MnDOT Guidance on State EAW Questions on Climate Adaptation and Resilience and Greenhouse Gas Emissions/Carbon Footprint

This guidance supports highway projects developing State Environmental Assessment Worksheets (EAWs) that include climate adaptation and resilience (Question 7 in the EAW), and greenhouse gas (GHG) emissions/carbon footprint (Question 18 in the EAW). This guidance offers best practices and supplements EQB's *Revised EAW Guidance – Developing a carbon footprint and incorporating climate adaptation and resilience*.

MnDOT contact for GHG Analysis:

- Office of Environmental Stewardship (OES), Environmental Modeling & Testing Unit: Pete Wasko and Lucas Bistodeau. For projects located in MnDOT Metro District, contact Natalie Ries.

MnDOT contact for Adaptation and Resiliency:

- Bridge Office, Hydraulics Engineer (for water related questions): Nick Olson and
- OES, Environmental Assessment Unit (for environmental review related questions): Katherine Lind
- Office of Sustainability and Public Health (for general resiliency questions): Brian Shekleton

Climate adaptation, resiliency, greenhouse gas (GHG) emissions and carbon footprint are concepts that are considered with other social, economic, and environmental concerns during environmental review and project development in the EAW. Depending on the transportation needs of a project and the relationship of these concepts with the project, they may be included in the evaluation of proposed projects and in avoidance, minimization and mitigation measures developed for the project.

The following guidance offers best practice approaches to address these concepts during environmental review for highway projects.

EAW Question #5 – Project Location

Below is a list of suggested resources and guidance that supplement the EQB *Revised EAW Guidance*. Note, the information here is recommended and is not an all-inclusive list:

- MnDOT, Transportation Project Development Process (TPDP), Environmental Review: *MnDOT Guidance on State EAW Questions on Climate Adaptation and Resilience and Greenhouse Gas Emissions/Carbon Footprint*.
- MnDOT, Greenhouse Gas Analysis guidance

- Minnesota Infrastructure Carbon Estimator (MICE) Tool and User Guide: https://www.dot.state.mn.us/environment/airquality/index.html
- National Weather Service, Analysis of Impact of Nonstationary Climate on NOAA Atlas 14 Estimates
- MnDNR, Minnesota Climate Explorer website at: https://arcgis.dnr.state.mn.us/ewr/climateexplorer/main/historical
- Emergency Relief Program:
    - *Emergency Relief Manual (Federal-Aid Highways), Update May 31, 2013*, https://www.fhwa.dot.gov/reports/erm/er.pdf.
    - U.S. Dept. of Transportation, Federal Highway Administration, *Emergency Relief Program*: https://www.fhwa.dot.gov/programadmin/erelief.cfm.
- Include other resources used to answer climate-related questions.

EAW Question #7 – Climate Adaptation and Resilience

Question 7.a*. Describe the climate trends in the general location of the project (see guidance: Climate Adaptation and Resilience) and how climate change is anticipated to affect that location during the life of the project.*

Prepared Statement:

Current and projected future changes in Minnesota's climate include greater intensity rainfall events, more localized flooding, more frequent (repeated) freeze/thaw cycles, lack of snow cover, extreme heat, drought, etc. that damage infrastructure and create safety risks. For transportation infrastructure, the two primary concerns are the projected changes in temperature and rainfall intensity.

For temperature, based on the *Minnesota Climate Explorer* tool, the "Modeled Present" mean value is [INSERT #] degrees and the "Late-Century (RCP 8.5)*" mean value is [INSERT #] degrees. The difference in average annual temperature is [INSERT #] degrees. This change is not expected to affect the stability of the project. More extreme heat days are also projected to increase [for concrete pavement[1]:] and could mean an increase in the risk of buckling.

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[1] Buckling is primarily a concrete pavement problem. Visit the following website for more information: http://www.dot.state.mn.us/pavementbuckle/.

U.S. Global Change Research Program (USGCRP), 2018. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018. https://nca2018.globalchange.gov/.

