Fast 4 on VT 73

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ABSTRACT

The Vermont Agency of Transportation used Expedited Project Delivery (EPD) and Accelerated Bridge Construction (ABC) with road closures to design and erect four bridge structures along VT 73 in Rochester in a little more than three years from project inception to completed construction. Several strategies were successfully used to expedite coordinated bridge replacements including extensive public outreach, improved internal communication and coordination, standardization, and early collaboration with the contractor.

INTRODUCTION

In August 2011, Tropical Storm Irene (TSI) pummeled the slopes and valleys of Vermont with heavy rain and wind, severely damaging more than 500 miles of state roads and 200 bridges, isolating 13 communities (1). Two bridge structures, Bridges 13 and 19, in the Town of Rochester along VT 73 were destroyed in the aftermath of the storm leaving local residents cutoff from civilization. With two structures damaged from Irene and two previously programmed for replacement, the Vermont Agency of Transportation (VTrans) developed the projects simultaneously for coordinated replacement during a single construction season to minimize disruptions to the traveling public, private properties, commerce, and local residents. But this posed several challenges, most notably the time restrictions associated with Emergency Relief (ER) Funding and a community hesitant to road closures after their TSI experience.

To expedite project delivery (EPD), the bridge replacement projects were assigned to VTrans' newly established Accelerated Bridge Program (ABP). Recognizing the need for heightened coordination, all four projects were assigned to a single VTrans project manager and design consultant Vanasse Hangen Brustlin (VHB). Given the substandard bridge widths, narrow roadway, restrictive Right-of-Way, and historic dwellings in close proximity to the structures, phased construction and temporary bridges were not feasible for three of the four structures. Instead, these structures were replaced using ABC methods and short term road closures. Unfortunately, given the rural nature of this corridor, state and local roads were scarce. The only detour route was 17 miles for a total trip of 34 miles end to end as shown in Figure 1, further substantiating the need for rapid bridge construction and short term road closures. With the community's recent experience with isolationism, the Agency limited all closures to long weekends for two of the bridges (Thursday or Friday evening to Monday morning) and fourteen days for the third. All projects were combined into a single contract to ensure coordinated replacement with a single contractor. Using several lessons learned from the Irene Recovery Efforts and strategies to EPD, the four bridge structures were designed and constructed in a little more than three years utilizing extensive public outreach, improved internal communication and coordination, standardization, and early coordination with the contractor.

EXISTING BRIDGE FEATURES AND SITE CONSTRAINTS

The four bridge structures (Bridges 13, 15, 16 and 19) along VT 73 in Rochester are located in a largely undeveloped, rural area. The roadway through this area is considered a rural major collector with a posted speed limit of 50 miles per hour (mph) and an estimated 2014 average annual daily traffic (AADT) of 750 vehicles per day (VPD) with the exception of an AADT of 1500 in the vicinity of Bridge 19.

