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Rose-Hulman Institute of Technology, CM 496
5500 Wabash Avenue
Terre Haute, Indiana 47803

May 13, 2010

Mr. Scott Robinson, AICP
City of Bloomington Planning Department
401 North Morton Street
Bloomington, Indiana 47402

Dear Mr. Robinson:

DGF Consulting Engineers has completed the Bloomington State Road (SR) 37 Grade Separated Crossing Feasibility Analysis and Design project. We are pleased to present you the final report documenting all of our work. Please use this report as you see fit and to provide any feedback.

In this final report, we have included all the work completed to date, which includes a feasibility study of three candidate locations, a summary of codes and regulations pertinent to multi-use trail crossings, a study of trail connectivity at each location, a geotechnical investigation, a description of each design option at each location, the results of our assessment of the design options, the design of a retaining wall including a connection design, a proposed trail alignment, the stormwater management for the crossing, the construction cost estimate and timeline, and a pavement design. In addition, we have proposed what needs to be completed before our design can be implemented and have offered recommendations for the implementation of our design.

DGF Consulting Engineers recommends that a multi-use trail crossing be implemented at the northern railroad underpass location. After analyzing the design options, this is the optimum location based on the criteria of overall cost, technical feasibility, aesthetics, and future implications and uses. The proposed design solution is to construct a soldier pile and timber lagging retaining wall with a row of tiebacks and a cast-in-place concrete facing along the south side of the railroad tracks in order create space for trail users. We have also surpassed the initial project scope by offering you a possible trail route to connect the crossing to existing trail systems.

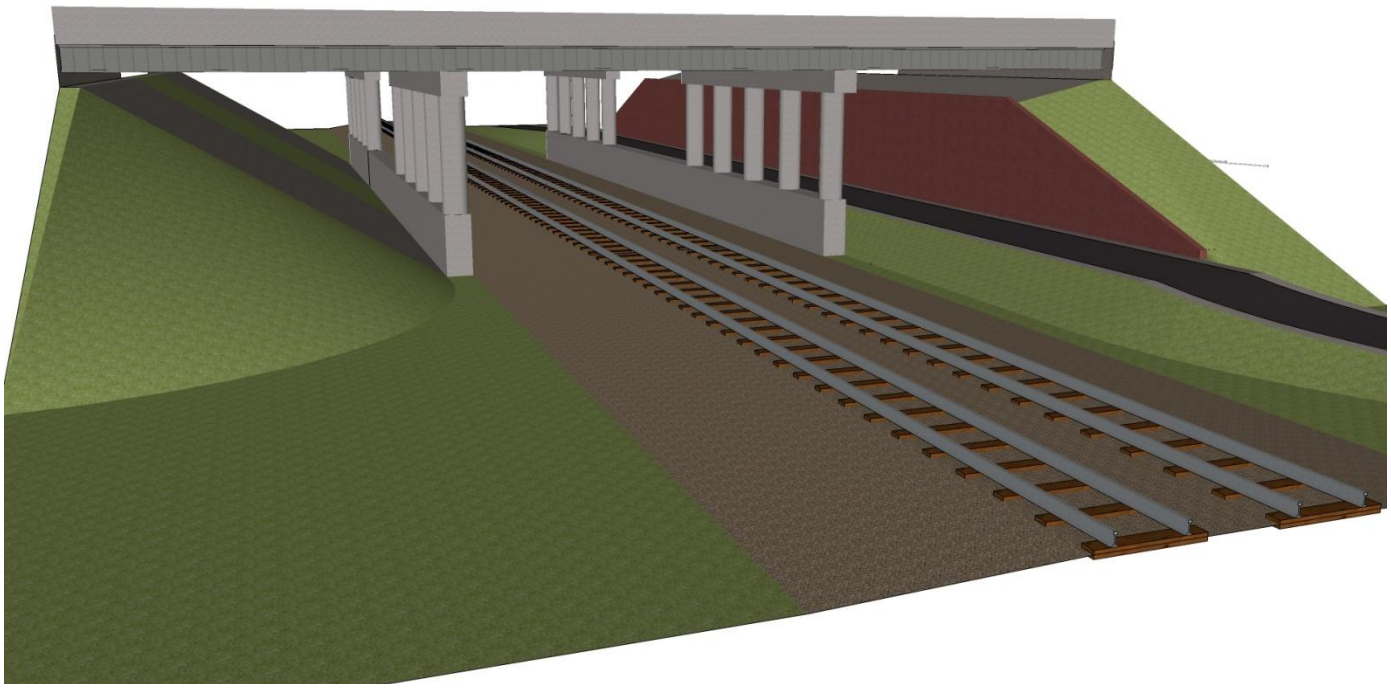
Thank you for giving us the opportunity to work on this project. We look forward to hearing any feedback on our design and reccomendations. If any questions arise, please feel free to contact Colin Dale by phone at 317-753-5888 or by e-mail at dalecm@rose-hulman.edu.

