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| Kentucky Division Office of the Federal Highway Administration |
| Programmatic Biological Assessment |
| On the Effects of Transportation Projects in Kentucky on the Federally Endangered Indiana Bat (*Myotis sodalis*) and Gray Bat (*Myotis grisescens*) |

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| FHWA-KYTC-USFWS9-27-2019 |

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# 1.0 Introduction / Background

## 1.1 Involved Agencies

The Kentucky Transportation Cabinet (KYTC), on behalf of the Kentucky Division Office of the Federal Highway Administration (FHWA) is requesting a programmatic consultation with the U.S. Fish and Wildlife Service’s Kentucky Field Office (KFO). This Programmatic Biological Assessment (BA) covers many of the activities funded or authorized by the FHWA. FHWA supports State and local governments in the design, construction, and maintenance of the Nation’s highway system through multiple funding programs. For KYTC projects that involve federal permits, such as U.S. Army Corps of Engineers (USACE) permits under the Clean Water Act, the FHWA will generally be the lead federal agency for the purposes of consultation with the USFWS under Section 7 of the Endangered Species Act (ESA). For KYTC projects that involve a Federal Land Management Agencies (FLMA), the FHWA would proposed to use this programmatic consultation process, initiate project specific consultation, or if applicable, use a consultation mechanism developed by the FLMA (e.g., existing consultations established for U.S. Forest Service, Tennessee Valley Authority, etc.).

## 1.2 Covered Species

Species evaluated under this BA include the federally listed Indiana bat (*Myotis sodalis*), and gray bat (*Myotis grisescens*). Together, these species will be referred to as the “covered” species. This BA contains an analysis of KYTC’s program and those proposed actions that may affect the covered species and their habitats. Other species that may be impacted by a specific project will require project specific consultation with the KFO, or may be addressed through other, applicable, programmatic consultations (e.g., northern long-eared bat).

The Indiana bat and gray bat occur throughout the state; therefore, all proposed projects could result in effects to these species.

The USFWS has designated critical habitat for the Indiana bat. Within the scope of this BA (i.e., Kentucky), critical habitat for the Indiana bat occurs in Edmonson and Carter counties. Critical habitat neither has been designated nor is currently proposed for the gray bat. This BA does not address potential impacts on Indiana bat critical habitat.

## 1.3 Programmatic Overview

Transportation projects are identified and scheduled in a master plan occurring in six-year increments (Six-Year Plan) and a fiscally constrained State Transportation Improvement Plan (STIP). Project priorities and time schedules within the six-year plan vary greatly depending on several factors (i.e. purpose and need, safety concerns, funding, etc.). Trends in the types of projects planned from year to year are difficult to forecast due to the variance in available funding, among other limiting factors. However, smaller-scoped projects are typical and consistent. When evaluating a new transportation project, attempting to account for potential adverse effects to federally listed species is increasingly difficult. Project construction schedules do not always align with the appropriate species survey time periods often used by the KYTC to determine the presence or probable absence of federally listed bats. Results of these surveys assist KYTC with the appropriate species effects determination for approval within the environmental review process.

Projects may affect Indiana bats due to removal of forested habitat and impacts to streams that provide roosting, foraging, and commuting habitat. Projects may also affect gray bats due to removal of forested habitat and impacts to streams that provide foraging and commuting habitat. KYTC typically addresses impacts to the Indiana bat by utilizing authorized incidental take. Impacts to gray bats are addressed by completing a project-specific BA to evaluate impacts to foraging and commuting habitat and propose specific conservation measures to minimize effects on these habitats and the species. Potential impacts to gray bats are generally similar for all projects, and past consultations with the KFO have resulted in a “not likely to adversely affect” determinations for this species.

Projects may also affect the covered species due to rehabilitation or replacement of an existing bridge that provides potential roosting habitat for these species. Over the next five years, KYTC will rehabilitate, repair, or replace more than 1,000 bridges as part of the Bridging Kentucky Program (BKY). The BKY program has delivered 121 bridge projects to construction through May 2019. For these types of projects, KYTC has historically addressed impacts to the covered species through project-specific or batched BAs that evaluate impacts to roosting habitat and propose conservation measures to minimize effects to the species. Past consultations with the KFO have resulted in a “not likely to adversely affect” determination for these species from bridge impacts.

# 2.0 Description of the Proposed Action

## 2.1 Introduction

The proposed action (Action) is the KYTC’s implementation of projects funded or authorized by the FHWA in Kentucky. KYTC maintains and constructs a wide variety of transportation infrastructure projects within Kentucky’s 120 counties. This section provides a brief general description of the development, maintenance, and operation of these transportation infrastructure projects, and identifies activity components of the Action. These activity components have the potential to generate stressors that may affect the covered species or alter their environment. In order to avoid, minimize, and/or compensate for project effects to the covered species, the FHWA/KYTC has developed and is committed to implementing the conservation measures discussed in this section, as appropriate.

## 2.2 Activity Components

There are several phases involved in the development, maintenance, and operation of transportation projects, and most projects are conducted in phases that are tied directly to funding authorization. The phases in project development are considered the activity components of this proposed action and include:

1. Planning,
2. Preliminary Design and Environmental (Phase I),
3. Detailed Design (Phase II), Right-of-Way (ROW) and Utilities,
4. Construction,
5. Maintenance,
6. Operation, and
7. Other/Emergency Actions

However, not every KYTC project will include all seven activity components. For example, the Planning component is typically reserved for those projects where a large number of alternatives are assessed to fulfill a transportation need. The Utilities component is only necessary when relocation of existing utilities is required for construction. Emergency Actions cannot be predicted, and depending on the severity of the action, one or all of the aforementioned activity components may apply. A more detailed description of each activity component follows, along with the identification of stressors that may affect the covered species.

### 2.2.1 Activity Component 1: Planning

The planning component is comprised of gathering data, analysis, and public involvement. Corridors for possible highway improvements, either along existing or on new alignments, are analyzed for feasibility, public acceptability, potential to meet project purpose and need, and environmental impacts. Review and compilation of existing data (e.g., crash data, traffic data, etc.) is undertaken, with some field verification.

* No stressors with the potential to affect the covered species and/or alter their environment have been identified during the planning component of the Action. We have determined that the planning component will have no effect on the covered species.

### 2.2.2 Activity Component 2: Preliminary Design and Environmental (Phase I)

During the preliminary design component of a project, potential solutions to address transportation needs are better defined and more thoroughly examined for feasibility. The design team creates alternatives for study and analysis. Environmental investigations, including aquatic and terrestrial species studies, are also conducted during this component. Some of these activities, such as mist netting, cave exploration, etc. could affect the covered species, but these activities are only conducted by qualified biologists in possession of the appropriate Kentucky Department of Fish and Wildlife Resources (KDFWR) and U.S. Fish and Wildlife Service permits. The outcome of this component is the selection of the location and type of transportation improvement that will be implemented.

* No stressors with the potential to affect the covered species and/or alter their environment have been identified during the preliminary design and environmental component of the Action. We have determined that this component will have no effect on the covered species.

### 2.2.3 Activity Component 3: Detailed Design (Phase II) / ROW and Utilities

After establishing the preliminary alignment and grade of the proposed project, a more detailed level of design is undertaken. Line and grade are adjusted to better meet conditions, and drainage structures are designed. As plans are defined in greater detail, right-of-way acquisition and utility relocations are examined. Right-of-way activities include determining the land acquisition needs for the project, conducting negotiations with property owners, and acquisition of land. Existing utilities are analyzed to determine if relocation is necessary for the project. Geotechnical investigations may also be conducted during this component.

During this component, there are very few activities that could potentially impact the covered species. Geotechnical investigations may require removal of forested habitat to access drilling areas and conduct drilling operations. This type of activity is typically minimized to prevent excessive habitat disturbance, primarily because KYTC often does not yet own or have an easement on the area where the activity is undertaken. Forested habitats may also be removed during ROW and utility activities in association with the Detailed Design Component, although this occurs infrequently due to added mobilization and project costs.

* Geotechnical investigations and ROW / utility work activities could result in the following stressors that may affect the covered species: noise and vibration and tree removal. These effects on the covered species would be similar to those discussed in the following Construction Component and will be considered in conjunction with construction activities within the Effects of the Action Section of this BA.

### 2.2.4 Activity Component 4: Construction

This activity component includes four primary sub-activities: 1) Site Preparation; 2) Bridge and Culvert Construction; 3) Roadway Construction; and 4) Post Construction.

Site Preparation

Site preparation may require removal of forested habitat to access the project site, and prepare the area for construction. KYTC anticipates the removal of approximately 800-1000 acres of forested habitat annually with projects considered in this BA. This activity also includes implementation of Best Management Practices (BMPs) to avoid and minimize impacts to streams and other water bodies that may provide foraging habitat for bats.

Bridge and Culvert Construction

Bridge and culvert construction range from minor rehabilitation activities of existing structures to full structure replacement to construction of new structures at new locations. These activities are intended to extend the useful life of an existing structure or provide a new structure to maintain safe vehicular crossings. Bridge rehabilitation activities include maintenance and repair of existing structures and do not usually alter the existing form of the structure. The majority of bridge rehabilitation activities are limited to the repair or replacement of specific parts of the bridge deck, superstructure, or substructure and do not require complete replacement of major bridge components. Deck maintenance and repair are standard activities that typically occur on the top of the bridge deck. These activities include spall repair; crack sealing; barrier wall/railing repair; drain/scupper repair, and header/expansion joint repair. Repair of spalling and cracking on the bridge deck and barrier wall/railing require the removal of loose material with jackhammers, concrete saws, milling or grinding equipment, or hydro-demolition equipment to expose sound material. Debris is collected using vacuum equipment, and the void is filled with the appropriate surfacing material (concrete or asphalt). Small surficial cracks can be repaired by sealing with epoxy or other suitable material to prevent water intrusion. Deck drains, scuppers, and other drainage structures that direct water away from the deck are typically maintained using hand tools, power washers, or compressed air to remove clogs. If severely deteriorated, pipes are cut using a cutting torch or other suitable tool, and a new section of pipe is added with a flexible coupler. Header and/or expansion joints allow expansion and contraction of the deck and are typically closed to prevent water intrusion. Closed joints typically consist of a concrete header with steel plates on the surface, with flexible material in the joint between the steel plates or under the plates. The sealing material in the joint can become dislodged, torn, or punctured and must be removed and replaced to reseal the joint. The steel plates of the expansion joints can become damaged by heavy vehicles or snow plows, and the concrete headers can be damaged or deteriorate. Depending on the severity of the damage and deterioration, a portion of the header or steel can be removed using a cutting torch or concrete saw.

Maintenance and repair activities on bridge superstructures and substructures include: spall and crack repair of girders/beams, caps-columns, end walls, and abutments; drilling/bolting of additional support members to metal beams; footer/piling repair; bearing replacement; metal repainting; scour repair around piers and abutments; and temporary work structures. Similar to maintenance of concrete on the bridge deck, spall and crack repair requires the removal of loose and unsound material; however, smaller, hand equipment such as hammer drills and hammer/chisel are used on the superstructure and substructure to avoid compromising these structures. Debris is collected using vacuum equipment or other methods, and the void or crack is filled with the appropriate surfacing material. Small surficial cracks may be repaired by sealing with epoxy or other suitable material. Maintenance and repair of metal components may require bolting or welding of additional plates to the existing structure. These activities require hand tools to clean and install the new support material. Replacement of bridge bearings requires the temporary use of hydraulic jacks to eliminate loads and provide support until new bearings are installed. Painting of metal structure components may be performed as a separate activity or in conjunction with other repair activities. Prior to painting, the surface is cleaned to remove loose material, and paint is applied using air compressors. Overspray is controlled through the use of temporary barriers or drapes. Scour repair involves the placement of rip rap or other channel protection around existing piers and abutments to replace lost material around the bases of these structures and prevent future scouring. Temporary coffer dams may be placed around piers and abutments to isolate these areas during repairs, create a safe, dry workspace, and prevent material from entering the stream.

Methods used to access the superstructure and substructure during rehabilitation activities include ladders, scaffolding, and truck mounted booms. Temporary structures, such as work pads or crossings, may be required to access longer bridges that span streams. Work pads are typically constructed of large rock placed within the stream channel to create a safe work platform for equipment. Temporary crossings are installed across streams when traffic must be restricted from the bridge during construction and a detour is not available or feasible. Crossings generally consist of large pipes laid in the stream channel parallel to flow and covered with rock. The size and placement of the pipes is determined by the stream hydrology.

Bridge replacement activities include replacement of major bridge components and full replacement of the entire structure. These activities require high intensity construction activities using heavy equipment and result in significant impacts to the existing structure, as well as potential changes to structure form. Activities include removal and replacement of the deck, support beams/girders, piers, and abutments. Temporary work structures, including coffer dams, work pads, and crossings, may also be required for replacement activities.

Culvert rehabilitation and replacement activities are similar to those associated with bridge activities; however, culvert activities are typically smaller in scale and more limited in scope. Rehabilitation activities generally include spall and crack repair on concrete surfaces and patching of metal surfaces through bolting/welding of additional plates. Culvert replacement involves the removal of the existing structure and installation of a new structure at the same location with similar materials. New structures may be completely or partially pre-fabricated off site or constructed on site, and heavy equipment is typically required during installation.

Roadway Construction

Roadway construction ranges from spot improvements, widening, and reconstruction of existing roadways within existing or new alignments to the construction of new roadways with completely new alignments. Activities associated with roadway construction may include demolition and removal of existing facilities, clearing, grubbing, excavation, blasting, grading, and reconstruction/construction of the roadway and associated structures. These activities typically require the use of heavy equipment, with activity intensity varying based on project type.

Post Construction

Following bridge, culvert, and/or roadway construction, the sites are stabilized and restored using a variety of techniques. Exposed areas are typically mulched and seeded and/or planted with shrubs or trees. Temporary access material is removed and areas are restored to a more natural grade and stabilized. This activity also includes implementation of permanent BMPs to avoid and minimize impacts to streams and other water bodies.

* Construction activities have the ability to alter or remove suitable habitat for the covered species. We expect the construction component of the Action to generate the following stressors that may affect the covered species: noise and vibration, night lighting, aquatic resource loss and degradation, tree removal, collision, alteration or loss of roosting habitat (bridges). These stressors are discussed in detail within the Effects of the Action Section of this BA.

### 2.2.5 Activity Component 5: Maintenance

In order to maintain safe roadways and ease congestion, KYTC performs maintenance activities on roads and bridges year-round. The maintenance work is similar to the construction component but on a much smaller scale and scope. The majority of the maintenance work performed has no direct or indirect impact on the covered species. Some of these activities include installing/replacing guardrail and signage, striping, asphalt repair/patching, mowing of herbaceous growth within existing ROW, roadside ditch maintenance, removing debris from bridge piers, and repair existing lighting. Maintenance activities are anticipated to occur during daylight hours and will not require the use of lighting. Occasionally the maintenance work activities can have potential minor impacts to the covered species and those activities include; slide repair, tree-trimming and clearing within existing ROW, herbicide application, and bridge/culvert maintenance. All of these activities are necessary to extend the life of existing infrastructure. Also, due to controlled costs and the limits of KYTC maintenance crews (man-power, equipment availability and expertise) the projects remain minor in both scope and potential impacts to the covered species.

* Maintenance activities have the ability to alter or remove suitable habitat for the covered species. We expect the maintenance component of the Action to generate the following stressors that may affect the covered species: noise and vibration, aquatic resource loss and degradation, tree removal, alteration or loss of roosting habitat (bridges). These stressors are discussed in detail within the Effects of the Action Section of this BA.

### 2.2.6 Activity Component 6: Operation

After a project is completed, the roadway/bridge is expected to continue in operation indefinitely. Operation activities include vehicle traffic and roadway illumination. These activities vary depending on road size, location, time of day/year, and have the potential to affect the covered species directly or indirectly.

* We expect the operation component of the Action to generate the following stressors that may affect the covered species: noise and vibration, night lighting, aquatic resource loss and degradation, and collision. These stressors are discussed in detail within the Effects of the Action Section of this BA.

### 2.2.7 Activity Component 7: Other/Emergency Actions

KYTC occasionally has emergency actions that require immediate attention and repair. These include, but are not limited to, bridge collapse or damage, rock fall or slides that endanger a roadway, and other potentially hazardous situations. These activities often occur in concert with a declared state of emergency (usually after severe weather, ice storm, tornado, or heavy snowfall) and have the potential to have adverse effects on the covered species depending on project specific scenarios.

* We expect that activities associated with the emergency action component of the Action to generate the same stressors as those previously discussed in the Construction Component. Emergency actions will be considered in conjunction with construction activities within the Effects of the Action Section of this BA.

## 2.3 Action Area

For the purposes of this programmatic consultation, KYTC has defined the Action Area to be the entire state of Kentucky. We have defined the Action Area as the entire state in order to consider all areas affected directly or indirectly by a project that could occur anywhere in the state.

## 2.4 Project Review Process

KYTC proposes to use a tiered programmatic approach to the project review process. This project review process will be used to determine if suitable habitat for any of the covered species is present within the affected area of a proposed project. The first tier involves the use of a Habitat Assessment Manual (HAM) developed by KYTC in 2006, and revised in 2018 (See Appendix A). If habitat is determined not to be present for any of the covered species (as determined by the process contained within the HAM) then the project will have "no effect" on that particular species. Conversely, if habitat is present for one or more of the covered species, then the project will be evaluated as part of the second tier of the programmatic approach. The second tier involves the analysis of potential impacts (i.e., stressors) of proposed projects on the covered species and its habitats to determine if the project is likely to adversely affect the covered species. See Appendix B for an outline of the two-tiered methodology, and discussion of the programmatic project review process

## 2.5 Proposed Conservation Measures

As part of the proposed Action, KYTC will implement the specific conservation measures discussed below for projects that have the potential to effect the covered species. We believe that these conservation measures would avoid, minimize, and/or compensate for project effects on the covered species.

### 2.5.1 Indiana Bat

*Avoidance and Minimization Measures*

1. The KYTC will utilize best management practices (BMP) and sediment and erosion control measures to prevent non-point source pollution, control storm water runoff, and minimize sediment damage in order to avoid and reduce overall water quality degradation. Implementation would avoid and minimize direct and indirect effects on clean drinking water and aquatic insects that could be used as prey items by Indiana bats. The BMPs proposed can be found in Appendix C.
2. The KYTC will restrict forested habitat removal during the time frame when non-volant Indiana bat pups could be present (June 1-July 31), minimizing the risk of potential direct effects on non-volant Indiana bats. If forested habitat removal during this timeframe is unavoidable, KYTC will consult with the KFO on a project specific basis in order to determine if use of the programmatic process is acceptable.
3. The KYTC will utilize the project review process discussed in section 2.4 in order to determine potential project impacts on the Indiana bat. Should a project require the types of impacts identified below, KYTC will contact the KFO and request a project-specific consultation to consider those types of effects on the species and/or its habitat.
	1. Projects that identify caves, mine adits, rock shelters, and/or karst features that are suitable as either winter habitat and/or summer roosting habitat for the covered species within a half mile of the project area.
	2. Project effects on a bridge structure that is known or has been identified as reasonably likely to support a maternity colony of Indiana bats.
	3. Project impacts on a known Indiana bat maternity roost tree.
	4. Project impacts within 1/2-mile of a known Indiana bat hibernacula (i.e., spring staging area).
	5. Project impacts on more than 250 acres of suitable, forested habitat per project.

*Compensation Measure*

1. In order to offset unavoidable adverse effects on Indiana bats and their summer roosting and fall swarming habitat(s), KYTC will contribute to the Imperiled Bat Conservation Fund (IBCF). The funds in the IBCF are used to permanently protect Indiana bat habitat in Kentucky for the conservation and recovery of the species. This mitigation measure would have a beneficial effect on the Indiana bat by ensuring that the species has suitable habitat available throughout their lifecycle. The contribution to the IBCF is expected to promote the survival and recovery of the species through protecting and managing existing forested habitat suitable to support the species, particularly those that would expand existing conservation ownerships.

KYTC proposes that contributions to the IBCF will be determined and computed on a project-by-project basis and will be based on the following formula: (acreage of impact) X (median land cost) X (mitigation multiplier) = amount of contribution.

The acreage of impact (Acreage) will be the number of acres of Indiana bat habitat that a proposed project will directly or indirectly impact (remove). For impacts to: a) continuous, unbroken habitat areas, the Acreagewill be the number of acres to the nearest hundredth acre; b) areas containing widely spaced or less than 20 trees, the Acreagewill be the number of trees that have been determined to exhibit those characteristics suitable for Indiana bat summer habitat (any tree over 5" diameter at breast height) present within the impacted area multiplied by 0.09 (the area occupied by a tree with a 35-foot crown radius); and c) projects containing both continuous, unbroken habitat and widely spaced, fragmented or less than 20 tree, Acreage will be determined using a combination of both calculation methods described above.

Through an on-going assessment of bridges within the Commonwealth of Kentucky, KYTC has reviewed 260 structures throughout the state. The assessed bridges have spanned a variety of sizes and bridge types, including bridges from 21 to 727 feet long and bridge types such as channel beam, box beam, pre-stressed concrete beam, metal beams, box culverts, and numerous others. The majority (92%) of these structures were identified as either unsuitable for bats or no bats or signs of bat use were observed. The remaining bridges (8%) had bats actively roosting on the structure or signs of bat use were observed. To determine the amount of potential roosting habitat for bats on each bridge, the bridge length and width were multiplied to calculate an acreage for each structure. Structures with documented bat use are generally larger than the average bridge, with a median size of 0.10 acre for bridges with bat use compared to 0.02 acre for all the bridges assessed to date. Based on this data, KYTC proposes to use 0.10 acre per bridge to calculate the amount of suitable bat habitat loss for projects involving bridge~~s~~ impacts.