Ragno, E., AghaKouchak, A., Love, C. A., Cheng, L., Vahedifard, F., & Lima, C. H. R., 2018. Quantifying changes in future Intensity-Duration-Frequency curves using multimodel ensemble simulations. Water Resources Research, 54, 1751– 1764. https://doi.org/10.1002/2017WR021975

[Note that if the project is determined to have a lifespan of 30 years or less, selecting the "Mid-Century" scenario is acceptable. Confirm with project design team on the anticipated lifespan of project components.]

For rainfall intensity, there are not currently robust future precipitation frequency estimates published for Minnesota, however it is widely accepted that "historical assumptions about the magnitude and frequency of extreme future events are not appropriate in the presence of nonstationary climate (USGCRP, 2018). Considering that many climate models indicate that the increasing trend in intensity and frequency of precipitation will likely continue in the future (Ragno, et. al., 2018)" (NWS, 2022). Recent observations of precipitation in Minnesota have supported the concerns with the increasing frequency of higher intensity events above current design data which are based on the historical assumption of a stationary climate.

Without robust future projected precipitation frequency estimates available, providing a project-specific projected increase in rainfall intensity is not reasonable. However, based on preliminary research in Minnesota and results in other areas of the United States, a temporary placeholder value of a 15% increase in the 100-year event will be used to assess climate resilience on the project (resiliency check storm[2]). The resiliency check storm will not factor into culvert, storm sewer, or bridge opening sizing. Instead, it is meant to be used to assess risks of infrastructure damage due rainfall intensity above the current design storms, and then recommend locations for armoring or other solutions to improve climate resiliency. This vulnerability assessment will help improve the climate resiliency of the project to extreme storms.

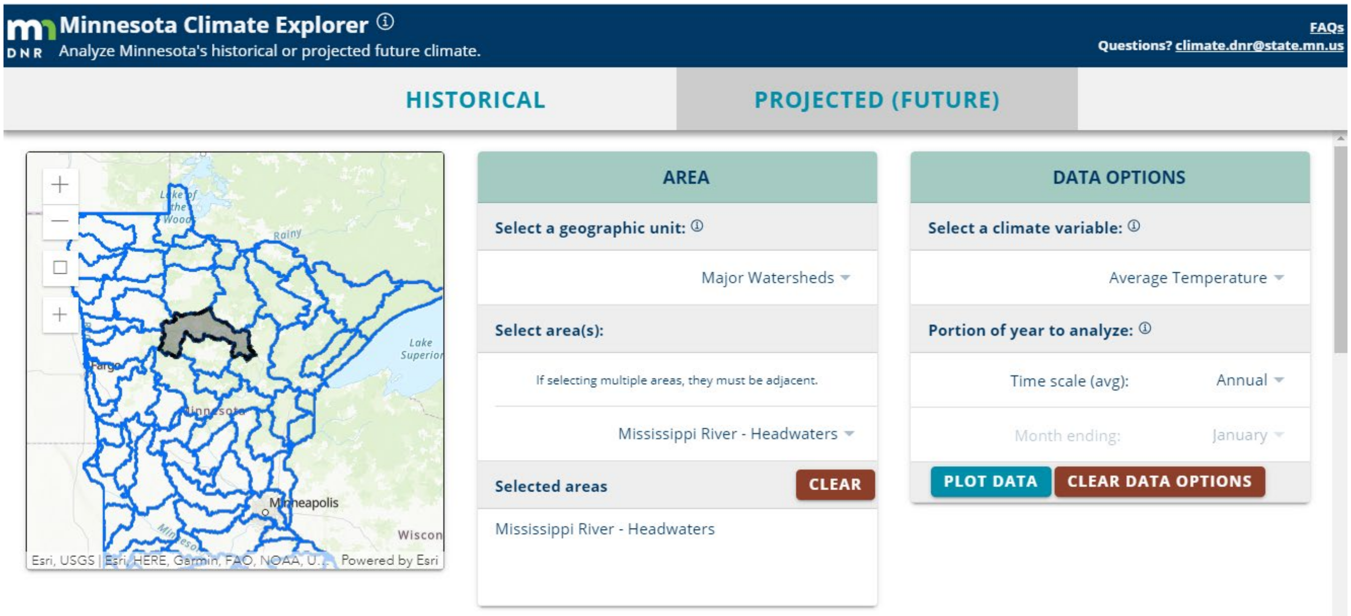
Robust precipitation frequency estimates accounting for climate change are anticipated to be available starting in 2024, and may be incorporated after assessment of their final methods and results.