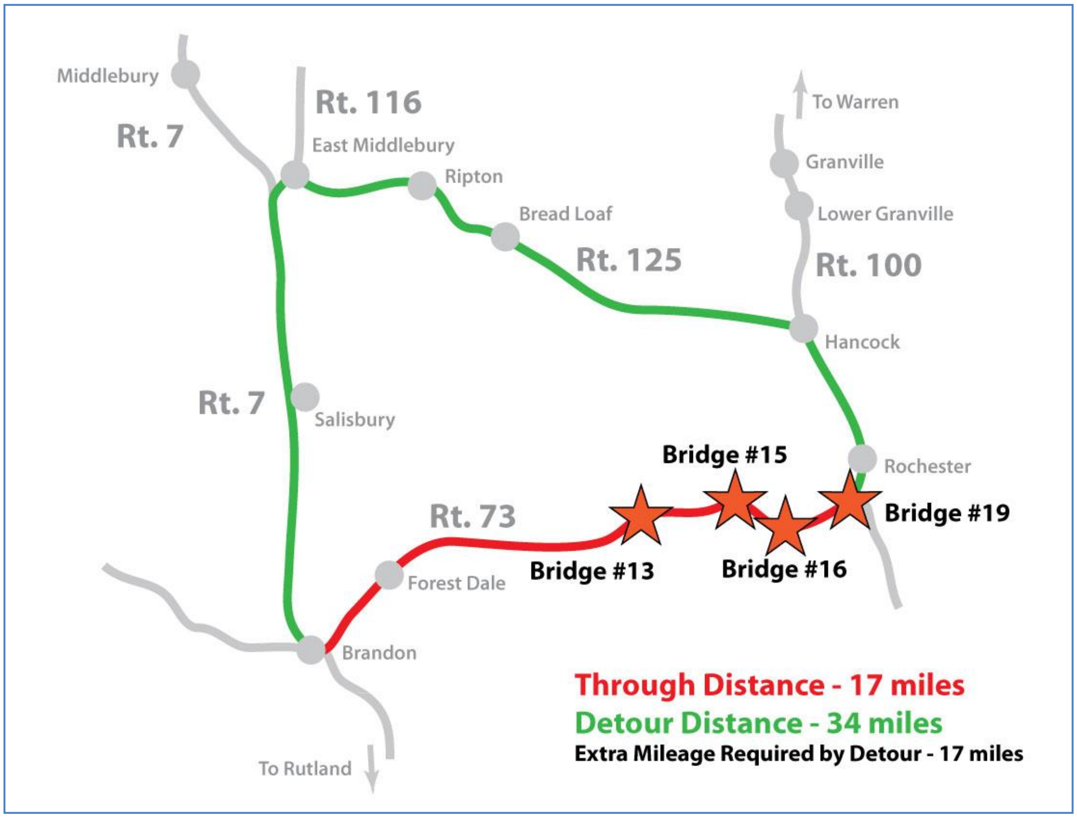

Figure 1: Project Location Map

Bridge 13

Bridge 13 is located in an undeveloped area of the Green Mountain National Forest, one of Vermont's many natural and recreational resources, and crosses over Brandon Brook, a steep mountainous stream with an average gradient of 11% through the project limits. The preexisting culvert was completely destroyed during TSI as shown in Figure 2. A temporary 10' diameter 134' long corrugated metal pipe (CMP) culvert was constructed later in the fall of 2011 to provide a safe two lane crossing over Brandon Brook. The temporary culvert required replacement due to inadequate hydraulic capacity and to provide Aquatic Organism Passage (AOP). There were no utilities or environmentally sensitive resources within the state ROW limits. To avoid potential delays in acquiring right-of-way (ROW) from the Forest Service, the project had to be constructed within the existing ROW.

Bridge 15

Bridge 15 over Brandon Brook was originally constructed in 1929. It is located in a rural historic district with houses adjacent to VT 73 on the northeast, southeast and southwest corners of the bridge. All of the houses in the vicinity of the bridge were deemed historic along with the bridge structure. The roadway alignment is substandard with a 90º curve on a 60-foot radius immediately west of the bridge necessitating a posted advisory speed limit of 25 mph. The existing structure was a single span, two lane bridge 43-feet in length and 20-feet in width from curb-to-curb. While the bridge was centered well over the stream channel, the narrow bridge opening constricted flows and caused ice jams. The bridge did not sustain direct damage from TSI, however, the storm caused heavy erosion behind the west abutment and aggradation of the channel. Overall, Bridge 15 required replacement due to its deteriorated condition, inadequate hydraulic capacity, and functionally obsolete width. Additional design constraints included historic requirements, aerial utility relocation and minimal ROW acquisition.

Bridge 16

Bridge 16 over Corporation Brook was constructed in 1929. It is located in a rural area with houses adjacent to VT 73 on the northeast and southwest corners of the bridge. All of the houses in the area of the structure are historic but unlike Bridge 15, the structure was not considered historic. The roadway through the immediate project area is in a mild sag vertical curve with a 3.9% grade immediately east of the bridge and a relatively flat grade west of the bridge. The existing structure was a single span, two lane bridge 25-feet in length and 20-feet in width from curb-to-curb. The narrow bridge opening was not aligned well with the channel and was hydraulically inadequate. The bridge sustained minimal damage from TSI with minor erosion behind the southeast wingwall. Overall, Bridge 16 required replacement due to its deteriorated condition, inadequate hydraulic capacity, potential for scour, poor channel alignment and functionally obsolete width. Additional design constraints included aerial utility relocation and minimal ROW acquisition.

