impact plans in 8.5" x 11" format as required and complete the application for submittal to the USACE.

- If this project lowers the FEMA flood elevations by more than 6 inches, a Letter of Map Revision (LOMR) based on the as-built survey of the structure, will likely need to be prepared for FEMA.

Non Required Permits

- A USACE permit under Section 10 of the Rivers and Harbors Appropriations Act of 1899 is only required for navigable water of the United States. This section of the Cocheco River is not considered navigable.

- An NHDES Alteration of Terrain (Site Specific) permit is not anticipated to be required. The total area impacted is expected to be less than the threshold of 50,000 square feet for projects in close proximity to water bodies. Based on preliminary design of the preferred alignment the disturbed land area is 49,000 square feet exclusive of staging and stockpile areas. Coordination with NHDES will be required to ensure that the design satisfies all requirements dictated by the Shoreland Protection Act.

- The New Hampshire Natural Heritage database has been checked for the occurrence of rare species and exemplary natural communities in the area of the project. None were found.

Probable Conditions for Permit Approvals

- Disturbed land area shall be less than 50,000 square feet.

Permits and notifications will be required from:

- NHDES for a Dredge and Fill Permit
- NHDES for a Shoreland Permit
- If project lowers the FEMA flood elevations by more than 6 inches, a Letter of Map Revision (LOMR) will likely need to be prepared for FEMA.

COST ESTIMATE

Project costs were developed for the bridge structure, roadway, and utility improvements. Project costs for right-of-way and engineering are also included to estimate the total project budget. For comparative purposes, the bridge substructure for each alternative is assumed to be full height cast-in-place abutments and wingwalls founded on spread footings on rock. The costs are given for three alternate superstructure types. The costs listed below are for the total project and are summarized in a table at the end of this section. It should be noted that the costs for engineering and construction administration do not include on-site inspection. An itemized list of costs for each alternate can be found in *Appendix B*.

Alternate 1, Option 1:

As mentioned above, Alternate 1 consists of a five steel girder superstructure. Option 1 has standard flat face concrete abutments and wingwalls. The estimated total project cost for this option is $3,423,500.

Alternate 1, Option 2:

Option 2 has the same superstructure as Option 1, but will employ the use of plain concrete form liner to the abutments and wingwalls to enhance their appearance. The addition of the form liner results in an estimated cost increase of $10,500. The estimated total project cost for this option is $3,434,000.

Alternate 2, Option 1:

Alternate 2 consists of a four steel girder superstructure. Option 1 has standard flat face concrete abutments and wingwalls. The estimated total project cost for this option is $3,323,500.

Alternate 2, Option 2:

Option 2 has the same four girder superstructure, but will employ the use of plain concrete form liner to the abutments and wingwalls to enhance their appearance. The addition of the form liner results in an estimated cost increase of $10,500. The estimated total project cost for this option is $3,334,000.

Alternate 3, Option 1:

Alternate 3 consists of a pre-fabricated steel truss superstructure. Option 1 has standard flat face concrete abutments and wingwalls. The estimated total project cost for this option is $3,456,500.

Alternate 3, Option 2:

Option 2 has the same steel truss superstructure, but will employ the use of plain concrete form liner to the abutments and wingwalls to enhance their appearance. The addition of the form liner results in an estimated cost increase of $10,500. The estimated total project cost for this option is $3,467,000.

TABLE 2 – COST SUMMARY MATRIX

	BRIDGE CONSTRUCTION	ROADWAY CONSTRUCTION	UTILITY CONSTRUCTION	TOTAL CONSTRUCTION	RIGHT-OF-WAY*	ENGINEERING AND CONSTRUCTION ADMINISTRATION**	TOTAL PROJECT COST
Alternate 1 Option 1 (5 Steel Girders w/ Concrete Deck)	$ 2,404,000	$ 519,500	$ 125,000	$ 3,048,500	$ 10,000	$ 365,000	$ 3,423,500
Alternate 1 Option 2 (Adds Plain Concrete Form Liner to Substructure)	$ 2,414,500	$ 519,500	$ 125,000	$ 3,059,000	$ 10,000	$ 365,000	$ 3,434,000
Alternate 2 Option 1 (4 Steel Girders w/ Concrete Deck)	$ 2,309,000	$ 519,500	$ 125,000	$ 2,953,500	$ 10,000	$ 360,000	$ 3,323,500
Alternate 2 Option 2 (Adds Plain Concrete Form Liner to Substructure)	$ 2,319,500	$ 519,500	$ 125,000	$ 2,964,000	$ 10,000	$ 360,000	$ 3,334,000
Alternate 3 Option 1 (Steel Truss Bridge System w/ Concrete Deck)	$ 2,427,000	$ 519,500	$ 125,000	$ 3,071,500	$ 10,000	$ 375,000	$ 3,456,500
Alternate 3 Option 2 (Adds Plain Concrete Form Liner to Substructure)	$ 2,437,500	$ 519,500	$ 125,000	$ 3,082,000	$ 10,000	$ 375,000	$ 3,467,000

* General estimate only.
** Does not include on-site resident engineering, material testing, or steel fabrication inspection services.

SUMMARY OF RECOMMENDATIONS

- The recommended horizontal alignment for the project is the slightly skewed orientation, which provides a tangent section over the entire bridge that matches into the roadway on both sides of the bridge. (Roadway Option 1)

- The vertical alignment should be set to minimize approach grading and impacts, while maintaining proper clearance over the river for a net zero impact to the existing floodway. Sag vertical curves on both sides of the bridge need to be maintained off the bridge to minimize costs and constructability of the bridge. To this end, a 30 MPH design speed is recommended.

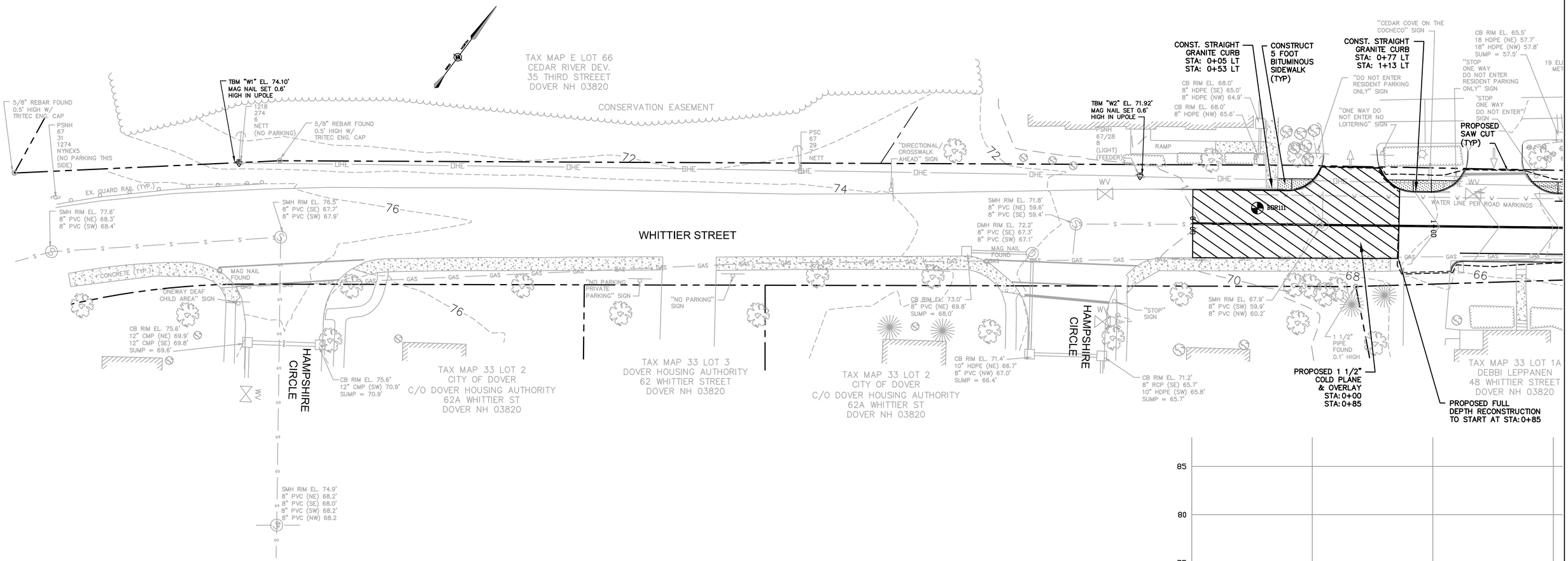
- The Whittier Street Bridge and approaches should be constructed with a 5-foot sidewalk on the north (upstream) side through the project limits to accommodate pedestrian traffic in the area.

- The Whittier Street Bridge is recommended to be a single-span bridge utilizing five (5) steel plate girders acting composite with a reinforced concrete deck. The City of Dover expressed the desire to have the option of maintaining vehicular and pedestrian traffic on the bridge during future deck replacement operations and also wanted to maximize the hydraulic clearance at the bridge. The substructure should consist of full-height, cast-in-place concrete cantilever abutments with U-back wingwalls.

- The recommended bridge amenities include the NHDOT standard aluminum railing and form liner treatments on the abutment and wingwall surfaces if an aesthetic treatment is desired. The additional cost for stone facing does not seem warranted at this location. The aluminum railing is recommended by the City of Dover Department of Public Works to provide maximum safety at the approaches, and to minimize future maintenance costs.

SECTION 2

Figures



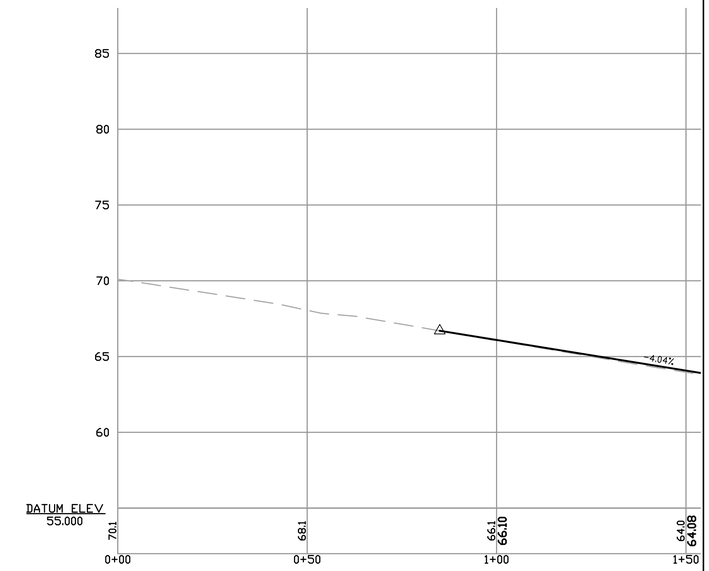
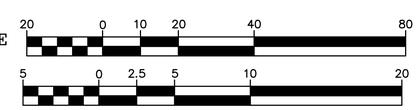


FIGURE 1A

GRAPHIC SCALE



THE Louis Berger Group, INC.
100 COMMERCIAL STREET, 2nd FLOOR, NORTH
Manchester, New Hampshire
(603) 644 5200

CITY OF DOVER, NEW HAMPSHIRE

WHITTIER STREET OVER COCHECO RIVER

ROADWAY PLAN AND PROFILE(1OF3)

DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
15402Plan&Profile2	15402	2	6