Below are directions for obtaining temperature projections from the Minnesota Department of Natural Resources', *Minnesota Climate Explorer* web tool.

National Weather Service (NWS), 2022. Analysis of Impact of Nonstationary Climate on NOAA Atlas 14 Estimates Assessment Report, https://hdsc.nws.noaa.gov/hdsc/files25/NA14_Assessment_report_202201v1.pdf.

[2] Future update to the MnDOT Drainage Manual is anticipated to include further information about the resiliency check storm approach. https://www.dot.state.mn.us/bridge/hydraulics/drainagemanual.html

Figure 1: Example of Inputs for MDNR, *Minnesota Climate Explorer* for Projected (Future)



To describe climate trends in the general project location, the MDNR, *Minnesota Climate Explorer* tool may be used: https://arcgis.dnr.state.mn.us/ewr/climateexplorer/main/historical.

- Select "Projected (Future)" at the top of the page > select watershed (Mississippi River Headwaters in the example), climate variable (average temperature), and timeframe (annual) > select "Plot Data" to review output. Figure 1 shows an example of the inputs to select. See Figure 1.

To describe climate change in terms of anticipated temperature changes projected for the project area, identify the "Modeled Present" mean value with that of the "Late-Century (RCP 8.5)" (see Figure 2) using the values on the first bar provided in each of the respective boxes (see Figures 3 and 4). As shown in the figures below, the difference is 39.56 vs49.07 (9.51) degrees Fahrenheit.

Figure 2: Example of MDNR, *Minnesota Climate Explorer* Output for Projected (Future) Average Temperature

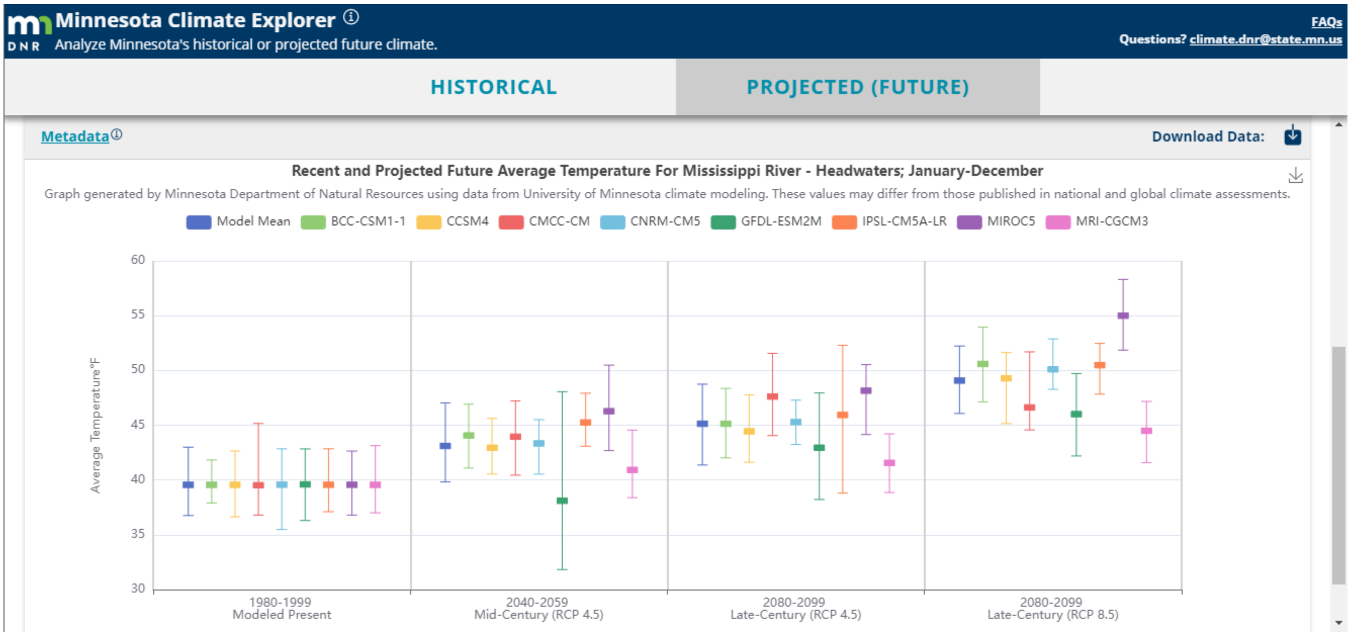


Figure 3: Example of MDNR, *Minnesota Climate Explorer* Output Showing Model Mean Temperature for "Modeled Present"