Bridge 19

Bridge 19 over the White River is located at the east end of VT 73 at the junction with VT 100. Agricultural fields are located on both sides of VT 73 with steep forested hills on the east side of VT 100. Rochester Village is approximately 0.6 miles north of the bridge on VT 100. The original 72-foot long single span steel beam bridge was severely damaged during TSI due to the failure of the west abutment. The west bank of the White River eroded during the storm widening the channel of the river at the bridge location as shown in Figure 3. In order to reopen VT 73, a 132'-0" long by 24'-0" wide two lane single span temporary bridge was installed on the existing alignment. Overhead utilities were relocated during the Irene Recovery Response. Additional design considerations included minimal ROW acquisition.

Figure 3: Bridge 19 following Tropical Storm Irene

Figure 2: Bridge 13 following Tropical Storm Irene

PROJECT DEVELOPMENT

In the winter of 2011, all four bridges were assigned to the newly established ABP under the auspices of a single VTrans project manager and design consultant to EPD and ensure consistency during project development. The two bridge structures severely damaged by TSI (Bridges 13 and 19) were eligible for ER funding. However, to be a recipient of this funding, emergency repair work had to be accomplished within a short timeframe following the natural disaster compressing VTrans' conventional project development duration from five to less than two years.

Other leading factors affecting the overall design of each project included minimizing impacts to traffic, environmental resources, ROW and utilities during construction. Given the substandard bridge widths, narrow roadway, restrictive ROW, and historic dwellings in close proximity to the structures, phased construction and temporary bridges were not feasible for Bridges 13, 15 and 16. Instead, these structures were to be replaced using ABC methods and short term road closures during a single construction season along with Bridge 19 which would be constructed using traditional construction methods and a temporary bridge. However the only detour was an additional 17 miles for a total trip of 34 miles end to end. With the community's recent experience with isolationism and understandable hesitation, the Agency limited all closures to long weekends, Thursday and Friday evening through Monday morning for Bridges 15 and 16, respectively, and fourteen days for Bridge 13. Even though project impacts were minimized by design, project development for each bridge structure posed significant challenges that required innovation to implement rapid construction including design details and special provisions, extensive public outreach, and improved internal communication and coordination.

Another challenge was to ensure coordinated bridge replacements and road closures to eliminate the risk of two or more bridges being closed at the same time or a claim from a contractor as a result of a delayed bridge opening impacting their schedule. To alleviate this possibly, all projects were combined into a single contract to guarantee synchronized replacement with a single contractor. As an added complication, two additional bridge replacement projects on neighboring routes within the vicinity of VT 73 required short term road closures during the same construction season (Bridge 13 in East Middlebury and Bridge 166 in Warren). The regional traffic plans for these two projects included detouring traffic onto VT 73 for Bridge 13 in East Middlebury or portions of the detour route for the Rochester Projects for Bridge 166 in Warren creating a detour within a detour creating greater delays and increasing the distance of the of the VT 73 detour route. Therefore, all five bridge closures had to be carefully coordinated and sequenced to ensure the only one bridge was closed at a time. To reduce the risk of a delayed bridge opening negatively impacting the other project schedules, a minimum of one week was provided between closure periods.

Design and Construction

Each of the Rochester bridge designs, when considered on the basis of complexity alone, are relatively straight forward by their nature. However there are several notable features and facets of the designs that distinguish the overall project due site constraints and need for rapid replacement.

Bridges 15 and 16

Bridges 15 and 16 share similar site characteristics and were designed to be constructed over the course of long weekend closures (Thursday evening through early Monday morning for Bridge 15 and Friday evening through early Monday morning for Bridge 16). This allowed both structures to use similar design details and specifications where practical. Using a more coordinated design approach provided the fabricators and contractors an opportunity to gain familiarity with the design and detailing which increased the likelihood for successful bridge replacements within the identified bridge closure periods (BCPs).