Sincerely,

Kyle Beaty
Final Report Project Manager

beatykm@rose-hulman.edu
Cell: 317-412-0137

SR 37 Grade-Separated Crossing



Prepared for:

Scott Robinson

City of Bloomington Planning Department

May 13, 2010

Prepared by:

DGF

Consulting Engineers

RELEASE

The City of Bloomington, Indiana Planning Department agrees to have this design project entitled "SR 37 Grade-Separated Crossing," reviewed and approved by professional, licensed engineer(s) prior to any and/or all actual implementation or use. In the event this design project is implemented or used in any manner by the City of Bloomington, Indiana Planning Department, then in consideration of the benefit to be derived by the City of Bloomington, Indiana Planning Department from this design project, the City of Bloomington, Indiana Planning Department acknowledges that said use and/or implementation has inherent risks and dangers of injury to person or property.

The City of Bloomington, Indiana Planning Department elects knowingly and voluntarily to assume and/or incur all risks of loss, damage or injury of whatever kind, including death, that may be sustained or suffered by the City of Bloomington, Indiana Planning Department from the implementation or use of this design project, and whether or not the result in whole or in part of acts or omissions, negligence or other unintentional fault of Rose-Hulman Institute of Technology, its officers, directors, agents, employees, servants, faculty, staff and students (hereafter, "Rose-Hulman").

The City of Bloomington, Indiana Planning Department agrees to indemnify, defend and hold harmless Rose-Hulman from and against any and all liabilities, claims, demands, causes of action and loss (including reasonable attorney's fees) which may be brought or imposed on or incurred by Rose-Hulman, arising from any negligence or other act or omission by the City of Bloomington, Indiana Planning Department alleged to have caused in whole or in part any injury to any person or property during the implementation or use of this design project.

This Release shall be binding on the heirs, assigns, beneficiaries, and personal representatives of the City of Bloomington, Indiana Planning Department. The undersigned with binding legal authority on behalf the City of Bloomington, Indiana Planning Department acknowledges that he/she has read this Release, understands it, and is signing this Release with intent to be effective, knowingly and voluntarily and that the undersigned is over eighteen (18) year of age and of sound mind.


(Signature) 5/11/10 (Date)

Long Range / Transportation Manager (Title)

Witness:  (Signature) 5/11/10 (Date)

DISCLAIMER

The contents of this engineering design report were prepared by civil engineering students at Rose-Hulman Institute of for their senior capstone design class. **DGF Consulting Engineers** is a fictitious company created by students **Kyle Beaty, Colin Dale, Justin Perry, and Brad Vannoy** for the purpose of this class. These students are not registered professional engineers. All material presented herein should be reviewed and stamped by a professional engineer prior to construction. A liability waiver has been signed by the client, and copies are available from the client and from Rose-Hulman Institute of Technology.

Executive Summary

State Road (SR) 37 bisects the city of Bloomington, Indiana, leaving non-motorized traffic with an absence of facilities by which to cross the busy highway. With the inevitability of the proposed Interstate 69 corridor passing through Bloomington along SR 37, the city recognizes the increased need for a non-motorized crossing. The members of the City of Bloomington Planning Department identified three possible crossing locations along the SR 37 corridor when they approached DGF Consulting Engineers (DGFCE) to determine the safest and most efficient crossing location. The three locations were a railroad overpass bridge south of Third Street, the Third Street/SR 37 interchange, and a railroad underpass north of Third Street. This report details our research and designs for a grade-separated multiuse crossing of SR 37.

DGFCE considered multiple crossing solutions at each identified location along the SR 37 corridor. We determined the optimal location by four design criteria: overall cost, technical feasibility, aesthetics, and future implications and uses. The best solution proved to be a crossing with a retention wall at the railroad underpass north of Third Street.

To provide user safety at the non-motorized crossing, the nearest edge of the path will remain thirty feet from the centerline of the active railroad tracks. To accommodate this distance, the slope wall on the south side of the railroad will need to be cut for the sixteen-foot wide path. DGFCE designed a soldier pile and timber lagging wall to brace the cut slope wall, as well as the appropriate connections to ensure the wall's stability. The wall includes a cast-in-place concrete facing that will support the excavated material once the timber lagging decays, and can also function as a spotlight for local art and culture.