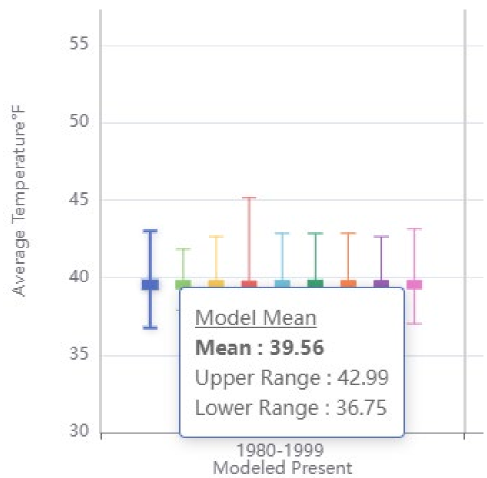
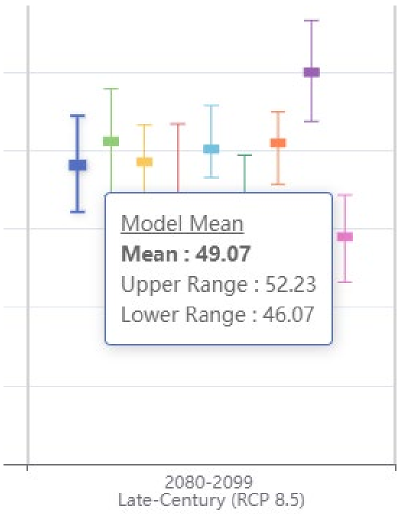
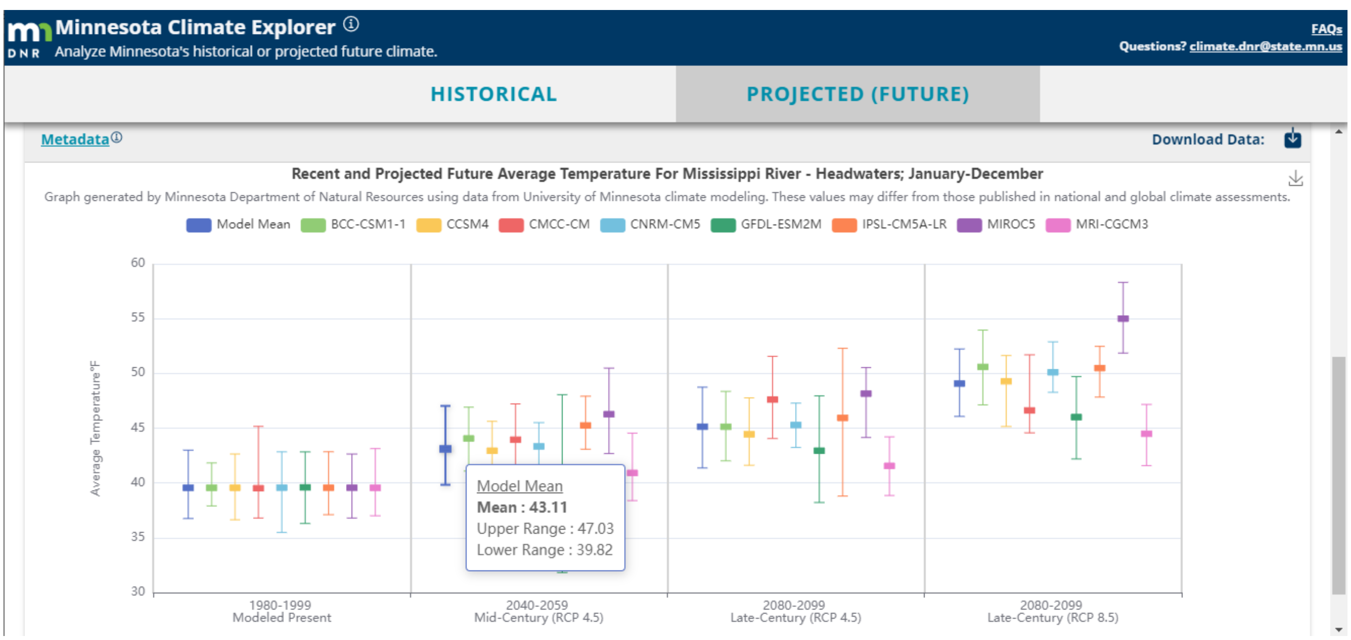


