

1.0 – PURPOSE AND NEED

1.2 Project Purpose

The primary purpose of the proposed project is to replace the functionally obsolete and structurally deficient bridges over the Red Cedar River to maintain safe and efficient traffic flow of vehicles, bicycles, and pedestrians along the Okemos Road corridor between West Grand River Avenue and I-96. A secondary purpose is to address the existing undesirable hydraulic conditions relating to bridges' geometry and skew in relation to the river channel.

1.3 Project Need

This section provides information about the existing bridge and hydraulic deficiencies and evaluates potential safety and hydraulic enhancements. Information supporting the need for the project is discussed in detail below.

1.3.1 Northbound Bridge

The need to replace the existing northbound bridge is driven by deteriorating condition and its functional deficiencies. Additionally, the clear travel way is only 20 feet wide and no shoulders are present on the bridge. The current width is below current design standards for this type of roadway per the American Association of State Highway and Transportation Officials' (AASHTO) *A Policy on Geometric Design of Highways and Streets*. This width does not adequately accommodate wide vehicles, such as trucks, busses, and recreational vehicles, passing side by side. The northbound bridge cannot be rehabilitated to increase the width due to the nature of camelback bridges. The two camelback shaped stringers support the entire load of the bridge with traffic driving between the two stringers. The stringers were designed to support a 20-foot-wide roadway. Widening the bridge would increase the dead load and further restrict the allowable vehicle weights.

The reinforced concrete structure has been deteriorated by almost 100 years of weather and wear. As a result, the bridge is currently posted for vehicle weight restrictions. If structural deterioration is not corrected, further restrictions or bridge closure may be necessary. The structural concrete is heavily delaminated including the girders, deck, and sidewalks. Delamination is a failure that develops inside of the concrete without being obvious on the surface. Numerous delaminations have spalled (i.e., chipped) allowing steel reinforcement to be exposed and potentially deteriorated. Many concrete surfaces also have significant cracking. Cracks on the bottom surface of the deck have leachate and stalactites, particularly along the centerline joint. This is evidence of moisture leaking through the deck.

The most recent bridge inspection found heavy deterioration in the tension zones of the camelback stringers. Both stringers have deep spalls and exposed steel reinforcement along the bottoms. The bottom row of steel reinforcement is exposed in two critical areas: midspan of the bridge and at the steel reinforcement overlap locations. This steel reinforcement provides a majority of the bridge's ability to support vehicle loads and is critical to the bridge's strength. Because of the location and depth to which a concrete repair would be required on both stringers, it would be unrealistic to expect the stringers to withstand the necessary amount of material removal to allow for a sound structural repair. Patching new material to inferior 100-year-old concrete would be required and may not result in a structurally sound repair. The lifespan of such repairs would be difficult to predict and would do nothing to slow the continuing decline of the remaining original concrete. The stringers have previous patches that have started to crack and delaminate.

The concrete deck also has heavy deterioration both in the roadway and on the sidewalks. The top surface has longitudinal and transverse cracking throughout. The bottom surface also has longitudinal and transverse cracking throughout. The transverse cracks have leachate and stalactites. Delaminations are scattered throughout. Many delaminations have spalled and steel reinforcement is exposed. Exposed steel is susceptible corrosion and section loss. According to the original plans, the deck has only one layer of steel reinforcement, located in the lower portion of the deck. This steel reinforcement is responsible for transferring the vehicle loads from the deck to the stringers. Section loss will decrease the deck's ability to transfer the vehicle loads resulting in further restrictions to vehicles. The deck has previous patches that have started to crack and delaminate.

Scour is not currently an issue and the bridge footings are considered stable based on the July 2018 bridge inspection. Scour is the removal of sediment (sand, topsoil, etc.) by moving water, such as a stream. Bridge abutments are ideally located outside of the stream's influence and parallel to the stream. When that is not feasible, scour protection measures, such as cofferdams, rock (riprap), or other materials are installed to keep the bridge safe. The northbound bridge has a total length of 90 feet compared to the 180-foot southbound bridge with the same amount of water passing beneath. Both abutments are within the stream. The south abutment footing has exposed areas making it susceptible to future scour. No scour protection is in place.

1.3.2 Southbound Bridge

The need to replace the existing southbound bridge is driven by deteriorating condition and its functional deficiencies. Additionally, no shoulders are present on the bridge. Per AASHTO's *A Policy on Geometric Design of Highways and Streets*, shoulders are required. The southbound bridge underwent emergency superstructure repairs in 2016 to keep the bridge open. The 2016 rehabilitation included expansion joint replacement, pin and hanger replacement, diaphragm replacement, and steel beam repairs totaling approximately \$400,000. Not all structural issues were addressed by this emergency project. Even after the repairs, the bridge is still in poor condition and nearing the end of its service life.

The bridge is currently posted for vehicle weight restrictions. If structural deterioration is not corrected, further restrictions or closure may be necessary. Numerous holes were found in the structural steel beams in 2015. In 2016, new flange and web plates were bolted to the existing beams where holes in the beams were found. The north expansion joint is leaking, leaving the beam ends below the bridge deck susceptible to future deterioration. Approximately half of the paint system (three layers of paint: primer, intermediate coat, and top coat) on the steel beams is failing. Only the steel immediately adjacent to the repairs was repainted. Other local areas of paint system failure were not repainted leaving the steel beams susceptible to further deterioration. The concrete deck has mild delamination and spalling. The deck has been previously patched, particularly along the centerline and transverse joints. The transverse cracks on the bottom surface of the deck are leaching. The deck fascia also has leaching cracks.