SDR PROCESSED	
NEW DESIGN	EZD
SHEET CHECKED	ELC
RECORD DRAWINGS	--

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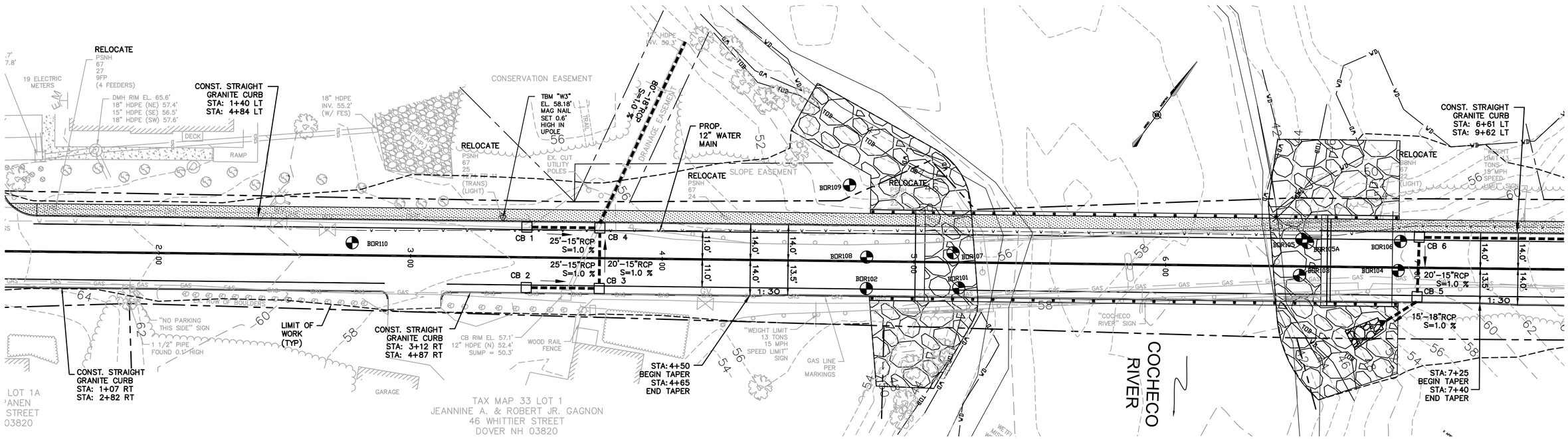

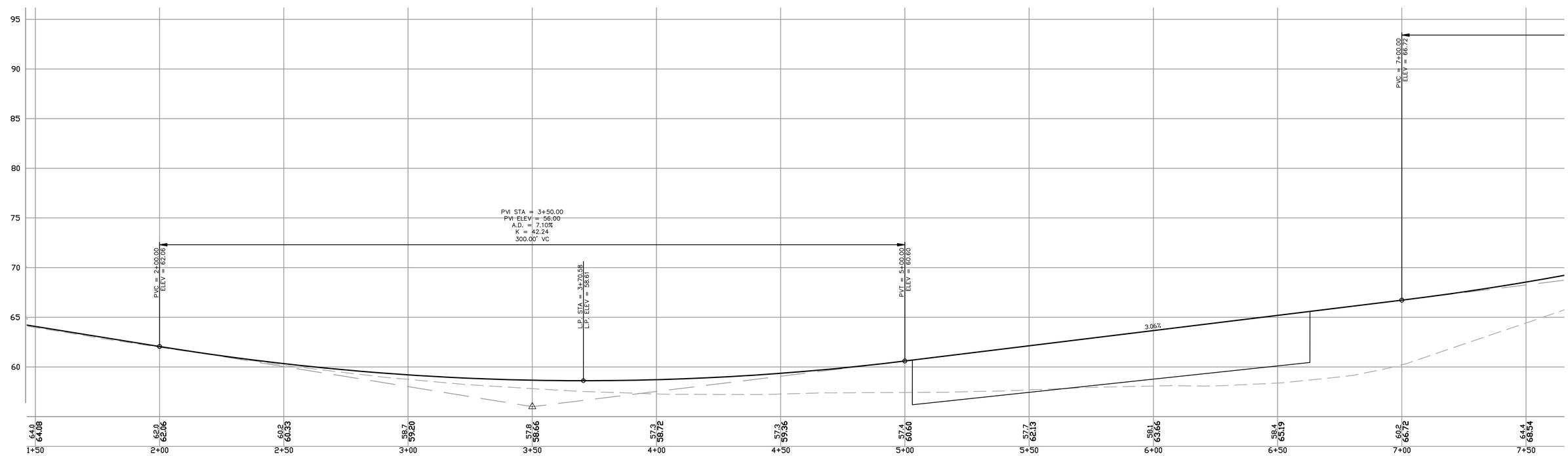

GRAPHIC SCALE

20 0 10 20 40 80 HORIZONTAL

5 0 2.5 5 10 20 VERTICAL

FIGURE 1B

THE Louis Berger Group, INC.
100 COMMERCIAL STREET, 2nd FLOOR, NORTH
Manchester, New Hampshire
(603) 644 5200

SDR PROCCESSED	
NEW DESIGN	EZD
SHEET CHECKED	ELC
RECORD DRAWINGS	--

CITY OF DOVER, NEW HAMPSHIRE

WHITTIER STREET OVER COCHECO RIVER

ROADWAY PLAN AND PROFILE(2OF3)

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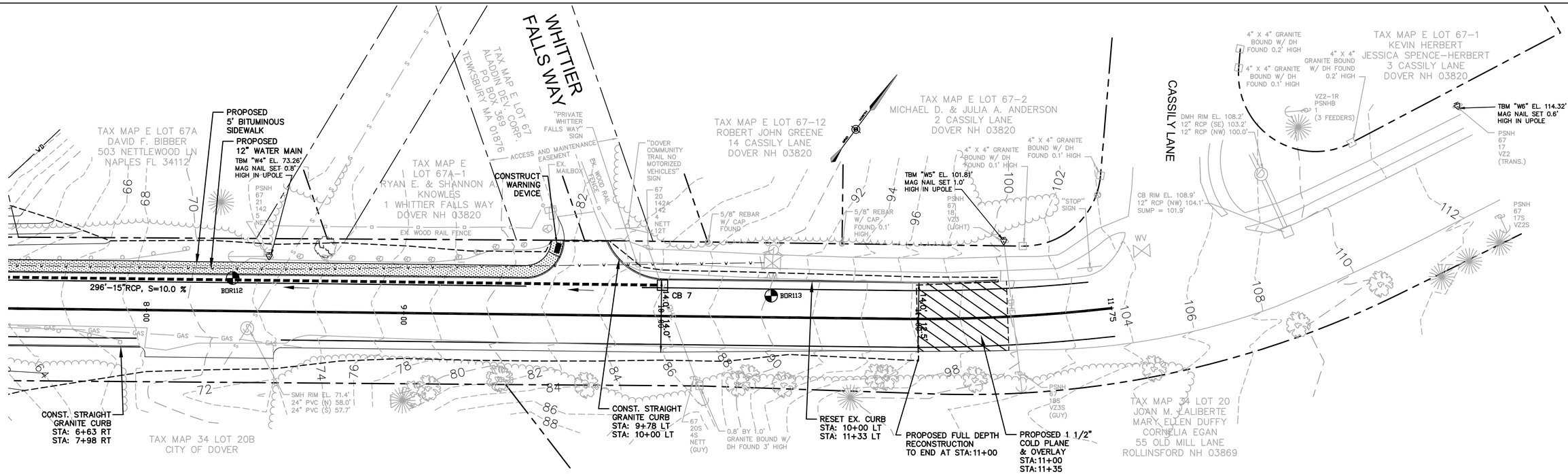
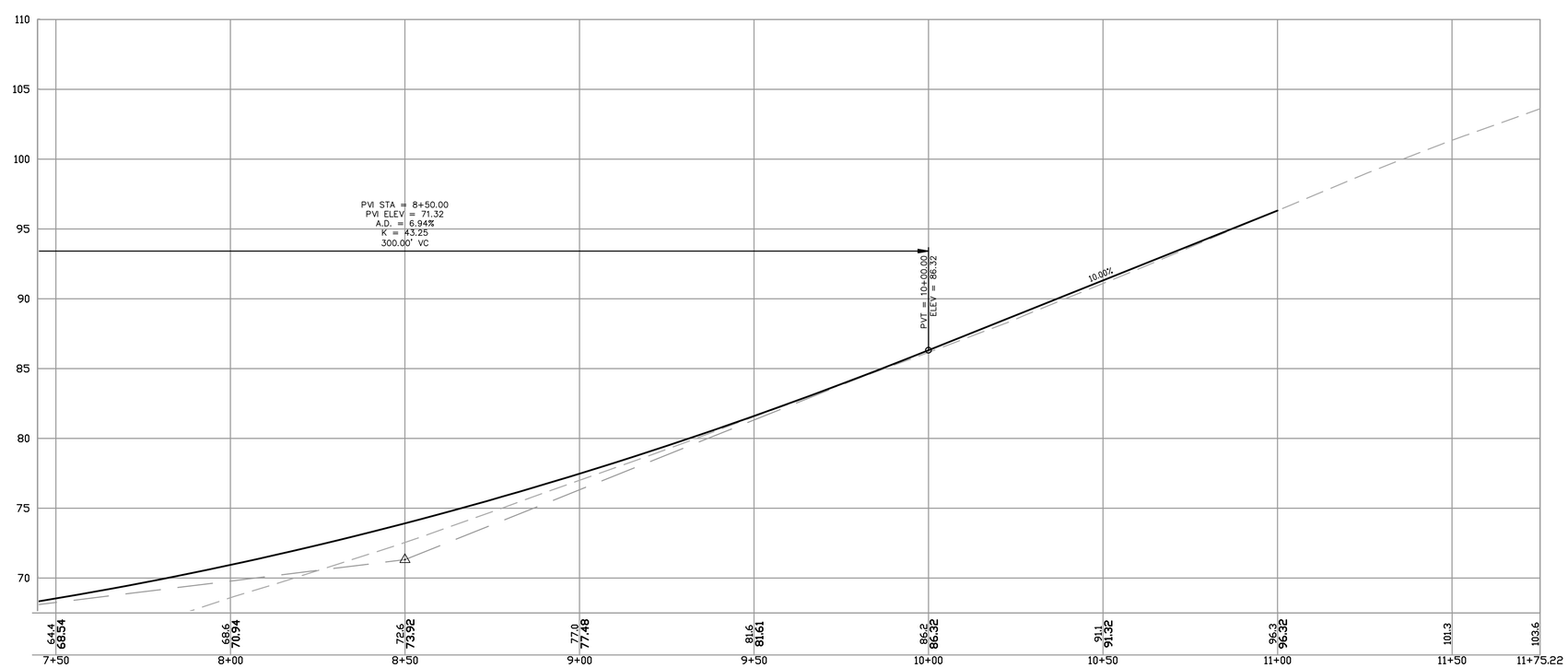
RECORD DRAWINGS	





GRAPHIC SCALE

FIGURE 1C

THE Louis Berger Group, INC.
100 COMMERCIAL STREET, 2nd FLOOR, NORTH
Manchester, New Hampshire
(603) 644 5200

CITY OF DOVER, NEW HAMPSHIRE

WHITTIER STREET OVER COCHECO RIVER

ROADWAY PLAN AND PROFILE(3OF3)

DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
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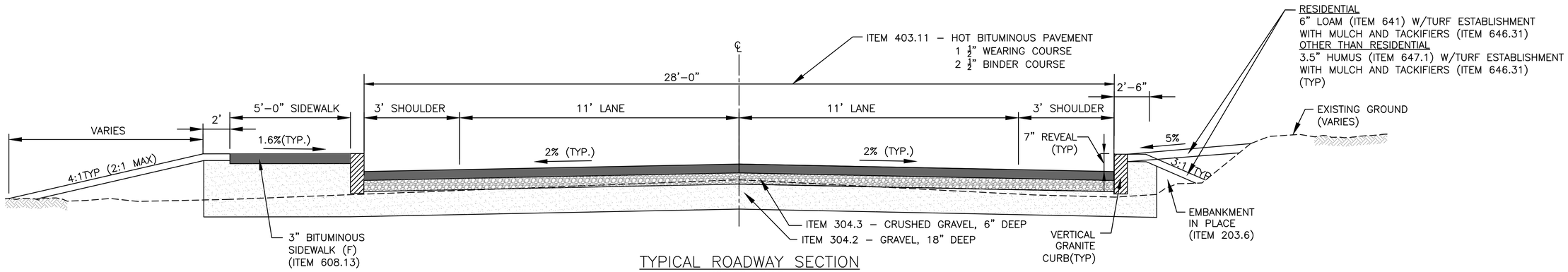