Bridges 15 and 16 are viewed in many ways as "sister structures" since the existing bridges were of similar length, width, and construction (both were cast-in-place reinforced concrete girder bridges), which lent them

Figure 4: Precast Flare for Historic Rail

Figure 5: Precast Concrete Curtain Wall

to being designed using similar details where practical. Both bridges feature 28” deep precast/prestressed concrete Northeast Extreme Tee (NEXT) Beam superstructures, bearing on precast concrete stub abutments, each founded on a single row of H-piles. Bridge 15 is a 64-foot single span bridge with a 32-foot curb-to-curb width (see figure 4), and Bridge 16 is a 58-foot single span bridge with a 27-foot curb-to-curb width. The longer span lengths of the proposed superstructures as compared to the existing span lengths not only accommodated increased hydraulic capacity, but also allowed the pile foundations to be installed behind the existing substructures, such that the installation could be completed prior to closing the roadways and demolishing the bridges. Each of the structures also utilized precast concrete approach slabs which bear on precast curtain walls previously cast onto the NEXT Beams at the fabrication plant (see figure 5). These details facilitated rapid construction in the field during the weekend closures. Utilizing the precast approach slabs also allowed for simplified design and construction of the abutments by shielding them from horizontal earth surcharges. The large semi-integral curtain walls cast onto the superstructure also allowed the bridges to be designed as a “strut” thereby mobilizing earth pressure, where needed, to resist longitudinal forces imparted on the superstructure instead of resisting the forces solely by the substructure, further reducing the demand on the pile groups.

Other notable features of the bridge designs included casting additional precast concrete elements onto the NEXT Beams at the fabrication plant to expedite the bridge installation and reduce the timeframe for the superstructure installation. Features included: a flared overhang at the end of one of the Bridge 15 NEXT Beams; decorative concrete bridge rail parapets for Bridge 15; concrete brush curbs for Bridge 16; and concrete curtain walls on the end of each NEXT Beam for support of precast approach slabs. The flared NEXT Beam end was required to accommodate truck turning movements at the inside of the 90˚ curve at Bridge 15. In addition to the flare, a decorative concrete parapet was required at Bridge 15 because the original bridge had a similar parapet and was considered historic. The bridge is also within a historic district, therefore a historic rail was required. The VTrans historic bridge rail detail consists of a concrete parapet with rectangular inlays and a two rail black powder coated steel rail placed across the top of the parapet. The concrete curbs for Bridge 16 were also cast onto the fascia NEXT Beams so that the two-rail steel bridge rail could be quickly attached in the field during the bridge closure. Several rapid construction details from the Strategic Highway Research Program 2 (SHRP 2) Toolkit (2) were utilized. The Toolkit provided precast concrete details for NEXT Beam closure pours and other miscellaneous fabrication details.

Bridge 13

On the surface, Bridge 13 over Brandon Brook is simply a precast culvert, however, there were several challenges specific to the site that made the design of this structure unique. First and foremost, the most notable feature of the structure is the sharp 56 degree skew of the waterway crossing relative to the roadway. This complicated the design, particularly when considering the allowable two-week closure for installation. In an ideal situation, the roadway would remain open to traffic using phased construction to replace the temporary CMP. In order to maintain traffic through the project site, however, the 28-foot span of the proposed structure when coupled with the skew of the crossing, made it prohibitive to use phased construction while working within the existing ROW. Therefore a road closure was necessary to construct the new culvert.

Also adding to the complexity of design and construction was the topography of the site and steep 115 gradient of Brandon Brook. To assist with the selection of the preferred structure type several fabricators were consulted concerning the longitudinal grade, site constraints and ease of construction. Based on feedback from fabricators, the grade of a new precast culvert was limited to 5% along the length of the structure. The gradient of the Brook more than doubled this allowable slope of the culvert. Therefore, the structure would have to be placed on an oversized pedestal which would vary in depth along the length of the structure to account for the 6% difference in the allowable structure grade in comparison to the actual grade of the Brook. Initially the footings were going to be “stepped” to help minimize the height of the pedestals. However, it was determined that stepping the footing would complicate construction thereby adding time to the construction duration. In order to simplify constructability, a constant height oversized pedestal was designed, allowing the footing to be placed on a constant grade for the full length of the structure.

Bridge 19

Bridge 19, in contrast to the other three structures, was considered “conventional” with traditional design details and permitted an entire construction season for erection. For this reason, the exclusive use of rapid bridge construction components was not considered a necessity; however, construction was simplified where practical in order to reduce the overall construction period. For instance, the 127-foot single span steel girder bridge was designed using an integral abutment founded on a single row of piles on the west approach. Additionally, the use of stay-in-place metal deck forms were allowed in order to reduce the required amount of time to form the deck. The east abutment, however, is a conventional full-height cantilevered abutment on a spread footing, founded on rock due to the close proximity of the intersection of VT Route 100 and the channel is directly adjacent, and parallel to, VT Route 100.

