Appendix C

Selection of Bridge Type
Selection of Bridge Type

A study was performed to select the bridge types that will be considered for the remaining alignment alternatives. The characteristics of each bridge type make some better suited than others depending on the demands of the loading and the physical constraints in which it will be used. Identifying these demands and constraints is the first step in determining an appropriate bridge type.

For this project, four main factors were identified and used in the selection of the appropriate bridge types. These factors include geography, loading, aesthetics, and cost and are discussed below.

Geography
The bridge is located within unique geological features that will affect the selection of the bridge types. Since the bridge is located within a gorge, the potential bridge types will be limited to those capable of spanning approximately 500 feet at a height greater than 200 feet.

Loading
The potential bridge types must be capable of carrying the vertical loads induced by railroad traffic. In addition, the bridge types must effectively transfer longitudinal loads due to traction and braking of the trains to the foundation elements. In general, a flexible bridge type, such as a cable stayed bridge or a cable suspension bridge, will not transfer these loads as effectively as a stiffer bridge type, such as a truss. Due to the fact that this is a high-level structure, wind loads will also be significant.

Aesthetics
The view of the gorge with the Portageville Bridge has been the scene of photographs and postcards for many years. The aesthetics of the new Portageville Bridge are important and will be considered from the numerous viewsheds identified. For the purpose of this bridge type study, a simple, slender bridge form will be considered more aesthetically pleasing since it will be less obtrusive to the view of the gorge. Also, a bridge that would be able to blend in with the natural geology is assumed to enhance the view, rather than detract from it.

Cost
Comparative costs between the selected bridge types were also evaluated. Preliminary cost estimates developed during the Alternatives Screening Analysis (Appendix H) were utilized for this comparison.

3.5.1 Trestle Bridge
The first bridge type selected for consideration was a trestle bridge. This type, which is the same type as the existing structure, consists of short spans supported by frames. Trestle bridges were commonly used by the railroad in the 19th and early 20th centuries. Longitudinal loads are well-distributed through the many trestle bents, which makes it a desirable structure type to handle the traction and braking loads induced by train traffic. Trestle bridges are best suited to span long distances in which a repetitive span is appropriate. Most trestle bridges are constructed of timber, steel, or concrete.
For the proposed structure, a span layout similar to the existing bridge was considered. The length of the end spans was increased from the existing structure, resulting in fewer substructure elements. The required construction of the substructure units in the gorge is undesirable. Also, construction of the superstructure and substructure will be complicated due to accessibility difficulties from the bottom of the gorge. For easier fabrication, inspection, and maintenance, the proposed trestle bridge utilized girders in the spans where the existing bridge had deck trusses. The longer end spans, in conjunction with the shallower girders, will be less visually congested and will be more cost effective.

The cost to build the proposed trestle bridge is approximately $48 million. This cost is the highest of the selected bridge types primarily due to the large amount of steel required for construction of the towers.

3.5.2 Truss Bridge

The second structure type selected for consideration was a truss bridge. Truss bridges are composed of a system of straight, connected elements, known as members. Similar to trestle bridges, truss bridges were popular in the 19th and 20th centuries for vehicular and railroad traffic. Trusses facilitated spanning greater distances with heavier loads using less material; however, trusses are somewhat more labor intensive to fabricate and erect than some of the other bridge types. Many of the early trusses were constructed from timber, although construction from wrought iron and steel was the most prevalent. The three primary classes of trusses are deck trusses, pony trusses, and through trusses.

Through trusses are commonly used when under-clearance of the structure is a concern, for example when the bridge is used as an overpass. Conversely, deck trusses are preferred when overhead clearance is necessary and clearance under the structure is available. Pony trusses are only used for short spans with light loads.

For the proposed structure, a steel deck truss was best suited for this location. A deck truss utilized the available under-clearance in the gorge, while reducing the required pier height at the tall pier. The rigidity of the trusses will be effective at transferring both vertical and longitudinal forces to the substructure elements. Although not as much construction is required in the gorge as compared to the trestle bridge, the pier and foundation in the gorge are a detriment to the truss. Extensive falsework to support the truss during erection may also be required. This pier is also somewhat obtrusive in the view looking down the river. The end spans were assumed to be girder spans due to their shallow section and ease of fabrication, maintenance, and inspection.

The cost for the proposed truss bridge is approximately $36 million, which is the median cost of the three bridge types. This cost is significantly less than the trestle bridge due to the more efficient placement of substructure units and more economical use of the structural steel.

3.5.3 Arch Bridge

The third, and final, structure type selected for consideration was the arch bridge. An arch bridge contains a curved element, referred to as the arch rib, which transfers the load through compression as thrust to the abutments. Early forms of arch bridges were constructed of stone; however most modern-day arch bridges are constructed of steel or concrete. The most common types of arch bridges are deck arches and tied arches. When an arch is loaded, it has the tendency to flatten resulting in outward forces at both ends of the arch. Traditional deck arches resist this outward force as horizontal thrust at the abutments. Tied arches resist this outward force as tension in the tie girder and are advantageous where large abutments are not feasible.

For the proposed structure, a steel spandrel-braced deck arch was selected. A deck arch was selected due to the capability of the gorge walls to resist horizontal thrust at the abutments, as
opposed to a tied arch. Conceptual geotechnical studies have been performed to confirm that
the rock is capable of withstanding this load. The bracing in the arch will distribute longitudinal
loads due to traction or braking of the train directly to the arch rib to be transferred to the
abutments. The walls of the gorge will be excavated for the construction of the abutment
footings. There is no need for foundation elements in the river with an arch bridge, which is
beneficial both environmentally and aesthetically. Furthermore, the construction of the arch may
be performed by cantilevering the spans from each side of the gorge using tiebacks and
connecting each cantilever span at the midspan. This form of construction does not require any
falsework in the gorge which is considered advantageous. The end spans were assumed to be
girder spans due to their shallow section and ease of fabrication, maintenance, and inspection.

The cost of the proposed arch bridge is approximately $34 million, which is the lowest cost of the
three selected bridge types. While the superstructure costs are similar between the truss and
arch bridges, cost savings are realized with this alternative due to fewer substructure units.

3.5.4 Recommended Bridge Type

Utilizing the data collected during this study, the arch bridge was determined to be the
recommended bridge type for this project. While the costs are similar between the truss and arch
bridges, the arch has less environmental impact and will provide an unobstructed view of the
river. Additionally, erecting the arch by cantilevering the spans will result in minimal
environmental impact to the gorge during construction.