TYPICAL ROADWAY SECTION

NOT TO SCALE

FIGURE 2

SDR PROCCESSED	
NEW DESIGN	EZD
SHEET CHECKED	ELC
RECORD DRAWINGS	--

THE Louis Berger Group, INC.
100 COMMERCIAL STREET, 2nd FLOOR, NORTH
Manchester, New Hampshire
(603) 644 5200

CITY OF DOVER, NEW HAMPSHIRE

WHITTIER STREET OVER COCHECO RIVER

TYPICAL ROADWAY SECTION

DGN	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
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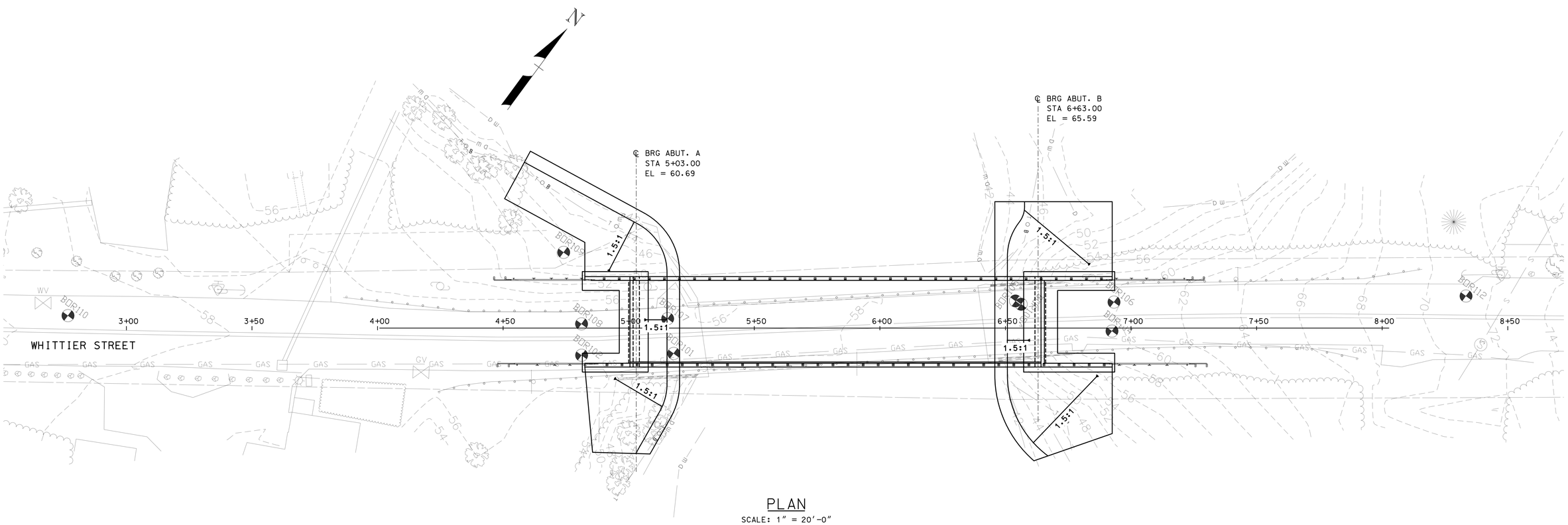
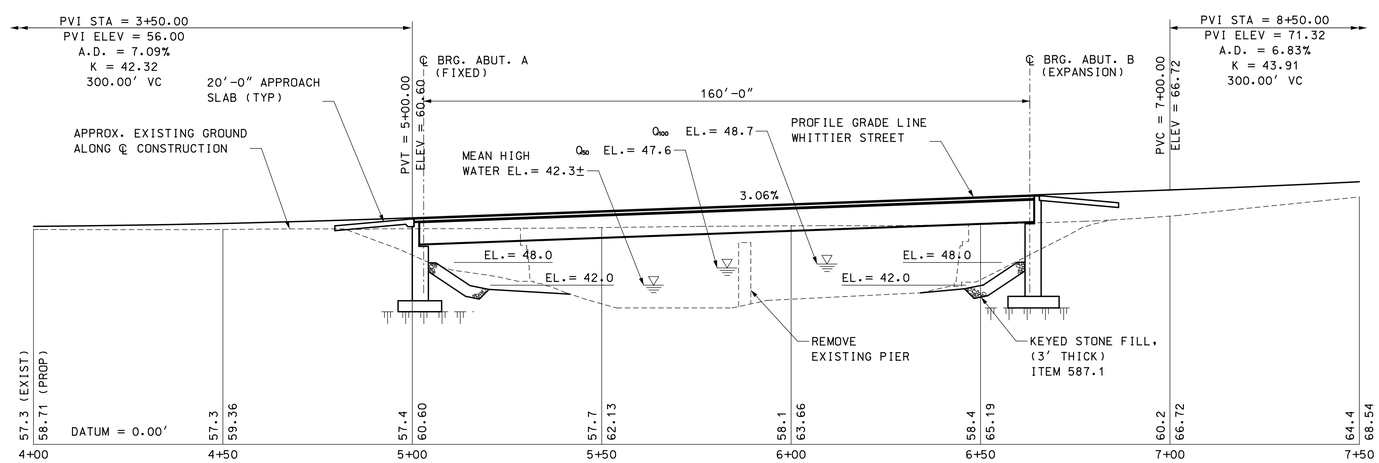


PLAN

SCALE: 1" = 20'-0"



PROFILE

SCALE: 1" = 20'-0"

FIGURE 3

CITY OF DOVER, NEW HAMPHIRE

DEPARTMENT OF COMMUNITY SERVICES

LOCATION WHITTIER STREET OVER COCHECO RIVER BRIDGE NO. 111/132 STATE PROJECT 15402

SITE PLAN AND PROFILE

BRIDGE SHEET 1 OF --

FILE NUMBER ---

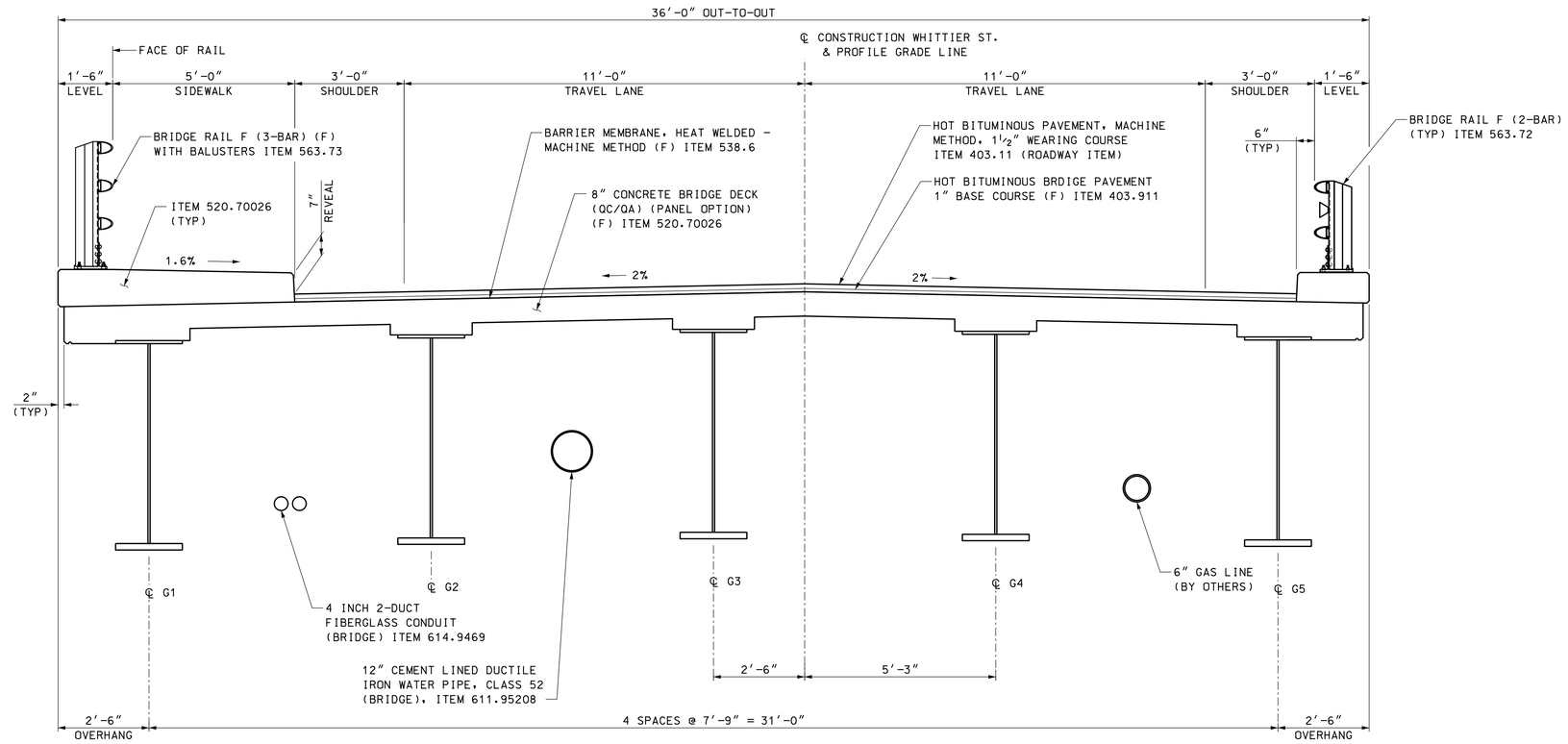
REVISIONS AFTER PROPOSAL	BY	DATE

DESIGNED			CHECKED	-	--
DRAWN	--	--	CHECKED	--	--
QUANTITIES	--	--	CHECKED	--	--

ISSUE DATE	=	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
REV. DATE		--	--	--

THE Louis Berger Group, INC.
Manchester, New Hampshire
(603) 644 5200

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
EMM	15402TSLPlan	AS NOTED



BRIDGE SECTION - ALTERNATE #1

SCALE: 1/2" = 1'-0"

FIGURE 4

CITY OF DOVER, NEW HAMPSHIRE
DEPARTMENT OF COMMUNITY SERVICES

LOCATION WHITTIER STREET OVER COCHECO RIVER BRIDGE NO. 111/132 STATE PROJECT 15402

TYPICAL BRIDGE SECTION - ALTERNATE #1

BRIDGE SHEET 2 OF --

THE Louis Berger Group, INC.
Manchester, New Hampshire
(603) 644 5200

REVISIONS AFTER PROPOSAL			BY	DATE		BY	DATE
		DESIGNED	--	--	CHECKED	-	--
		DRAWN	--	--	CHECKED	--	--
		QUANTITIES	--	--	CHECKED	--	--