The median land cost will be the most recently published median agricultural land cost on a per acre basis. This cost is intended to provide an index of the estimated replacement cost of Indiana bat habitat in Kentucky. This number will be updated each time the United States Department of Agriculture publishes a new cost (typically the beginning of August).

The mitigation multiplierfactor is derived from the habitat type that will be impacted and season the project impacts occur. The Indiana bat habitat map (attached as Appendix D) displays the habitat types that are based on the known records of Indiana bat captures and hibernacula locations. Table 1 shows each mitigation multiplier, based on habitat type, and the seasonal dates of each habitat type depicting when that habitat is expected to be active or inactive by Indiana bats.

Table 1. Proposed Indiana Bat Mitigation Multiplier Matrix

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Habitat Type | Active Season (\*\*) | Active Dates | Inactive Season | Inactive Dates |
| Known Swarming | 2.25 (2.75) | April 1 to Nov 14 | 1.75 | Nov 15 – March 31 |
| Known Summer | 1.75 (2.25) | April 1 to Oct 14 | 1.25 | Oct 15 – March 31 |
| Unsurveyed | 1.0 (1.5) | April 1 to Oct 14 | 0.5 | Oct 15 – March 31 |

\*\* Ratio for tree removal in June and July. Use requires KYTC coordination with the KFO for project specific evaluation.

NOTE: For the purposes of the mitigation multiplier, swarming active season dates also consider the active dates of known summer and unsurveyed habitat types because Indiana bats likely use known swarming areas during these active timeframes of their life cycle as well.

1. If it is determined that a different mitigation opportunity (i.e., range-wide ILF program, species mitigation bank, in-kind mitigation, etc.) is available and/or more appropriate, KYTC will coordinate with the KFO to ensure project impacts are accounted for sufficiently.

### 2.5.2 Gray Bat

*Avoidance and Minimization Measures*

1. Potential impacts to gray bat foraging and aquatic resources will be minimized by limiting tree clearing along streams to the extent possible, avoiding and minimizing impacts to streams during construction, and implementation of BMPs as seen in Appendix C.
2. The KYTC will utilize the project review process discussed in section 2.4 in order to determine potential project impacts on the Indiana bat. Should a project require the types of impacts identified below, KYTC will contact the KFO and request a project-specific consultation to consider those types of effects on the species and/or its habitat.
	1. Projects that identify caves, mine adits, rock shelters, and/or karst features that are suitable as either winter habitat and/or summer roosting habitat for the covered species within a half mile of the project area.
	2. Project effects on a bridge structure that is known or has been identified as reasonably likely to support a maternity and/or bachelor colony of gray bats.

*Compensation Measure*

1. In order to offset unavoidable adverse effects on gray bats utilizing bridges as roosting habitat, KYTC is committed to funding the protection of a known gray bat maternity site and surrounding habitat. This conservation measure would have a beneficial effect on the gray bat by ensuring that the species has suitable habitat available for roosting and rearing of pups during the summer period of their lifecycle. Funding this conservation measure is expected to promote the survival and recovery of the species through protecting and managing existing year round roosting habitat suitable to support the species, particularly one that would expand conservation ownerships.

## 2.6 Summary

KYTC has identified Detailed Design Component (Phase II) (geotechnical work, ROW, and utilities), Construction Component, Maintenance Component, Operation Component, and Other/Emergency Actions Component as activity components having the ability to impact the covered species. Potential adverse effects of the Detailed Design Component (Phase II) (geotechnical work, ROW, and utilities) and Other/Emergency Actions Component would be similar to those discussed in the Construction Component Section (section 2.2.4), and we have considered these effects in conjunction with construction activities within the Effects of the Action Section of this BA. These activity components (Construction, Maintenance, and Operation) may take up to 6 years to complete, depending on the complexity of any individual project. Further, these activity components have the ability to affect the covered species or alter their environment (i.e., a stressor on the species). Effects on the covered species may occur through direct impacts to the species or changes to the species’ baseline habitat conditions (noise, lighting, water quality, and forested habitat, etc.) within the Action Area. Based on our evaluation of the aforementioned activity components, KYTC has determined that the programmatic action will result in the following stressors as seen in Table 2; these stressors and their effects on the covered species are discussed in the following Effects of the Action Section.

**Table 2.** **Stressors by Activity Component**

|  |  |
| --- | --- |
|  | **Activity Component** |
| **Stressors** | Construction | Maintenance | Operation |
| Noise and Vibration | X | X | X |
| Night Lighting | X |  | X |
| Aquatic Resource Loss and Degradation | X | X | X |
| Tree Removal | X | X |  |
| Collision | X |  | X |
| Alteration or Loss of Roosting Habitat (Bridges) | X | X |  |

# 3.0 Status of the Species

## 3.1 Indiana Bat

The Indiana bat was originally listed as an endangered species on March 11, 1967 under the Endangered Species Preservation Act of 1966 (USFWS 1967) and is currently listed as endangered under the ESA. The range of the Indiana bat includes most of the eastern United States (USFWS 2007). Winter records for the Indiana bat are known from 19 states; however, over 90 percent of the estimated population hibernates in just five states, including Indiana, Missouri, Kentucky, Illinois, and New York (USFWS 2007, USFWS IFO 2017). Summer occurrences of this species are scattered throughout the range, with known maternity colonies in 16 states. The majority of these maternity colonies have been found in the upper Midwest, including southern Iowa, northern Missouri, Illinois, Indiana, southern Michigan, western Ohio, and Kentucky (USFWS 2007). Critical habitat was designated for the species on September 24, 1976 and includes 11 caves and three mines in six states (USFWS 1976a).

In Kentucky, the Indiana bat may occur statewide (USFWS ECOS 2017a). The majority of occurrence records are associated with maternity colonies scattered throughout central and eastern Kentucky and along the Ohio River in the western part of the state. Hibernacula are concentrated in the karst areas of the state. Indiana bats have been documented in over 100 caves in Kentucky, and extant winter populations are currently known in 96 of these caves. Several Priority 1 hibernacula are located in Kentucky, including three caves (Coach, Dixon, and Long Caves) in the Mammoth Cave system in the south-central portion of the state, Bat Cave in the northeast, and Line Fork Cave in the southeast (USFWS KFO 2016). Bat and Coach Caves are designated as critical habitat for the Indiana bat (USFWS 1976a).

The Indiana bat uses different habitats during the winter and summer months. During the winter months, Indiana bats are restricted to suitable underground hibernacula typically consisting of caves located in karst areas of the east-central United States; however, this species also hibernates in cave-like locations, including abandoned mines (USFWS 2007). Hibernacula tend to be voluminous, with large passages and extensive, vertical structures, often below the lowest entrance (Tuttle and Stevenson 1978, Tuttle and Kennedy 2002, USFWS KFO 2016). This species generally prefers caves and mines where the ambient temperature is relatively stable and remains below 10° C (50.0° F), with a preferred range between 4° C and 8° C (Humphrey 1978, Tuttle and Kennedy 2002, USFWS KFO 2016). Humidity levels above 74 percent but below saturation are also preferred. It is generally accepted that Indiana bats are philopatric and typically return to the same hibernaculum each year (LaVal and LaVal 1980). Colonization of new hibernacula has been documented, particularly in abandoned mines (Hicks and Novak 2002, Kath 2002), indicating that this species has some capacity to exploit unoccupied habitats and expand their winter distribution.

During the spring, summer, and fall, the Indiana bat uses a variety of forested habitats used for roosting, foraging, and commuting. These habitats include forest blocks and woodlots, as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Isolated trees may provide suitable roosting habitat if they exhibit the characteristics of a suitable roost tree and are located within 1,000 feet of other suitable habitat. Suitable roosting habitat consists of live or dead trees and snags with a diameter at breast height (dbh) of five inches or greater that possess any or all of the following characteristics: exfoliating bark; cavities, crevices, or cracks; or dead or dying trunk/branches. Roost trees are typically located within canopy gaps, along a fencerow, or along a wooded edge. Maternity colonies are typically found in dead or dying trees with larger dbhs (at least nine inches) that receive direct sunlight for more than half the day (USFWS KFO 2016). Maternity roosts have been documented in riparian zones, bottomland and floodplain habitats, wooded wetlands, and upland communities (USFWS 2007). Foraging habitat for the Indiana bat includes closed to semi-open forested habitats, where bats forage along forest edges and above the tree canopy (Humphrey et al. 1977, LaVal et al. 1977, Brack 1983). Commuting habitat includes forested blocks and corridors that connect roosting and foraging areas.

Indiana bats have also been documented using bridges and culverts as day and night-roosting habitat during the spring, summer, and fall. Concrete structures seem to be preferred due to their tendency to retain heat longer than other materials; however, metal and wood structures may also be used with less frequency. Bridges used as day roosts are typically constructed of concrete and contain vertical crevices, expansion joints, or other locations that allow bats to retreat into the bridge deck or superstructure (Keeley and Tuttle 1999, Feldhamer et al. 2003, Cleveland and Jackson 2013). Bridges with a concrete deck and concrete or metal girders have also been documented as day roosts for this species, and maternity and bachelor colonies have been found in each of these bridge types (Cervone et al. 2016, King 2017, Roby 2018, S. Burke, West Virginia Division of Highways, pers. comm.). Concrete girder bridge types also seem to be preferred as night roosts due to their ability to retain heat into the night, trap rising heat from under the bridge in the chambers between girders, and provide protection from wind, weather, and predators. (Keeley and Tuttle 1999, Kiser et al. 2002). Night-roosting bats are typically found on the vertical surface of the girder at the intersection with the underside of the deck, and areas near the abutments and over land seem to be preferred more than the central portion of the bridge and areas spanning water. Bridges that lack crevices/expansion joints or girders are rarely used as day or night roosts (Adam and Hayes 2000, Feldhamer et al. 2003, Ormsbee et al. 2007); however, structures with cave-like areas or other unique features that provide suitable roosting locations can also provide suitable roosting habitat.

Culverts utilized by Indiana bats are typically greater than five feet in height and may be constructed of concrete or metal (Cervone 2014). These structures are generally 50 feet or longer and provide dark zones, protection from high winds, and are not susceptible to frequent flooding. Preferred roosting locations include dark areas with crevices and structural imperfections. Culverts less than five feet high are not generally used as roosting habitat (Keeley and Tuttle 1999).

## 3.2 Gray Bat

On April 28, 1976, the gray bat was listed as endangered under the ESA (USFWS 1976b). This species is primarily found in the cave regions of Alabama, Arkansas, Kentucky, Missouri, and Tennessee, with smaller populations known from Florida, Georgia, Illinois, Indiana, Kansas, Mississippi, North Carolina, Oklahoma, Virginia, and West Virginia (USFWS 2009). In Kentucky, the gray bat is considered to occur statewide, with higher concentrations in the western and central portions of the state and fewer occurrences in eastern counties (USFWS ECOS 2017b). The largest concentrations of gray bats are found in and around Mammoth Cave National Park in Edmonson County, located in south-central Kentucky (USFWS 2009). No critical habitat has been designated or is currently proposed for this species.

The gray bat typically roosts in caves year-round and is often found in large numbers, with colonies in excess of one million individuals reported (Brady et al. 1982). Habitat requirements for roosts are highly specific, with fewer than five percent of caves representing suitable habitat (Tuttle 1979). The gray bat utilizes varying types of caves during different times of the year, including caves with deep vertical shafts that provide a cold air trap during winter (hibernacula) and caves with domed ceilings that trap warm air during summer. Hibernacula typically have multiple entrances, good air flow (Martin 2007), and temperatures between 1° and 9° Celsius (C), although 1° to 4° C seems to be preferred (Tuttle and Kennedy 2005). Approximately 95 percent of the total species population hibernates in only nine caves. Maternity colonies are typically found in caves with temperatures between 14° and 25° C that are located within one to four kilometers of a stream or water body (Tuttle 1976, Tuttle and Kennedy 2005, Martin 2007). Other caves, known as dispersal caves, are used as roosting sites during migration from maternity caves to hibernacula.

Gray bats are also known to use bridges and culverts as roosting habitat during the spring, summer, and fall. Concrete structures seem to be preferred due to their tendency to retain heat longer than other materials; however, metal and wood structures may also be used with less frequency. Gray bats have been observed using bridges and culverts as both day and night roosts. Bridges used as day roosts are typically constructed of concrete and contain vertical crevices, expansion joints, or other locations that allow bats to retreat into the bridge deck or superstructure (Keeley and Tuttle 1999, Feldhamer et al. 2003, Cleveland and Jackson 2013). Bridges with a concrete deck and concrete or metal girders seem to be preferred as night roosts (Keeley and Tuttle 1999, Kiser et al. 2002). This bridge type retains heat into the night, and the chambers between the girders trap heat rising from under the bridge and provide protection from wind, weather, and predators. Night-roosting bats are typically found on the vertical surface of the girder at the intersection with the underside of the deck, often near the bridge abutments. Areas over land seem to be preferred more than the central portion of the bridge and areas spanning water. Bridges that lack crevices/expansion joints or girders are rarely used as day or night roosts (Adam and Hayes 2000, Feldhamer et al. 2003, Ormsbee et al. 2007); however, structures with cave-like areas or other unique features that provide suitable roosting locations can also provide suitable roosting habitat.

Culverts utilized by gray bats are typically concrete box culverts between five and 10 feet in height; however, this species may also use metal culverts with similar dimensions. These structures are generally 50 feet or longer and provide dark zones, protection from high winds, and are not susceptible to frequent flooding. Roosting locations preferred by gray bats include dark areas with crevices and structural imperfections. Culverts less than five feet high are not generally used as roosting habitat (Keeley and Tuttle 1999, USFWS 2009).

Gray bats usually forage in riparian areas or over open water bodies such as rivers, streams, lakes, or reservoirs. While foraging, the gray bat consumes a variety of insects, most of which are aquatic-based (Brack and LaVal 2006). Studies in Indiana, Kentucky, Alabama, and Missouri have revealed that Tricoptera, Lepidoptera, Coleoptera, and Diptera are most frequently consumed, with a total of 14 insect orders documented as prey for this species (Brack et al. 1984, Whitaker et al. 2001, Brack and LaVal 2006). Commuting habitat for the gray bat primarily consists of wooded corridors used to travel between roosting and foraging habitat. Gray bats of all ages, including newly volant young, typically travel in the tree canopy while commuting, which may provide protection from predators (Brady et al. 1982).

# 4.0 Effects of the Action

This section analyzes the direct and indirect effects of the Action on the Indiana bat and gray bat. This analysis includes the direct and indirect effects of interrelated and interdependent actions. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Transportation project development / operation, and its’ sub-activities, are interrelated and/or interdependent actions to the Action, which is FHWA’s funding or authorization of transportation projects implemented by KYTC. These actions are more fully described in the Proposed Programmatic Action section. FHWA and KYTC are not aware of any additional relevant project specific interrelated or interdependent actions. KYTC understands its obligations under the ESA and maintains that any analysis of interrelated or interdependent effect on the covered species will occur on a project specific basis and be coordinated with the Service’s KFO.

For purposes of consultation under the ESA, cumulative effects are the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed Action are not considered, because they require separate consultation under the ESA. This BA evaluates the proposed Action at the programmatic level, and it is not reasonable to identify potential cumulative effects at the project specific level. Many of KYTC’s projects will have no cumulative effects, as defined by the ESA, but some may. KYTC will address cumulative effects on a project-by-project basis in coordination with the Service’s KFO to ensure all potential effects to the covered species are addressed for each proposed project.

Based on the description of the Action and the species’ biology, KYTC has identified six stressor(s) to the covered species (i.e., the alteration of the environment that is relevant to the species) that may result from the Action. These stressor(s) are noise and vibration, night lighting, aquatic resource loss and degradation, tree removal, collision, and alteration or loss of roosting habitat (bridges). Below, we discuss the best available science relevant to each stressor. Then, we describe the Stressor-Exposure-Response pathways that identify the circumstances for an individual bat’s exposure to the stressor (i.e., the overlap in time and space between the stressor and the species). Finally, we identify and consider how proposed conservation measures may reduce the severity of the stressor or the probability of an individual bat’s exposure for each pathway.

## 4.1 Indiana bat

This BA does not address project impacts to designated critical habitat, maternity and/or bachelor colonies occupying a bridge, or caves, mine adits, rock shelters, and/or karst features that are suitable as either winter habitat and/or summer roosting habitat for the Indiana bat. Therefore, we have focused our analysis on impacts to known and potential summer roosting (tree and bridges), foraging, and commuting habitat(s) in and near streams and construction footprints, which is the environment that is relevant to the species and this consultation.

### 4.1.1 Stressor 1: Noise and Vibration

Noise and vibration are stressors that may disrupt bats by causing individuals to flush from bridges being used as a roost or roost trees during the day and/or night timeframes, and/or alter travel corridors and foraging behaviors. Bats may be exposed to this stressor during the construction, maintenance, and operation components of the Action. Significant changes in noise levels in an area could result in temporary to permanent alteration of bat behaviors. The novelty of these noises and their relative volume levels will likely dictate the range of responses from individuals or colonies of bats.

During the construction component of the Action, the felling of trees and operation of heavy equipment and tools will produce noise and vibrations. This could occur during any time of the year. During most of construction activities, the project area would be absent of trees and natural vegetation and will no longer provide habitat for the Indiana bat. Construction blasting may be conducted in areas that have previously been cleared of trees. Therefore, we expect that the exposure of Indiana bats to blasting would be reduced but not necessarily eliminated. This is because the distance between the blasting location and any remaining roost sites would increase after the initial tree removal occurs, but nearby forested areas would remain intact and would be occupied by Indiana bats.

Bats that currently use a project site would be exposed to noise and vibration from adjacent, facilities, interstate and major highways, and other urban, rural, and/or commercial land uses; therefore, we would expect them to be habituated to noise and vibration to some extent. During the operation component, noise and vibration will be limited to those effects caused by normal vehicular traffic.

Noise and vibration during the maintenance component are anticipated to be typically at or below levels caused by normal traffic. However, some maintenance activities may involve tree removal or bridge rehabilitation by use of heavy equipment and effects may be similar to those discussed above for construction activities. Bridge and roadway maintenance is expected to occur during daylight hours and will not disrupt foraging or commuting by bats.

*Applicable Science*

Bats exposed to noise and vibration may flush from their roost trees or bridges. Bats that flush during the daytime are at greater risk of harm due to predation (Mikula et al. 2016). Additionally, bats that flush their roost and/or avoid travel and foraging areas in response to this stressor may be harmed due to an increase in energy expenditure. Increased energy demands could have a significant effect on bats due to their low body mass. Because females require increased energy reserves during lactation (Kurta et al. 1989), an increased demand for energy in response to noise and vibrations could be especially detrimental to lactating females and, subsequently, their pups.

Studies have found that Indiana bats can tolerate some level of noise and vibration. For example, several construction projects, prior to documentation of white-nose syndrome, have occurred on Fort Drum adjacent to multiple known Indiana bat roosts (U.S. Army Garrison Fort Drum 2011). Construction around these project sites has been ongoing for multiple years during the active season. The last known capture and roosting locations of Indiana bats near these projects have been within approximately 800 and 400 meters (0.5 and 0.25 mi) of the construction activities, respectively. Further, military installations generally have large amounts of noise and disturbance, but Indiana bats have continued to occupy Fort Knox suggesting that noise from machinery may disturb colonies of roosting bats, but such disturbances would have to be severe to cause roost abandonment (Hawkins et al. 2008). Gardner et al. (1991) had evidence that Indiana bats continued to roost and forage in an area with active timber harvest. This suggested that noise and exhaust emissions from machinery could possibly disturb colonies of roosting bats, but such disturbances would have to be severe to cause roost abandonment. Callahan (1993) noted the likely cause of the bats in his study area abandoning a primary roost tree was disturbance from a bulldozer clearing brush adjacent to the tree. In another study near 1-70 and the Indianapolis Airport, a primary maternity roost was located 1,970 ft. (0.6 km) south of 1-70 (3D/International, Inc. 1996). This primary maternity roost was not abandoned despite constant noise from the Interstate and airport runways. However, the roost's proximity to 1-70 may be related to a general lack of suitable roosting habitat in the vicinity, and due to the fact that the noise levels from the airport were not novel to the bats (i.e., the bats had apparently habituated to the noise) (USFWS 2002). Noise and vibration could cause an Indiana bat to flush from its roost, expending extra energy and making it more vulnerable to predation (Mikula et al. 2016). Novel noises would be expected to result in some changes to bat behaviors, but research suggests that bats can become habituated to this stressor.