Special Provisions

New and innovative special provisions were developed by the project team to facilitate rapid construction of Bridges 13, 15, and 16. The material and construction management special provisions were intended to reduce onsite construction durations and aid with communication, coordination and sequencing of the Bridge Closure Periods (BCPs).

The two material specifications incorporated into the contract to shorten active construction time were: 1) the “Membrane Waterproofing, Spray Applied” (3) and 2) “High Performance Concrete, Rapid Set” (4). While the spray applied membrane had been used previously on traditional construction projects to provide additional protection for concrete bridge decks, it had not been widely implemented due to higher costs as compared to standard torch applied membranes. However, spray applied membranes have unique advantages over the standard torch applied bridge membranes making them an ideal application for ABC projects. Specifically, spray applied membranes with an aggregate wearing course may be driven over immediately following application allowing bridges to be opened to traffic prior to applying the bituminous concrete wearing surface. The other essential material special provision for ABC is known as “rapid set high performance concrete.” This specification developed jointly between the Materials and Research and the Structures Sections of VTrans contains strict requirements for the concrete mix design including minimum compressive strengths such as 2500 psi at 12 hours and 7000 psi at 28 days. Other parameters include permeability, air content, slump, Alkali-Silica Reactivity (ASR), and a maximum allowable shrinkage of 0.04%. As part of this specification, the contractor was required to submit a mix design for approval and produce and place a 2 cubic yard trail batch. In accordance with the specification, the trail batch was tested for slump, air content, unit weight and compressive strength. The deck end closure pour was required to obtain a minimum compressive strength of 3500 psi prior to being opened to traffic. This material was used to fill the pile cavity voids in the precast concrete substructures and the joints between the prestressed precast concrete NEXT beams. Expediting the strength gain was critical to replacing Bridge 15 and 16 within the allotted time.

The construction management specifications used to ensure the contractor had properly planned the construction sequence with a special emphasis on the BCP and provide additional motivation to meet or exceed the BCP included the “Critical Path Methodology (CPM) Schedule” (5) and the “Incentive/Disincentive” (6) specification respectively. The critical path methodology (CPM) schedule was developed specifically for short term bridge closures to be used by the Resident Engineer (RE) to monitor progress, allow the contractor to plan the level-of effort by its own work forces and subcontractors, and as a critical decision making tool. The specification required that the contractor; 1) define a complete and logical plan that could realistically be accommodated for executing the work defined in the contract, 2) include sufficient activities for adequate project planning for the subcontractor, third party vendors, and supplier activities, 3) clearly show the critical path with a maximum duration of 15 days for an activity outside of the BCP and 12 hours during a road closure. In addition to the individual schedules for each bridge replacement project, the contractor also supplied an overall schedule for all four projects to make sure the closures were sequenced in accordance with the contract. These schedules were critical to ensure the contractor had a realistic timeline for completion of Bridges 15 and 16 and that they had accounted for the correct amount of cure time for the high performance rapid set concrete in accordance with the specifications. The incentive/disincentive specification had been used on previous VTrans projects but was modified to include allowable construction activities prior to, during and following the BCP. These special provisions specified the allowable BCP for Bridges 13, 15 and 16. Additionally, due to seasonable variability in Vermont's weather patterns and unforeseen circumstances, variable BCPs were permitted. These timeframes sequenced around community events and the other two regional bridge projects on VT 125 and VT 100. In addition, the specification provided the contractor financial incentives for completing the project ahead of schedule and/or on time as well as a disincentive if they went beyond the BCP. The total amount of compensation was limited to a maximum of 5% of the Engineers Construction Cost Estimate for each bridge. VTrans' goal was to provide the contractor with a "carrot" and not the "stick". Therefore emphasis was placed on completing the bridge on-time and not ahead of schedule. This was accomplished by incentivizing the contract to include both a onetime lump sum payment for completing the identified work on or before the BCP and an hourly or daily incentive which matched the hourly or daily disincentive amount.