FILE NUMBER ---

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE	ISSUE DATE	—	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
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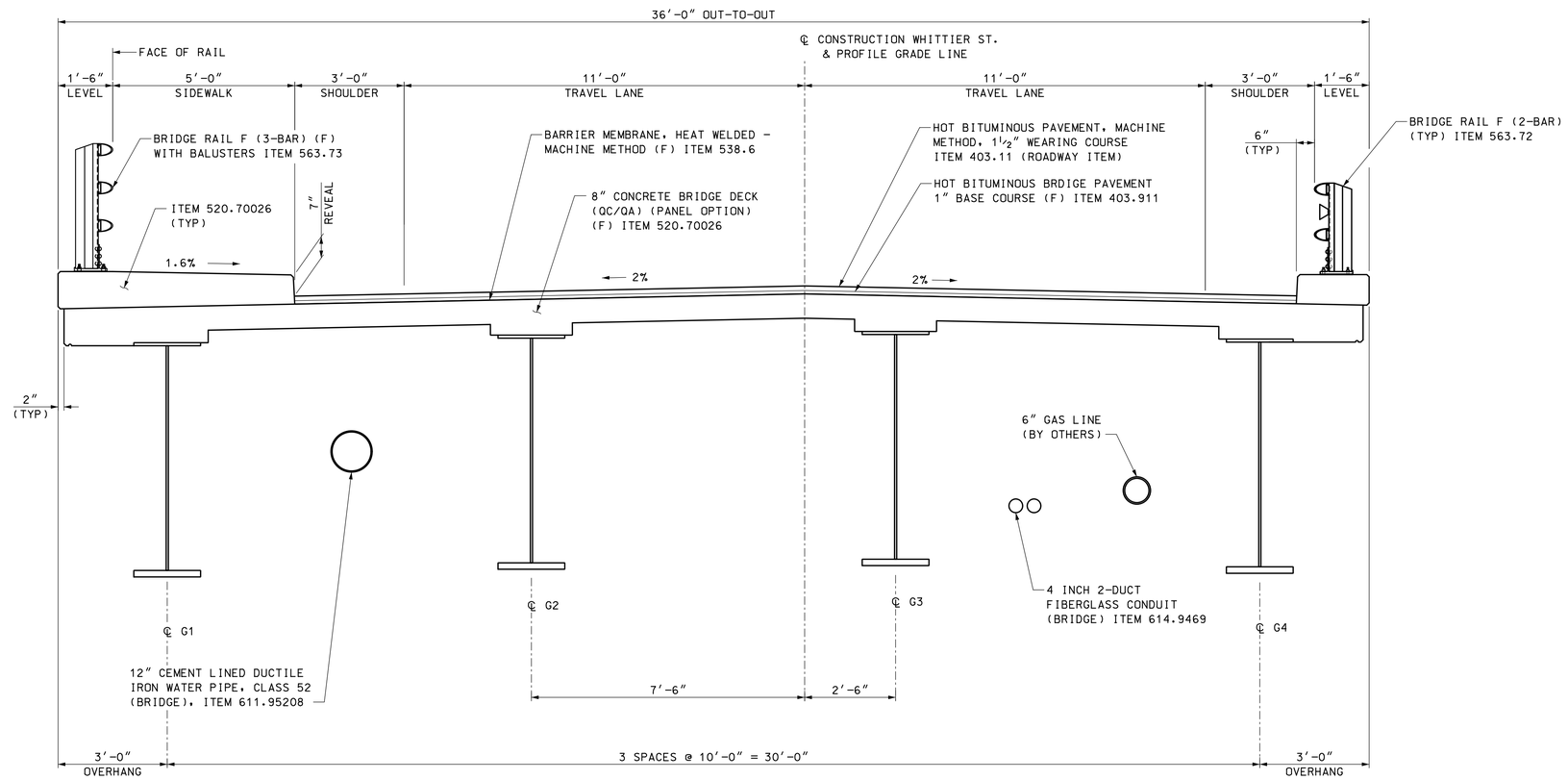

BRIDGE SECTION - ALTERNATE #2

SCALE: 1/2" = 1'-0"

FIGURE 5

CITY OF DOVER, NEW HAMPSHIRE
DEPARTMENT OF COMMUNITY SERVICES

LOCATION WHITTIER STREET OVER COCHECO RIVER BRIDGE NO. 111/132 STATE PROJECT 15402

TYPICAL BRIDGE SECTION - ALTERNATE #2

BRIDGE SHEET 3 OF --

THE Louis Berger Group, INC.
Manchester, New Hampshire
(603) 644 5200

REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	--	--	CHECKED	-	--
	DRAWN	--	--	CHECKED	--	--
	QUANTITIES	--	--	CHECKED	--	--

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE	ISSUE DATE	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
Super	15402DeckSect	AS NOTED	REV. DATE	--	--	--

FILE NUMBER ---

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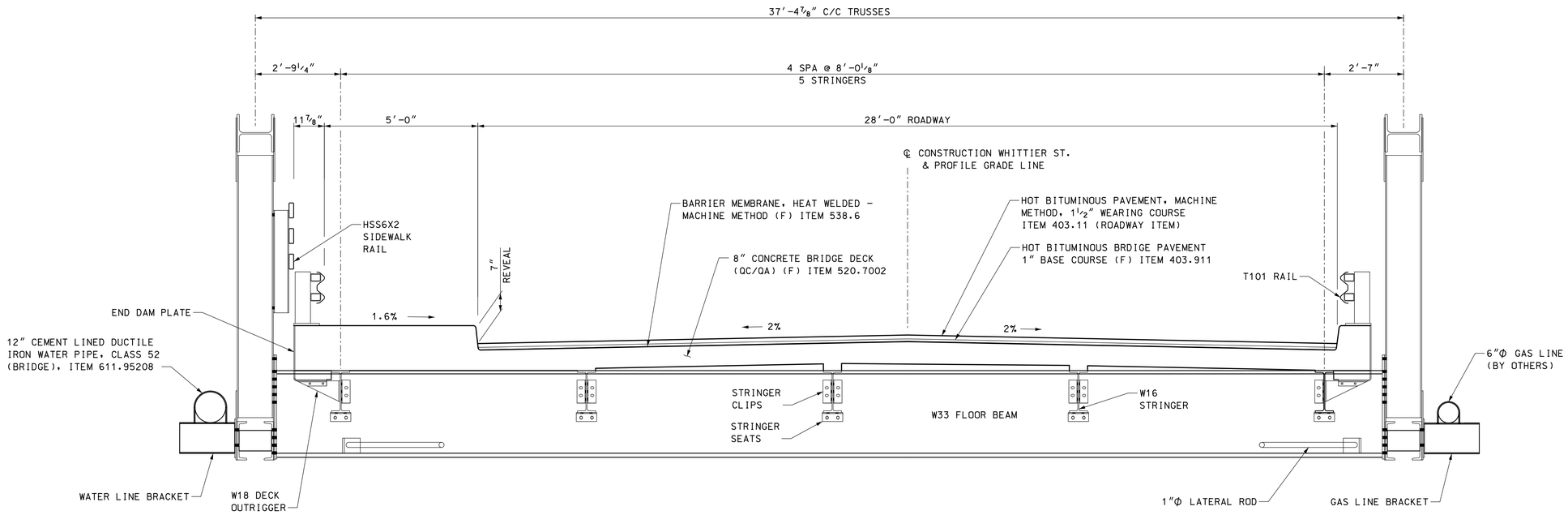

BRIDGE SECTION – ALTERNATE #3

SCALE: 1/2″ = 1′-0″

FIGURE 6

CITY OF DOVER, NEW HAMPSHIRE
DEPARTMENT OF COMMUNITY SERVICES

LOCATION WHITTIER STREET OVER COCHECO RIVER BRIDGE NO. 111/132 STATE PROJECT 15402

TYPICAL BRIDGE SECTION - ALTERNATE #3

THE Louis Berger Group, INC.
Manchester, New Hampshire
(603) 644 5200

REVISIONS AFTER PROPOSAL			BY	DATE		BY	DATE
		DESIGNED	--	--	CHECKED	-	--
		DRAWN	--	--	CHECKED	--	--
		QUANTITIES	--	--	CHECKED	--	--

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE	ISSUE DATE	—	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
Super	15402DeckSect	AS NOTED	REV. DATE		--	--	--

BRIDGE SHEET 4 OF --

FILE NUMBER ---

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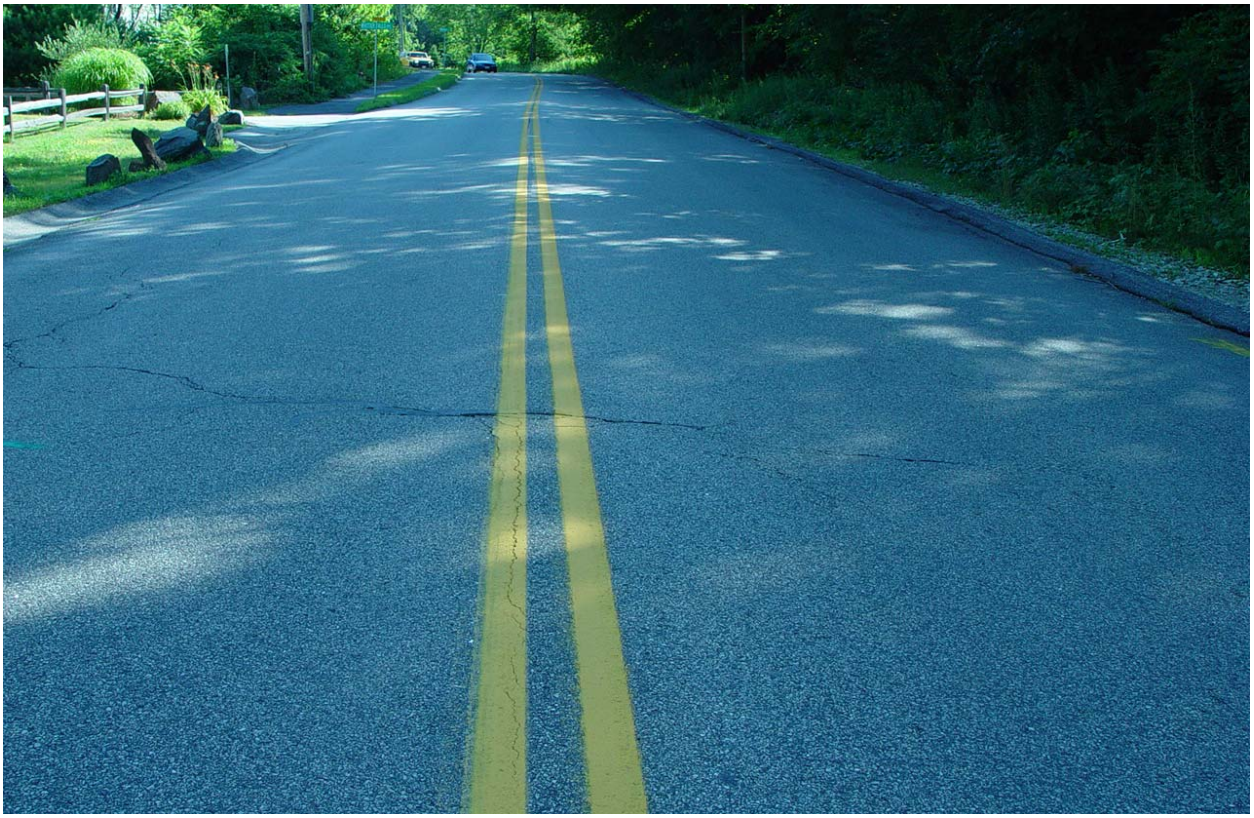
APPENDIX A