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| **Effects Pathway – Indiana Bat #1** |
| **Activity:** Construction and Maintenance |
| **Stressor:** Noise and Vibration |
| *Exposure (time)* | April 1 – November 14 (active timeframe); duration of activity  |
| *Exposure (space)* | Roosting habitat throughout Action Area |
| *Resource affected* | Individuals (adults and juveniles) |
| *Individual response*  | * Flushing from bridge roost or roost trees results in extra energy expenditure that can reduce fitness, and result in reduced survival / reproductive success.
* Flushing from bridge roost, or roost trees will increase chances of predation.
* Avoidance of the stressor can require extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
 |
| *Conservation Measures* | Avoidance of project effects on:* A bridge structure that is known or has been identified as reasonably likely to support a maternity colony.
* A known maternity roost tree.
* A known Indiana bat hibernacula within ½ mile of the project area
 |
| *Interpretation* | Bats may become startled by the noise and/or vibrations and flush from their roosts. Most of the activities causing this stressor will occur concurrently with habitat removal or after the habitat has been removed when the species would no longer be present in the construction limits. Indiana bats exposed to this stressor during habitat removal are likely to respond in a way that would lead to adverse effects. Indiana bats exposed to this stressor during the construction and maintenance phase after habitat removal would be exposed to low levels of this stressor and, because of their current proximity to other sources of noise and vibration, we expect them to be habituated and to respond minimally to the stressor. |
| *Effect* | Harm, direct and indirect |

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| **Effects Pathway – Indiana Bat #2** |
| **Activity:** Operation |
| **Stressor:** Noise and Vibration |
| *Exposure (time)* | April 1 – November 14 (active timeframe); indefinitely |
| *Exposure (space)* | Roosting and foraging habitat throughout Action Area |
| *Resource affected* | Individuals (adults, juveniles) |
| *Individual response*  | * Flushing from bridge roost or roost trees results in extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
* Flushing from bridge roost, or roost trees will increase chances of predation.
* Avoidance of the stressor can require extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
 |
| *Interpretation* | The activities causing this stressor during operation will occur after the habitat has been removed. Thus, Indiana bats exposed will be limited to those using habitat on the margins of a project site. The bats that remain within the area during the operation of a new roadway and/or bridge are already exposed to noise and vibration from adjacent facilities, interstate and major highways, and other urban, rural, and/or commercial land uses. We would expect them to be habituated to this. We do not expect the additional noise and vibration contributed by the proposed Action to significantly increase the stressor in the Action Area. We do not expect Indiana bats to respond to the additional noise and vibration during operation in a way that would be significant. |
| *Effect* | Insignificant |

### 4.1.2 Stressor 2: Night Lighting

Lighting may be required during the construction and operation of the Action. During construction, temporary lighting is likely to only occur within a small portion of Action Area at any one time. Lights may be used during early morning and evening hours during periods of fewer daylight hours (i.e., fall and winter) and may be visible immediately outside the disturbance limits. Construction lighting is anticipated to be downward facing and not directed horizontally where it would illuminate potential roosting, foraging or commuting habitat.

Permanent lighting during the operation component is expected to be the same prior to construction for existing roadways and bridges. Roadways and bridges with lighting before construction are expected to have lighting afterwards, and lighting is not anticipated to be added to facilities without previous lighting. Permanent lighting may be added to new roadways/bridges; however, lighting will occur in areas that were cleared of potential foraging and commuting habitat during construction and is typically limited to highly developed areas. Maintenance activities are anticipated to occur during daylight hours and will not require the use of lighting.

*Applicable Science*

Studies document highly variable responses among species to artificial lighting. Some bat species seem to benefit from artificial lighting, taking advantage of high densities of insects attracted to light (Jung and Kalko 2010); however, other species may avoid artificial light (Furlonger et al. 1987, Rydell 1992) or not be affected (Stone et al. 2012). Lighting can cause delays in night bat activity (Stone et al. 2009; Downs et al. 2003). Effects of artificial lighting on bat activity may vary with season and moon phase (Jung and Kalko 2010).

While there is limited information regarding Indiana bats’ response to increased light levels, slow-flying bats such as *Rhinolophus*, *Myotis*, and *Plecotus* species have echolocation and wing-morphology adapted for cluttered environments (Norberg and Rayner 1987) and emerge from roosts relatively late when light levels are low, probably to avoid predation by diurnal birds of prey (Jones and Rydell 1994). In Indiana, Indiana bats avoided foraging in urban areas, and Sparks et al. (2005) suggested that it may have been in part due to high light levels. Using captive bats, Alsheimer (2011) found that a closely related species, the little brown bat (*M. lucifugus*), was more active in the dark than light.

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| **Effects Pathway – Indiana Bat #3** |
| **Activity:** Construction |
| **Stressor:** Night Lighting |
| *Exposure (time)* | April 1 – November 14 (active timeframe); duration of activity |
| *Exposure (space)* | Roosting, foraging, and commuting habitat in and near construction limits |
| *Resource affected* | Summer and swarming habitat, used by individuals (adults, juveniles) |
| *Individual response*  | * Increased visibility to predators increases chances of predation.
* Avoidance of the stressor can require extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
 |
| *Interpretation* | Indiana bats roosting underneath or in the bridge deck are unlikely to be affected by lighting on top of the bridge deck. Lighting will not be directed down toward night roosting bats. Additionally, should the activity alter the bridge allowing night lighting to reach roosting habitat, it is unlikely that the bats are still using the bridge (impacts associated with the alteration or loss of roosting habitat (bridges) are addressed in Pathway # 16.Bats day roosting at the bridge may delay or avoid returning to the bridge at dawn. Lighting is unlikely to be used during this time, and bats that avoid the bridge likely have other available roosts in the immediate area. Lighting may cause bats to avoid using the bridge as a night roost; however, it is expected that bats can use alternate roosts in the area without significant additional energy expenditure. Indiana bats will likely avoid areas lit within roadway construction areas because they would be lit after they are cleared of forested roosting habitat. Foraging bats avoiding lighting can forage along other portions of a stream or nearby habitats. Commuting bats can use other travel routes to avoid lighting. Lighting is not expected to significantly affect the Indiana bat. |
| *Effect* | Insignificant |

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| **Effects Pathway – Indiana Bat #4** |
| **Activity:** Operation |
| **Stressor:** Night Lighting |
| *Exposure (time)* | April 1 – November 14 (active timeframe); indefinitely |
| *Exposure (space)* | Roosting, foraging, and commuting habitat throughout Action Area |
| *Resource affected* | Summer and swarming habitat, used by individuals (adults, juveniles) |
| *Individual response* | * Increased visibility to predators increases chances of predation.
* Avoidance of the stressor can require extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
 |
| *Interpretation* | Indiana bats that use the periphery of a lit roadway will likely be habituated to lighting already in the area and not significantly impacted by the additional lighting of the operation of the proposed project. |
| *Effect* | Insignificant |

### 4.1.3 Stressor 3: Aquatic Resource Loss and Degradation

Loss of aquatic resources may occur during the construction component of the Action. Some projects may require the filling of streams or ponds during realignment of existing facilities or the construction of new facilities. Stream realignment may also be required for some projects, resulting in loss of a portion of the existing stream channel. Loss of aquatic resources may also occur during culvert installation due to the replacement of the natural stream substrate with an artificial structure. Aquatic resource loss is not anticipated during the operation or maintenance components.

Aquatic resource degradation may occur during the construction, operation, and maintenance components of the Action. Water quality may be affected as a result of increased sedimentation due to ground disturbance and runoff during construction or through the introduction of environmental contaminants during construction, operation, and/or maintenance. Activities that reduce the quantity or alter the quality of aquatic resources could impact the Indiana bats, even if conducted while individuals are not present. The introduction of environmental contaminants to waterways also has the potential to negatively affect bats by exposing them to toxic substances.

Bridge rehabilitation and replacement projects have the greatest potential to degrade aquatic resources due to their proximity to streams. Potential degradation of streams from bridge rehabilitation during the construction component are expected to be minimal. The majority of rehabilitation activities will not require work within the stream, and impacts to water quality are expected to be absent or minimal. Rehabilitation activities that occur over or near the stream could result in debris, materials, equipment, or contaminants entering the stream. Temporary structures, such as crossings or work pads, may be required for some bridge rehabilitation and replacement activities to maintain traffic or access portions of the bridge that cannot be reached from land or the bridge deck. These structures will be placed in the stream channel and will cause temporary impacts to the substrate and aquatic habitat. Coffer dams may also be placed in streams to create a safe, dry work area around piers, footers, and abutments during structure repair and rehabilitation of scour areas. Temporary structures will be removed after rehabilitation is complete, and the stream will be restored to pre-construction conditions.

Degradation of streams could occur as a result of bridge replacement during the construction component. Removal and installation of piers, pilings, and abutments will require work within the stream channel and disturb the substrate, which could result in degradation of the stream though habitat alteration and sedimentation within and downstream of the bridge footprint. Temporary structures, including crossings, work pads, and coffer dams may also be required during bridge replacement.

Environmental contaminants used in conjunction with equipment during construction activities may also lead to degradation of aquatic resources. Hazardous materials used during construction may include: diesel fuel, gasoline, hydraulic fluids, oils, lubricants, solvents, adhesives, and battery chemicals. Spills and/or leakage of these materials into aquatic resources could affect water quality.

During operation, hazardous materials could enter aquatic resources from spills associated with traffic accidents or leaks from disabled vehicles. Activities associated with snow/ice and vegetation control include the application of chemicals directly to the road surface or adjacent right-of-way. De-icing agents and salt could be carried from the roadway to aquatic resources through surface runoff, leading to short-term effects to water quality. Herbicides may be applied along roadway rights-of-way and could enter aquatic resources through wind-induced drift or runoff.

*Applicable Science*

Indiana bats feed on aquatic and terrestrial insects. Numerous foraging habitat studies have found that Indiana bats often forage in closed to semi-open forested habitats and forest edges located in floodplains, riparian areas, lowlands, and uplands; old fields and agricultural fields are also used (USFWS 2007). Drinking water is essential, especially when bats actively forage. Indiana bats obtain water from streams, ponds and water-filled road ruts in forest uplands.

The Indiana bat’s diet varies seasonally and among different ages, sexes, and reproductive status (USFWS 1999). Four orders of insects contribute most: Coleoptera, Diptera, Lepidoptera, and Trichoptera (Belwood 1979, Brack 1983, Brack and LaVal 1985, Lee 1993, Kiser and Elliot 1996, Kurta and Whitaker 1998, Murray and Kurta 2002, Whitaker 2004). Various reports differ considerably in which of these orders is most important. Consistent use of moths, flies, beetles, and caddisflies throughout the year at various colonies suggests that Indiana bats are selective predators to a certain degree, but incorporation of other insects into the diet also indicates that these bats can be opportunistic (Murray and Kurta 2002). Brack and LaVal (1985) and Murray and Kurta (2002) suggested that the Indiana bat may best be described as a “selective opportunist.”

Filling streams in the construction limits will permanently reduce aquatic insect habitat, which will reduce the amount of prey available to Indiana bats. The Action may also impact streams downstream of the construction limits. Negative impacts of sedimentation on aquatic insect larvae is well-documented. In a literature review, Henley et. al (2000) summarized how stream sedimentation impacts these communities. Sediment suspended in the water column affects aquatic insect food sources by physically removing periphyton from substrate and reducing light available for primary production of phytoplankton. Sediment that settles out of the water column onto the substrate fills interstitial spaces occupied by certain aquatic insect larvae. Increases in sedimentation can change the composition of the insect community in a stream. In a three-year study measuring sedimentation and macroinvertebrate communities before, after, and during disturbance from a highway construction site, Hendrick (2008) found increased turbidity and total suspended solids downstream from the construction that correlated with a shift in macroinvertebrate communities. The change, however, was not great, and the Hilsenhoff Biotic Index used to evaluate the effects decreased from “excellent” before construction to “good” after construction. The use of BMPs likely minimized the effects of the construction on the macroinvertebrate communities.

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| **Effects Pathway – Indiana Bat #5** |
| **Activity:** Construction |
| **Stressor:** Aquatic Resource Loss |
| *Exposure (time)* | Indefinitely |
| *Exposure (space)* | Aquatic foraging habitat throughout the Action Area |
| *Resource affected* | Habitat, used by individuals (adults, juveniles) |
| *Individual response* | * Increased flight distances to access foraging resources requires extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
* Reduced foraging efficiency can reduce fitness and result in reduced survival / reproductive success.
 |
| *Interpretation* | Indiana bats are expected to use other streams within the same and/or adjacent watersheds |
| *Effect* | Insignificant |

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| **Effects Pathway – Indiana Bat #6** |
| **Activity:** Construction and Maintenance |
| **Stressor:** Aquatic Resource Degradation (**s**edimentation) |
| *Exposure (time)* | Active timeframe, temporary |
| *Exposure (space)* | Aquatic foraging habitat in and downstream of project site |
| *Resource affected* | Habitat, prey (aquatic insects), used by individuals (adults, juveniles) |
| *Individual response* | * Increased effort to access sufficient foraging resources requires extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
* Reduced foraging efficiency can reduce fitness and result in reduced survival / reproductive success.
 |
| *Conservation Measures* | Implementation of BMPs to limit impacts to streams and downstream aquatic resources |
| *Interpretation* | The effects of sedimentation on aquatic resources are expected to be minimal due to the temporary nature of the activity and implementation of the conservation measures. |
| *Effect* | Insignificant |

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| **Effects Pathway – Indiana Bat #7** |
| **Activity:** Construction,Operation, and Maintenance |
| **Stressor:** Aquatic Resource Degradation **(**pollutants) |
| *Exposure (time)* | Indefinitely |
| *Exposure (space)* | Aquatic foraging habitat in and downstream of the project site. |
| *Resource affected* | Habitat, prey (aquatic insects), used by individuals (adults, juveniles) |
| *Individual response* | * Increased effort to access sufficient foraging resources requires extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
* Reduced foraging efficiency can reduce fitness and result in reduced survival / reproductive success.
 |
| *Conservation Measures* | * Implementation of BMPs to limit impacts to streams and downstream aquatic resources.
* Ensure proper use of herbicides
* Limiting use of deicing agents to only the amount necessary.
 |
| *Interpretation* | Implementation of the conservation measures are expected to minimize and/or prevent contamination from pollutants.  |
| *Effect* | Insignificant |

### 4.1.4 Stressor 4: Tree Removal

The Action would result in the removal and loss of up to 800-1000 acres of forested Indiana bat habitat per year and no more than 250 acres of habitat per project. The majority of this removal of forested habitats would occur during construction; however, a small amount may occur during maintenance activities. Trees removed during the April – November timeframe may be occupied by Indiana bats when they are removed. We do not know which trees would be removed during the active timeframe or exactly which trees Indiana bats would be occupying. The resulting forested habitat loss would be permanent. The loss of this habitat may create a gap in forested habitat between larger blocks of forested habitat within the Action Area and potential foraging corridors.

KYTC has determined that this Stressor, Tree Removal, may result in the following sub-stressors:

* Removal of summer habitat, active timeframe
* Removal of summer habitat, inactive timeframe
* Loss and fragmentation of forested habitats
* Removal of swarming habitat, active timeframe
* Removal of swarming habitat, inactive timeframe

*Removal of Summer Habitat (Active Timeframe) - Applicable Science*

Risk of injury or death from being crushed when a tree is felled is most likely to impact non-volant pups, but adults may also be injured or killed. This risk is greater for adults during cooler weather when bats periodically enter torpor and would be unable to arouse quickly enough to respond (i.e., flush and potentially avoid being in the roost when it is felled). Belwood (2002) reported on the felling of a dead maple in a residential lawn in Ohio that resulted in one dead adult Indiana bat female and 33 non-volant young. Three of the young bats were already dead when they were picked up, and two more died subsequently. The rest were apparently retrieved later by adult bats that had survived.

In addition to the expenditure of additional energy to find new roost trees, the removal of primary or alternate maternity roosts can lead to the fragmentation or break up of the maternity colony (Sparks et al. 2003, Silvis et al. 2014). The effect of colony fragmentation on Indiana bats is unknown. However, Indiana bats presumably congregate in large maternity colonies due to the benefits it provides. Barclay and Kurta (2007) stated that Indiana bats benefit from the formation of maternity colonies through (1) information sharing about roosting and foraging habitats, (2) reduced predation risk, and (3) thermoregulatory advantages. However, this colonial behavior also comes with risks, such as increased parasite transmission and competition for resources.

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| **Effects Pathway – Indiana Bat #8** |
| **Activity:** Construction and Maintenance |
| **Stressor:** Tree Removal, Removal ofSummer Habitat (active timeframe) |
| *Exposure (time)* | April 1 – October 14 (active timeframe) |
| *Exposure (space)* | Forested habitat throughout the Action Area |
| *Resource affected* | Summer habitat (roost trees), individuals (adults, juveniles) |
| *Individual response*  | * Bats struck by equipment or crushed by a felled tree will be injured or killed.
* Increased effort to find new suitable roosting habitat requires extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
* Colony fragmentation could decrease thermoregulation efficiency / decreased foraging efficiency that can decrease fitness and result in reduced survival / reproductive success.
* Colony fragmentation will increase the risk of predation.
 |
| *Conservation Measures* | * Tree clearing restrictions will occur when non-volant pups would likely be present (June 1 – July 31). Consultation with the KFO would occur on a project specific basis in order to determine if tree clearing during the non-volant timeframe is acceptable under the programmatic process.
* Avoidance of project effects on a known maternity roost tree.
* Minimize project impacts to no more than 250 acres of suitable, forested habitat per project.
 |
| *Interpretation* | Bats occupying trees that are removed may be injured or killed. Injured bats may subsequently die. Those that survive will have to spend extra energy in addition to what is necessary to for foraging, pup rearing, social interactions, or other activities. The use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle processes (e.g., migration, pregnancy, lactation, etc.) or other stressors (e.g., WNS), is likely to reduce fitness and subsequently reduce survival and reproductive success.  |
| *Effect* | Harm, direct and indirect |

*Removal of Summer Habitat (Inactive Timeframe) - Applicable Science*

The potential for indirect effects of tree removal of Indiana bats during the inactive timeframe is rooted in the well-documented knowledge that Indiana bats exhibit strong fidelity to their summer roosting areas and foraging habitat (Kurta et al. 2002; Garner and Gardner 1992; USFWS 2007). Indirect effects to Indiana bats associated with the removal of forested habitats occur through several pathways that lead to a reduction in individual fitness as a result of increased energy expenditure. This evaluation is supported by numerous bat researchers, including Kurta and Rice (2002), who commented:

*The U.S. Fish and Wildlife Service often allows potential roost trees to be cut after Indiana bats leave for hibernation in order to make way for developments such as new bridges, highways, and housing projects. This policy understandably is intended to allow human developments to proceed while preventing direct "take" of Indiana bats. This practice, however, should be limited, because it destroys potential roost trees without establishing whether they actually are used by Indiana bats, which may leave the bats with no shelter when they return in spring in an energetically stressed condition. Upon returning, the bats have just completed 6-7 months of hibernation and an extensive migration, and they arrive already pregnant and at a time when air temperatures are low and food (flying insects) is scarce. Excessive precipitation and/or colder-than-average temperatures drastically reduce reproductive success of temperate bats (Grindal et al. 1992; Lewis 1993), and such negative effects likely would occur even during normal weather if Indiana bats do not have adequate shelter.*

Indiana bats must have the energetic resources to carry out the different phases of their lifecycle. Certain processes in their life cycle are particularly costly (Kunz et al. 1998). Indiana bats must enter into hibernation with enough fat reserves to survive the winter (Speakman and Rowland 1999) and, for females, to trigger ovulation and gestation following emergence (Zhao et al. 2003). After migrating to their summer habitat, Indiana bats must be prepared to cope with spring conditions by having sufficient energy resources to thermoregulate during cooler weather conditions and at a time when prey is scarce (Kurta and Rice 2002). Additionally, they must have sufficient energy resources throughout the summer roosting period to cope with unpredictable stressors, such as unseasonably cold temperatures or high precipitation that can negatively affect reproductive success (Grindal et al. 1992) and survival.

Forested habitat loss or alteration during the hibernation season (i.e., while the bats are not present) harms Indiana bats by requiring the increased use of energy to respond to the habitat loss or alteration, when bats return to summer habitats. This is likely to impair essential behavior patterns associated with sheltering (roosting), breeding and/or feeding (foraging). This impairment, in turn, results in reduced survival and/or reproduction of the affected individuals. These effects are compounded in the Action Area because most of the returning bats are coming from hibernacula infected with white-nose syndrome (WNS). Individuals surviving WNS have additional energetic demands. For example, WNS-affected bats have less fat reserves than non-WNS-affected bats when they emerge from hibernation (Reeder et al. 2012; Warnecke et al. 2012) and have wing damage (Reichard and Kunz 2009, Meteyer et al. 2009) that makes migration and foraging more challenging. Females that survive the migration to their summer habitat must partition energy resources between foraging, keeping warm, maintain a successful pregnancy, rearing pups, and healing their own bodies.