Outside of the crossing location, we included a recommended trail route, starting in the Whitehall Crossing parking lot and terminating at the current end of the B-Line Trail near the Bloomington City Hall. Included in the trail route plans are the required cross sections, signage, and pavement markings.

The engineering estimate of the crossing with the retention wall, neglecting the trail route, is about $371,000.

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1.0 Problem Description

The city of Bloomington, Indiana has need for a new, non-motorized crossing of State Road (SR) 37. Bloomington is located in south-central Indiana, as shown in Figure 1.1, and has a current population of approximately 71,000 residents (Onboard Informatics, 2009). It is home to Indiana University, the largest educational institution in Indiana with an attendance greater than 40,000 students (Onboard Informatics, 2009). Consistent with its collegiate atmosphere, there is a high concentration of non-motorist traffic. Additionally, with new development in the area, there is a need to take measures to ensure effective transportation to all parts of the city.

Figure 1.1: Bloomington is located in south central Indiana.

(Adapted from Greenwich Mean Time, 2009)

The City of Bloomington Planning Department has growing concerns about the lack of non-motorist crossings in developing areas of the city. The members of the City of Bloomington Planning Department have an aim of ensuring the safety of non-motorized traffic in existing areas of high motorist traffic concentration. SR 37 is a four-lane divided highway that runs north and south through the city. There is development to both the east and west along this corridor. With the probable extension of Interstate 69 from Indianapolis to Evansville, the state of Indiana is investigating use of the SR 37 corridor as a new

alignment for Interstate 69. The primary goal of the City of Bloomington Planning Department is to provide a safe route for non-motorized traffic attempting to cross SR 37. In the probable event that Interstate 69 passes through Bloomington as proposed, our design follows the codes and regulations for structures near interstate highways. The Schneider Corporation in Indianapolis prepared an initial feasibility study for the proposed I-69 extension through Bloomington that includes potential non-motorized crossing sites. After reviewing this study, the city limited the scope to three locations, as illustrated by Figure 1.2. The northern site is a CSX Railroad underpass below SR 37. The middle site is where Third Street crosses over SR 37. The southern site is an Indiana Rail Road overpass. The City of Bloomington Planning Department has requested DGF Consulting Engineers (DGFCE) to assess each location by performing a feasibility study and cost analysis to determine the crossing location that will best serve the needs of the public. A viable design solution follows the completion of these tasks. The primary goal of this project is to design a safe, cost-effective multiuse crossing connecting busy residential regions and commercial areas, one that can be integrated into existing and future paths in the city.

Figure 1.2: Three potential multiuse crossing sites on State Road 37 (Adapted from Bing Maps, 2009).

Connectivity to other paths within the city is a major placement consideration. Providing an easy and efficient route connecting the multiuse crossing to other trails for users within the region is a concern for the Planning Department. Figure 1.3 displays existing trails within the immediate vicinity of the candidate crossing locations.

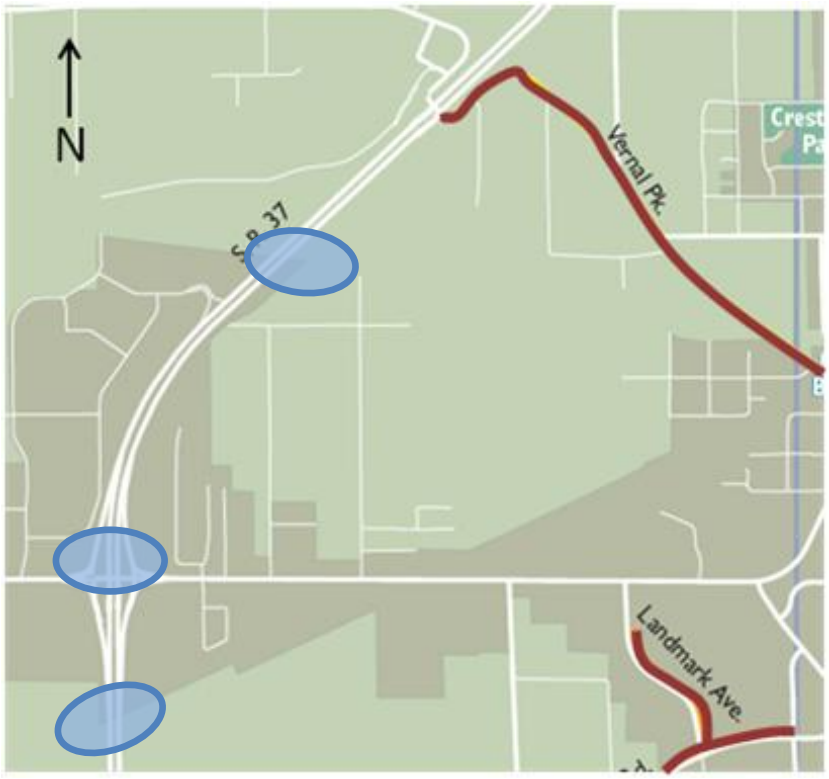

Figure 1.3: Existing Trails in the SR 37 region. Note the Vernal Pike and Landmark Avenue trails. (Adapted from City of Bloomington, 2009)