Existing Conditions Photos

Downstream Elevation of Bridge

West Approach Looking West

East Approach Looking West toward Bridge



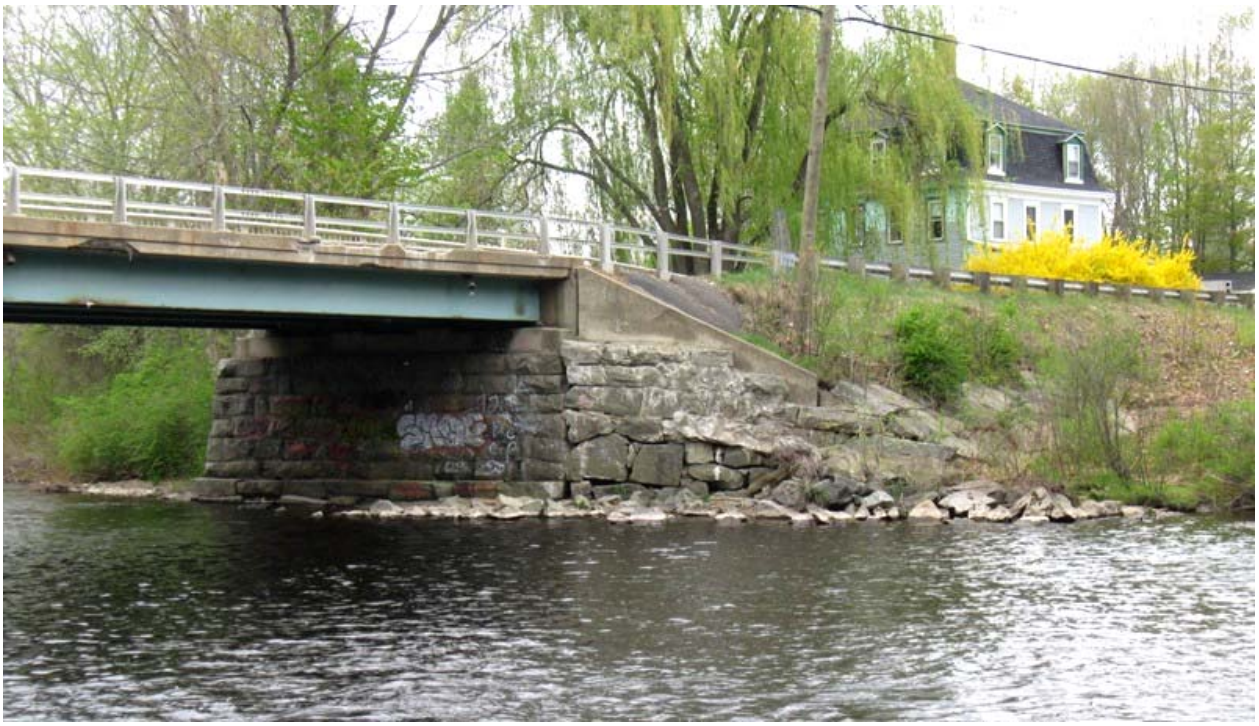
East Approach Looking East

West Approach Looking East toward Bridge

South Side of West Approach

East Abutment and Existing Gas Line

Existing Pier



West Abutment

Underside of Bridge at Pier

APPENDIX B

Quantity and Cost Summary Sheets

THE Louis Berger Group, INC.
100 Commercial Street
2nd Floor North
Manchester, NH 03101

BY TPL DATE 08/27/12 SHEET 1 OF 2
CHKD BY NDC DATE 08/28/12 PROJECT CCM 1813
SUBJECT Whittier Street over Cocheco River - Dover, NH (TS & L Estimate)

Engineer's Estimate - Bridge: Steel 5 Girder Alternative

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
207.3	UNCLASSIFIED CHANNEL EXCAVATION	CY	1340	$20.00	$26,800.00
209.201	GRANULAR BACKFILL (BRIDGE) (F)	CY	1020	$35.00	$35,700.00
403.911	HOT BITUMINOUS BRIDGE PAVEMENT, 1" BASE COURSE (F)	T	29	$135.00	$3,915.00
502	REMOVAL OF EXISTING BRIDGE STRUCTURE	U	1	$126,000.00	$126,000.00
503.201	COFFERDAMS	U	1	$159,000.00	$159,000.00
504.1	COMMON BRIDGE EXCAVATION (F)	CY	1440	$35.00	$50,400.00
504.2	ROCK BRIDGE EXCAVATION	CY	288	$100.00	$28,800.00
520.01027	CONCRETE CLASS AA (QC/QA) (PRECAST OPTION) (F)	CY	28	$800.00	$22,400.00
520.03027	CONCRETE CLASS AA, APPROACH SLABS (QC/QA) (PRECAST OPTION) (F)	CY	52	$300.00	$15,600.00
520.12	CONCRETE CLASS A ABOVE FOOTINGS (F)	CY	353	$800.00	$282,400.00
520.211	CONCRETE CLASS B, FOOTINGS (ON ROCK)	CY	201	$400.00	$80,400.00
520.70026	CONCRETE BRIDGE DECK (QC/QA) (PANEL OPTION) (F)	CY	222	$900.00	$199,800.00
534.3	WATER REPELLENT (SILANE-SILOXANE)	GAL	62	$75.00	$4,650.00
538.2	BARRIER MEMBRANE, PEEL AND STICK - VERTICAL SURFACES (F)	SY	38	$50.00	$1,900.00
538.5	BARRIER MEMBRANE, HEAT WELDED (F)	SY	19	$45.00	$855.00
538.6	BARRIER MEMBRANE, HEAT WELDED - MACHINE METHOD (F)	SY	496	$30.00	$14,880.00
541.1	PVC WATERSTOPS, NH TYPE 1 (F)	LF	30	$7.00	$210.00
541.4	PVC WATERSTOPS, NH TYPE 4 (F)	LF	98	$10.00	$980.00
541.5	PVC WATERSTOPS, NH TYPE 5 (F)	LF	30	$10.00	$300.00
544.3	REINFORCING STEEL (CONTRACTOR DETAILED)	LB	68170	$1.50	$102,255.00
544.31	REINFORCING STEEL, EPOXY COATED (CONTRACTOR DETAILED)	LB	88410	$1.60	$141,456.00
544.7	SYNTHETIC FIBER REINFORCEMENT (F)	LB	370	$8.00	$2,960.00
547	SHEAR CONNECTORS (F)	EA	1215	$5.00	$6,075.00
548.21	ELASTOMERIC BEARING ASSEMBLIES (F)	EA	10	$4,000.00	$40,000.00
550.1	STRUCTURAL STEEL (F)	LB	341940	$1.85	$632,589.00
559.41	MODIFIED ELASTOMERIC PLUG TYPE FLEXIBLE JOINT, 6" WIDE (F)	LF	36	$90.00	$3,240.00
561.110	PREFABRICATED EXPANSION JOINT, TYPE A (F)	LF	36	$550.00	$19,800.00
562.1	SILICONE JOINT SEALANT (F)	LF	111	$12.00	$1,332.00
563.72	BRIDGE RAIL F (2-BAR) (F)	LF	210	$150.00	$31,500.00
563.73	BRIDGE RAIL F (3-BAR) (F)	LF	210	$175.00	$36,750.00
565.72	BRIDGE APPROACH RAIL F (2-BAR) (F)	U	2	$4,500.00	$9,000.00
565.73	BRIDGE APPROACH RAIL F (3-BAR) (F)	U	2	$5,200.00	$10,400.00
587.1	KEYED STONE FILL	CY	980	$40.00	$39,200.00
593.411	GEOTEXTILE PERM. EROSION CONTROL, CLASS 1, NON-WOVEN	SY	1230	$5.00	$6,150.00

THE Louis Berger Group, INC.
100 Commercial Street
2nd Floor North
Manchester, NH 03101

BY TPL DATE 08/27/12 SHEET 2 OF 2
CHKD BY NDC DATE 08/28/12 PROJECT CCM 1813
SUBJECT Whittier Street over Cocheco River - Dover, NH (TS & L Estimate)

Engineer's Estimate - Bridge: Steel 5 Girder Alternative (Cont'd)

603.25112	12" STEEL PIPE SLEEVE, STANDARD SCHEDULE	LF	64	$120.00	$7,680.00
603.25116	16" STEEL PIPE SLEEVE, STANDARD SCHEDULE	LF	64	$120.00	$7,680.00
1008.11	ALTERATIONS AND ADDITIONS AS NEEDED - UNANTICIPATED WORK	$	1	$20,000.00	$20,000.00
1008.9	ALTERATIONS AND ADDITIONS AS NEEDED - TESTING OF MATERIAL	$	1	$10,000.00	$10,000.00
1010.42	QUALITY CONTROL / QUALITY ASSURANCE (QC/QA) FOR CONCRETE	$	1	$17,000.00	$17,000.00

BRIDGE ITEM TOTAL = $2,200,061.00
10% Contingency = $220,006.10
STRUCTURE TOTAL = $2,420,067.10

SAY=> **$2,421,000.00**

THE Louis Berger Group, INC.
100 Commercial Street
2nd Floor North
Manchester, NH 03101

BY *TPL* DATE *11/11/11* SHEET 1 OF 2
CHKD BY *NDC* DATE *11/16/11* PROJECT *CCM 1813*
SUBJECT *Whittier Street over Cocheco River - Dover, NH (TS & L Estimate)*

Engineer's Estimate - Bridge: Steel 4 Girder Alternative

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
207.3	UNCLASSIFIED CHANNEL EXCAVATION	CY	1340	$20.00	$26,800.00
209.201	GRANULAR BACKFILL (BRIDGE) (F)	CY	1020	$35.00	$35,700.00
403.911	HOT BITUMINOUS BRIDGE PAVEMENT, 1" BASE COURSE (F)	T	28	$135.00	$3,780.00
502	REMOVAL OF EXISTING BRIDGE STRUCTURE	U	1	$126,000.00	$126,000.00
503.201	COFFERDAMS	U	1	$159,000.00	$159,000.00
504.1	COMMON BRIDGE EXCAVATION (F)	CY	1440	$35.00	$50,400.00
504.2	ROCK BRIDGE EXCAVATION	CY	288	$100.00	$28,800.00
520.01027	CONCRETE CLASS AA (QC/QA) (PRECAST OPTION) (F)	CY	32	$800.00	$25,600.00
520.03027	CONCRETE CLASS AA, APPROACH SLABS (QC/QA) (PRECAST OPTION) (F)	CY	52	$300.00	$15,600.00
520.12	CONCRETE CLASS A ABOVE FOOTINGS (F)	CY	356	$800.00	$284,800.00
520.211	CONCRETE CLASS B, FOOTINGS (ON ROCK)	CY	269	$400.00	$107,600.00
520.70026	CONCRETE BRIDGE DECK (QC/QA) (PANEL OPTION) (F)	CY	214	$900.00	$192,600.00
534.3	WATER REPELLENT (SILANE-SILOXANE)	GAL	61	$75.00	$4,575.00
538.2	BARRIER MEMBRANE, PEEL AND STICK - VERTICAL SURFACES (F)	SY	38	$50.00	$1,900.00
538.5	BARRIER MEMBRANE, HEAT WELDED (F)	SY	19	$45.00	$855.00
538.6	BARRIER MEMBRANE, HEAT WELDED - MACHINE METHOD (F)	SY	481	$30.00	$14,430.00
541.1	PVC WATERSTOPS, NH TYPE 1 (F)	LF	30	$7.00	$210.00
541.4	PVC WATERSTOPS, NH TYPE 4 (F)	LF	98	$10.00	$980.00
541.5	PVC WATERSTOPS, NH TYPE 5 (F)	LF	30	$10.00	$300.00
544.3	REINFORCING STEEL (CONTRACTOR DETAILED)	LB	77360	$1.25	$96,700.00
544.31	REINFORCING STEEL, EPOXY COATED (CONTRACTOR DETAILED)	LB	86150	$1.50	$129,225.00
544.7	SYNTHETIC FIBER REINFORCEMENT (F)	LB	370	$8.00	$2,960.00
547	SHEAR CONNECTORS (F)	EA	948	$5.00	$4,740.00
548.21	ELASTOMERIC BEARING ASSEMBLIES (F)	EA	8	$4,000.00	$32,000.00
550.1	STRUCTURAL STEEL (F)	LB	273427	$2.00	$546,854.00
559.41	MODIFIED ELASTOMERIC PLUG TYPE FLEXIBLE JOINT, 6" WIDE (F)	LF	37	$90.00	$3,330.00
561.110	PREFABRICATED EXPANSION JOINT, TYPE A (F)	LF	37	$550.00	$20,350.00