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| **Effects Pathway – Indiana Bat #9** |
| **Activity:** Construction and Maintenance |
| **Stressor:** Tree Removal,Removal of Summer Habitat (inactive timeframe) |
| *Exposure (time)* | Inactive timeframe (October 15 – March 31) removal will expose Indiana bats to indirect effects from April 1 – October 14, for one season after removal. |
| *Exposure (space)* | Forested habitat throughout the Action Area |
| *Resource affected* | Summer habitat (roost trees), used by individuals (adults) |
| *Individual response* | * Increased effort to find new suitable roosting habitat requires extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
* Colony fragmentation could decrease thermoregulation efficiency / decreased foraging efficiency that can decrease fitness and result in reduced survival / reproductive success.
* Colony fragmentation will increase the risk of predation.
 |
| *Conservation Measures* | * Avoidance of project effects on a known maternity roost tree.
* Minimize project impacts to no more than 250 acres of suitable, forested habitat per project.
 |
| *Interpretation* | Direct effects are avoided. Adult Indiana bats will experience indirect effects after they arrive at their summer roosting habitat the first year after tree removal. The extra energy to find new habitat is in addition to what is necessary for foraging, pup rearing, social interactions, or other activities. The use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle processes (e.g., migration, pregnancy, lactation, etc.) or other stressors (e.g., WNS), is likely to result in adverse effects. Indiana bats are expected to adapt to this stressor in subsequent years after they have found new suitable habitat.  |
| *Effect* | Harm, indirect |

*Loss and Fragmentation of Forested Habitats – Applicable Science*

In addition to removal of roosting habitat, tree removal often results in the loss and fragmentation of forested habitats, resulting in the degradation of Indiana bat foraging and commuting habitat. Patterson et al. (2003) noted that the mobility of bats allows them to exploit fragments of habitat. However, they cautioned that reliance on already diffuse resources (e.g., roost trees) leaves bats highly vulnerable, and that energetics may preclude the use of overly patchy habitats.

In a fragmented landscape, Indiana bats may have to fly across less suitable habitat. This could pose greater risk from predators (e.g., raptors) (Mikula et al. 2016). Indiana bats consistently follow tree-lined paths rather than cross large open areas (Gardner et al. 1991, Murray and Kurta 2004). Murray and Kurta (2004) found that Indiana bats increased their commuting distances by 55% to follow these paths rather than flying over large agricultural fields. However, if these corridors are not available, Indiana bats may be forced over open areas. For example, Kniowski and Gehrt (2014) observed Indiana bat flying across open expanses of cropland >1 km (0.6 miles) to reach remote, isolated woodlots or riparian corridors.

Indiana bat maternity colonies in Illinois, Indiana, Michigan, and Kentucky have been shown to use the same roosting and foraging areas during subsequent years (Gardner et al. 1991; Humphrey et al. 1977; Kurta and Murray 2002; Kurta et al. 1996, 2002). Bats using familiar foraging and roosting areas are thought to benefit from decreased susceptibility to predators, increased foraging efficiency, and the ability to switch roosts in case of emergencies or alterations surrounding the original roost (Gumbert et al. 2002). Conversely, bats that must use new or inferior habitats after a loss or alteration of their normal forested habitat would not have these same benefits.

Racey and Entwistle (2003) discussed the difficulties of categorizing space requirements in bats, as they are highly mobile and show relatively patchy use of habitat (and use of linear landscape features), although connectivity of habitats has some clear advantages (e.g., aid orientation, attract insects, provide shelter from wind and/or predators). Carter et al. (2002) found Indiana bat roosts in a highly fragmented landscape in their southern Illinois, although both the number of patches and mean patch size were higher in the area surrounding roosts than around randomly selected points. Kniowski and Gehrt (2014) suggest longer or more frequent commuting flights will be required by Indiana bats in highly fragmented landscapes, with smaller, more distant suitable habitat patches, to obtain similar resources compared to landscapes with larger, more abundant habitat patches. This has been observed directly in Ohio where radio tagged bats in areas with limited forested cover moved further than those with greater forested cover (K. Lott, USFWS, pers. comm.).

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| **Effects Pathway – Indiana Bat #10** |
| **Activity:** Construction and Maintenance |
| **Stressor:** Tree Removal, Loss and Fragmentation of Forested Habitats |
| *Exposure (time)* | One time removal; exposure will be permanent |
| *Exposure (space)* | Forested habitat throughout the Action Area |
| *Resource affected* | Forested habitat, used by individuals (adults, juveniles) |
| *Individual response* | * Increased effort to access sufficient foraging resources requires extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
* Reduced foraging efficiency can reduce fitness and result in reduced survival / reproductive success.
* Increased visibility to predators increases chances of predation.
 |
| *Conservation Measures* | Minimize project impacts to no more than 250 acres of suitable, forested habitat per project. |
| *Interpretation* | The loss of roost trees will adversely affect Indiana bats the first year after the removal of those trees (discussed in effects pathway #9). We expect them to find new roosting habitat that they will continue to use in subsequent years. The tree removal will create a larger gap in habitat between that Indiana bats may be using for foraging and commuting habitat. The gap would make access to these areas difficult, requiring more energy expenditure and/or exposure to predators, or would cut off access to habitat altogether. Individual Indiana bats that use the Action Area in the summer after habitat removal are expected to be indirectly harmed. |
| *Effect* | Harm; direct and indirect |

*Removal of Fall Swarming Habitat – Applicable Science*

The active fall swarming period is August 16 – November 14 and is a sensitive period for Indiana bats. This is when mating occurs and when bats are busy foraging to store sufficient fat reserves to survive winter hibernation. Suitable fall swarming habitat happens in forested/wooded habitats where they roost, forage, and travel, which is most typically within 5 to 10 miles of a hibernaculum. This includes forested patches as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure.

In general, Indiana bats use roosts, foraging, and commuting habitat(s) in the fall similar to those selected during the summer. Therefore, we are considering the applicable science discussed above for “Loss of Summer Habitat (active and inactive timeframes)”, and “Forest Loss and Fragmentation” for our analysis of this specific sub-stressor.

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| **Effects Pathway – Indiana Bat #11** |
| **Activity:** Construction and Maintenance |
| **Stressor:** Tree Removal,Removal ofFall Swarming Habitat (active timeframe) |
| *Exposure (time)* | August 16 – November 14 (active timeframe) |
| *Exposure (space)* | Forested habitat throughout the Action Area |
| *Resource affected* | Swarming habitat used by individuals (adults, juveniles) |
| *Individual response*  | * Bats struck by equipment or crushed by a felled tree will be injured or die.
* Increased effort to find new suitable roosting habitat requires extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
* Increased effort to access sufficient foraging resources requires extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
* Reduced foraging efficiency can reduce fitness and result in reduced survival / reproductive success.
* Increased visibility to predators increases chances of predation.
 |
| *Conservation Measures* | * Avoidance of project impacts on forested habitat within ½-mile of a known Indiana bat hibernacula
* Minimize project impacts to no more than 250 acres of suitable, forested habitat per project.
 |
| *Interpretation* | Bats occupying trees that are removed may be injured or killed. Injured bats may subsequently die. During a period when weight gain is critical to survival, additional energy spent searching for new roost trees also results in less time for foraging, both of which could result in reduced weight gain. It can be expected that lower weight gains during fall swarming could result in lower fitness in those stressed individuals as exhibited by reduced survival and/or reproductive success. |
| *Effect* | Harm, direct and indirect |

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| **Effects Pathway – Indiana Bat #12** |
| **Activity:** Construction and Maintenance |
| **Stressor:** Tree Removal,Removal of Swarming Habitat (inactive timeframe) |
| *Exposure (time)* | Inactive timeframe (November 15 – August 15) removal will expose Indiana bats to indirect effects from August 16 – November 14, for one season after removal. |
| *Exposure (space)* | Forested habitat throughout the Action Area |
| *Resource affected* | Swarming habitat used by individuals (adults, juveniles) |
| *Individual response* | * Increased effort to find new suitable roosting habitat requires extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
* Increased effort to access sufficient foraging resources requires extra energy expenditure that can reduce fitness and result in reduced survival / reproductive success.
* Reduced foraging efficiency can reduce fitness and result in reduced survival / reproductive success.
* Increased visibility to predators increases chances of predation.
 |
| *Conservation Measures* | * Avoidance of project impacts on forested habitat within ½-mile of a known Indiana bat hibernacula
* Minimize project impacts to no more than 250 acres of suitable, forested habitat per project.
 |
| *Interpretation* | Direct effects are avoided. Indiana bats will experience indirect effects after they arrive at their fall swarming habitat the first year after tree removal. The extra energy to find new habitat is in addition to what is necessary for foraging, social interactions, or other activities. The use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle processes (e.g., migration and mating) or other stressors (e.g., WNS), is likely to result in adverse effects. Indiana bats are expected to adapt to this stressor in subsequent years after they have found new suitable habitat.  |
| *Effect* | Harm, indirect |

### 4.1.5 Stressor 5: Collision

During the construction component of the Action, collisions could potentially occur between Indiana bats and construction vehicles and equipment. The majority of activities associated with these components will occur during daylight hours when flying bats are inactive. Some bridge replacement and road construction activities may occur at night (e.g., pouring of concrete); however, these activities will involve stationary or slow-moving vehicles. During the operation component, traffic will be present on roadways and bridges year-round and during the night. Vehicle collision may occur from dusk until dawn while Indiana bats are foraging and commuting. Collisions are not expected during the maintenance component due to these activities occurring during daylight hours.

*Applicable Science*

Collisions have been documented for Indiana bats and other myotids. Russell et al. (2009) assessed the level of mortality from road kills on a bat colony in Pennsylvania and collected 27 road-killed little brown bats and one Indiana bat. Butchkoski and Hassinger (2002) had previously studied this same colony in Pennsylvania and documented little brown bats that had apparently collided with vehicles along a major highway that separated the roosting habitat from the primary foraging areas. Russell et al. (2009) documented Indiana bat mortality at a site where the roost site was separated from the foraging areas by a major highway. This study noted that when bats crossed at open fields, they flew much lower than canopy height (< two meters), and when adjacent canopy was low, bats crossed lower and closer to traffic. Collision has also been documented for other myotids in Europe (Lesinski et al. 2011).

Collision risk of bats varies depending on time of year, location of a road in relation to roosting/foraging areas, flight characteristics of a species, traffic volume, and whether young bats are dispersing (Lesinski 2007, 2008; Russell et al. 2009; Bennett et al. 2011). In the Czech Republic, Gaisler et al. (2009) noted the majority of bat fatalities were associated with a road section between two artificial lakes. Lesinski (2007) evaluated road kills in Poland and determined that the number of young of year bats killed were significantly higher than adults. Also, low-flying gleaners (e.g., *Myotis daubentonii*) were killed more frequently than high-flying aerial hawkers (e.g., *Nyctalus noctula*). Lesinski et al. (2011) indicated that a review of previously published literature on factors causing bats to be killed at roads are not consistent, and, therefore, it is difficult to predict exact sites where bats may be at risk. They also indicated that estimates represent a small portion of the number of bats actually killed.

It can be difficult to determine whether roads pose greater risk for bats colliding with vehicles or greater likelihood of deterring bat activity in the area (thus decreasing risk of collision). As discussed in the Noise and Vibration stressor section, many studies suggest that roads may serve as a barrier to bats (Bennett and Zurcher 2013; Bennett et al. 2013; Berthinussen and Altringham 2012; Wray et al. 2006). Bennett et al. (2011) indicated that three main characteristics contribute to the barrier effects of roads: traffic volume, road width, and road surface. Roads with very few vehicles and only two lanes had little effect on Indiana bat movement (Bennett et al. 2013). Zurcher et al. (2010) concluded that bats perceive vehicles as a threat and were more than twice as likely to reverse course if a vehicle was present than if it was absent. Berthinussen and Altringham (2012) found that bat activity and diversity was lower closer to roads, but that activity and diversity increased where there was continuity in trees and hedgerows. Kerth and Melber (2009) studied barbastelle bats (*Barbastella barbastellus*) and Bechstein’s bats (*Myotis bechsteinii*) and found that roads restricted habitat accessibility for bats, but the effect was related to the species’ foraging ecology and wing morphology. Foraging ecology of gleaning and woodland species were more susceptible to the barrier effect than high-fliers that feed in open spaces (Kerth and Melber 2009).

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| **Effects Pathway – Indiana bat #13** |
| **Activity:** Construction |
| **Stressor:** Collision |
| *Exposure (time)* | April 1 – November 14 (active timeframe); duration of the activity |
| *Exposure (space)* | Bridge and roadway construction within the project area |
| *Resource affected* | Individuals (adults, juveniles)  |
| *Individual response* | Mortality from collision with vehicles or equipment. |
| *Interpretation* | The most likely effect of collision between an Indiana bat and a moving vehicle is harm in the form of mortality. However, since most construction activities would occur during daylight hours, collisions would be avoided. Risk of collision with construction vehicles during night time is minimized by the slow speed of construction vehicles in the work area. Further, construction activities that occur from dusk through dawn hours are likely localized to one area and do not require a substantial amount of construction vehicle travel. Based on this information, construction vehicle collision with an Indiana bat is unlikely to occur; therefore, any potential effects are considered discountable. |
| *Effect* | Discountable |

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| **Effects Pathway – Indiana bat #14** |
| **Activity:** Operation |
| **Stressor:** Collision |
| *Exposure (time)* | April 1 – November 14 (active timeframe); indefinitely |
| *Exposure (space)* | Bridge and roadways, throughout the Action Area |
| *Resource affected* | Individuals (adults, juveniles)  |
| *Individual response* | Mortality from collision with vehicles. |
| *Interpretation* | The risk of collision between a Indiana bat and vehicle travelling across a bridge while foraging is considered to be low due to the ability of bats to fly under bridges to avoid traffic and the reduced amount of traffic during evening hours when bats are active. However, collisions between bats and vehicles along roadways have been documented, and the bridge and roadways are expected to operate indefinitely. Exposure to this stressor is expected to harm an indeterminable number of Indiana bats within the Action Area. |
| *Effect* | Harm, direct |

### 4.1.6 Stressor 6: Alteration or Loss of Roosting Habitat (Bridges)

Rehabilitation and replacement of bridges will result in alteration and loss of roosting habitat for Indiana bats during the maintenance and construction components. Bridge rehabilitation activities are generally considered as maintenance, and may occur in areas where bats typically roost on the superstructure and underside of the bridge deck. Activities such as patching and sealing of cracks on the superstructure, repairs to header/expansion joints in the deck, and cleaning of deck drains/scuppers could impact roosting bats and cause alteration or loss of roosting locations. Bridge replacement during construction will involve the removal of individual bridge components (i.e., deck, superstructure, and substructure) or the entire structure using heavy equipment and tools. Removal of the bridge deck will result in the loss of roosting habitat in the deck and will likely alter roosting locations on the superstructure. Impacts could also occur to Indiana bats roosting on these structures during removal. After replacement projects are complete, a bridge will be present at the same or similar location; however, the new structure may not provide roosting habitat, resulting in a potential loss of roosting habitat for Indiana bats.

*Applicable Science*

Indiana bats have been documented using bridges as roosting habitat during the spring, summer, and fall. No occurrences of this species hibernating in bridges during the winter have been reported. Concrete structures seem to be preferred for roosting due to their tendency to retain heat longer than other materials; however, metal and wood structures may also be used with less frequency. Indiana bats have been observed using bridges as both day and night roosts. Day roosts are typically used by bats between sunrise and sunset and consist of sheltered areas that provide protection from adverse weather conditions and predators (Keeley and Tuttle 1999, Kiser et al. 2002).

Night roosts are generally used by bats between sunset and sunrise to rest, digest food between foraging bouts, conserve energy, and avoid inclement weather (Ormsbee et al. 2007). Bridges with a concrete deck and concrete or metal girders seem to be preferred as night roosts (Keeley and Tuttle 1999, Kiser et al. 2002). This bridge type retains heat into the night, and the chambers between the girders trap heat rising from under the bridge and provide protection from wind, weather, and predators. Night-roosting bats are typically found on the vertical surface of the girder at the intersection with the underside of the deck. Areas near the bridge abutments and over land seem to be preferred over the central portion of the bridge and areas spanning water. Bridges that lack crevices/expansion joints or girders are rarely used as day or night roosts (Adam and Hayes 2000, Feldhamer et al. 2003, Ormsbee et al. 2007); however, structures with cave-like areas or other unique features that provide suitable roosting locations can also provide suitable roosting habitat.

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| **Effects Pathway – Indiana Bat #15** |
| **Activity:** Maintenance (bridge rehabilitation) |
| **Stressor:** Alteration or Loss of Roosting Habitat (bridges) |
| *Exposure (time)* | April 1 – November 14 (active timeframe); duration of the activity |
| *Exposure (space)* | Bridges |
| *Resource affected* | Summer or swarming roosting habitat, individuals (adults, juveniles) |
| *Individual response*  | * Flushing from bridge roost results in extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Flushing from bridge roost will increase chances of predation.
* Increased effort to find new suitable roosting habitat requires extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
 |
| *Conservation Measures* | Avoidance of project effects on a bridge structure that is known or has been identified as reasonably likely to support a maternity colony. |
| *Interpretation* | Bats may flush from their roosts on the bridge. Bats that flush during the daytime are at greater risk of harm due to predation. Additionally, bats that flush their roosts may be harmed due to an increase in energy expenditure. The most severe effects of flushing a bat from a bridge may result in harm if the bat was a female with a pup. The longer the female is absent, the more likely the effects to the pup would be significant. Bats that flush must also expend additional energy to locate other roosting habitat. The use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle processes (e.g., migration, pregnancy, lactation, etc.) or other stressors, is likely to reduce fitness and subsequently reduce survival and reproductive success. Indiana bats exposed to this stressor while roosting on the bridge are likely to respond in a way that would lead to adverse effects. |
| *Effect* | Harm, direct and indirect |

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| **Effects Pathway – Indiana Bat #16** |
| **Activity:** Construction (bridge replacement) |
| **Stressor:** Alteration or Loss of Roosting Habitat (bridges) |
| *Exposure (time)* | April 1 – November 14 (active timeframe); duration of the activity |
| *Exposure (space)* | Bridges |
| *Resource affected* | Summer or swarming roosting habitat, individuals (adults, juveniles) |
| *Individual response*  | * Mortality during bridge removal.
* Flushing from bridge roost results in extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Flushing from bridge roost will increase chances of predation.
* Increased effort to find new suitable roosting habitat requires extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
 |
| *Conservation Measures* | Avoidance of project effects on a bridge structure that is known or has been identified as reasonably likely to support a maternity colony. |
| *Interpretation* | Bats roosting in bridge may be injured or killed. Injured bats may subsequently die. Bats may flush from their roosts on the bridge. Bats that flush during the daytime are at greater risk of harm due to predation. Additionally, bats that flush their roosts may be harmed due to an increase in energy expenditure. The most severe effects of flushing a bat from a bridge may result in harm if the bat was a female with a pup. The longer the female is absent, the more likely the effects to the pup would be significant. Bats that flush must also expend additional energy to locate new roosting habitat. The use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle processes (e.g., migration, pregnancy, lactation, etc.) or other stressors, is likely to reduce fitness and subsequently reduce survival and reproductive success. Indiana bats exposed to this stressor while roosting on the bridge are likely to respond in a way that would lead to adverse effects.  |
| *Effect* | Harm, direct and indirect |
|  |  |
| **Effects Pathway – Indiana Bat #17** |
| **Activity:** Maintenance and Construction (bridge rehabilitation/replacement) |
| **Stressor:** Alteration or Loss of Roosting Habitat (bridges) |
| *Exposure (time)* | Inactive timeframe (November 15 – March 31) removal will expose Indiana bats to indirect effects from April 1 – November 14, for one season after removal. |
| *Exposure (space)* | Bridges |
| *Resource affected* | Summer and swarming roosting habitat, used by individuals (adults) |
| *Individual response*  | * Increased effort to find new suitable roosting habitat requires extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
 |
| *Conservation Measures* | Avoidance of project effects on a bridge structure that is known or has been identified as reasonably likely to support a maternity colony. |
| *Interpretation* | Direct effects are avoided. Adult bats will experience indirect effects after they arrive at their summer roosting habitat the first year after bridge rehabilitation/replacement. The extra energy to find new habitat is in addition to what is necessary for foraging, pup rearing, social interactions, or other activities. The use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle processes (e.g., migration, pregnancy, lactation, etc.) or other stressors, is likely to result in adverse effects. Indiana bats are expected to adapt to this stressor in subsequent years after they have found new suitable habitat.  |
| *Effect* | Harm, indirect |

## 4.2 Summary of Effects

**Table 3.** A summary of the effects of the Action on the Indiana bat.

|  |  |  |
| --- | --- | --- |
| **Stressors** | **Adverse** | **Insignificant/****Discountable** |
| Noise and vibration: *construction and maintenance* | harm, direct and indirect |  |
| Noise and vibration: *operation* |  | insignificant |
| Night lighting: *construction and operation* |  | insignificant |
| Night lighting: *maintenance* |  | discountable |
| Aquatic resource loss: *construction* |  | insignificant |
| Aquatic resource degradation, sedimentation: *construction and maintenance* |  | insignificant |
| Aquatic resource degradation, pollutants: *construction, operation, and maintenance* |  | insignificant |
| Tree removal, summer habitat (active timeframe): *construction and maintenance* | harmdirect and indirect |  |
| Tree removal, summer habitat (inactive timeframe): *construction and maintenance* | harmindirect |  |
| Tree removal, forest loss and fragmentation: *construction and maintenance* | harmdirect and indirect |  |
| Tree removal, swarming habitat (active timeframe): *construction and maintenance* | harm direct and indirect |  |
| Tree removal, swarming habitat (inactive timeframe): *construction and maintenance* | harm indirect |  |
| Collison (construction equipment): *construction* |  | discountable |
| Collison (vehicle): *operation* | harm, direct |  |
| Alteration or loss of roosting habitat (bridges) (active timeframe): *maintenance* (rehabilitation) | harmdirect and indirect |  |
| Alteration or loss of roosting habitat (bridges) (active timeframe): *construction* (replacement) | harmdirect and indirect |  |
| Alteration or loss of roosting habitat (bridges): *maintenance and* *construction* (rehab or replacement) (inactive timeframe) | harmindirect |  |

## 4.3 Gray Bat

This BA does not address project impacts to caves, mine adits, rock shelters, and/or karst features that are suitable as either winter habitat and/or summer roosting habitat for the gray bat. Therefore, we have focused our analysis on potential gray bat roosting (bridges), foraging, and commuting habitat(s) in and near streams and construction footprints, which is the environment that is relevant to the species and this consultation.