Public Involvement and Outreach

Building and maintaining public support from project development through construction has been a critical component in expediting the delivery of the four Rochester projects. At the onset of the project definition phase, the project manager sat down with VTrans staff from the Irene Incident Command Center (ICC) to learn more about the temporary relief efforts associated with the two structures impacted by Irene (Bridges 13 and 19) and related public concerns. For instance, one of the property owners adjacent to Bridge 19 was extremely dissatisfied with the temporary aerial utility relocation established across their agricultural field immediately following the storm. Knowing that temporary and permanent ROW acquisitions would be needed, the project manager met with the property owners personally during conceptual plan development to listen to their concerns and learn more about their farming practices in the context of the bridge replacement project. These initial meetings proved invaluable to attaining their support for the project. For example, the cattle that grazed in their fields would walk into the river under the structure to get from one side of the road to the other. Due to degradation from the storm event, the gravel bed the cows used to cross was gone. Working together, the project manager and designers found a way to provide an inexpensive crossing. To address concerns about the utility relocation, an onsite utility coordination meeting was held to discuss future expectations following project completion. These small additions to the plans solidified their support for the project which helped during public meetings and also helped to expedite the ROW acquisition process.

Several public meetings were held throughout the project development process to keep the public informed about existing deficiencies, proposed bridge and roadway features and road closure details. Prior to notifying the public, the project manager and Regional Planning Commission (RPC) identified key stakeholders and customers including area representatives and senators, local and town officials, emergency services, public school administrators and adjacent property owners. All public meeting announcements were placed in local newspapers, posted around town and distributed to all stakeholders. Three public meetings were held during development including a Local Concerns Meeting, Alternatives Presentation and Public Information Meeting. Meeting participants were encouraged to ask questions and provide feedback. These meetings provided an opportunity to effectively engage the public and gather input about perceived deficiencies and essential design elements. For instance, during the initial response from TSI for Bridge 19, the Agency erected a pedestrian bridge while plans were developed for a temporary bridge structure. This encouraged pedestrian movements and became a popular and symbolic walking route for local residents. The designers widened both shoulders on the proposed typical section to facilitate future bike and pedestrian movements. The project manager and designers incorporated several changes to the proposed plans based on public comment. However, as with all projects, it was not possible to integrate all suggested modifications due to site and budgetary constraints. In all cases, letters responding to public comments were drafted and distributed to the town and residents. In addition, plan modifications due to public comments were highlighted during subsequent public meetings providing a mechanism for the public to see how they contributed to the final design and garner their support for the projects.

In addition to the three road closures along VT 73 to replace Bridges 13, 15 and 16, two additional road closures were planned for the 2014 construction season (Bridge 13 on VT 125 in Middlebury and Bridge 166 on VT 100 in Warren) with conflicting detour routes. The Agency quickly recognized the need for heightened outreach to ensure the public received accurate up-to-date information on the sequencing of the bridge closures, closure durations, and detour routes. To address this need, a project outreach coordinator was hired to provide and implement various outreach strategies for all six bridge replacement projects including the creation of a uniform brand to give the impression that all projects were planned and advanced as a single and coordinated effort. Other outreach mechanisms included the development of a dedicated website (7) to provide stakeholders and customers a single source for current information as well as project factsheets that contained details about existing bridge deficiencies and their need for replacement, selected alternatives, advantages of ABC, the name of the awarded contractor and the contract amount, variable BCPs and durations, and the detour route. An informational public meeting was held in the Town of Rochester roughly one month prior to the first closure to meet with residents and other affected parties. The entire project team, including the project manager, designers, regional construction engineer, RE, contractor superintendent and project outreach coordinator presented jointly on the upcoming road closures. This unified approach alleviated many concerns about project impacts, where to go for current information, and how to register a comment or concern. Finally, weekly construction updates were distributed to stakeholders and those on the project email distribution list. All of these efforts proved invaluable to keeping the public and key stakeholders informed about the five bridge projects. In fact, Agency leadership commented many times during the construction season that they had only received positive feedback.