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BY TPL DATE 11/11/11 SHEET 2 OF 2
CHKD BY NDC DATE 11/16/11 PROJECT CCM 1813
SUBJECT Whittier Street over Cocheco River - Dover, NH (TS & L Estimate)

Engineer's Estimate - Bridge: Steel 4 Girder Alternative (Cont'd)

562.1	SILICONE JOINT SEALANT (F)	LF	111	$12.00	$1,332.00
563.72	BRIDGE RAIL F (2-BAR) (F)	LF	205	$150.00	$30,750.00
563.73	BRIDGE RAIL F (3-BAR) (F)	LF	205	$175.00	$35,875.00
565.72	BRIDGE APPROACH RAIL F (2-BAR) (F)	U	2	$4,500.00	$9,000.00
565.73	BRIDGE APPROACH RAIL F (3-BAR) (F)	U	2	$5,200.00	$10,400.00
587.1	KEYED STONE FILL	CY	925	$40.00	$37,000.00
593.411	GEOTEXTILE PERM. EROSION CONTROL, CLASS 1, NON-WOVEN	SY	1180	$5.00	$5,900.00
603.25112	12" STEEL PIPE SLEEVE, STANDARD SCHEDULE	LF	64	$120.00	$7,680.00
603.25116	16" STEEL PIPE SLEEVE, STANDARD SCHEDULE	LF	64	$120.00	$7,680.00
1008.11	ALTERATIONS AND ADDITIONS AS NEEDED - UNANTICIPATED WORK	$	1	$20,000.00	$20,000.00
1008.9	ALTERATIONS AND ADDITIONS AS NEEDED - TESTING OF MATERIAL	$	1	$10,000.00	$10,000.00
1010.15	FUEL ADJUSTMENT	$	1	$5,000.00	$5,000.00
1010.42	QUALITY CONTROL / QUALITY ASSURANCE (QC/QA) FOR CONCRETE	$	1	$17,000.00	$17,000.00

BRIDGE ITEM TOTAL = $2,113,706.00
10% Contingency = $211,370.60
STRUCTURE TOTAL = $2,325,076.60

SAY=> $2,326,000.00

THE Louis Berger Group, INC.
100 Commercial Street
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BY *TPL* DATE *10/13/11* SHEET 1 OF 2
CHKD BY *NDC* DATE *11/16/11* PROJECT *CCM 1813*
SUBJECT *Whittier Street over Cocheco River - Dover, NH (TS & L Estimate)*

Engineer's Estimate - Bridge: Steel Truss Alternative

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
207.3	UNCLASSIFIED CHANNEL EXCAVATION	CY	1320	$20.00	$26,400.00
209.201	GRANULAR BACKFILL (BRIDGE) (F)	CY	1080	$35.00	$37,800.00
403.911	HOT BITUMINOUS BRIDGE PAVEMENT, 1" BASE COURSE (F)	T	28	$135.00	$3,780.00
502	REMOVAL OF EXISTING BRIDGE STRUCTURE	U	1	$126,000.00	$126,000.00
503.201	COFFERDAMS	U	1	$163,000.00	$163,000.00
504.1	COMMON BRIDGE EXCAVATION (F)	CY	1490	$35.00	$52,150.00
504.2	ROCK BRIDGE EXCAVATION	CY	297	$100.00	$29,700.00
520.01027	CONCRETE CLASS AA (QC/QA) (PRECAST OPTION) (F)	CY	16	$800.00	$12,800.00
520.03027	CONCRETE CLASS AA, APPROACH SLABS (QC/QA) (PRECAST OPTION) (F)	CY	52	$300.00	$15,600.00
520.12	CONCRETE CLASS A ABOVE FOOTINGS (F)	CY	436	$800.00	$348,800.00
520.211	CONCRETE CLASS B, FOOTINGS (ON ROCK)	CY	283	$400.00	$113,200.00
520.7002	CONCRETE BRIDGE DECK (QC/QA) (F)	CY	192	$800.00	$153,600.00
534.3	WATER REPELLENT (SILANE-SILOXANE)	GAL	66	$75.00	$4,950.00
538.2	BARRIER MEMBRANE, PEEL AND STICK - VERTICAL SURFACES (F)	SY	42	$50.00	$2,100.00
538.5	BARRIER MEMBRANE, HEAT WELDED (F)	SY	19	$45.00	$855.00
538.6	BARRIER MEMBRANE, HEAT WELDED - MACHINE METHOD (F)	SY	489	$30.00	$14,670.00
541.1	PVC WATERSTOPS, NH TYPE 1 (F)	LF	30	$7.00	$210.00
541.4	PVC WATERSTOPS, NH TYPE 4 (F)	LF	98	$10.00	$980.00
541.5	PVC WATERSTOPS, NH TYPE 5 (F)	LF	30	$10.00	$300.00
544.3	REINFORCING STEEL (CONTRACTOR DETAILED)	LB	87120	$1.25	$108,900.00
544.31	REINFORCING STEEL, EPOXY COATED (CONTRACTOR DETAILED)	LB	76060	$1.50	$114,090.00
544.7	SYNTHETIC FIBER REINFORCEMENT (F)	LB	370	$8.00	$2,960.00
550.17	ERECT STRUCTURAL STEEL SUPERSTRUCTURE	U	1	$100,000.00	$100,000.00
559.41	MODIFIED ELASTOMERIC PLUG TYPE FLEXIBLE JOINT, 6" WIDE (F)	LF	40	$90.00	$3,600.00
561.110	PREFABRICATED EXPANSION JOINT, TYPE A (F)	LF	40	$550.00	$22,000.00

THE Louis Berger Group, INC.
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BY TPL DATE 10/13/11 SHEET 2 OF 2
CHKD BY NDC DATE 11/16/11 PROJECT CCM 1813
SUBJECT Whittier Street over Cocheco River - Dover, NH (TS & L Estimate)

Engineer's Estimate - Bridge: Steel Truss Alternative (Cont'd)

562.1	SILICONE JOINT SEALANT (F)	LF	148	$12.00	$1,776.00
565.72	BRIDGE APPROACH RAIL F (2-BAR) (F)	U	2	$4,500.00	$9,000.00
565.73	BRIDGE APPROACH RAIL F (3-BAR) (F)	U	2	$5,200.00	$10,400.00
587.1	KEYED STONE FILL	CY	897	$40.00	$35,880.00
593.411	GEOTEXTILE PERM. EROSION CONTROL, CLASS 1, NON-WOVEN	SY	1150	$5.00	$5,750.00
603.25112	12" STEEL PIPE SLEEVE, STANDARD SCHEDULE	LF	64	$120.00	$7,680.00
603.25116	16" STEEL PIPE SLEEVE, STANDARD SCHEDULE	LF	64	$120.00	$7,680.00
1008.11	ALTERATIONS AND ADDITIONS AS NEEDED - UNANTICIPATED WORK	$	1	$20,000.00	$20,000.00
1008.9	ALTERATIONS AND ADDITIONS AS NEEDED - TESTING OF MATERIAL	$	1	$10,000.00	$10,000.00
1010.15	FUEL ADJUSTMENT	$	1	$5,000.00	$5,000.00
1010.42	QUALITY CONTROL / QUALITY ASSURANCE (QC/QA) FOR CONCRETE	$	1	$13,000.00	$13,000.00

BRIDGE ITEM TOTAL =	$1,584,611.00
10% Contingency =	$158,461.10
Pre-fabricated Steel Truss Superstructure (Supplied by others) =	$700,000.00
STRUCTURE TOTAL =	$2,443,072.10
SAY=>	$2,444,000.00

THE **Louis Berger Group**, INC.
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Engineer's Opinion of Construction Cost (4" Pavement, 6" Cr Gravel, 18" Gravel)
Sta. 0+00 - Sta. 11+35

Project: **Whittier Street**

201.1	CLEARING AND GRUBBING (F)	A	0.15	6,700.00	$1,005.00
201.21	REMOVING SMALL TREES	EA	2	300.00	$600.00
201.22	REMOVING LARGE TREES	EA	2	750.00	$1,500.00
202.41	REMOVE EXISTING PIPE 0-24" DIA	LF	30	10.00	$300.00
202.5	REMOVAL OF CATCH BASINS, DROP INLETS, AND MANHOLES	EA	1	340.00	$340.00
202.7	REMOVAL OF GUARD RAIL	LF	550	2.50	$1,375.00
203.1	COMMON EXCAVATION	CY	1,300	5.00	$6,500.00
203.2	ROCK EXCAVATION	CY	5	20.00	$100.00
203.4	MUCK EXCAVATION	CY	100	10.00	$1,000.00
203.5555	GUARDRAIL 25' EAGRT PLATFORM	U	4	500.00	$2,000.00
203.6	EMBANKMENT-IN-PLACE (F)	CY	3,500	5.00	$17,500.00
214	FINE GRADING	U	1	3,500.00	$3,500.00
304.2	GRAVEL	CY	3,200	13.50	$43,200.00
304.3	CRUSHED GRAVEL	CY	500	22.00	$11,000.00
304.32	CRUSHED GRAVEL FOR SHOULDER LEVELING	TON	15	25.00	$375.00
304.35	CRUSHED GRAVEL FOR DRIVES	CY	60	25.00	$1,500.00
403.11	HOT BITUMINOUS PAVEMENT, MACHINE METHOD	TON	650	75.00	$48,750.00
403.12	HOT BITUMINOUS PAVEMENT, HAND METHOD	TON	40	125.00	$5,000.00
417	COLD PLANING BITUMINOUS SURFACES	SY	450	5.00	$2,250.00
520.1	CONCRETE CLASS A	CY	5	650.00	$3,250.00
585.3	STONE FILL, CLASS C	CY	10	30.00	$300.00
603.00315	15" R.C. PIPE, 3000D	LF	400	50.00	$20,000.00
603.00318	18" R.C. PIPE, 3000D	LF	100	55.00	$5,500.00
603.85218	18" CORR. POLYETHYLENE END SECTION	EA	1	200.00	$200.00
604.12	CATCH BASINS TYPE B	U	5	2,000.00	$10,000.00
604.16	CATCH BASINS TYPE F	U	3	2,200.00	$6,600.00
604.51	RECONSTRUCTING/ADJUSTING SEWER MANHOLES	LF	5	500.00	$2,500.00
606.1455	BEAM GUARDRAIL (TERM. UNIT TYPE EAGRT 25 FT.)	U	4	1,500.00	$6,000.00
606.417	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF	60	20.00	$1,200.00
608.13	3" BITUMINOUS SIDEWALK (F)	SY	390	20.00	$7,800.00
608.54	DETECTABLE WARNING DEVICE CAST IRON	SY	1	500.00	$500.00
609.01	STRAIGHT GRANITE CURB	LF	1350	20.00	$27,000.00
609.5	RESET GRANITE CURB	LF	150	10.00	$1,500.00
611.05212	12" CEMENT LINED DUCTILE IRON WATER PIPE , CL.52	LF	800	100.00	$80,000.00
611.70012	12" FITTING	EA	4	800.00	$3,200.00
611.71001	REPLACE NUTS ON EXISTING WATER VALVE	U	1	500.00	$500.00
611.72012	12" BUTTERFLY VALVE	EA	2	2,000.00	$4,000.00
611.74	CHLORINE INJECTION TAP	EA	1	1,000.00	$1,000.00
611.811	ADJUSTING/RELOCATING HYDRANTS	EA	1	2,500.00	$2,500.00
611.90001	ADJUSTING WATER GATES AND SHUTOFFS SET BY OTHERS	EA	3	250.00	$750.00
615.03	TRAFFIC SIGN TYPE C (F)	SF	25	50.00	$1,250.00
618.61	UNIFORMED OFFICERS WITH VEHICLE	Allow	1	1,200.00	$1,200.00
619.1	MAINTENANCE OF TRAFFIC	U	1	10,000.00	$10,000.00
619.25	PORTABLE CHANGEABLE MESSAGE SIGN	U	2	10,000.00	$20,000.00
622.1	STEEL WITNESS MARKERS	EA	2	30.00	$60.00
628.2	SAWED BITUMINOUS PAVEMENT	LF	200	3.00	$600.00
632.3104	RETROREFLECT. THERMOPLAS. PAVE. MARKING, 4" LINE	LF	5,000	0.75	$3,750.00
632.3112	RETROREFLECT. THERMOPLAS. PAVE. MARKING, 12" LINE	LF	50	1.55	$77.50