### 4.3.1 Stressor 1: Noise and Vibration

Transportation projects approaching streams and bridge rehabilitation / replacement projects will result in noise and vibration during the construction, operation, and maintenance components. During the maintenance component, bridge rehabilitation may require heavy equipment and tools used to repair the bridge deck, superstructure, and substructure that will cause noise and vibration. Bridge replacements will also produce noise and vibration from the use of heavy equipment and tools during demolition and removal of existing bridge structure and construction of a new structure. During the operation component, noise and vibration from bridge rehabilitation and replacement will be limited to those effects caused by normal vehicular traffic.

The majority of activities during the maintenance component will be limited to the bridge deck or adjacent areas and will avoid potential roosting locations. Further, some maintenance activities (e.g., painting, debris removal from piers, vegetative maintenance) may occur under the bridge near potential roosting locations. In general, maintenance activities will be localized to specific areas of the bridge and are generally completed over a short duration. Noise and vibration during the maintenance component varies and at times may be at or below levels caused by normal traffic. Bridge maintenance is expected to occur during daylight hours and will not disrupt foraging or commuting by bats.

*Applicable Science*

The effects of traffic noise on bats have been analyzed in several studies. For example, Schaub et al. (2008) found that captive greater mouse-eared bats (*Myotis myotis*) preferred silent chambers versus chambers with playback of close traffic noise 80 percent of the time. Berthinussen and Altringham (2012) conducted acoustic transects from 0 to 1,600 meters of a major road in the United Kingdom and found that bat (*Pipistrellus pipistrellus, Pipistrellus pygmaeus, Nyctalus* spp., and *Myotis* spp.) activity and species diversity increased with distance from the road. However, this could not be completely attributed to traffic noise. Noise levels decreased significantly with distance from the road, but 89 percent of the change occurred in the first 50 meters (164 feet) and no change was detected beyond 100 meters (328 feet). Ultimately, they found that the most likely explanation was a barrier effect from the road itself (opening).

Although noise can potentially affect the behavior of some bat species, studies have not shown measurable effects of military noise on bats. 3D/Environmental, Inc. (1996) examined the potential for various firing activities (e.g., demolitions, artillery, grenade simulators) and heavy

equipment operation to disturb hibernating Indiana bats and a maternity roost of gray bats on Fort Leonard Wood in Missouri. Their research found that sound from munitions and equipment generally attenuated prior to reaching roost sites. Additionally, research was conducted to determine the effects of military noise, primarily high-caliber weapons fire, on foraging bat activity on Fort Knox in Kentucky (Martin et al. 2004; Martin 2005). The study obtained measurements of bat vocalizations using ultrasonic bat detectors, thermal infrared (TIR) imagery, and military noise monitoring technology. Statistical analysis of bat vocalizations, TIR detection, and military noise data showed extremely large variations in bat response across space and time, and results indicated that elevated noise levels associated with high-caliber weapons fire, as tested, did not have a significant effect on bat navigation and foraging activity (Martin et al. 2004).

Bats roosting or foraging in all of the examples above have likely become habituated to noise and vibration. However, novel noises from equipment and activities associated with bridge rehabilitation and replacement would be expected to result in some changes to bat behavior. Changes in behavior are most likely to occur during the construction component and some maintenance activities when heavy equipment and tools will be used within or directly adjacent to roosting habitat. Bats that roost on bridges are expected to be habituated to noise and vibration associated with normal operation.

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| **Effects Pathway – Gray Bat #1** |
| **Activity:** Construction and Maintenance |
| **Stressor:** Noise and Vibration |
| *Exposure (time)* | Active timeframe; duration of activity |
| *Exposure (space)* | Roosting (bridge) |
| *Resource affected* | Individuals (adults, juveniles) |
| *Individual response*  | * Flushing from bridge roost results in extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Flushing from bridge roost will increase chances of predation.
* Avoidance of the stressor can require extra energy expenditure, in order to find suitable roosting habitat, which can reduce fitness and result in reduced survival/reproductive success.
 |
| *Conservation Measures* | Avoidance of project effects on a bridge structure that is known or has been identified as reasonably likely to support a maternity and/or bachelor colony. |
| *Interpretation* | Bats may become startled by noise and/or vibration and flush from their roosts on the bridge. Bats that flush during the daytime are at greater risk of harm due to predation. Additionally, bats that flush their roosts may be harmed due to an increase in energy expenditure. The most severe effects of flushing a bat from a bridge may result in harm if the bat was a female with a pup. The longer the female is absent, the more likely the effects to the pup would be significant. Gray bats exposed to this stressor while roosting on the bridge are likely to respond in a way that would lead to adverse effects.  |
| *Effect* | Harm, direct and indirect |

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| **Effects Pathway – Gray Bat #2** |
| **Activity:** Construction |
| **Stressor:** Noise and Vibration |
| *Exposure (time)* | Active timeframe; duration of activity |
| *Exposure (space)* | Foraging, and commuting habitat in and near construction limits |
| *Resource affected* | Individuals (adults, juveniles) |
| *Individual response*  | Avoidance of the stressor can require extra energy expenditure, in order to find suitable foraging and commuting habitat, which can reduce fitness and result in reduced survival/reproductive success. |
| *Interpretation* | Gray bats that utilize these habitats during construction are expected to become habituated to noise and vibration or not be affected by this stressor in a significant manner. There is no data that shows that gray bats are likely to modify their foraging and commuting behaviors during temporary periods of elevated noise and vibrations; therefore, gray bats are not expected to respond to the stressor during construction in a way that would significantly affect foraging and commuting behaviors. |
| *Effect* | Insignificant |

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| **Effects Pathway – Gray Bat #3** |
| **Activity:** Operation |
| **Stressor:** Noise and Vibration |
| *Exposure (time)* | Active timeframe; indefinitely |
| *Exposure (space)* | Roosting (bridge), foraging, and commuting habitat throughout the Action Area |
| *Resource affected* | Individuals (adults, juveniles) |
| *Individual response*  | * Flushing from bridge roost results in extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Flushing from bridge roost will increase chances of predation.
* Avoidance of the stressor can require extra energy expenditure, in order to find suitable roosting, foraging, and commuting habitat, which can reduce fitness and result in reduced survival/reproductive success.
 |
| *Interpretation* | Gray bats that roost on bridges and/or forage and travel around these structures and roadways during operation are assumed to be habituated and respond minimally to this stressor; therefore, noise and vibration from operation are unlikely to cause bats to flush or alter use of its habitat. Gray bats are not expected to respond to the stressor during operation in a way that would be significant. |
| *Effect* | Insignificant |

### 4.3.2 Stressor 2: Night Lighting

Transportation projects approaching streams and bridge rehabilitation / replacement may require lighting during the construction, operation, and maintenance components. Bridge rehabilitation activities are not expected to occur at night, with the exception of minor, temperature-sensitive activities limited to the bridge deck (e.g., pouring concrete). Lighting during bridge replacement will be minimal and localized to the work area, occurring in the early morning, late evening, and rarely at night. Construction lighting is anticipated to be focused downward at the bridge and not directed horizontally where it would illuminate potential foraging and commuting habitat. Bridge lighting during the operation component is anticipated to be the same as before rehabilitation/replacement activities. Bridges with lighting before rehabilitation/replacement are expected to have lighting afterwards; however, lighting is not expected to be added to bridges without previous lighting. Bridge maintenance is anticipated to occur during daylight hours and will not require the use of lighting.

*Applicable Science*

Studies document highly variable responses among bat species to artificial lighting. Some species seem to benefit from artificial lighting, taking advantage of high densities of insects attracted to light (Jung and Kalko 2010); however, other species may avoid artificial light (Furlonger et al. 1987, Rydell 1992) or not be affected (Stone et al. 2012). Artificial lighting can cause delays in nightly bat activity (Stone et al. 2009; Downs et al. 2003), and effects from lighting may vary with season and moon phase (Jung and Kalko 2010).

Some bat species appear to avoid lights. Downs et al. (2003) found that lighting of *Pipistrellus pygmaeus* roosts reduced the number of bats that emerged. In Canada and Sweden, *Myotis* spp.and *Plecotus auritus* were only recorded foraging away from street lights (Furlonger et al. 1987; Rydell 1992). Stone et al. (2009) found that commuting activity of lesser horseshoe bats (*Rhinolophus hipposideros*) in Britain was reduced dramatically and the onset of commuting was delayed in the presence of high pressure sodium lighting. Stone et al. (2012) also found that light-emitting diodes (LEDs) caused a reduction in *Rhinolophus hipposideros* and *Myotis* spp. activity. In contrast, there was no effect of lighting on *Pipistrellus pipistrellus*, *Pipistrellus pygmaeus,* or *Nyctalus/Eptesicus* spp.

While there is little information regarding gray bats’ response to artificial lights, other closely related *Myotis* species appear to avoid lighting. In Indiana, Indiana bats avoided foraging in urban areas, which may have been in part due to high light levels (Sparks et al. 2005). Using captive bats, Alsheimer (2011) found that the little brown bat (*Myotis lucifugus*) was more active in the dark than light. Based on the variable and contrasting responses by bats to artificial lighting, it is possible that gray bats could be impacted by lighting associated with bridge rehabilitation and replacement.

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| **Effects Pathway – Gray Bat #4** |
| **Activity:** Construction |
| **Stressor:** Night Lighting |
| *Exposure (time)* | Active timeframe; duration of activity |
| *Exposure (space)* | Roosting (bridge), foraging, and commuting habitat in and near the construction limits |
| *Resource affected* | Individuals (adults, juveniles) |
| *Individual response*  | * Avoidance of day roost after foraging results in extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Increased visibility to predators increases chances of predation.
* Avoidance of the stressor can require extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
 |
| *Conservation Measures* | Avoidance of project effects on a bridge structure that is known or has been identified as reasonably likely to support a maternity and/or bachelor colony. |
| *Interpretation* | Gray bats roosting underneath or in the bridge deck are unlikely to be affected by lighting on top of the bridge deck. Lighting will not be directed down toward night roosting bats. Additionally, should the activity alter the bridge allowing night lighting to reach roosting habitat, it is unlikely that the bats are still using the bridge (impacts associated with the alteration or loss of roosting habitat (bridges) are addressed in Pathway # 13.Bats day roosting at the bridge may delay or avoid returning to the bridge at dawn. Lighting is unlikely to be used during this time, and bats that avoid the bridge likely have other available roosts in the immediate area. Lighting may cause bats to avoid using the bridge as a night roost; however, it is expected that bats can use alternate roosts in the area without significant additional energy expenditure. Foraging bats avoiding bridge lighting can forage along other portions of the stream or nearby streams. Commuting bats can use other travel routes to avoid lighting. Lighting is not expected to significantly affect the gray bat.  |
| *Effect* | Insignificant |

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| **Effects Pathway – Gray Bat #5** |
| **Activity:** Operation |
| **Stressor:** Night Lighting |
| *Exposure (time)* | Active timeframe; indefinitely |
| *Exposure (space)* | Roosting (bridge), foraging, and commuting habitat throughout the Action Area |
| *Resource affected* | Individuals (adults, juveniles) |
| *Individual response* | * Avoidance of day roost after foraging results in extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Increased visibility to predators increases chances of predation.
* Avoidance of the stressor can require extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
 |
| *Interpretation* | Gray bats roosting in the bridge and/or foraging and commuting near the road crossing during operation were likely using this habitat prior to rehabilitation/replacement. These bats will likely be habituated to lighting and not significantly impacted by this stressor. |
| *Effect* | Insignificant |

### 4.3.3 Stressor 3: Aquatic Resource Loss and Degradation

Loss of aquatic resources may occur during the construction component of the Action. Some projects may require the filling of streams or ponds during realignment of existing facilities or the construction of new facilities. Stream realignment may also be required for some projects, resulting in loss of a portion of the existing stream channel. Loss of aquatic resources may also occur during culvert installation due to the replacement of the natural stream substrate with an artificial structure. Transportation projects and bridge rehabilitation / replacement are not anticipated to result in overall significant loss of aquatic resources during the construction or operation component.

Potential degradation of aquatic resources from transportation projects and bridge rehabilitation during the construction component are expected to be minimal. The majority of these activities will not require work within streams or wetlands, and impacts to water quality are expected to be absent or minimal. Activities that occur over or near the aquatic resources could result in debris, materials, equipment, or contaminants entering them. Temporary structures, such as crossings or work pads, may be required for some bridge rehabilitation and replacement activities to maintain traffic or access portions of the bridge that cannot be reached from land or the bridge deck. These structures will be placed in the stream channel and will cause temporary impacts to the substrate and aquatic habitat. Cofferdams may also be placed in streams to create a safe, dry work area around piers, footers, and abutments during structure repair and rehabilitation of scour areas. Removal and installation of piers, pilings, and abutments will require work within the stream channel and disturb the substrate, which could result in degradation of the stream though habitat alteration and sedimentation within and downstream of the bridge footprint. Temporary structures will be removed after work is complete, and the stream will be restored to pre-construction conditions.

During the operation component, hazardous materials from the roadway surface could enter streams through bridge deck drains and scuppers. Materials include oil, gasoline, diesel fuel, deicing agents, and other fluids associated with vehicular use of the bridge. These materials could enter streams directly from spills and leaks or through stormwater runoff, which could result in a short-term reduction in aquatic insects that provide prey for gray bats.

Bridge maintenance, such as painting and debris removal from piers/abutments, could result in minor degradation of aquatic resources. Paint could enter the stream through spills or runoff. Removal of debris that has collected against piers and abutments will result in temporary disturbance of the stream substrate and may lead to sedimentation downstream.

Herbicides may be used to control weed species along the right-of-ways and are generally applied once during the year either during the spring, summer, or fall. The herbicide application is applied during the day and in a method to minimize wind-induced drift. It is possible that some non-water safe herbicide could enter surface waters from either overspray or drift, which may affect bat’s drinking water and/or cause bats to ingest chemicals through drinking or through bioaccumulation from eating affected insects. However, this is unlikely due to requirements that all herbicides be used in accordance to their label instructions and herbicide applicators should be appropriately licensed. Further, it is also unlikely since application would occur during the daytime and any chemical coming in contact with the water would have time to become diluted prior to bats foraging at night.

*Applicable Science*

Gray bats primarily forage over open water bodies, such as rivers, streams, lakes, and reservoirs, and associated riparian areas (Tuttle 1976, 1979; LaVal et al. 1977). While foraging, the gray bat consumes a variety of insects, most of which are aquatic-based (Brack and LaVal 2006). Insects in the orders Ephemeroptera, Tricoptera, and Plecoptera are especially important, as well as Lepidoptera, Coleoptera, and Diptera (Whitaker et al. 2001; Tuttle and Kennedy 2005). Juvenile gray bats tend to forage more frequently in riparian areas and woodlands near roosts and eat more beetles than adults (Brack and LaVal 2006).

Impacts to aquatic habitats can have detrimental effects on gray bats and their prey. Loss of aquatic habitats through fill will permanently reduce aquatic insect habitat, which will reduce the amount of prey available to gray bats. Sedimentation will also result in negative impacts to aquatic insect populations. Sediment suspended in the water column affects aquatic insect food sources by physically removing periphyton from the substrate and reducing light available for primary production of phytoplankton. In addition, sediment that settles out of the water column onto the substrate fills interstitial spaces occupied by certain aquatic insect larvae. Increases in sedimentation can also change the composition of the insect community in a stream (Henley et al. 2000). In a three-year study measuring sedimentation and macroinvertebrate communities before, after, and during disturbance from a highway construction site, Hendrick (2008) found increased turbidity and total suspended solids downstream from the construction that correlated with a shift in macroinvertebrate communities. The change, however, was not great, and the Hilsenhoff Biotic Index used to evaluate the effects decreased from “excellent” before construction to “good” after construction. The use of BMPs likely minimized the effects of the construction on the macroinvertebrate communities.

While foraging, gray bats may travel long distances, with individuals recorded up to 35 kilometers (22 miles) from their day roosts (LaVal et al. 1977, Tuttle and Kennedy 2005). Bats typically travel individually or in small groups that forage in an area for a short period before moving to another area. A radiotelemetry study in Alabama found that gray bats rarely foraged in one area for more than an hour (Thomas and Best 2000). During another tracking study in Missouri, one female bat foraged for approximately one hour foraging along a 0.5-kilometer section of a river. Another female was recorded traveling along a 0.6-kilometer section of river over 21 minutes (LaVal et al. 1977). These studies suggest that gray bats visit multiple foraging areas during the night and travel frequently between these areas.

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| **Effects Pathway – Gray Bat #6** |
| **Activity:** Construction |
| **Stressor:** Aquatic Resource Loss |
| *Exposure (time)* | Indefinitely |
| *Exposure (space)* | Aquatic foraging habitat in and near the project site |
| *Resource affected* | Habitat, used by individuals (adults, juveniles) |
| *Individual response* | * Increased flight distances to access foraging resources requires extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Reduced foraging efficiency can reduce fitness and result in reduced survival/reproductive success.
 |
| *Interpretation* | Loss of ephemeral and intermittent streams do not likely provide important foraging habitat for gray bats because of their relative size and flow status. Data indicates that gray bats visit multiple foraging sites in one evening; therefore, gray bats are expected to utilize other perennial streams and waterbodies in the affected watershed. |
| *Effect* | Insignificant |

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| **Effects Pathway – Gray Bat #7** |
| **Activity:** Construction and Maintenance |
| **Stressor:** Aquatic Resource Degradation **(**sedimentation) |
| *Exposure (time)* | Active timeframe; temporary |
| *Exposure (space)* | Aquatic foraging habitat in and downstream of the project site |
| *Resource affected* | Habitat, prey (aquatic insects), used by individuals (adults, juveniles) |
| *Individual response* | * Increased effort to access sufficient foraging resources requires extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Reduced foraging efficiency can reduce fitness and result in reduced survival/reproductive success.
 |
| *Conservation Measures* | Implementation of BMPs to limit impacts to streams and downstream aquatic resources.  |
| *Interpretation* | The effects of sedimentation on aquatic resources are expected to be minimal due to the temporary nature of the activity and implementation of the conservation measures.  |
| *Effect* | Insignificant |

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| **Effects Pathway – Gray Bat #8** |
| **Activity:** Construction, Operation, and Maintenance |
| **Stressor:** Aquatic Resource Degradation **(**pollutants) |
| *Exposure (time)* | Indefinitely |
| *Exposure (space)* | Aquatic foraging habitat throughout the Action Area |
| *Resource affected* | Habitat, prey (aquatic insects), used by individuals (adults, juveniles) |
| *Individual response* | * Increased effort to access sufficient foraging resources requires extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Reduced foraging efficiency can reduce fitness and result in reduced survival/reproductive success.
 |
| *Conservation Measures* | * Implementation of BMPs to limit impacts to streams and downstream aquatic resources.
* Limiting use of deicing agents to only the amount necessary.
* Ensure proper use of herbicides
 |
| *Interpretation* | Implementation of the conservation measures are expected to minimize and/or prevent contamination from pollutants.  |
| *Effect* | Insignificant |

### 4.3.4 Stressor 4: Tree Removal

Tree removal will result in fragmentation of forested areas on the landscape and has the potential to impact travel corridors as well as foraging areas for the gray bat. Road construction and maintenance will result in the loss of forested habitat in both linear corridors and blocks of habitat varying in width and length. Minimal tree removal may occur during the construction component of bridge replacement; however, tree removal is not expected to occur during the operation component. Tree removal during stream crossings is typically limited to areas immediately adjacent to the existing bridge to provide access for equipment and the installation of temporary crossings and work pads. For the majority of bridge replacement projects, tree removal is minimal and consists of a small number of trees in the riparian corridor on each side of the bridge. This type of tree removal results in widening of the cleared area that was created during the original construction of the bridge. Some projects involve realignment of the roadway associated with the bridge, causing the bridge to be replaced immediately upstream or downstream of the existing bridge. In this case, a higher number of trees must be removed for site preparation, access, and other construction-related activities. After removal of the existing bridge, the former site is typically allowed to revegetate naturally, eventually closing the gap in the riparian corridor.

*Applicable Science*

Foraging gray bats seem to prefer streams and other waterbodies bordered by forested habitat, and may avoid foraging in areas where the forested riparian corridor has been cleared (LaVal et al. 1977). Gray bats also travel along the forest canopy from their roosts to foraging areas, and may travel considerable distances to follow fence rows or other linear forested corridors (Brady et al. 1982). Patterson et al. (2003) noted that the mobility of bats allows them to exploit fragments of habitat. This behavior is believed to be a measure to avoid predation by aerial predators, such as screech owls, which have more difficulty capturing bats in the tree canopy (Tuttle 1979).