Internal Communication and Coordination

Advancing the four VT 73 projects concurrently and keeping them all on schedule was an extremely daunting task. As with all rehabilitation and replacement projects, each one had unique constraints and risks. Assigning one project manager and design consultant to advance the projects helped create and maintain a consistent approach to project development and design. This approach also allowed the Agency to more effectively engage resource groups and acquire the necessary clearances from the environmental specialists, ROW agents, and utility supervisors to meet project milestone deadlines. To aid with internal communication and coordination, the project manager scheduled several planned and impromptu collaboration meetings to attain support for the project design schedules, discuss project constraints, brainstorm solutions, and determine reasonable recovery measures when the ROW process for Bridge 15 began to fall behind. This approach increased the commitment and focus of the team members.

Although most project activities were accommodated within the existing VT 73 state highway ROW through the use of road closures, it was necessary to obtain temporary and permanent easements and acquisitions to replace three of existing structures (Bridges 15, 16 and 19). Unfortunately, ROW acquisition is often one of the most difficult and lengthy project development activities in Vermont. To expedite the ROW process, the project manager met with ROW agents during the conceptual and preliminary plan stages of design to discuss the proposed bridge replacement alternatives, associated ROW impacts and vet ideas on how to accelerate the ROW acquisition process. During one of these collaboration meetings, the head of the Agency ROW group suggested an innovative ROW acquisition process called "Minor Alternations." This process prescribes an established protocol and timeframe for procurement including the stipulation that once necessity has been demonstrated for a project or project(s), in any case which "an owner is dissatisfied with the award for damages he or she may appeal" but that "notice or petition for appeal shall not delay the proposed work or activity." The "Minor Alterations" process reduced ROW acquisition from two and a half to one and a half years and is one of the primary reasons the projects advertised on time. However it required heightened collaboration between the project manager, design, and ROW to minimize risks and delays.

Since adoption of ABC was still relatively new to Vermont at the time of project development, it was essential to get feedback on proposed design details from the Agency's Construction Section to minimize the risk of construction delays and contractor claims. However, most of the regional construction engineers and project residents were actively managing projects under construction making it almost impossible to complete online shared reviews within the allocated timeframe. To better meet Construction's time constraints, two constructability meetings were held following preliminary and final plan design. This inspired a free flowing dialog about comments and concerns related to design details, specifications, and other elements that could possibly be modified to make the designs more constructible during the short duration road closures. Modifications included incorporation of a variable depth lean concrete “mud-mat” to be placed under the precast footings in order to reduce risk of issues due to variable rock elevations, and the use of a spray-applied membrane to be used on Bridges 15 & 16, allowing the bridges to be open to traffic prior to placing pavement on the bridges (thereby eliminating paving from the BCP.

Lessons Learned

As with all projects regardless of the amount of planning, coordination and collaboration there will always be takeaways and the Rochester Fast 4 are no exception. These combined bridge replacement projects were some of the earliest assigned to the newly implemented ABP. Since the program was in its infancy, there were no clear guidelines or established policies on how to use EPD. Additionally, this was the first time VTrans bundled four projects using ABC and road closures into one contract. With a compressed project development schedule of 24 months as compared to the standard 60 month, the project team tried innovative strategies to EPD that encompassed design, special provisions, improved internal coordination and collaboration with resource groups and the ROW section, earlier input from construction and heightened public outreach. Many of the strategies were successful and have subsequently been incorporated into the standard development schedule for the ABP. However, some strategies needed to be implemented earlier or revisited for maximum efficiency and effectiveness.

Traditionally, the Construction and Materials Section (CMS) within VTrans does not identify a RE until the project has been awarded due to uncertainly in the number of projects that will be awarded in a given year. However, to reduce the risk of a delayed bridge opening, it’s essential that all of the design elements are constructible within the time allotted for the BCP. Therefore, feedback from the CMS during the project development is critical. While input is requested through online shared reviews at various project development milestones, the REs are typically busy working on active construction projects and simply don’t have the time to review and comment on the plans. To combat this predicament and provide a means for more active dialog, constructability meetings were conducted at the final plan stage. These meetings included development team, VTrans in-house design staff and several representatives from CMS. While these meetings were certainly successful in terms of producing more construable designs, it would have been more beneficial to conduct two, one immediately following preliminary plan development to discuss the site constraints and proposed design details and one following final plans to examine the special provisions. In addition, the RE should be identified during plan development and participate in the online shared reviews and constructability meetings to gain their input, buy-in and have thorough knowledge of the history of the project and why certain decisions were made.