2.0 Design Requirements

Each of the three locations identified by the City of Bloomington Planning Department has advantages and disadvantages as a feasible crossing solution. The client requested a feasibility study encompassing all three locations in order to determine the ideal placement of a multiuse crossing according to these requirements.

The ability to connect to other trails and multiuse paths in the area is a prime factor in the selection of the crossing's location. Another controlling factor for the crossing location is the potential for nearby development in the future. Whether or not Interstate 69 is built using the SR 37 corridor, it is still

almost certain that the area will still experience growth and expansion. Being able to provide a quick and efficient public route that effectively connects different trails and paths in the area is important to the Planning Department and the public.

2.1 Client Requirements/Requests

The major design requirements, as dictated by the City of Bloomington Planning Department, can be summarized as follows:

- Investigate different alternatives and provide cost estimates for various design options,
- Identify the optimum location for a non-motorized crossing of SR 37, and
- Investigate potential for connectivity to existing trails in the city of Bloomington.

The City of Bloomington Planning Department has requested the following items from DGFCE:

- Schematic design drawings of the proposed solution (Size: 11” x 17”),
- Limitations, benefits, and cost estimates of the crossing options,
- DGFCE’s design solution,
- A public presentation of the proposed solution, and
- A written report detailing our process.

2.2 Project Constraints

The primary site constraints of this project are physical boundaries and barriers. All three locations are in dense, built-up areas, and two of the proposed sites are near railroads. The close proximity to the railroads poses challenges due to codes that regulate construction near railway corridors. The Third Street/SR 37 interchange has its own challenges due to the high motorist traffic volume that passes through the area, along with development and current property usage. Another major constraint concerns connectivity with other trails within the area. In determining the optimal trail connection to the chosen crossing, DGFCE had to consider the number of privately- and publicly-owned land parcels affected.

2.3 Deliverables

We are submitting a hardbound copy and a digital copy of the final report of this project to the client. This report contains in-depth design analyses that we used to determine the best location. These analyses include a feasibility study, design, cost estimate, construction timeline, and detailed drawings. We are providing 11" x 17" hard copy drawings for the report and AutoCAD 2007 files with the digital copy.

3.0 Project Approach

DGFCE achieved the design requirements for this project with the following project approach:

- **Preliminary Feasibility Study** – investigate site characteristics, locate utilities, identify any environmental concerns, determine zoning districts, and identify basic soil types and characteristics for the three locations along SR 37.
- **Codes and Regulations** – research the codes and regulations applicable to the design of a multiuse trail near railroads and highways.
- **Existing Conditions and Trail Connectivity** – examine the steps necessary to connect the design options to existing trails in the Bloomington area.
- **Geotechnical Investigation** – determine soil properties and analyze soil abilities to support each design option, based on representative soil samples taken from the region.
- **Project Locations and Design Options** – outline the general details of the considered design options at each location.
- **Analysis of Locations and Design Options** – assess the advantages and disadvantages of the design options at each location against the client-approved decision criteria using decision matrices to determine the optimal design option at the chosen location.
- **Retention Wall Design** – perform appropriate structural and geotechnical design of the retention wall at the railroad underpass crossing.
- **Trail Alignment** – recommend a trail alignment to connect the proposed underpass crossing to existing non-motorized traffic facilities in the city.
- **Stormwater Runoff Management** – design a culvert for the blocked drainage swale west of the proposed underpass crossing.

- **Construction Cost Estimates** – assess material and construction costs for the underpass crossing and complete a detailed construction cost estimate, based on the *2009 RS Means Heavy Construction Cost Data* (Waier, 2009b) and the Indiana Department of Transportation (INDOT) Pay Items Unit Price Summaries (INDOT, 2009), as well as regional contractors.
- **Construction Schedule** – assemble a preliminary construction timeline for the chosen design option that accounts for total construction duration, based on productivity rates from the *2009 RS Means Heavy Construction Cost Data* (Waier, 2009b) and regional contractors.
- **Connection Design** – perform the design of connections within the proposed retention wall.
- **Pavement Design** – perform the design of the multiuse trail pavement and sub-grade.