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| **Effects Pathway – Gray Bat #9** |
| **Activity:** Construction and Maintenance |
| **Stressor:** Tree Removal |
| *Exposure (time)* | One time removal, exposure will be permanent |
| *Exposure (space)* | Forested habitat throughout the Action Area |
| *Resource affected* | Forested habitat, used by individuals (adults, juveniles) |
| *Individual response*  | * Increased effort to access sufficient foraging resources requires extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Reduced foraging efficiency can reduce fitness and result in reduced survival/reproductive success.
 |
| *Interpretation* | Gaps in the riparian corridor are present along the majority of streams; gray bats foraging in the vicinity of a bridge are expected to be habituated to the existing gap in the forested riparian corridor at the bridge. Minor widening of and/or creation of a new gap is unlikely to alter foraging behavior. The mobility of gray bats allow them to adjust to ever-changing landscapes and forest fragmentation while commuting. Bats affected by tree removal within foraging and/or commuting habitat are expected to utilize other portions of these habitats across the landscape. |
| *Effect* | Insignificant |

### 4.3.5 Stressor 5: Collision

During the construction component of the Action, collisions could potentially occur between gray bats and construction vehicles and equipment. The majority of activities associated with these components will occur during daylight hours when bats are inactive. Some bridge replacement activities may occur at night (e.g., pouring of concrete); however, these activities will involve stationary or slow-moving vehicles and equipment primarily on the bridge deck. During the operation component, traffic will be present on roadways and bridges year-round and during the night. Vehicle collision may occur from dusk until dawn while gray bats are foraging and commuting. Collisions are not expected during the maintenance component due to these activities occurring during daylight hours.

*Applicable Science*

The current literature does not include data on collisions between gray bats and vehicles; however, collisions have been documented for Indiana bats and other myotids. Russell et al. (2009) assessed the level of mortality from road kills on a bat colony in Pennsylvania and collected 27 road-killed little brown bats and one Indiana bat. Butchkoski and Hassinger (2002) had previously studied this same colony in Pennsylvania and documented little brown bats that had apparently collided with vehicles along a major highway that separated the roosting habitat from the primary foraging areas. Russell et al. (2009) documented Indiana bat mortality at a site where the roost site was separated from the foraging areas by a major highway. This study noted that when bats crossed at open fields, they flew much lower than canopy height (< two meters), and when adjacent canopy was low, bats crossed lower and closer to traffic. Collision has also been documented for other myotids in Europe (Lesinski et al. 2011).

Collision risk of bats varies depending on time of year, location of a road in relation to roosting/foraging areas, flight characteristics of a species, traffic volume, and whether young bats are dispersing (Lesinski 2007, 2008; Russell et al. 2009; Bennett et al. 2011). In the Czech Republic, Gaisler et al. (2009) noted the majority of bat fatalities were associated with a road section between two artificial lakes. Lesinski (2007) evaluated road kills in Poland and determined that the number of young of year bats killed were significantly higher than adults. Also, low-flying gleaners (e.g., *Myotis daubentonii*) were killed more frequently than high-flying aerial hawkers (e.g., *Nyctalus noctula*). Lesinski et al. (2011) indicated that a review of previously published literature on factors causing bats to be killed at roads are not consistent, and, therefore, it is difficult to predict exact sites where bats may be at risk. They also indicated that estimates represent a small portion of the number of bats actually killed.

It can be difficult to determine whether roads pose greater risk for bats colliding with vehicles or greater likelihood of deterring bat activity in the area (thus decreasing risk of collision). As discussed in the Noise and Vibration stressor section, many studies suggest that roads may serve as a barrier to bats (Bennett and Zurcher 2013; Bennett et al. 2013; Berthinussen and Altringham 2012; Wray et al. 2006). Bennett et al. (2011) indicated that three main characteristics contribute to the barrier effects of roads: traffic volume, road width, and road surface. Roads with very few vehicles and only two lanes had little effect on Indiana bat movement (Bennett et al. 2013). Zurcher et al. (2010) concluded that bats perceive vehicles as a threat and were more than twice as likely to reverse course if a vehicle was present than if it was absent. Berthinussen and Altringham (2012) found that bat activity and diversity was lower closer to roads, but that activity and diversity increased where there was continuity in trees and hedgerows. Kerth and Melber (2009) studied barbastelle bats (*Barbastella barbastellus*) and Bechstein’s bats (*Myotis bechsteinii*) and found that roads restricted habitat accessibility for bats, but the effect was related to the species’ foraging ecology and wing morphology. Foraging ecology of gleaning and woodland species were more susceptible to the barrier effect than high-fliers that feed in open spaces (Kerth and Melber 2009).

Gray bats flying along streams below bridges are less likely to be affected by the barrier effect or collision as bats flying at or near roadway level. While foraging, gray bats typically fly within three meters of the water’s surface (Tuttle 1976). The majority of bridges with nighttime traffic volumes and speeds high enough to create a barrier effect and pose a risk of collision for gray bats are two to four-lane bridges that are generally more than three meters over streams. Gray bats foraging along streams will be unlikely to avoid or fly over these bridges when they can maintain their normal foraging height by going under the bridges. These bridges also typically contain concrete barrier walls or guardrails on each side of the bridge, forcing bats flying over bridges to be higher than the level of the roadway. Bridges that are less than three meters from the water’s surface are typically one to two-lane structures with low traffic volumes, especially at night, that contain vehicles traveling at slower speeds. The potential for collisions between gray bats and vehicles on these bridges is considered low.

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| **Effects Pathway – Gray Bat #10** |
| **Activity:** Construction |
| **Stressor:** Collision |
| *Exposure (time)* | Active timeframe; duration of the activity |
| *Exposure (space)* | Bridge and roadway construction within the project area |
| *Resource affected* | Individuals (adults, juveniles)  |
| *Individual response* | * Mortality from collision with vehicles or equipment.
 |
| *Interpretation* | The most likely effect of collision between a gray bat and a moving vehicle is harm in the form of mortality. However, since most construction activities would occur during daylight hours, collisions would be avoided. Risk of collision with construction vehicles during night time is minimized by the slow speed of construction vehicles in the work area. Further, construction activities that occur from dusk through dawn hours are likely localized to one area and do not require a substantial amount of construction vehicle travel. Based on this information, construction vehicle collision with a gray bat is unlikely to occur; therefore, any potential effects are considered discountable. |
| *Effect* | Discountable |

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| **Effects Pathway – Gray Bat #11** |
| **Activity:** Operation |
| **Stressor:** Collision |
| *Exposure (time)* | Active timeframe; indefinitely |
| *Exposure (space)* | Bridge and roadways throughout the Action Area |
| *Resource affected* | Individuals (adults, juveniles)  |
| *Individual response* | * Mortality from collision with vehicles.
 |
| *Interpretation* | The risk of collision between a gray bat and vehicle travelling across a bridge while foraging is considered to be low due to the ability of bats to fly under bridges to avoid traffic and the reduced amount of traffic during evening hours when bats are active. However, collisions between bats and vehicles along roadways have been documented, and the bridge and roadways are expected to operate indefinitely. Exposure to this stressor is expected to harm an indeterminable number of gray bats within the Action Area. |
| *Effect* | Harm, direct  |

### 4.3.6 Stressor 6: Alteration or Loss of Roosting Habitat (Bridges)

Rehabilitation and replacement of bridges will result in alteration and loss of roosting habitat for gray bats during the maintenance and construction components. Bridge rehabilitation activities during are generally considered as maintenance, and may occur in areas where bats typically roost on the superstructure and underside of the bridge deck. Activities such as patching and sealing of cracks on the superstructure, repairs to header/expansion joints in the deck, and cleaning of deck drains/scuppers could impact roosting bats and cause alteration or loss of roosting locations. Bridge replacement during construction will involve the removal of individual bridge components (i.e., deck, superstructure, and substructure) or the entire structure using heavy equipment and tools. Removal of the bridge deck will result in the loss of roosting habitat in the deck and will likely alter roosting locations on the superstructure. Impacts could also occur to gray bats roosting on these structures during removal. After replacement projects are complete, a bridge will be present at the same or similar location; however, the new structure may not provide roosting habitat, resulting in a potential loss of roosting habitat for gray bats.

*Applicable Science*

Gray bats have been documented using bridges as roosting habitat during the spring, summer, and fall. No occurrences of this species hibernating in bridges during the winter have been reported. Concrete structures seem to be preferred for roosting due to their tendency to retain heat longer than other materials; however, metal and wood structures may also be used with less frequency. Gray bats have been observed using bridges as both day and night roosts. Day roosts are typically used by bats between sunrise and sunset and consist of sheltered areas that provide protection from adverse weather conditions and predators (Keeley and Tuttle 1999, Kiser et al. 2002). Bridges used as day roosts by gray bats are typically constructed of concrete and contain vertical crevices, expansion joints, or other locations that allow bats to retreat into the bridge deck or superstructure (Keeley and Tuttle 1999, Feldhamer et al. 2003, Cleveland and Jackson 2013).

Night roosts are generally used by bats between sunset and sunrise to rest, digest food between foraging bouts, conserve energy, and avoid inclement weather (Ormsbee et al. 2007). Bridges with a concrete deck and concrete or metal girders seem to be preferred as night roosts (Keeley and Tuttle 1999, Kiser et al. 2002). This bridge type retains heat into the night, and the chambers between the girders trap heat rising from under the bridge and provide protection from wind, weather, and predators. Night-roosting bats are typically found on the vertical surface of the girder at the intersection with the underside of the deck. Areas near the bridge abutments and over land seem to be preferred over the central portion of the bridge and areas spanning water. Bridges that lack crevices/expansion joints or girders are rarely used as day or night roosts (Adam and Hayes 2000, Feldhamer et al. 2003, Ormsbee et al. 2007); however, structures with cave-like areas or other unique features that provide suitable roosting locations can also provide suitable roosting habitat.

Multiple studies and surveys have reported gray bats roosting on bridges. A gray bat maternity colony is known to use a concrete box beam bridge over a large stream in central Kentucky, with estimated numbers ranging from 50 to more than 100 individuals (S. Martin, USFWS, pers. comm.). The colony roosts inside vertical expansion joints that are present between the concrete beams that comprise the bridge superstructure. Potential use of two additional concrete box beam bridges located upstream of the maternity colony has also been noted; however, these records have not been confirmed.

Gray bats have also been documented roosting in several concrete box beam bridges in western North Carolina (K. Etchison, North Carolina Wildlife Resources Commission, pers. comm.; J. Weber, Indiana State University, pers. comm.). Up to 1,000 individuals, including males and females, have been observed day-roosting throughout the summer in expansion joints between box beams at two separate bridges. Sporadic summer use of two other concrete box beam bridges has also been noted for smaller numbers of day-roosting gray bats. The same study also found gray bats day-roosting on several different bridges with concrete decks and concrete/metal girder superstructures, with over 300 bats roosting in vertical expansion joints in the bridge deck above columns and piers. The type of use (e.g., maternity colony, bachelor/non-reproductive colony) of these bridges has not been confirmed; however, it is possible that maternity colonies are using some of these bridges based on the number of individuals observed and the time of year.

Several observations of gray bats roosting on concrete girders at the intersection of the girder and bridge deck have been reported; however, these records typically consist of sporadic use by individual bats. During the North Carolina bridge study, two bats were found day-roosting at the intersection of girders and bridge decks (K. Etchison, North Carolina Wildlife Resources Commission, pers. comm.; J. Weber, Indiana State University, pers. comm.). Cervone et al. (2016) found two gray bats day-roosting under a concrete girder bridge on two different occasions, including one bat in April and a second bat in September. The timing of these occurrences suggest that these bats were using the bridge as a transient roost during the spring and fall migration periods. Gray bats have also been found day-roosting under a concrete girder bridge in southern Kentucky (S. Martin, USFWS, pers. comm.). Gray bats have been documented night-roosting at the intersection of girders and bridge decks, including 20 to 30 individuals found under two different bridges in northwest Georgia (Johnson et al. 2002). Other structures on bridges that provide sheltered areas may also be used as roosts. In North Carolina, a gray bat was found day-roosting in a clogged deck drainage pipe on a bridge (K. Etchison, North Carolina Wildlife Resources Commission, pers. comm.; J. Weber, Indiana State University, pers. comm.).

Gray bats show strong philopatry to their summer ranges and typically use the same roost sites year after year (Tuttle 1976, 1979; Martin 2007). Maternity colonies tend to concentrate at one roost site until the young are volant, then begin to alternate more frequently between other roost sites within their home range (Thomas 1994). Adult males and yearlings form bachelor colonies or small groups at roost sites separate from maternity colonies. These individuals typically alternate between roost sites more frequently than reproductive females.

|  |
| --- |
| **Effects Pathway – Gray Bat #12** |
| **Activity:** Maintenance (bridge rehabilitation) |
| **Stressor:** Alteration or Loss of Roosting Habitat (bridges) |
| *Exposure (time)* | Active timeframe; duration of the activity |
| *Exposure (space)* | Bridges |
| *Resource affected* | Day or night roosting habitat, individuals (adults, juveniles) |
| *Individual response*  | * Flushing from bridge roost results in extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Flushing from bridge roost will increase chances of predation.
* Increased effort to find new suitable roosting habitat requires extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
 |
| *Conservation Measures* | Avoidance of project effects on a bridge structure that is known or has been identified as reasonably likely to support a maternity and/or bachelor colony. |
| *Interpretation* | Bats may flush from their roosts on the bridge. Bats that flush during the daytime are at greater risk of harm due to predation. Additionally, bats that flush their roosts may be harmed due to an increase in energy expenditure. The most severe effects of flushing a bat from a bridge may result in harm if the bat was a female with a pup. The longer the female is absent, the more likely the effects to the pup would be significant. Bats that flush must also expend additional energy to locate other roosting habitat. The use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle processes (e.g., migration, pregnancy, lactation, etc.) or other stressors, is likely to reduce fitness and subsequently reduce survival and reproductive success. Gray bats exposed to this stressor while roosting on the bridge are likely to respond in a way that would lead to adverse effects. |
| *Effect* | Harm, direct and indirect |

|  |
| --- |
| **Effects Pathway – Gray Bat #13** |
| **Activity:** Construction (bridge replacement) |
| **Stressor:** Alteration or Loss of Roosting Habitat (bridges) |
| *Exposure (time)* | Active timeframe; duration of the activity |
| *Exposure (space)* | Bridges |
| *Resource affected* | Day or night roosting habitat, individuals (adults, juveniles) |
| *Individual response*  | * Mortality during bridge removal.
* Flushing from bridge roost results in extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
* Flushing from bridge roost will increase chances of predation.
* Increased effort to find new suitable roosting habitat requires extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
 |
| *Conservation Measures* | Avoidance of project effects on a bridge structure that is known or has been identified as reasonably likely to support a maternity and/or bachelor colony. |
| *Interpretation* | Bats roosting in bridge may be injured or killed. Injured bats may subsequently die. Bats may flush from their roosts on the bridge. Bats that flush during the daytime are at greater risk of harm due to predation. Additionally, bats that flush their roosts may be harmed due to an increase in energy expenditure. The most severe effects of flushing a bat from a bridge may result in harm if the bat was a female with a pup. The longer the female is absent, the more likely the effects to the pup would be significant. Bats that flush must also expend additional energy to locate new roosting habitat. The use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle processes (e.g., migration, pregnancy, lactation, etc.) or other stressors, is likely to reduce fitness and subsequently reduce survival and reproductive success. Gray bats exposed to this stressor while roosting on the bridge are likely to respond in a way that would lead to adverse effects.  |
| *Effect* | Harm, direct or indirect |
| **Effects Pathway – Gray Bat #14** |
| **Activity:** Maintenance and Construction, (bridge rehabilitation/replacement) |
| **Stressor:** Alteration or Loss of Roosting Habitat (bridges) |
| *Exposure (time)* | Inactive timeframe removal will expose gray bats to indirect effects during the active timeframe for one season after removal |
| *Exposure (space)* | Bridges |
| *Resource affected* | Day or night roosting habitat, used by individuals (adults) |
| *Individual response*  | * Increased effort to find new suitable roosting habitat requires extra energy expenditure that can reduce fitness and result in reduced survival/reproductive success.
 |
| *Conservation Measures* | Avoidance of project effects on a bridge structure that is known or has been identified as reasonably likely to support a maternity and/or bachelor colony. |
| *Interpretation* | Direct effects are avoided. Adult gray bats will experience indirect effects after they arrive at their summer roosting habitat the first year after bridge rehabilitation/replacement. The extra energy to find new habitat is in addition to what is necessary for foraging, pup rearing, social interactions, or other activities. The use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle processes (e.g., migration, pregnancy, lactation, etc.) or other stressors, is likely to result in adverse effects. Gray bats are expected to adapt to this stressor in subsequent years after they have found new suitable habitat.  |
| *Effect* | Harm, indirect |

## 4.4 Summary of Effects

**Table 4.** A summary of the effects of the Action on the gray bat

|  |  |  |
| --- | --- | --- |
| **Stressors** | **Adverse** | **Insignificant/****Discountable** |
| Noise and vibration (bridge roosting): *construction and maintenance* | Harm direct and indirect |  |
| Noise and vibration (foraging): *construction* |  | insignificant |
| Noise and vibration: *operation* |  | insignificant |
| Night lighting: *construction and operation* |  | insignificant |
| Night lighting: *maintenance* |  | discountable |
| Aquatic resource: *construction* |  | insignificant |
| Aquatic resource degradation, (sedimentation): *construction and maintenance* |  | insignificant |
| Aquatic resource degradation, (pollutants): *construction, operation, and maintenance* |  | insignificant |
| Tree removal: *construction and maintenance* |  | insignificant |
| Collison: *construction*  |  | discountable |
| Collison: *operation* | harm, direct |  |
| Alteration or loss of roosting habitat (bridges):  *maintenance* (rehabilitation) | harmdirect and indirect |  |
| Alteration or loss of roosting habitat (bridges): *construction* (replacement) | harmdirect and indirect |  |
| Alteration or loss of roosting habitat (bridges): *maintenance and construction* (rehab or replacement) (inactive timeframe) | harmindirect |  |

# 5.0 Analysis of Annual Forested Habitat Removal

KYTC anticipates the removal of 800-1000 acres of forested habitat annually in association with projects considered under this consultation. Review of KYTC' s use of Indiana bat authorized take from 2013 - 2018 under the KFO’s Intra-service Biological Opinion and Incidental Take Statement and other KFO project specific biological opinions and Indiana bat incidental take statements indicate that a total of approximately 3,160.25 acres of forested habitat over 6 years (an average of 526.71 acres per year) was utilized. Beginning in April of 2015, the Intra-service Biological Opinion limited the use of authorized take to those projects that removed less than 100 acres of habitat per project; the previous cap was 250 acres. Project specific biological opinions (BOs) were completed for projects exceeding the established cap. Based on the data in Table 5, which shows an average of 257.83 acres of habitat per project specific BO, KYTC proposes that the maximum acreage of habitat per project addressed in this programmatic consultation is 250 acres.

Table 5: Acres of Indiana Bat Forested Habitat Impacted from 2013-2018

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|   | 2018 | 2017 | 2016 | 2015 | 2014 | 2013 | Over 100 acre Project Specific BO |
| Jan | 202.71 | 1.27 | 132.06 | 1.04 | 9.99 | 56.9 | 145.12 (2016) |
| Feb | 1.47 | 0.38 | 73.26 | 0.57 | 0 | 1.03 |   |
| March | 8.97 | 7.71 | 1.69 | 2.55 | 0.23 | 0 |   |
| April  | 5.95 | 14.32 | 20.71 | 12.18 | 24.87 | 17.42 |   |
| May | 12.04 | 9.33 | 4.56 | 130.26 | 44.03 | 13.83 |   |
| June | 14.56 | 0.37 | 39.75 | 20.68 | 18.19 | 5.53 |   |
| July | 12.83 | 18.71 | 5.04 | 44.94 | 1.98 | 3.06 |   |
| August | 3.19 | 5.98 | 1.64 | 83.19 | 53.88 | 1.16 | 190 (2018) |
| Sept | 18.98 | 51.09 | 4.42 | 10 | 6.29 | 5.94 |   |
| Oct | 86.91 | 47.04 | 25.16 | 35.38 | 8.13 | 6.53 |   |
| Nov | 1.71 | 0.65 | 7.38 | 194.41 | 1.95 | 51.32 |   |
| Dec | 44.26 | 81.01 | 173.82 | 51.42 | 46.19 | 22.95 | 314.41 (2016), 381.77 (2016) |
| TOTAL | 413.58 | 237.86 | 489.49 | 586.62 | 215.73 | 185.67 |   |

# 6.0 Proposed Programmatic Process and ESA Compliance Options

The intent of KYTC and FHWA is to implement a programmatic consultation for the covered species that streamlines the consultation process and results in better conservation outcomes. This consultation is not intended to cover all types of potential adverse effects on the covered species and/or their habitat(s). Actions that are outside the scope of this consultation, or that may affect ESA listed species besides the covered species, or any designated critical habitat, will require separate or additional Section 7 consultation.

This proposed programmatic process provides a framework for conducting efficient ESA Section 7 consultations. This programmatic consultation applies only to those projects that can meet the effect determinations, project conditions, and conservation measures described in this document. KYTC will further coordinate with the KFO in order to develop a user’s guide and/or key to assist in the implementation of the programmatic process.