Figure 4: Example of MDNR, *Minnesota Climate Explorer* Output Showing Model Mean Temperature for "Late-Century (RCP 8.5)"



If the project lifespan is less than 50 years (e.g., 25 years), use the mean value from the "Mid-Century (RCP 4.5)" box, as shown in the "Model Mean" box in Figure 5. Confirm with project design team on the anticipated lifespan of project components.

Figure 5: Example of MDNR, *Minnesota Climate Explorer* Output Showing Model Mean Temperature for "Mid-Century"



Question 7.b*. For each Resource Category in the table below: Describe how the project's proposed activities and how the project's design will interact with those climate trends. Describe proposed adaptations to address the project effects identified.*

Climate risk assessments, like the one conducted here, and resilience strategies for individual projects may be aimed at capturing value in the form of risk reduction and avoided future impacts to people and damage to infrastructure, property and/or ecosystem services. Existing risks and vulnerabilities associated with the increased frequency and intensity of precipitation events include transportation infrastructure damage, closures, washouts, slope failures, and others. Additionally, risks and vulnerabilities associated with warming temperatures and increased frequency of high-heat days include increased road-surface cracking and road buckling, as well as challenging pedestrian accessibility. These impacts may affect the lifespan and maintenance of a project. Frequent examples of adaptation practices are listed below. This is not an all-inclusive list; select the adaptation practices that are likely to apply to a project and provide any additional description[3].

- Design considerations
    - Run resiliency check storm scenarios
    - Accommodate overtopping to minimize impacts via armoring and emergency overflow routes
    - Facilitate terrestrial and aquatic connectivity (e.g., span bridges > box culverts > round pipe).
- Roadway practices
    - Armoring
    - Bioswales and bioslopes
    - Native vegetation, including grasses, forbs, trees and shrubs
    - Address Priority Areas for Walking score (PAWS)
    - Address Suitability of Pedestrian and Cycling Environment score (SPACE)
    - Blowing Snow Control (living and structural fencing, snow sloping)
    - Changing roadway profile
- Bridge practices
    - Elevate roadway or bridge
    - Reinforce approach
    - Aggregate surfacing and passage benches (ecosystem connectivity)
- Culvert practices
    - Floodplain culverts (using geomorphic design)
    - Aquatic organism passage design
    - Size to serve multiple purposes (conveyance of water and wildlife)
    - Armoring (both waterway and roadway inslope)
    - Identifying emergency overflow paths in urban areas
    - Reducing culverts/storm sewer in poor condition
    - Considerations for land cover upstream (impervious, field soil health, infiltration)
    - Ponding/storage
- Other practices
    - Remove a portion (or all) of the facility – eliminates the need to design for a given hazard
    - Increase in overall wetlands, tree cover, or planted area to manage stormwater
    - Stabilizers for Gravel Roads
    - Construction phasing: examples include developing 1-mile construction increments

[3] Practices that increase resilience do not necessarily decrease greenhouse gas emissions, and vice versa.

- Visual Quality practices
    - Traffic calming, tree shading, and wind protection to encourage and retain non-motorized users;
    - Considerations for existing trees and other vegetation removed compared to trees/vegetation replaced;
    - Use the 2015 FHWA "Guidelines for the Visual Impact Assessment of Highway Projects.

Resource Category	**Climate Considerations**	**Project Information**	**Adaptations**
Project Design	*The increase in frequency and severity of extreme precipitation events potentially adds additional risk to related impacts (flooding, damage, closure, etc.)*	See details above	See details above
Land Use	*Same as above*	See details above	See details above
Contamination/ Hazardous Materials/ Wastes	*Same as above*	See details above	See details above

EAW Question #8 – Cover Types

Green infrastructure includes a wide array of cover type practices that help manage stormwater and reduce stormwater runoff, but also provide other benefits including carbon sequestration, wildlife habitat, recreation, and increased property values. Green infrastructure practices can reduce adverse impacts of climate change when designed, constructed, and maintained properly.