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Engineer's Opinion of Construction Cost (4" Pavement, 6" Cr Gravel, 18" Gravel)
Sta. 0+00 - Sta. 11+35

Project: **Whittier Street**

632.32	RETROREFLECT. THERMOPLAS. PVMNT MARKING, SYMBOL OR WORD	SF	350	5.00	$1,750.00
641	LOAM	CY	150	25.00	$3,750.00
645.3	EROSION STONE	TON	100	25.00	$2,500.00
645.531	SILT FENCE	LF	1,500	3.00	$4,500.00
645.7	STORMWATER POLLUTION PREVENTION PLAN	U	1	6,000.00	$6,000.00
645.71	MONITORING SWPPP AND EROSION AND SEDIMENT CONTROLS	HR	150	80.00	$12,000.00
646.31	TURF ESTABLISHMENT WITH MULCH &TACKIFIERS	SY	1,200	2.00	$2,400.00
647.1	HUMUS	CY	110	15.00	$1,650.00
670.066	MAILBOX SUPPORT ASSEMBLIES	EA	3	200.00	$600.00
670.95	TEMPORARY SAFETY FENCE	LF	1,000	5.00	$5,000.00
692	MOBILIZATION	U	1	50,000.00	$50,000.00
698.11	FIELD OFFICE TYPE A	MON	9	1,700.00	$15,300.00
699	MISCELLANEOUS TEMPORARY EROSION AND SEDIMENT CONTROL	Allow	1	10,000.00	$10,000.00
1008.11	ALTERATIONS AND ADDITIONS AS NEEDED - UNANTICIPATED WORK	Allow	1	20,000.00	$20,000.00
1009.2	TREAT. OR DISPOSAL OF CONTAMINATED SOIL/GROUNDWATER	Allow	1	20,000.00	$20,000.00
1010.15	FUEL ADJUSTMENT	Allow	1	20,000.00	$20,000.00
1010.2	ASPHALT CEMENT ADJUSTMENT	Allow	1	20,000.00	$20,000.00
				SUBTOTAL	**$564,483**
				10% Contingency	$56,448
				TOTAL	**$620,931**

APPENDIX C

Geotechnical Report

APPENDIX D

Hydrologic & Hydraulic Back-Up Data

CM1813 - Whittier Street City of Dover, Strafford County

SCS TR-20 (from FEMA FIS)

	Flow	
Q_{10} =	6330.0	cfs
Q_{50} =	11140.0	cfs
Q_{100} =	13560.0	cfs
Q_{500} =	19110.0	cfs

See FEMA Strafford County Flood Insurance Study, May 17, 2005.

NEHL / AWM Methods: Method used = NEHL

P = 1.55 in. — P is the precipitation index, NHDOT Figure 2-10, p. 2-38

171.4 sq. mi. — A is the drainage area, in square miles,

K = 6% — K is the storage index as a % of wetlands, ponds and broad valleys relative to the total drainage area as measured on the USGS map.

Q_{10} = **6400** cfs from NHDOT graph Figure 2-8, p. 2-37

Q_{50} = **11500** Can't determine this flow with this method

Average of methods:

Q_{50} =	11785 cfs	(4 methods)
Q_{100} =	14461 cfs	(3 methods)

USGS Method:

Pt is the peak discharge, in cubic feet per second, for the specified recurrence interval t, in years,

A is the drainage area, in square miles, measured from USGS Topographic Map in square miles

S is the main-channel slope, in feet per mile, calculated between 10% and 85% of the main-channel length as measured from downstream to upstream

Overall Length of Main Channel=	183107	ft.	(34.68 mi.)
Length to 85%=	155641	ft.	(29.48 mi.)
Length to 10%=	18310.7	ft.	(3.47 mi.)
Elevation @ 85%ft.=	430	ft.	
Elevation @ 10%ft.=	120	ft.	
Therefore; Slope=	11.92	ft./mi.	

I is the maximum 24-hour precipitation having a recurrence interval of 2 years, expressed in inches from U.S. Weather Bureau, 1959, Rainfall intensity-frequency regime, northeastern United States: U.S. Weather Bureau Tech. Paper 29, 35 p.

A = 171.40 sq. mi. S = 11.92 I = 3.7

$P_2 = 1.34A^{1.06}S^{0.37}I^{1.24} =$ 3962 cfs

$P_5 = 1.00A^{1.06}S^{0.44}I^{1.69} =$ 6337 cfs

$P_{10} = 0.84A^{1.06}S^{0.46}I^{1.98} =$ 8174 cfs

$P_{25} = 0.70A^{1.05}S^{0.52}I^{2.29} =$ 11262 cfs

$P_{50} = 0.62A^{1.05}S^{0.54}I^{2.50} =$ **13797** cfs

$P_{100} = 0.55A^{1.05}S^{0.56}I^{2.72} =$ **17150** cfs

Regression Equations Applicable for area 0.27 to 622 sq. miles

FHWA 5 - Parameter Equation: NH, Zone 9

$Q_{10} = 7.7165 * A^{0.5814} * R^{0.0547} * DH^{0.3865} * L^{0.0990} * P_{60}^{0.8217}$ — Q_{10} = **5982 cfs**

$Q_{50} = 1.45962 * Q_{10}^{1.02342}$ — Q_{50} = **10704 cfs**

$Q_{100} = 1.64380 * Q_{10}^{1.02918}$ — Q_{100} **12674 cfs**

A =	171.4
R =	95
Highest Elevation (ft.) =	880
Lowest Elevation (ft.) =	40
DH =	840
L =	(34.68 mi.)
P_{60} =	1.75

A = Drainage Area (sq.mi.)
R = Iso-erodent Factor (from map, App. C, page 113)
DH = elevation difference between highest main channel at its most distant boundary as measured along the channel and the elevation at the culvert (ft.).
L = length of principal drainage channel (mi.).
P_{60} = 10-yr, 60-minute rainfall (see map, App. D, page 167).
(see "Runoff Estimates for Small rural Watersheds and Development of a Sound Design Method", FHWA-RD-77-159)