Use of this programmatic process is voluntary and for any project, KYTC may also choose to utilize a different method to achieve ESA compliance. These methods include: 1) use of the Tier 1 project review process and NE determination; 2) conduct a presence / absence survey; 3) use of the FHWA Rangewide Consultation; 4) request project specific informal consultation with the Service, or 5) request project specific formal consultation with the Service. Presence / absence surveys may be conducted in conjunction with informal or formal consultations.

# 7.0 Reporting and Documentation of Programmatic Process

KYTC will maintain adequate records for each of the covered species in order to document and support “no effect” and “not likely to adversely affect determinations” in accordance with the programmatic consultation. In addition, KYTC will monitor projects to (1) ensure that all of the identified Conservation Measures are implemented and maintained, as necessary, by the contractor(s) and (2) inform the KFO of any changes or deviations from these measures and request technical assistance.

KYTC will coordinate with FHWA to provide a monthly accounting ledger to the KFO that identifies qualified projects covered under the programmatic process outlined in the consultation. The ledger will address each of the covered species, be specific to each month’s project letting schedule, and will include all covered projects, including those where mitigation measures were not required. The report will identify those projects where mitigation is required and the preferred mitigation method.

Specific ledger information required for the programmatic consultation, roles and responsibilities, specific monitoring requirements, and other details regarding this process will be developed via coordination with the KFO. Examples of information that is likely required is:

* + - Description of the proposed action (e.g., type of action, location, involved federal agencies);
		- Verifies that the project is within the scope of the programmatic consultation;
		- Provides details of impacts (e.g., acres of tree removal, timing of tree removal, bridge work); and
		- Identifies all proposed conservation measures that will avoid, minimize and/or compensate the project’s impacts.

# 8.0 Conclusion

The KYTC is proposing to address ESA Section 7 consultations involving the covered species for transportation projects in Kentucky using a two-tiered, programmatic approach. The first tier is the use of a habitat assessment manual to determine if habitats for the covered species are present within a project area. If habitat is deemed to be present then tier two is utilized to analyze the potential impacts the project may have on one or more of the covered species. During the second tier, KYTC may achieve ESA compliance at the project specific level via several methods. Where it is likely that unavoidable adverse effects to the Indiana bat and gray bat could occur, the requested programmatic formal consultation and utilization of authorized incidental take would provide KYTC with a streamlined approach.

The FHWA and KYTC determine that the proposed Action, as described, is likely to adversely affect the Indiana bat and gray bat. However, many individual actions covered by the proposed programmatic approach will have no effect, or be not likely to adversely affect the Indiana bat and gray bat.

# Literature Cited

3D/International, Inc. 1996. 1996 field studies for interim mitigation for impacts to Indiana bats

at the Indianapolis International Airport in Marion County, Indiana. 125pp.

Adam, M.D. and J.P. Hayes. 2000. Use of bridges as night roosts by bats in the Oregon Coast Range. Journal of Mammalogy 81(2): 402-407.

Alsheimer, L.R. and K. Kazial. 2011. The effects of artificial night lighting on the Little Brown bat (*Myotis lucifugus*). Master’s Thesis, SUNY Fredonia, NY.

Barclay, R.M.R. and A. Kurta. 2007. Ecology and behavior of bats roosting in tree cavities and under bark. *In* M.J. Lacki, J.P. Hayes, and A. Kurta (eds), Bats in forests: conservation and management. Johns Hopkins University Press, Baltimore, MD.

Belwood, J.J. 1979. Feeding ecology of an Indiana bat community with emphasis on the endangered Indiana bat, Myotis sodalist. M.S. Thesis, University of FLoriday, Gainesville, FL. 103pp.

Belwood, J.J. 2002. Endangered bats in suburbia: observations and concerns for the future. Pp. 193-198 *in* A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Bennett, V.J., and A.A. Zurcher. 2013. When corridors collide: Road-related disturbance in commuting bats. The Journal of Wildlife Management 77(1):93-101.

Bennett, V. J., W. P. Smith, and M. G. Betts. 2011. Toward understanding the ecological impact of transportation corridors. General Technical Report. Pacific Northwest Research Station, USDA Forest Service.

Bennett, V.J., D.W. Sparks, and P.A. Zollner. 2013. Modeling the indirect effects of road networks on the foraging activities of an endangered bat. Landscape Ecology 28:979-991.

Berthinussen, A., and J. Altringham. 2012. The effect of a major road on bat activity and diversity. Journal of Applied Ecology 49:82–89.

Brack, V., Jr. 1983. The non-hibernating ecology of bats in Indiana with emphasis on the endangered Indiana bat, Myotis sodalis. Dissertation. Purdue University, West Lafayette, IN. 280 pp.

Brack, V., Jr. 1983. The non-hibernating ecology of bats in Indiana with emphasis on the endangered Indiana bat, Myotis sodalis. Dissertation. Purdue University, West Lafayette, IN. 280 pp.

Brack, V., and R.K. LaVal. 1985. Food habits of the Indiana bat in Missouri. Journal of Mammalogy, 66:308-315.

Brack, V., Jr. and R.K. LaVal. 2006. Diet of the gray bat (Myotis grisescens): variability and consistency, opportunism, and selectivity. Journal of Mammalogy, 87(1):7-18.

Brack, V., Jr., R.E. Mumford, and V.R. Holmes. 1984. The gray bat (Myotis grisescens) in Indiana. American Midland Naturalist 111:205.

Brady, J.T., T.H. Kunz, M.D. Tuttle, and D.E Wilson. 1982. Gray Bat Recovery Plan. U.S. Fish and Wildlife Service, Denver, CO. 143 pp.

Butchkoski, C.M., and J.M. Hassinger. 2002. Ecology of a maternity colony roosting in a building. Pp. 130–142 *in* A. Kurta and J. Kennedy, Eds. The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, Texas, 253 pp.

Callahan, E.V., III. 1993. Indiana bat summer habitat requirements. M.S. Thesis, University of Missouri, Columbia, MO.

Carter, T.C., W.M. Ford, and M.A. Menzel. 2002. Fire and bats in the southeast and mid-Atlantic: more questions than answers? *In* Ford, W. M., Russell, K. R., and Moorman, C. E., Eds. The role of fire in nongame wildlife management and community restoration: traditional uses and new directions: proceedings of a special workshop. Nashville, TN. USDA Forest Service, Northeastern Research Station, Newton Square, PA. p. 139-143, General Technical Report NE-288. <http://www.fs.fed.us/ne>.

Cervone, T.H., 2014. Results of Bat Survey dated 18 September 2014 for 1400597 I-65 Clark County Added Travel Lane. Lochmueller Group, Evansville, IN.

Cervone, T.H., R.K. Yeager, and R.A. King. 2016. Bats Under an Indiana Bridge. Proceedings of the Indiana Academy of Science 125(2): 91-102.

Cleveland, A.G. and J.G. Jackson. 2013. Environmental factors influencing the status and management of bats under Georgia (USA) bridges. Proceedings of the 2013 International Conference on Ecology and Transportation.

Downs, N.C., V. Beaton, J. Guest, J. Polanski, S.L. Robinson, and P.A. Racey. 2003. The effects of illuminating the roost entrance on the emergence behavior of *Pipistrellus pygmaeus*. Biological Conservation 111:247-252.

Feldhamer, G.A., T.C. Carter, A.T. Morzillo, and E.H. Nicholson. 2003. Use of Bridges as Day Roosts by Bats in Southern Illinois. Transactions of the Illinois State Academy of Science, Vol. 96, No. 2

Furlonger, C.L., H.J. Dewar, and M.B. Fenton. 1987. Habitat use by foraging insectivorous bats. Canadian Journal of Zoology 65:284-288.

Gaisler, J., Z. Rehak, and T. Bartonicka. 2009. Bat casualties by road traffic (Brno-Vienna). Acta Theriologica 54:147–155.

Gardner, J.E., J.D.Garner, and J.E. Hofmann. 1991. Summer roost selection and roosting behavior of *Myotis sodalis* (Indiana bat) in Illinois. Unpublished report to Region-3 U.S. Fish and Wildlife Service, Fort Snelling, MN. 56 pp.

Garner, J.D., and J.E. Gardner. 1992. Determination of summer distribution and habitat utilization of the Indiana bat (*Myotis sodalis*) in Illinois. Unpublished Report. Endangered Species Coordinator, Region 3, Service, Twin Cities, MN.

Grindal, S.D., T.S. Collard, R.M. Brigham, R.M.R. Barclay. 1992. The influence of precipitation on reproduction by *Myotis* bats in British Columbia. American Midland Naturalist 128(2): 339-344.

Gumbert, M.W., J.M. O’Keefe, and J.R. MacGregor. 2002. Roost fidelity in Kentucky Pp. 143-152 *in* A. Kurta and J. Kennedy (eds.), The Indiana Bat: Biology and Management of an Endangered Species. Bat Conservation International, Austin, TX.

Hawkins, J.A., J. Jaskula, A.Mann, and V. Brack, Jr. 2005. Habitat Conservation Plan: 2004 telemetry study of autumn swarming behavior of the Indiana bat (Myotis sodalis). Report prepared for the Indiana Department of Natural Resources, Indianapolis, IN. 25 pp. plus appendices.

Hendrick, L.B. 2008. Evaluation of the impacts of highway construction on sediment and benthic macroinvertebrates in Appalachian streams. PhD dissertation. West Virginia University, Morgantown, West Virginia.

Henley, W.F., M.A. Patterson, R.J. Neves, and A.D. Lemly. 2000. Effects of Sedimentation and turbidity on lotic food webs: a concise review for natural resource managers. Reviews in Fisheries Science. 8(2): 125-139.

Hicks, A.C. and P.G. Novak. 2002. History, status, and behavior of hibernating populations in the northeast. Pp. 35-47 in A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Hawkins, J.A., P.L. Sewell, and M.W. Gumbert. 2008. Final Report: Indiana bat survey and anthropogenic stimuli study conducted at US Army Garrison Fort Knox and Brashears Creek study sites during summer 2007. Copperhead Environmental Consulting, Inc.

Humphrey, S.R. 1978. Status, winter habitat, and management of the endangered Indiana bat, *Myotis sodalis*. Florida Scientist 41:65-76.

Humphrey, S.R. and J.B. Cope. 1977. Survival rates of the endangered Indiana bat, *Myotis sodalis*. Journal of Mammalogy 58:32-36.

Humphrey, S.R., A.R. Richter, and J.B. Cope. 1977. Summer habitat and ecology of the endangered Indiana bat, Myotis sodalis. Journal of Mammalogy 58:334-346.

Johnson, J.B., M.A. Menzel, J.W. Edwards, and W.M. Ford. 2002. Gray bat night-roosting under bridges. Journal of the Tennessee Academy of Science 0040-313X.

Jones, G. and J. Rydell. 1994. Foraging strategy and predation risk as factors influencing emergence time in echolocating bats. Philosophical Transactions of the Royal Society of London Series B, Biological Sciences. 346:445-455.

Jung, K., and E.K.V. Kalko. 2010. Where forest meets urbanization: foraging plasticity of aerial insectivorous bats in an anthropogenically altered environment. Journal of Mammalogy 91(1):144-153.

Kath, J.A. 2002. An overview of hibernacula in Illinois, with emphasis on the Magazine Mine. Pp. 110-116 in A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Keeley, B.W. and M.D. Tuttle. 1999. Bats in American Bridges. Bat Conservation International, Austin TX.

Kerth G. and M. Melber. 2009. Species-specific barrier effects of a motorway on the habitat use of two threatened forest-living bat species. Biological Conservation 142: 270-279.

King, R.A. 2017. Site visit and inspection of bats roosting beneath bridge in western Tippecanoe County, Indiana. U.S. Fish and Wildlife Service Memorandum. June 29, 2017.

Kiser, J.D. and C.L. Elliott. 1996. Foraging habitat, food habits, and roost tree characteristics of the Indiana bat (*Myotis sodalis*) during autumn in Jackson County, Kentucky. Report prepared for Kentucky Department of Fish and Wildlife Resources, Nongame Program, Frankfort, KY. 65 pp.

Kiser, J.D., J.R. MacGregor, J.D. Bryan, and A. Howard. 2002. Use of concrete bridges as night roosts in the Indiana Bat: Biology and Management of an Endangered Species. Bat Conservation International, Austin, TX.

Kniowski, A.B., and S.D. Gehrt. 2014. Home range and habitat selection of the Indiana bat in an agricultural landscape. Journal of Wildlife Management 78(3):503-512.

Kunz, T.H., J.A. Wrazen, C.D. Burnett. 1998. Changes in body mass and body composition in pre-hibernating little brown bats (*Myotis lucifugus*). Ecoscience 5: 8-17.

Kurta, A. and S.W. Murray. 2002. Philopatry and migration of banded Indiana bats (*Myotis sodalis*) and effects of radio transmitters. Journal of Mammalogy 83:585-589.

Kurta, A. and H. Rice. 2002. Ecology and management of the Indiana bat in Michigan. Michigan Academician 33:361-376.

Kurta, A., and J.O. Whitaker, Jr. 1998. Diet of the endangered Indiana bat (*Myotis sodalis*) on the northern edge of its range. American Midland Naturalist 140:280-286.

Kurta, A., K.J. Williams, and R. Mies. 1996. Ecological, behavioral, and thermal observations of a peripheral population of Indiana bats (*Myotis sodalis*). Pages 102-117 *in* Bats and Forests Symposium (R. M. R. Barclay and R. M. Brigham, eds.). Research Branch, British Columbia Ministry of Forests, Victoria, British Columbia, Canada, Working Paper 23:1-292.

Kurta, A., S.W. Murray, and D.H. Miller. 2002. Roost selection and movements across the summer landscape. Pp. 118-129 *in* A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Kurta A., G.P. Bell, K.A. Nagy, and T.H. Kunz. 1989. Energetics of pregnancy and lactation in free-ranging little brown bat (*Myotis lucifugus*). Physiological Zoology 62: 804–818.

LaVal, R.K. and M.L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Missouri Department of Conservation, Terrestrial Series 8:1-52.

LaVal, R.K., R.L. Clawson, M.L. LaVal and W. Caire. 1977. Foraging Behavior and

Nocturnal Activity Patterns of Missouri Bats, with Emphasis on the endangered species *Myotis grisescens* and *Myotis sodalis*. J. Mammalogy 58(4):592-599.

Lee, Y.F. 1993. Feeding ecology of the Indiana bat, *Myotis sodalist*, and resource partitioning with *Myotis keenii* and *Myotis lucifugus*. Unpubl. M.S. Thesis, the University of Tennessee, Knoxville, TN.

Lesinski, G. 2007. Bat road casualties and factors determining their number. Mammalia, 71, 138–142.

Lesinski, G. 2008. Linear landscape elements and bat casualties on roads—an example. Annales Zoologici Fennici 45:277–280.

Lesinski, G., A. Sikora, and A. Olszewski. 2011. Bat casualties on a road crossing a mosaic landscape. European Journal of Wildlife Research 2010:1–7.

Lewis, S.E. 1993. Effect of climatic variation on reproduction by pallid bats (*Antrozous pallidus*). Canadian Journal of Zoology 71:1429-1433.

Martin, C.O. 2005. Effects of military training noise on bat behavior. U.S. Army Corps of Engineers Threatened and Endangered Species Research Update Newsletter, November 2005:3-4.

Martin, C.O. 2007. Assessment of the population status of the gray bat (Myotis grisescens). Status review, DoD initiatives, and results of a multi-agency effort to survey wintering populations at major hibernacula, 2005-2007. Environmental Laboratory, U.S. Army Corps of Engineers, Engineer Research and Development Center Final Report ERDC/EL TR-07-22. Vicksburg, MS. 97pp.

Martin, C.O., R.F. Lance, B.M. Sabol, and L.L. Pater. 2004. An investigation of military training noise impacts on endangered bats. Paper B9-03 in B. C. Alleman and S. A. Downs, eds., Sustainable Range Management – 2004, Proceedings of the Conference on Sustainable Range Management, New Orleans, LA, 5-8 Jan 2004. Battelle Press, Columbus, OH.

Meteyer, C.U., E.L. Buckles, D.S. Blehert, A.C. Hicks, D.E. Green, V. Shearn-Bochsler, N.J.

Thomas, A. Gargas, and M.J. Behr. 2009. Histopathologic criteria to confirm white-nose syndrome in bats. Journal of Veterinary Diagnostic Investigation 21:411-414.

Mikula, P., F. Morelli, R.K. Lucan, D.N. Jones, P. Tryjanowski. 2016. Bats as prey of diurnal birds: a global perspective. Mammal Review 46: 160-174.

Murray, S.W. and A. Kurta. 2002. Spatial and temporal variation in diet. Pp. 182-192 *in* A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Murray, S.W. and A. Kurta. 2004. Nocturnal activity of the endangered Indiana bat (*Myotis sodalis).* Journal of Zoology 262:197-206.

Norberg, U.M., J.M.V. Rayner. 1987. Ecological morphology and flight in bats (Mammalia: Chiroptera): wing adaptations, flight performance, foraging strategy and echolocation. Philosophical Transactions of the Royal Society of London B. 316, 335-427.

Ormsbee, P.C., J.D. Kiser, and S.I. Perimeter. 2007. Importance of night roosts to the ecology of bats. Chapter 5 in Forests: Conservation and Management (M.J. Lacki, J.P. Hayes, and A. Kurta, Eds). John Hopkins University Press, Baltimore, MD.

Patterson, B.D., M.R. Willig, and R.D. Stevens. 2003. Trophic strategies, niche partitioning, and patterns of ecological organization. *In* T.H. Kunz and M.B. Fenton (Eds), Bat Ecology. The University of Chicago Press.

Racey, P.A. and A.C. Entwistle. 2003. Conservation ecology of bats. *In* T.H. Kunz and M.B. Fenton (Eds), Bat Ecology. The University of Chicago Press.

Reeder, D.M., C.L. Frank, G.R. Turner, C.U. Meteyer, A. Kurta, E.R. Britzke, M.E. Vodzak, S.R. Darling, C.W. Stihler, A.C. Hicks, R. Jacob, L.E. Grieneisen, S.A. Borwnlee, L.K. Muller, and D.S. Blehert. 2012. Frequent arousal from hibernation linked to severity of infection and mortality in bats with white-nose syndrome. PLoS ONE 7:e38920.

Reichard, J.D. and T.H. Kunz. 2009. White-nose syndrome inflicts lasting injuries to the wings of little brown myotis (*Myotis lucifugus*). Acta Chiropterologica, 11(2):457-464.

Roby, P. 2018. Summary of KY HWY 61 Bridge Use by Indiana Bats. Report submitted to the U.S. Fish and Wildlife Service, Frankfort, KY.

Russell, A.L., C.M. Butchkoski, L. Saidak, and G.F. McCracken. 2009. Road-killed bats, highway design, and the commuting ecology of bats. Endangered Species Research 8:49–60.

Rydell, J. 1992. Exploitation of insects around streetlamps by bats in Sweden. Functional Ecology 6(6):744-750.

Schaub, A., J. Ostwald, and B.M. Siemers. 2008. Foraging bats avoid noise. Journal of Experimental Biologist 211:3174-3180.

Silvis, A., A.B. Kniowski, S.D. Gehrt, and W.M. Ford. 2014. Roosting and foraging social structure of the endangered Indiana bat (*Myotis sodalis*). PloS ONE 9(5):1-12.

Sparks D.W., M.T. Simmons, C.L. Gummer, and J.E. Duchamp. 2003. Disturbance of roosting bats by woodpeckers and raccoons. Northeastern Naturalist 10:105-8.

Sparks, D.W., J.O. Whitaker, Jr., and C.M. Ritzi. 2005. Foraging ecology of the endangered Indiana bat. Pp. 15-27 *in* K.C. Vories and A. Harrington (eds.),The Proceedings of the Indiana bat and coal mining: a technical interactive forum. Office of Surface Mining, U.S. Department of the Interior, Alton, IL.

Speakman, J.R. and A. Rowland. 1999. Preparing for inactivity: how insectivorous bats deposit a fat store for hibernation. Proc. Nutr. Soc. 58(1): 123-131

Stone, E.L., G. Jones, and S. Harris. 2009. Street lighting disturbs commuting bats. Current Biology 19:1123-1127.

Stone, E.L., G. Jones, and S. Harris. 2012. Conserving energy at a cost to biodiversity? Impacts of LED lighting on bats. Global Change Biology 18:2458-2465.

Thomas, D. P. 1994. A radiotelemetric assessment of the foraging ecology of the gray bat (*Myotis grisescens*) at Guntersville Reservoir, Alabama. M.S. Thesis, Auburn University, AL.

Thomas, D.P. and T.L. Best. 2000. Radiotelemetric Assessment of Movement Patterns of the Gray Bat (*Myotis grisescens*) at Guntersville Reservoir, Alabama. In B.R. Chapman and J. Laerm, eds., Fourth Colloquium of Conservation of Mammals in the Southeastern United States. Occasional Papers of the North Carolina Museum of Natural Sciences and the North Carolina Biological Survey, Number 12, Fall 2000.

Tuttle, M.D. 1976. Population ecology of the gray bat (Myotis grisescens): Philopatry, timing and patterns of movement, weight loss during migration, and seasonal adaptive strategies. Occas. Papers 54:1-38, Museum of Natural History, University of Kansas, Lawrence, KS.

Tuttle, M.D. 1979. Status, cause of decline, and management of endangered gray bats. Journal of Wildlife Management 43:1-17.