Cover type-focused practices included in the "green infrastructure" category include, but are not limited to:

- Constructed infiltration systems
- Constructed tree trenches and tree boxes
- Constructed wetlands
- Constructed permeable pavements
- Use of native plantings
- Increased percent tree canopy
- Increased percent native turf and woody species

Reference EQB EAW Guidance for additional cover type-focused practice guidance.

EAW Question #12 – Water Resources

Question 12b: *Describe effects from project activities on water resources and measures to minimize or mitigate the effects in Item b.i. through Item b.iv. below.*

When discussing climate trends in this section, pull from the information gathered/reported in Q7. Generally, the main climate trend in Minnesota will be increased precipitation in rainfall intensity and annual volume – use this question to discuss how the project could be impacted by extreme rain, what the design standards for the project are, and if/how the design prepares for increased precipitation. Also discuss how or if increased precipitation will affect any of the project impacts (i.e., how proposed use of water [or dewatering] could be affected, effects on wetlands, etc.). If the increased climate impacts are considered, describe how, including any contingency plans, etc. If more severe precipitation events were not considered, note that and describe the reasons why (e.g., limited timing, limited funding, short project life, etc.)

Prepared Statement: MnDOT reviewed climate trends, and though precipitation is projected to increase in rainfall intensity and volume, the project is being designed using current standards. There is not yet an agreed upon standard of practice for how best to incorporate projected precipitation increases into projects. However, as discussed in Question 7, a resiliency check storm will be analyzed as the project develops to identify and reduce climate vulnerability risks on the project. The resiliency check storm is currently defined as a 15% increase in the 100-year design event, which is a statewide temporary placeholder until more robust precipitation frequency estimates based on nonstationary climate are published and assessed. Example one: The resiliency check storm analysis was reviewed and did not identify areas vulnerable to this more extreme rainfall event. Example two: The resiliency check storm analysis was reviewed and identified vulnerable areas. As project design advances, additional analysis will be completed and improvements identified to address resiliency issues.

For Stormwater (12.b.ii.): At the time of environmental review, estimated total acres of disturbance and impervious surface are [*describe*]. Predictions on what type(s) of stormwater treatment and sequence of methods that will be attempted include [*describe*]. Stormwater management strategies follow a sequence whereby the first attempt at management is infiltration; if infiltration is not possible, filtration, which is then followed by retention if infiltration and filtration measures are not feasible.

EAW Question #14 – Fish, wildlife, plant communities, and sensitive ecological resources (rare features)

Question 14.c. *Discuss how the identified fish, wildlife, plant communities, rare features and ecosystems may be affected by the project including how current Minnesota climate trends and anticipated climate change in the general location of the project may influence the effects. Include a discussion on introduction and spread of invasive species from the project construction and operation. Separately discuss effects to known threatened and endangered species.*

Climate change impacts on natural resources is expected to vary between species, populations, and ecosystems. Both positive and negative impacts are anticipated and will depend on the specific species, populations, and ecosystems examined. In response to changing climate, more mobile fish, wildlife, and plant species may shift their ranges to track the conditions in which they are best adapted to survive. Less mobile species may not be able to migrate, and other interventions may be needed (e.g., assisted migration). The protection of movement corridors and population refugia, and efforts to increase landscape permeability, are expected to be of key importance in a changing climate (Mawdsley et al. 2017).

MnDOT seeks to maintain and enhance ecological connectivity on its projects through both programmatic approaches such as the standard use of wildlife passage benches under bridges spanning public waters and through project-specific designs components such as multi-use structures and dedicated wildlife crossing structures. Maintaining and enhancing ecological connectivity reduces barrier effects roads have on individual animals, populations, and ecosystems, which in turn improves natural resource resiliency.

The following offers prepared statements for wildlife passages:

This project will install wildlife passage benches and/or aggregate surfacing at bridges [INSERT BRIDGE NUMBERS] to improve connectivity along riparian corridors in the project area. In addition, [INSERT BRIDGE NUMBERS] culverts along the project corridor are designed to achieve both hydrologic objectives and facilitate under-the-road movement of small to medium sized wildlife.