4.0 Design Solution

4.1 Preliminary Feasibility Study

We completed a preliminary feasibility study to gain an understanding of the conditions at each location and to help determine the optimal location for a multiuse crossing of SR 37. DGFCE has researched site characteristics and topography, soils information, wetlands and floodplain locations, utility information, and zoning districts for each location. We also performed a site inspection for each location to confirm site characteristics and land use found in the course of our research. This study also helped to identify any difficulties that arose during the design process. In this study, DGFCE found that the two northernmost locations, the northern railroad underpass and the site for a multiuse bridge just north of Third Street, present the fewest obstacles for constructing a multiuse crossing. The southern railroad overpass location, maintained by the Indiana Rail Road Company, proved to have a high density of utilities in combination with steep slopes leading up to the railroad overpass. All locations have the common hindrance of limited right-of-way and the issue of connecting to other trails nearby. Figure 4.1 illustrates each location's proximity to the existing trail and path networks in the Bloomington area. These trail connections converge to a common point at the southern end of Vernal Pike. Although DGFCE found the two northernmost locations to be the most feasible for a multiuse crossing of SR 37, necessary steps for construction will include utility relocation, a soil study, and continued interaction with area residents and representatives from both the CSX Corporation and Indiana Rail Road Company. The details of this preliminary feasibility study appear in Appendix A.

Figure 4.1: Multiuse crossing location options (Adapted from City of Bloomington, 2009).

4.2 Codes and Regulations

DGFCE examined pertinent codes and regulations to ensure a viable and safe crossing solution, as well as to ensure that highway and city codes are followed. We examined the following codes and regulations to ensure that our project complies with regard to clearance issues, traffic control, and accessibility for persons with disabilities:

- *Indiana Design Manual* (INDOT, 2010),
- *Guide for Development of Bicycle Facilities* (AASHTO, 1999),
- *Manual on Uniform Traffic Control Devices* (FHWA, 2003),
- *AASHTO Bridge Design Manual* (AASHTO, 2004), and
- *ADA Standards for Accessible Design* (United States Department of Justice, 1994).

We also examined the following codes for further structural design of the underpass crossing:

- American Institute of Steel Construction (AISC) *Steel Construction Manual* (AISC, 2005), and
- American Concrete Institute (ACI) *Building Code Requirements for Structural Concrete* (ACI, 2008).

Finally, DGFCE also inspected the Bloomington *Unified Development Ordinance* (*UDO*) (City of Bloomington Planning Department, 2007) to make certain that all other codes and regulations examined comply with the limits set by the city as well. Included in the *UDO* are some of the public aspects of the project, such as holding an open meeting to gain public insight into the viability of the project. Appendix B describes these codes and regulations in further detail and describes more of the aspects that DGFCE used from each code in this project.

4.3 Existing Conditions and Trail Connectivity

DGFCE considered existing structures, traffic projections, and trail connectivity in analyzing the engineering difficulties of each of the potential crossing locations. We conducted two site visits to gather information about the site and document our findings at each of the proposed locations. We specifically observed the structures on site to focus on the potential complications with capacity and space constraints at each of the considered locations. The northern railroad underpass location would require extensive excavation before construction of an actual crossing. The Third Street crossing would

pose issues with trail users crossing the motor traffic on the ramps to and from SR 37. The southern railroad overpass posed the issue of having a trail close to the railroad for a longer distance than just crossing SR 37. We also obtained traffic projection data to account for user safety with regards to each proposed solution. DGFCE studied the Bloomington trail map and identified potential trail connections to each candidate crossing location. The specific findings of our site visits and assessment are presented in Appendix C.

4.4 Geotechnical Investigation

DGFCE conducted a subsurface investigation at two locations to classify the on-site soils and to summarize the conditions in the area in order to provide geotechnical design recommendations. We traveled to the project location and obtained representative samples from the region. We conducted tests to determine soil strength and characteristics. DGFCE used these results in the design process to help determine which options and locations would be the most feasible considering the existing soil properties. From the samples, we determined that existing soils will be strong enough to support a multiuse crossing facility. A description of the tests, the test results, and DGFCE's recommendations are included in Appendix D.

4.5 Project Locations and Design Options

DGFCE considered the three alternative locations that the client identified with at least two options at each location. At the northern railroad underpass we determined two options: a multiuse path with a retaining wall parallel to the railroad or a tunnel under SR 37. At the Third Street interchange we determined three options: attach a recessed multiuse path to either side of the Third Street bridge, widen the Third Street bridge to allow for a multiuse path on one side, or construct a freestanding bridge just north of the Third Street/SR 37 interchange. At the southern railroad overpass location we identified two options: attach a multiuse path to the existing railroad bridge or construct a freestanding multiuse bridge away from the railroad bridge. More detailed descriptions of each option at all three locations appear in Appendix E.