Tuttle, M.D. and D. Stevenson. 1978. Variation in the cave environment and its biological implications. Pp. 108-121 in R. Zuber, J. Chester, S. Gilbert, and D. Rhodes (eds.), 1977 National Cave Management Symposium Proceedings. Adobe Press, Albuquerque, NM. 140 pp.

Tuttle, M.D. and J. Kennedy. 2002. Thermal requirements during hibernation. Pp. 68-78 in A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Tuttle, M.D. and J. Kennedy. 2005. Field guide to eastern cave bats. Bat Conservation International, Inc., Austin, TX. 41 pp.

U.S. Army Garrison Fort Drum. 2011. Biological Assessment on the proposed activities on the Fort Drum Military Installation, Fort Drum, New York (2012-2014) for the Federally-endangered Indiana bat (*Myotis sodalis*).

U. S. Fish and Wildlife Service (USFWS). 1967. Native Fish and Wildlife, Endangered Species. 32 FR 4001.

U. S. Fish and Wildlife Service (USFWS). 1976a. Determination of critical habitat for American crocodile, California condor, Indiana bat, and Florida manatee. 41 FR 41914-41916.

U. S. Fish and Wildlife Service (USFWS). 1976b. To the list of endangered and threatened species, Fish and Wildlife Service added the gray bat, Mexican wolf, and two butterfly species. 41 FR 17736-17740.

U.S. Fish and Wildlife Service (USFWS). 1999. Final biological opinion for the proposed streambank stabilization and the Yano Range and upgrade of the Wilcox Tank Range at Fort Knox, Kentucky. USFWS Cookeville Field Office, Cookeville, TN. 18 pp.

U.S. Fish and Wildlife Service (USFWS). 2002. Final biological opinion on the application for an incidental take permit for the federally endangered Indiana bat (*Myotis sodalis*) for the Six Points Road interchange and associated development. USFWS Bloomington Field Office, Bloomington, IN. 36 pp.

U.S. Fish and Wildlife Service (USFWS). 2007. Indiana bat (*Myotis sodalis*) Draft Recovery Plan: First Revision. Fort Snelling, MN.

U. S. Fish and Wildlife Service (USFWS). 2009. Gray Bat (Myotis grisescens) 5-year Review Summary and Evaluation. Columbia, MO. 34 pp.

U. S. Fish and Wildlife Service (USFWS). 2018. Programmatic Biological Opinion for Transportation Projects in the Range of the Indiana Bat and Northern Long-Eared Bat. Midwest Regional Office. Bloomington, MN. 163 pp.

U. S. Fish and Wildlife Service (USFWS). 2019. Range-Wide Indiana Bat Survey Guidelines (April 2018). United States Fish and Wildlife Service. 62 pp.

U. S. Fish and Wildlife Service Environmental Conservation Online System (USFWS ECOS). 2017a. Species Profile for Indiana bat (Myotis sodalis). https://ecos.fws.gov/ecp0/profile/speciesProfile?spcode=A000.

U. S. Fish and Wildlife Service Environmental Conservation Online System (USFWS ECOS). 2017b. Species Profile for Gray bat (Myotis grisescens). https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=6329.

U. S. Fish and Wildlife Service Indiana Ecological Services Field Office (USFWS IFO). 2017. 2017 Indiana Bat (Myotis sodalis) Population Status Update. https://www.fws.gov/midwest/Endangered/mammals/inba/pdf/2017IBatPopEstimate5July2017.pdf

U. S. Fish and Wildlife Service Kentucky Ecological Services Field Office (USFWS KFO). 2016. Revised Conservation Strategy for Forest-Dwelling Bats in the Commonwealth of Kentucky. Kentucky Ecological Services Field Office. Frankfort, KY. 32 pp.

Warnecke, L., J.M. Turner, T.K. Bollinger, J.M. Lorch, V. Misra, P.M. Cryan, G. Wibbelt, D.S.Blehert, and C.K.R. Willis. 2012. Inoculation of bats with European *Geomyces destructans* supports the novel pathogen hypothesis for the origin of white-nose syndrome. PNAS 109(18):6999-7003.

Whitaker, J.O., Jr. 2004. Prey selection in a temperate zone insectivorous bat community. Journal of Mammalogy 85:460-469.

Whitaker, J. O., Jr., L. Pruitt, and S. Pruitt. 2001. The gray bat, Myotis grisescens, in Indiana. Proceedings of the Indiana Academy of Science 110:114-122.

Wray S, Reason P, Wells D, Cresswell W and Walker H. 2006. Design, installation, and monitoring of safe crossing points for bats on a new highway scheme in Wales. *In* Proceedings of the 2005 International Conference on Ecology and Transportation, Eds. Irwin CL, Garrett P, McDermott

KP. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC: pp. 369-379.

Zhao, J., T.H. Kunz, N. Tumba, L.C. Schulz, C. Li, M. Reeves, and E.P. Widmaier. 2003. Comparative analysis of expression and secretion of placental leptin in mammals. American Journal of Physiology Regulatory, Integrative and Comparative Physiology 285: 438–446.

Zurcher, A.A, D.W. Sparks, and V.J. Bennett. 2010. Why the bat did not cross the road. Acta Chiropterologica 12:337–340.

# Appendix A – Habitat Assessment Manual

Electronic File

# Appendix B – Tiered Programmatic Project Review Process

**Programmatic Project Review Process**

Tier 1

KYTC personnel trained in the implementation of the HAM will conduct project reviews to determine if potential bat habitat is present and would be affected directly and/or indirectly by a specific project.

1) A “No Effect” determination is appropriate when the HAM review of a project results in a finding that NO suitable habitat for the specific covered species would be impacted by the project. No further consultation with KFO is required when this type of effects determination is reached.

2) If known or potential bat habitat (summer, winter, or foraging habitat) is identified for a proposed project, then a KYTC Subject Matter Expert (SME) will be contacted to provide assistance on the types of potential impacts, and how to address potential impacts via the Tier 2 project review process. (See Tier 2)

Tier 2

If the KYTC SME determines that a specific project does not meet the criteria for a “no

effect” finding, further analysis of the project will be pursued to determine the appropriate ESA

compliance option pursuant to the Tier 2 project review process.

Habitat assessments will be performed for proposed projects to determine if suitable habitat is present, or may be affected, for the covered species following the methods included in the KYTC HAM. The HAM includes office and field assessment methods for the covered species based on their known habitat preferences, as discussed in the Status of the Species sections. Due to the similarities in habitat preferences of the covered species, the assessment methods for these species are similar. Summaries of the office and field assessment methods for the covered species are included below.

**Office Assessment**

The office assessment for the covered species includes a review of available resources to identify caves and other karst features, cave-bearing geologic strata (e.g., Ordovician and Mississippian age limestone), abandoned mine portals/adits, underground quarries, rockshelters, and cliff lines within three miles of the project that could provide potential hibernacula for the covered species or year-round roosting habitat for the gray bat. Resources include U.S. Geological Survey topographic and geologic quadrangle maps, karst potential maps, and available mine maps from the Energy and Environment Cabinet Division of Mines. Coordination with cave and karst groups, such as the Kentucky Speleological Survey, is also performed when applicable. Features identified as potential habitat located within one-half mile of the project are evaluated further during the field assessment.

A review of topographic maps, aerial photography, right-of-way strip maps, and project plan sheets is also preformed to identify forested habitats that may provide summer roosting, foraging, and commuting habitat for the Indiana bat, as well as foraging and commuting habitat for the gray bat. Suitable summer habitat for the Indiana bat is considered to be forested areas comprised of trees that have a diameter at breast hight (dbh) of five inches or greater. Isolated trees are considered suitable roosting habitat if they exhibit the characteristics of a suitable roost tree and are located within 1,000 feet of other suitable habitat. Streams, lakes, and other water bodies are also located that could provide foraging and commuting habitat for the gray bat.

**Field Assessment**

During the field assessment, features identified as potential hibernacula and roosting habitat for the covered species located within one-half mile of the project are evaluated. A pedestrian survey of the project area is also conducted to evaluate features identified during the office assessment and locate any additional features that could provide potential habitat for the covered species. Identified features are assessed following the protocols provided in the most current version of the *Range-wide Indiana Bat Survey Guidelines* (USFWS 2019) <https://www.fws.gov/midwest/endangered/mammals/inba/surveys/pdf/2019_Rangewide_IBat_Survey_Guidelines.pdf>. Bridges and culverts located in the project area are also examined to document bat use, evidence of use, and structure characteristics to determine their potential as roosting habitat following the guidelines included in *Bridge/Structure Assessment Guidance of the Programmatic Biological Opinion for Transportation Projects in the Range of the Indiana Bat and Northern Long-Eared Bat* (USFWS 2018).

Forested habitat, streams, lakes, and other waterbodies identified as potential bat habitat are also evaluated during the field assessment. Areas of suitable habitat located in the project area are documented and marked on field maps.

# Appendix C – Best Management Practices

Sediment and Erosion Control Measures – Plans for the proposed project will include erosion control sheets that depict the DDAs and related information. These plan sheets will show the existing project conditions with areas delineated by DDAs within the right-of-way limits, discharge points, and areas that drain to each discharge point. Project managers and designers will analyze the DDAs and identify site-specific BMPs. The balance of the BMPs for the project will be listed in the bid documents for selection and use by the contractor on the project, with approval by the resident engineer. Erosion control sheets that do not have DDAs annotated will employ the same concepts for development and managing BMP plans.

The contractor and resident engineer will annotate the erosion control sheets showing location and type of BMPs for each of the DDAs that will be disturbed at the outset of the proposed project. This annotation will be accompanied by an order of work that reflects the order or sequence of major soil moving activities. The remaining DDAs are to be designated as "Do Not Disturb" until the contractor and resident engineer prepare the plan for BMPs to be employed. The initial BMPs shall be for the first phase (generally Clearing and Grubbing) and shall be modified as needed as the project changes phases. The BMP Plan will be modified to reflect disturbance in additional DDAs as the work progresses. All DDAs will have adequate BMPs in place before being disturbed.

Non-Structural BMPs – The following non-structural BMPs will be implemented throughout the project duration:

* Sediment control BMPs will be maintained when the sediment reaches 1/2 the depth of the BMP.
* Appropriate stock of straw erosion control blanket (ECB) and straw bales shall be available onsite at all times.
* Straw ECB or seeding mulched with blown straw followed by crimping shall be applied within seven days of the cessation of the land disturbing activity. If blown straw is used, the blower and crimping equipment shall be kept on-site during land disturbing activities.
* Disturbed areas shall be stabilized prior to a forecasted rain event.
* Erosion Prevention and Sediment Control/Stormwater Pollution Prevention Plan inspections shall be performed at least once a week and within 24 hours of the end of a rain event of 0.5 inches or greater.

Disturbed Drainage Areas – As DDAs are prepared for construction, the following will be addressed for the project as a whole or for each DDA, as appropriate:

* Construction Access – This is the first land-disturbing activity. As soon as construction begins, bare areas will be stabilized with straw ECB or straw followed by crimping, and designated construction entrances will be installed.
* Sources – At the beginning of the project, all DDAs for the project will be inspected for areas that are a source of storm water pollutants. Areas that are a source of pollutants will receive appropriate cover or BMPs to arrest the introduction of pollutants into storm water. Areas that have not been opened by the contractor will be inspected periodically (once per month) to determine if there is a need to employ BMPs to keep pollutants from entering storm water.
* Clearing and Grubbing – The following BMPs will be considered and used where appropriate:
	+ Leaving areas undisturbed when possible.
	+ Silt basins to provide silt volume for large areas.
	+ Silt Traps Type A for small areas.
	+ Silt Traps Type C in front of existing and drop inlets that are to be saved.
	+ Diversion ditches to catch sheet runoff and carry it to basins or traps, or to divert it around areas to be disturbed.
	+ Brush and/or other barriers to slow and/or divert runoff.
	+ Silt fences to catch sheet runoff on short slopes. For longer slopes, multiple rows of silt fence may be considered.
	+ Temporary mulch for areas which are not feasible for the afore mentioned types of protections.
	+ Non-standard or innovative methods.
	+ Spill Containment Areas to protect sinkholes and outfalls.
* Cut and FM and Placement of Drainage Structures – The BMP Plan will be modified to show additional BMPs, such as:
* Silt Traps Type B in ditches and/or drainways as they are completed.
* Silt Traps Type C in front of pipes after they are placed.
* Channel lining.
* ECB.
* ECB and/or straw, seeding, and crimping for areas where construction activities will be ceased for 14 days or more.
* Non-standard or innovative methods.
* Profile and X-Section in Place – The BMP Plan will be modified to show elimination of BMPs that had to be removed and the addition of new BMPs as the roadway was shaped. Probable changes include:
* Silt Trap Type A, brush and/or other barriers, temporary mulch, and any other BMP that had to be removed for final grading to take place.
* Additional Silt Traps Type B and Type C to be placed as final drainage patterns are put in place.
* Additional Channel Lining and/or ECB and/or Turf Reinforcement Mats.
* Temporary mulch and/or seeding for areas where construction activities will be ceased for 14 days or more.
* Finish Work (Paving, Seeding, Protect, etc.) – A final BMP Plan will result from modifications during this phase of construction. Probable changes include:
* Removal of Silt Traps Type B from ditches and drainways if they are protected with other BMPs that are sufficient to control erosion, i.e. ECB, Turf Reinforcement Mats, or Permanent Seeding and Protection on moderate grades.
* Permanent Seeding and Protection.
* Placing Sod.
* Post Construction – BMPs, including Karst policy BMPs, to be installed during construction to control the pollutants in stormwater discharges that will occur after construction has been completed are:
* Filter ditches: Filter ditches are grass swales placed at the outlets of some of the spill containment areas to promote infiltration and vegetative filtering.
* Spill containment areas: Detention/containment basins for capturing accidental spills on the newly constructed roadway will be provided in accordance with KYTC's Design Policy.

Other Control Measures – The following control measures will be utilized during project construction:

* Solid Materials – No solid materials, including building materials, shall be discharged to waters of the Commonwealth, except as authorized by a Section 404 permit.
* Waste Materials – All waste materials that may leach pollutants (paint and paint containers, caulk tubes, oil/grease containers, liquids of any kind, soluble materials, etc.) will be collected and stored in appropriate covered waste containers. Waste containers shall be removed from the project site on a sufficiently frequent basis as to not allow wastes to become a source of pollution. All personnel will be instructed regarding the correct procedure for waste disposal. Wastes will be disposed in accordance with appropriate regulations. Notices stating these practices will be posted in the office.
* Hazardous Waste – All hazardous waste materials will be managed and disposed of in the manner specified by local or state regulation. The contractor shall notify the Resident Engineer if there are any hazardous wastes being generated at the project site and how these wastes are being managed. Site personnel will be instructed with regard to proper storage and handling of hazardous wastes when required. The KYTC will file for generator registration, when appropriate, with the Division of Waste Management and advise the contractor regarding waste management requirements.
* Spill Prevention – The following material management practices will be used to reduce the risk of spills or other exposure of materials and substances to the weather and/or runoff.
	+ Good Housekeeping – The following good housekeeping practices will be followed onsite during the construction project:
		- An effort will be made to store only enough product required to do the job.
		- All materials stored onsite will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure.
		- Products will be kept in their original containers with the original manufacturer's label.
		- Substances will not be mixed with one another unless recommended by the manufacturer.
		- Whenever possible, all of the product will be used up before disposing of the container.
		- Manufacturers' recommendations for proper use and disposal will be followed. The site contractor will inspect daily to ensure proper use and disposal of materials onsite.
* Hazardous Products – These practices will be used to reduce the risks associated with any and all hazardous materials:
	+ Products will be kept in original containers, unless they are not re-sealable.
	+ Original labels and material safety data sheets (MSDS) will be reviewed and retained.
	+ Contractor will follow procedures recommended by the manufacturer when handling hazardous materials.
	+ If surplus product must be disposed of, manufacturers' or state/local recommended methods for proper disposal will be followed.
* The following product-specific practices will be followed onsite:
	+ Petroleum Products: Vehicles and equipment that are fueled and maintained on site will be monitored for leaks and receive regular preventative maintenance to reduce the chance of leakage. Petroleum products onsite will be stored in tightly sealed containers, which are clearly labeled and will be protected from exposure to weather. The contractor shall prepare an Oil Pollution Spill Prevention Control and Countermeasure plan when the project involves the storage of petroleum products in 55 gallon or larger containers with a total combined storage capacity of 1,320 gallons. This is a requirement of 40 CFR 112.
	+ Fertilizers: Fertilizers will be applied at rates prescribed by the contract, standard specifications, or as directed by the resident engineer. Once applied, fertilizer will be covered with mulch or blankets or worked into the soil to limit exposure to storm water. Storage will be in a covered shed. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills.
	+ Paints: All containers will be tightly sealed and stored indoors or under roof when not being used. Excess paint or paint wash water will not be discharged to the drainage or storm sewer system but will be properly disposed of according to manufacturers' instructions or state and local regulations.
	+ Concrete Truck Washout: Concrete truck mixers and chutes will not be washed on pavement, near storm drain inlets, or within 75 feet of any ditch, stream, wetland, lake, or sinkhole. Where possible, excess concrete and wash water will be discharged to areas prepared for pouring new concrete, flat areas to be paved that are away from ditches or drainage system features, or other locations that will not drain off site. Where this approach is not possible, a shallow earthen wash basin will be excavated away from ditches to receive the wash water.
	+ Spill Control Practices: In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup:
		- Manufacturers' recommended methods for spill cleanup will be clearly posted. All personnel will be made aware of procedures and the location of the information and cleanup supplies.
		- Materials and equipment necessary for spill cleanup will be kept in the material storage area. Equipment and materials will include, as appropriate, brooms, dust pans, mops, rags, gloves, oil absorbents, sand, sawdust, and plastic and metal trash containers.
		- All spills will be cleaned up immediately after discovery.
		- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.
		- Spills of toxic or hazardous material will be reported to the appropriate state/local agency, as required by KRS 224 and applicable federal law.
		- The spill prevention plan will be adjusted as needed to prevent spills from reoccurring and improve spill response and cleanup.
		- Spills of products will be cleaned up promptly. Wastes from spill clean-up will be disposed in accordance with appropriate regulations. Spills will be addressed in the "dry" and will not be "washed away" to clean.

Other State and Local Plans – The BMP plan shall include any requirements specified in sediment and erosion control plans, storm water management plans, or permits that have been approved by other state or local officials. Upon submittal of the Notice of Intent, other requirements for surface water protection are incorporated by reference into and are enforceable under this permit (even if they are not specifically included in this BMP plan). This provision does not apply to master or comprehensive plans, non-enforceable guidelines or technical guidance documents that are not identified in a specific plan, or permit issued for the construction site by state or local officials.

Maintenance – The BMP plan shall include a clear description of the maintenance procedures necessary to keep the control measures in good and effective operating condition. Maintenance of BMPs during construction shall be a result of once a week and post-rain event inspections, with action being taken by the contractor to correct deficiencies within three working days. Post construction maintenance will be a function of normal highway maintenance operations. Following final project acceptance by the KYTC, district highway crews will be responsible for identification and correction of deficiencies regarding ground cover and cleaning of storm water BMPs. Post-construction BMP maintenance will be covered in the KYTC’s MS4 permit under MCM 5 activities.

Inspections – Inspection and maintenance practices that will be used to maintain erosion and sediment controls include:

* All erosion prevention and sediment control measures will be inspected by the Contractor at least once a week and within 24 hours of the end of a rain event of 0.5 inches or greater.
* Inspections will be conducted by individuals that have received Kentucky Erosion Prevention and Sediment Control – Roadway Inspector (KEPSC-RI) training or other qualification as prescribed by the KYTC that includes instruction concerning erosion prevention and sediment control.
* Inspection reports will be written, signed, dated, and kept on file.
* Stabilization of disturbed areas shall be performed within 14 days of the cessation of the land disturbing activity.
* Disturbed areas shall be stabilized prior to a forecasted rain event.
* Sediment control BMPs will be maintained when the sediment reaches 1/2 the depth of the BMP.
* All measures will be maintained in good working order. If a repair is necessary, it will be initiated within 48 hours of being reported and completed within three working days.
* Silt fences will be inspected for bypassing, overtopping, undercutting, depth of sediment, tears, and to ensure attachment to secure posts.
* Diversion dikes and berms will be inspected and any breaches promptly repaired. Areas that are eroding or scouring will be repaired and re-seeded/mulched as needed.
* Temporary and permanent seeding and mulching will be inspected for bare spots, washouts, and healthy growth. Bare or eroded areas will be repaired as needed.
* All material storage and equipment servicing areas that involve the management of bulk liquids, fuels, and bulk solids will be inspected weekly for conditions that represent a release or possible release of pollutants to the environment.

Non-Storm Water Discharges – It is expected that non-storm water discharges may occur from the site during the construction period. Examples of non-storm water discharges include:

* Water from water line flushings.
* Water from cleaning concrete trucks and equipment.
* Pavement wash waters (where no spills or leaks of toxic or hazardous materials have occurred).
* Uncontaminated groundwater and rain water (from dewatering during excavation).

All non-storm water discharges will be directed to the sediment basin or to a filter fence enclosure in a flat vegetated infiltration area or be filtered via another approved commercial product.

Groundwater Protection Plan – This plan serves as the groundwater protection plan as required by 401 KAR 5:037.

# Appendix D – Indiana Bat Habitat Map

Electronic File