1.3.3 Hydraulics

The northbound bridge crosses the Red Cedar River at a skew, resulting in the bridge abutments protruding from the natural stream bank into the river channel, disrupting and restricting the natural flow of the river and leaving the abutments susceptible to scour. This restriction has a lesser hydraulic area than the natural stream, resulting in higher backwater surface elevations, which increase the potential of upstream flooding. The Red Cedar River is prone to flooding and would benefit from a greater hydraulic area at the Okemos Road crossing. Scour is the removal of stream material (soil) by moving water. Scour generally occurs during flood events when a larger amount of water is flowing faster than normal. Abutments and piers obstruct the flow of the stream causing the water to flow even faster around them. The south abutment of the northbound bridge has already been exposed by scour. Most bridge failures in the United States are related to scour/hydraulics.

2.0 – ALTERNATIVES

Alternative 1: Reconstruct and Rehabilitate Bridges on Existing Alignment

Alternative 1 included reconstruction of a new two-lane southbound bridge and rehabilitation of the existing two-lane northbound bridge. See Figures 1 and 4. Both bridges would continue to be used for vehicles and the Okemos Road alignment would not change. The existing pedestrian bridge on the west side of Okemos Road would remain in place.

Under this alternative, the structural and aesthetics deficiencies of the northbound bridge would be rehabilitated and restored. Rehabilitation and restoration would include: concrete chipping and patching of delaminated or spalled concrete areas; clean and inject cracks in concrete members; replacement of roadway approach slabs; place riprap (large stone) at the south abutment; place healer/sealer or epoxy overlay on the top surface of the bridge deck and sidewalk; remove brush along approaches near the bridge; and, seal or replace all roadway/deck joints.

The proposed southbound bridge would carry two 11-foot lanes of traffic with two-foot shoulders. The total width of the proposed southbound bridge would be 29 feet. New abutments would be placed behind the existing abutments increasing the length to approximately 186 feet long. The existing steel beams are approximately 36 inches deep. To minimize the grade impacts on the approaches, proposed beams would be of similar depth. A two-span bridge with 42-inch prestressed concrete bulb-tee beams or a three-span bridge with 36-inch prestressed concrete bulb-tee beams would be sufficient.

It is estimated that this alternative would cost approximately \$3,635,000.

This alternative was eliminated from consideration as it would not address the functional obsolescence of the existing northbound bridge (i.e., the bridge cannot be widened to meet the minimum required widths without affecting the historic integrity of the bridge). Additionally, the bridge is so structurally deficient that it cannot be rehabilitated to meet minimum acceptable load requirements without affecting the historic integrity of the bridge. Finally, this alternative would perpetuate the undesirable hydraulic conditions caused by the existing substructure's geometry.

2.2.3 Alternative 2: Build New Bridge on New Alignment - Maintain Historical Bridge

Alternative 2 included construction of a single five-lane bridge to carry both northbound and southbound traffic. Under this alternative, the southbound bridge would be demolished, and the northbound bridge would be converted for pedestrian use. The new bridge would consist of two travel lanes in each direction and a center left turn lane to provide left turns in either directions (i.e., two-way left-turn lane (TWLTL)). See Figures 2 and 4. The existing pedestrian bridge on the west side of Okemos Road would remain in place. Under this alternative, Meridian Township (or another entity) would be required to take ownership of the northbound (historic camelback bridge) and would be responsible for future maintenance.

The bridge would carry five 11-foot lanes of traffic with two-foot shoulders. The total width of the bridge would be 62 feet. New abutments would be placed behind the existing abutments of the southbound bridge for a total length to approximately 186 feet. The existing steel beams are approximately 36 inches deep. To minimize the grade impacts on the approaches, proposed beams should be of similar depth. A two-span bridge with 42-inch prestressed concrete bulb-tee beams or a three-span bridge with 36-inch prestressed concrete bulb-tee beams would be sufficient. The bridge abutments outside of the river channel greatly improving the hydraulics and less susceptible to scour.

Under this alternative, the location of the camelback bridge would restrict the new bridge width and prevent the addition of an attached non-motorized facility on the east side of the new bridge (Figure 4). Therefore, pedestrian and bicycle traffic would use the camelback bridge as a non-motorized path.

This alternative would require realignment of Okemos Road and the Okemos Road/Mt. Hope intersection and removal of the grass median to account for the new single bridge location. The northbound roadway would be shifted to the west of the existing northbound bridge, while the southbound roadway would be shifted slightly to the east of the existing southbound bridge. The existing laneage at the intersection would remain unchanged except for the TWLTL, which would run from Mt. Hope Road to the Wonch Park entrance. The entrances to both Wonch Park and Ferguson Park may require minor grading depending on the magnitude of grade changes.

It is estimated that this alternative would cost approximately \$5,995,000.

2.2.4 Alternative 3: Build New Bridge on New Alignment – Remove Historical Bridge

Alternative 3 is the same as Alternative 2 except both existing bridges would be demolished, and five-foot bike lanes with three-foot buffers would be added to both sides of the new bridge. Additionally, a non-motorized facility would be incorporated on the east side of the new bridge for a total width of 82 feet. See Figures 3 and 4.

It is estimated that this alternative would cost approximately \$6,700,000.

2.2.1 Alternative 4: No Build

The "No Build" alternative assumes no work beyond standard repair and maintenance. The existing deteriorated conditions documented in the bridge inspection report would not be addressed and the existing structure would provide an estimated remaining life of only 10-20 years. This alternative does not meet the Purpose and Need for the proposed project as it does not address the functional obsolescence or structural deficiencies or improve the hydraulic conditions of the river. Per NEPA guidance, the No Build Alternative is carried through the environmental study to provide a baseline comparison against the Preferred Alternative.