4.6 Analysis of Locations and Design Options

Considering all of the design options for the three locations, DGFCE determined decision criteria to identify the best option. The client-approved weights to the decision criteria reflect the importance of the criteria to the City of Bloomington Planning Department. Table 4.1 shows the decision criteria with their assigned weights in the top row of the table. We evaluated all of the design options with respect to each decision criterion. DGFCE assembled a conceptual construction cost estimate for each option and predicted the overall cost by combining industry cost indices with construction methods. We considered how the new crossing could negatively impact motorist traffic in the area, and how the new crossing would affect the motorist traffic in the future as a part of the technical feasibility. Our team evaluated the ease of connectivity of the crossing location and factored this into the decision as another part of technical feasibility. DGFCE evaluated the aesthetics of each option along with how visual appeal can be added to each option. DGFCE also considered the ease of use for a pedestrian or bicyclist. We evaluated each location, and we determined the best design option for each location in the final decision matrix, as viewed in Table 4.1.

Table 4.1 – Final Decision Matrix

	Overall Cost (35%)	Technical Feasability (30%)	Aesthetics (20%)	Future Implications/Uses (15%)	Total
Northern RR Underpass Retention Wall	3	2	2	2	2.4
Third Street Overpass At Grade Path Attached	2	2	2	2	2.0
Southern RR Overpass Cantilevered Path Attached	3	1	2	2	2.1

DGFCE determined that the best design option for a grade-separated multiuse crossing of SR 37 is a retention wall that runs along the northern railroad underpass. Detailed descriptions of the decision criteria and scoring appear in Appendix F, along with how all of the criteria apply to each location and the explanation of scoring for the best option at each location.

4.7 Retention Wall Design

DGFCE determined that the most feasible method of constructing a retaining wall at the underpass crossing is a concrete retention wall. A 2:1 slope wall runs from the SR 37 end bents to the abutments. A bench will need to be cut out of the slope wall to create space for the sixteen-foot-wide trail to pass. The trail will be placed thirty feet away from the centerline of the nearest railroad tracks, which places the wall forty-six feet from the centerline of the railroad. The height of the wall facing is seventeen feet with sixteen vertical feet of retained earth. The total length of the wall is two hundred and eighty feet with the last thirty-five feet on both ends tapering to a wall height of one foot. Because of the height of the retained earth is so high, DGFCE recommends using a row of tie-back anchors.