Add paragraph if dedicated wildlife crossing structures are included in project scope (e.g., wildlife underpass, wildlife overpass).

Discuss fencing, if included, and whether it is designed to address wildlife-vehicle collisions (e.g., deer fence, small animal fence). EAW Question #18 - GHG Emissions/Carbon Footprint

Question 18.a. *GHG Quantification: For all proposed projects, provide quantification and discussion of project GHG emissions. Include additional rows in the tables as necessary to provide project-specific emission sources. Describe the methods used to quantify emissions. If calculation methods are not readily available to quantify GHG emissions for a source, describe the process used to come to that conclusion and any GHG emission sources not included in the total calculation.*

MnDOT's *Greenhouse Gas Analysis* guidance is to be used to help guide the development of the content for this section. The tables provided in the EAW form are an example of how to display the emissions information. Use the MnDOT subject guidance, which has been approved for use through MPCA and EQB. Template language for the EAW is located on pages 8 – 11. Replace the "Construction Emissions" and "Operational Emissions" data tables in the EAW with the "Analysis Results" table on page 10 of the MnDOT Greenhouse Gas Analysis guidance.

- MnDOT, Greenhouse Gas Analysis guidance is currently housed on the Highway Project Development Process webpage: http://www.dot.state.mn.us/planning/hpdp/index.html.

To quantify GHG emissions from MnDOT and local highway projects, the Minnesota Infrastructure Carbon Estimator (MICE) tool should be used for calculating project construction and maintenance, and operational emissions.

- The MICE tool and User Guide is available on the MnDOT, Air Quality Webpage: https://www.dot.state.mn.us/environment/airquality/index.html.

Due to limitations of data and modeling real-life scenarios, not all transportation-related project activities are covered by the MICE tool.

Work types covered by MICE: Bridges and overpasses; bus rapid transit; culverts; light and heavy rail; lighting; parking; pathways (trails and sidewalks); roadways; roadway resurfacing and reconstruction; signage.

Work types not covered by MICE: Custom pavements; fencing; guardrails and cable barriers; landscaping; noise walls; pavement overlay projects (e.g., chip seal); projects under negotiated maintenance contracts; ramp metering; traffic signals/replacements; variable message signs; WIM and other truck monitoring infrastructure.

If a project or some of the project's proposed activities are not covered by MICE, include a description in the EAW of those activities that are not covered by the tool.

Question 18.b. GHG Assessment

> *i. Describe any mitigation considered to reduce the project's GHG emissions.*
> *ii. Describe and quantify reductions from selected mitigation, if proposed to reduce the project's GHG emissions. Explain why the selected mitigation was preferred.*
> *iii. Quantify the proposed projects predicted net lifetime GHG emissions (total tons/# of years) and how those predicted emissions may affect achievement of the Minnesota Next Generation Energy Act goals and/or other more stringent state or local GHG reduction goals*

"18.b.i." in the EAW form requests a description and quantification of mitigation practices that reduce project emissions, *if* a project has planned mitigation activities. GHG mitigation practices may or may not be planned depending on feasibility of the practice for an individual project.

MnDOT has identified several practices that when used in a given project can help reduce emissions. These practices directly reduce emissions through decreased fuel use, or indirectly through materials reuse (i.e., decreases processing and transport of new materials). At this phase in project development the plans are approximately 30% complete [note correct % if known], so use of the listed mitigation practices are dependent on further development. If the project is planning to include any of these practices, note them in this section's response and in the project's Environmental Management Plan (EMP). That said, this project is planning to implement the following: [insert list of planned actions from the list below].

Examples of practices that may reduce emissions during a project[4]:

- Full Depth Reclamation (FDR);
- Cold In-Place Recycling (CIR) and Cold Central Plant Recycling (CCPR);
- Warm-mix asphalt;
- Recycled concrete aggregate;
- Increase in overall wetlands, tree cover, or planted area.

[4] MnDOT Bituminous Manual. http://www.dot.state.mn.us/materials/manuals/bituminous/Minnesota_Department_of_Transportation_Bituminous_Manual.pdf