One goals of the ABP is to advertise and award all projects in the fall prior to the following construction season which generally occurs in Vermont between May and October in order to provide sufficient time for the fabrication of the precast components as well as all review and approval of other submittals. This includes, but is not limited to, proposed CPM schedules, erosion control plans, concrete mix designs, traffic control plans and erection plans. Unfortunately, many of the design and construction submittals were late resulting in a delay to two of the three proposed BCPs. For example, the BCP for Bridge 16 was pushed out one weekend because of delayed fabrication drawings for all of the precast components. In addition, the design team was pressed to approve partial fabrication submittals to keep the fabricator on schedule. In the case of Bridge 13, a new subcontractor was hired to provide erection services one week prior to the proposed BCP. This subcontractor had opposing ideas on how to assemble the precast components for the culvert resulting in delayed excavation and erection plans. Ultimately, the proposed BCP was moved out a week and half. In both cases, the project outreach coordinator had already distributed roadway closure notifications. Modifying the closure periods after the announcements went out to the public caused confusion and angered some residents that lived in the area. Timely submission of design and construction submittals is recommended to ensure the projects are constructed in accordance with the schedule.

With respect to the design and constructability, the contractor was successful at opening all of the BCPs ahead of schedule. The design elements, details, and material and construction management special provisions helped to facilitate rapid construction. However, filling the pile cavities with the HPC proved to be difficult. The pile cavities shown in the plans were developed on the previous ABC project and necked down to a 3” diameter duct at the top of the precast concrete pile caps. During the closure for Bridge 15, the contractor quickly realized that these voids where not an ideal diameter to allow for the placement of a ¾" aggregate rapid set HPC. The contractor switched to a 3/8" aggregate mix for the rapid set HPC and used traffic cones and vibes to funnel the concrete into the ducts which helped but did not completely alleviate the issue. As this issued arose on the first bridge replacement project, it provided an opportunity to increase to duct size to 4" on the second structure which allowed for a speedier placement of the 3/8" aggregate rapid set HPC. In addition, more time needs to be allotted for the HPC trial batch. The 14 day requirement was insufficient as the trial batch failed two times. The third trial batch did meet all of the material requirements but was approved only one day in advance of the BCP for Bridge 15. Additionally while the concrete reached the required strength within the 24 hour period to open the bridges to traffic, the 28 day compressive strength was never tested and the concrete did not achieve the required 28 day compressive strength. Further refinement of the specification is required and will be implemented on future ABC projects.

While the premise of ABC is that a bridge is easily erected like a Lego® set, the actual fit up of the precast components at the interface between the curtainwalls and fascia of the NEXT Beams to their opposing surfaces, the backs and check walls of the substructures, did not always line up as anticipated. This was due to several factors including the layout and erection of the precast elements precast. While these minimal indiscrepancies were easily resolved with the use of preformed joint filler or grout it, a mock fit up at the fabrication plant is recommended for future ABC projects. Additionally the variance between the actual camber and calculated camber of the NEXT Beams resulted in the elastomeric bearings being loaded more toward their backs rather than being loaded uniformly. While the design plans required the contractor provide ¼" galvanized shims to be used, tapered shims should also be required to account for the increase in the camber of the beams.

The remoteness of the bridge sites was a concern throughout the planning and design process as communication with the outside world during ABC is a must. As the four projects were combined into a single construction contract there was only one office trailer required which the contractor provided in the form of an office space in the village of Rochester which was located several miles from the project locations. Cell phone coverage at the project sites was not available. The contractor recognizing the need for effective communications with the outside world at each site during the BCP installed a hard wired telephone at the closest utility pole for each bridge. This allowed the contractor, their subcontractors, the RE and design team to communicate quickly without having to leave the site.

CONCLUSIONS

All three bridges were completed ahead of schedule allowing the contractor to receive the full incentive payment along with the lump sum payment. The successful completion of these projects confirms that ABC projects with short closure durations can be effectively developed and executed with proper planning, design, support, public outreach, and Contractor coordination. Furthermore successful ABC projects, where applicable, are a benefit to their communities and the Agency, and the public at-large as they reduce impacts to natural and cultural resources, significantly decrease the roadway closure duration, and provide safer bridges with longer service lives. To continue to attain these benefits through ABC, design and construction techniques should be updated continuously to reflect advances in technology and insight gained through constructing ABC projects.

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