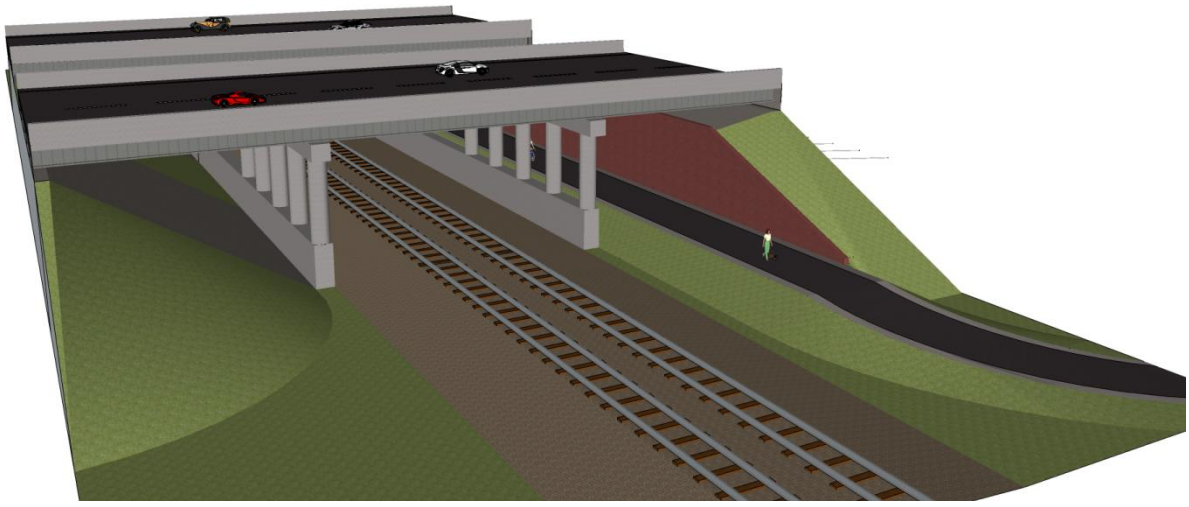

Figure 4.2: Rendering of retaining wall and path passing under SR 37 bridges

The retention wall consists of HP 12 x 74 piles driven eight feet apart to a minimum depth of twenty-six feet before excavation. Spanning the gap between the piles is timber lagging, installed from top to bottom during excavation of the bench. A row of 1-¼-inch diameter pre-stressing tiebacks are placed twelve and one-half feet above the base of the wall. The pre-stressing bars are fifty feet long with a thirty foot un-bonded length and a twenty foot bonded length. The tieback inclination is five degrees. Since the timber lagging will eventually decay, the concrete facing will retain the soil. The permanent facing is a twelve inch thick cast-in-place concrete wall with No. 4 horizontal and vertical steel reinforcement to support the excavated earth. The horizontal steel reinforcement is spaced nine inches

apart, and the vertical reinforcement is spaced at eighteen inches apart. Eight-inch long, 5/8-inch diameter shear studs spaced thirty-six inches apart are used to secure the facing to the piles. The design calculations for the retention wall are presented in Appendix G.

4.8 Trail Alignment

DGFCE recommends a trail alignment to connect the chosen railroad underpass crossing to existing non-motorized traffic facilities within the city. The multiuse trail follows the CSX railroad north of Third Street for most of the trail's length, which is about 1.8 miles. For most of the trail segment along the railroad, the nearest edge of the trail shoulder runs thirty feet from the centerline of the nearest railroad tracks. The complete trail alignment in Appendix H includes plan and profile drawings, as well as detailed descriptions of points of interest along its length. Figure 4.2 shows an overview of the suggested trail alignment and its connection on the east end to the B-Line Trail in downtown Bloomington.

Figure 4.3: Suggested trail alignment (Adapted from Google Maps, 2009).

4.9 Stormwater Runoff Management

The proposed trail alignment to connect the railroad underpass crossing to existing non-motorized traffic facilities blocks the drainage of an existing swale between the Kohl's parking lot and the southbound lanes of SR 37. In order to provide adequate drainage for this swale, DGFCE recommends installing an eighteen-inch diameter corrugated metal culvert pipe. The culvert is nearly eighty feet long and at a one percent slope below the proposed trail just west of the underpass crossing. Since the stormwater runoff traveling through the pipe will gain velocity over present drainage conditions at the

outlet point, DGFCE recommends placing a riprap basin at the culvert's outlet to prevent soil erosion. The median riprap particle diameter will need to be about five inches, placed fifteen inches thick for about two feet downstream of the culvert outlet. The riprap lining could be extended downstream at a shallower depth if desired. Figure 4.4 shows the location of the culvert with respect to the underpass crossing. Appendix I addresses additional details concerning the design of the culvert and riprap sizing.

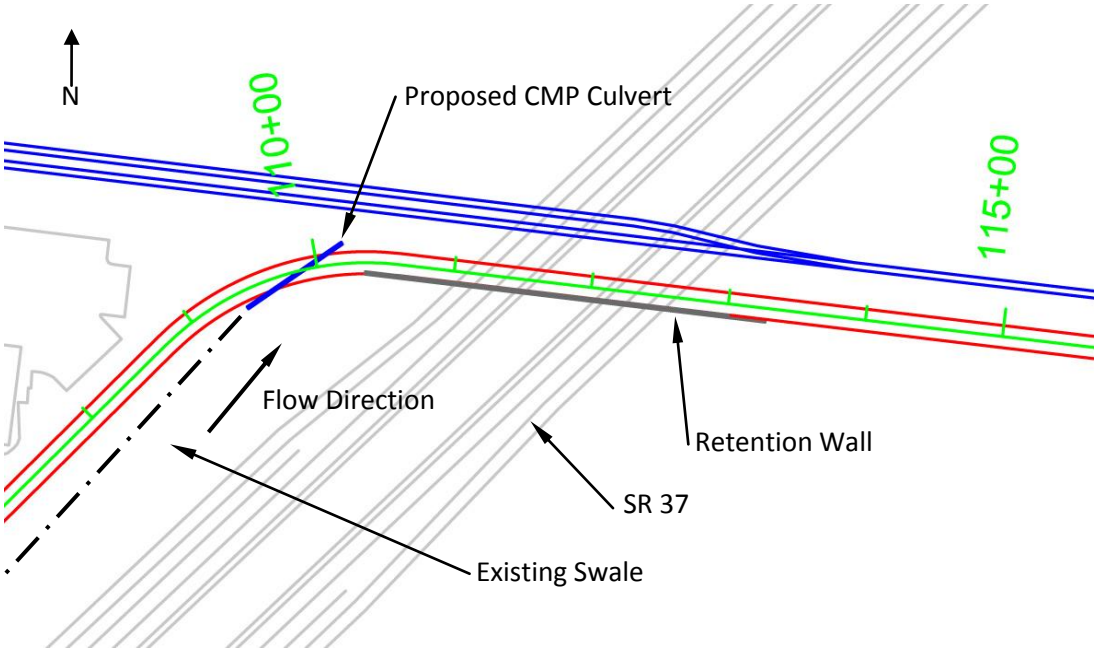

Figure 4.4: Plan view of proposed culvert with stations referenced in Appendix H.