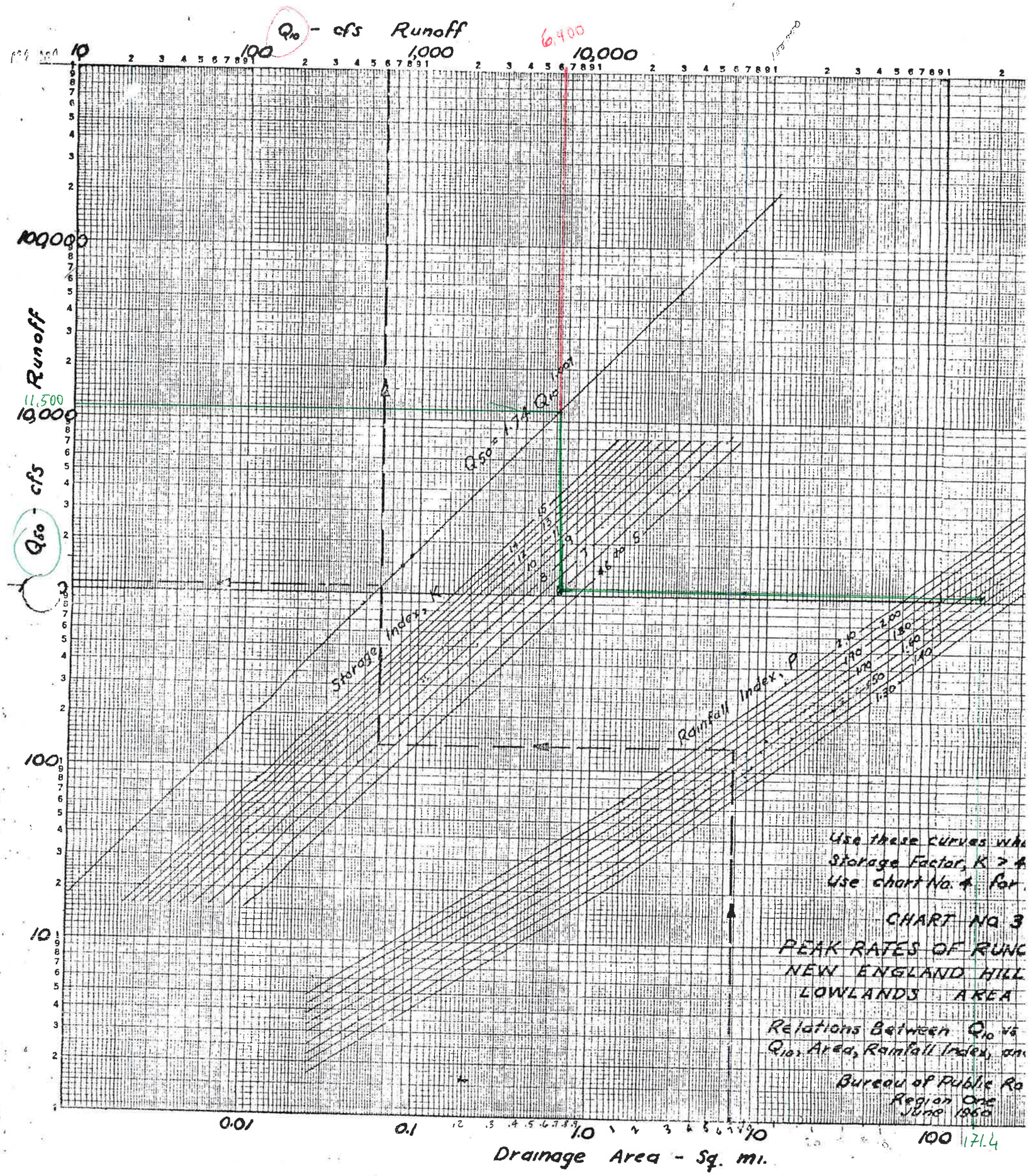
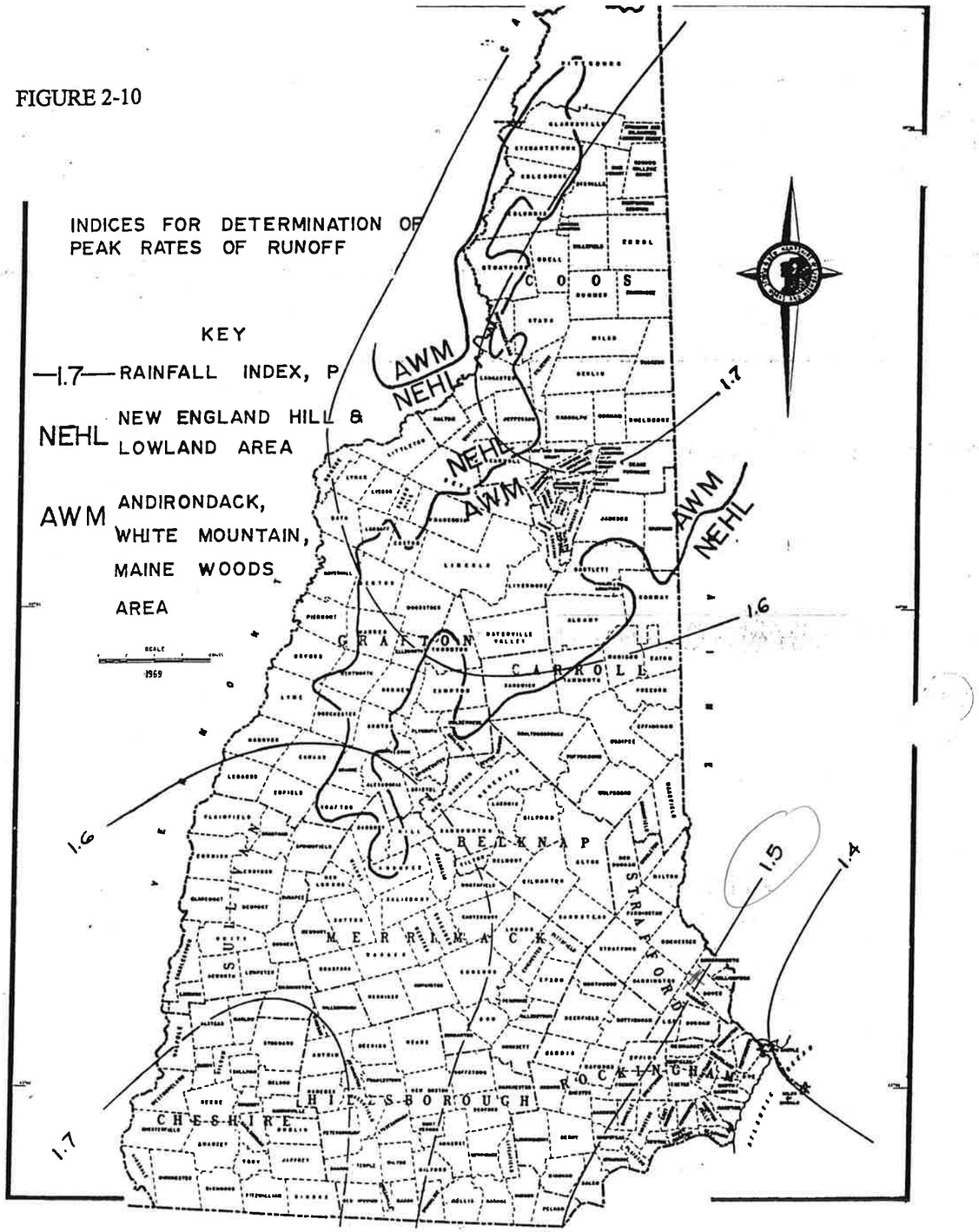
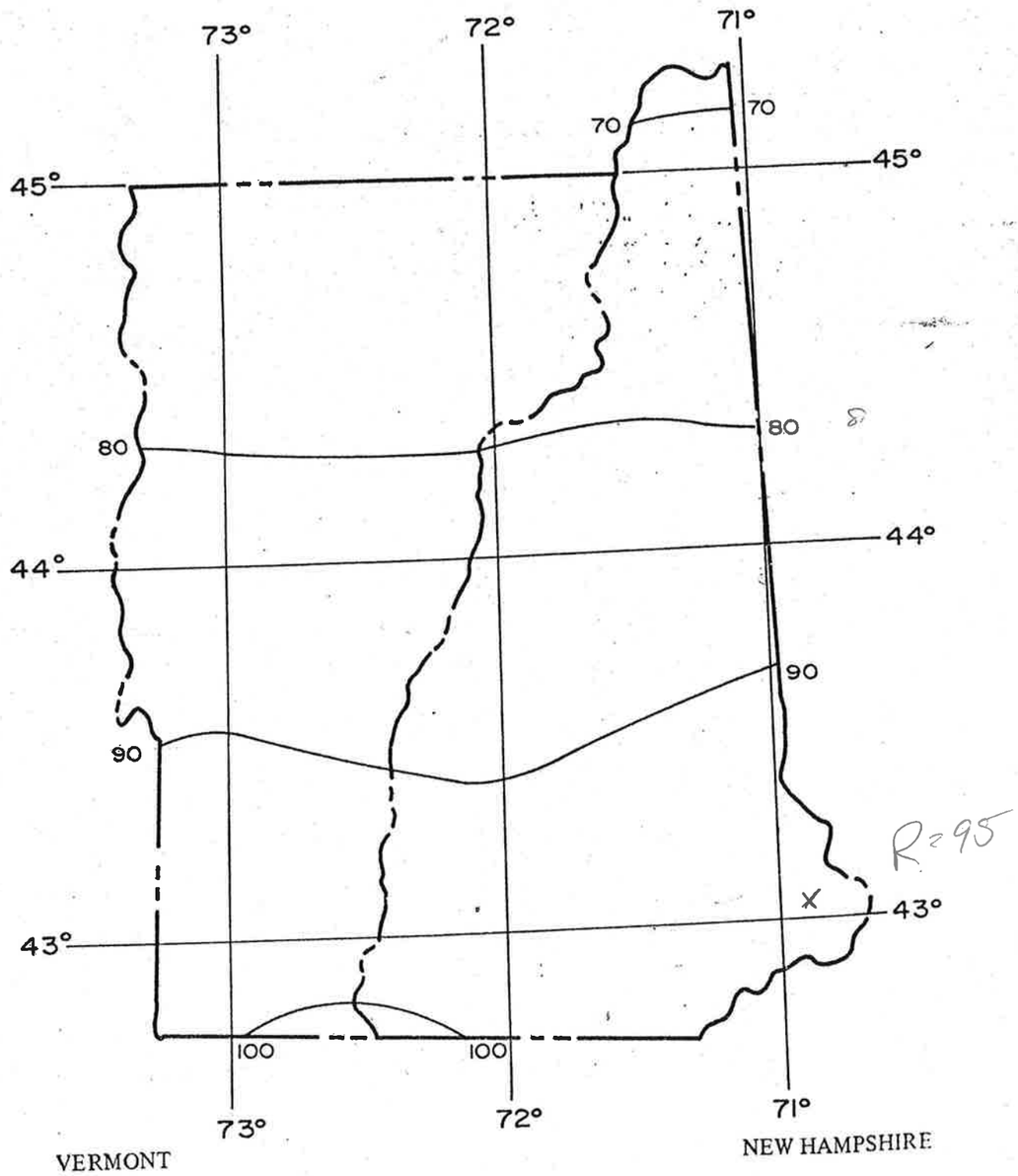

Q10 - cfs Runoff
6,400
11,500
Q50 - cfs Runoff
Q50 = 1.74 Q10^1.07
Storage Index, K
Rainfall Index, P
Drainage Area - Sq. mi.
171.4
Use these curves wh
Storage Factor, K > 4
Use chart No. 4 for
CHART NO 3
PEAK RATES OF RUNO
NEW ENGLAND HILL
LOWLANDS AREA
Relations Between Q10 vs
Q10, Area, Rainfall Index, an
Bureau of Public Ro
Region One
June 1960

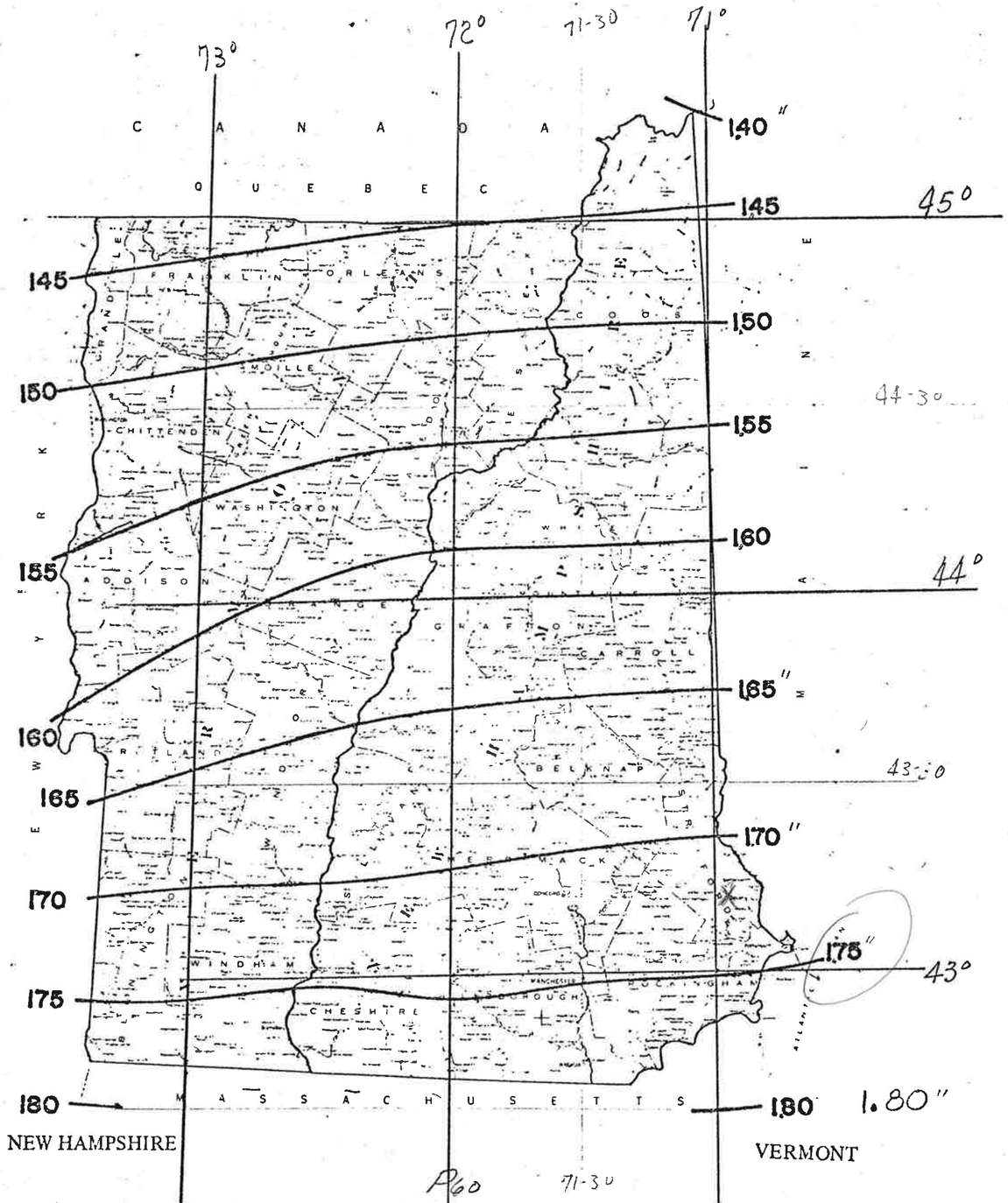
FIGURE 2-10



NOTE: METRIC CONVERSION: 1 INCH = 25.4 mm
1mm = 0.0394 IN.



Appendix C-33. Isoerodent, R, map of New Hampshire.
Appendix C-50. Isoerodent, R, map of Vermont.



Appendix D-33. Isohyetal map of 10-year 1-hour rainfall for New Hampshire.
Appendix D-50. Isohyetal map of 10-year 1-hour rainfall for Vermont.