4.10 Construction Cost Estimates

After completing the design, DGFCE utilized the *2009 RS Means Heavy Construction Cost Data* (Waier, 2009b) to complete the construction cost estimate for the crossing. The estimate covers the cost of the materials, labor, equipment, and overhead and profit for the construction process. We evaluated and applied unit quantities estimated in the construction schedule (Appendix K) to properly calculate the overall construction cost of the underpass crossing. DGFCE considered low headroom constraints and task overlapping to minimize the construction cost. All crew sizes and unit costs are based on the *2009 RS Means Building Cost Data* (Waier, 2009a). The *2009 RS Means Building Cost Data* includes Historical Cost Indices and Location Factors for many cities across the country. Using data from the *2009 RS Means Building Cost Data*, we estimate the project to cost about $416,000. The Bloomington Location

Factor is 89.3%, which reduces the expected cost from $416,000 to $371,000. Additional details of the cost estimate appear in Appendix J.

4.11 Construction Schedule

DGFCE prepared a construction schedule that will aid the contractors of the excavation and retaining wall in efficiently planning the details of the construction process. The schedule first identifies all necessary tasks to be completed. We used the *2009 RS Means Heavy Construction Cost Data* (Waier, 2009b) and the *2009 RS Means Building Cost Manual* (Waier, 2009a) to calculate the time needed to complete all necessary tasks for the wall construction. The tasks are scheduled to minimize the required amount of time needed to complete the project, as some tasks can be performed simultaneously with other tasks to maximize efficiency. We accounted for time considerations due to special construction procedures associated with low headroom and limited maneuverability. DGFCE also tabulated the equipment and labor requirements for the project, and this will guide the contractor in determining necessary measures to complete the construction of the retention wall. DGFCE anticipates that it will take 18 weeks to construct the soldier pile and timber lagging retaining wall. Additional details of the construction schedule appear in Appendix K.

4.12 Connection Design

The soldier pile wall will be constructed in an area with low headroom. Therefore, the piles cannot be driven in one section and require column splices to connect each section to the one section below it. Four sections measuring seven and half feet long will be spliced together to make up the total length. We used the maximum bending and shear loads, calculated in Appendix G, to design a column splice that adequately handles the worst case scenario in both shear and moment. DGFCE designed welded plates to connect the flanges and webs of the spliced soldier piles. Welded flange plates withstand the bending loads and welded web plates withstand the shear loads. The flange plate is a PL 10x10x3/4 section made of A36 steel. The web plate is a PL 7x7x1 section made of A36 steel. Design details of the wall connections appear in Appendix L.

4.13 Pavement Design

The trail will consist of asphalt pavement designed to withstand the service loads on the trail. The maximum load on the trail will most likely be that of an ambulance in an emergency situation. DGFCE

concluded, however, that the loads will not be substantial enough to facilitate an advanced pavement design. Therefore the use of minimum pavement thicknesses is adequate. Using the existing soil conditions in conjunction with the expected loads, DGFCE determined that the pavement shall consist of a three-inch asphalt concrete base layer with a two-inch asphalt concrete surface layer. There are also two foot wide and one foot deep gravel shoulders for trail drainage, consisting of compacted No. 53 aggregate. Further details of the pavement design are provided in Appendix M.

5.0 Future Work

Since the underpass crossing of SR 37 is a public project, the City of Bloomington Planning Department needs to hold at least one public meeting to gain input from the residents affected by this project (City of Bloomington Planning Department, 2007). If the Planning Department considers using DGFCE's suggested trail route, those residents along the proposed trail need to be informed and given the opportunity to voice their concerns with regard to the underpass crossing and trail (City of Bloomington Planning Department, 2007).

The Planning Department should also consider placing benches and lights near street intersections. Plants and trees need to be selected for the vegetative barrier between the railroad tracks and trail for most of the length of the proposed trail. These plants and trees should be indigenous to south-central Indiana and should require little maintenance for most of the year to reduce annual costs.

Specific to the crossing design, DGFCE's proposal needs to include an erosion and sedimentation control plan to be implemented during construction.

6.0 References

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