MID-STATES CORRIDOR

Appendix HH: Ecosystem Impacts

Mid-States Corridor
Tier 1 Environmental Impact Statement

Prepared for

Indiana Department of Transportation

Mid-States Corridor Regional Development Authority

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TABLES

INTRODUCTION

The purpose of this appendix is to provide details on the potential impacts to the ecosystem types and the potential ecological effects from construction of a new roadway. **Table 3.25-1** in Volume I highlight potential ecosystem impacts for end-to-end alternatives. The tables in this appendix provide impacts by section and facility type. Mitigation to offset the impacts from construction of the new roadway is also discussed. General strategies for development of Tier 2 mitigation are provided.

NATURAL REGIONS

A natural community consists of organisms interrelated to their environment, and amongst each other. Biotic and abiotic features such as glacial history, soil type, soil moisture, vegetation structure and topography define the boundary and extent of a natural community. Ten natural regions or natural communities have been defined and described by numerous authors (Homoya et al 1985, Whitaker et al. 2012) for Indiana. Many of these regions have one or more unique subregions. These natural regions and subregions dictate the types of habitats and the range of plant and animal species that occupy them.

Four of the ten natural regions described for Indiana occur within the Project Study Area. **Table 1**, **2**, **3**, **4** and **5** depict the mileage and acreage for each natural region and subregion crossed by the alternatives. **Table 6** depicts the mileage and acreage for each natural region and subregion crossed by the local improvements associated with each alternative. Some natural regions within the study area have characteristics like those prior to settlement, while many regions have been substantially altered and have very little natural habitat that is representative of pre-settlement conditions.

A detailed description of each natural region and subregion crossed by alternatives is provided.

The Southern Bottomlands Natural Region

The Southern Bottomlands Natural Region includes the frequently inundated floodplains and bottomlands along the silt-bottomed, low-gradient rivers and streams in Southwestern Indiana, like the Patoka River. Historically, this region had an equal mix of forest (39 percent) and forest/wetland (41 percent) complexes. Today the region is only 26.5 percent forested. Agriculture and grassland now account for 67.5 percent of the land cover within the region. Many species found within this natural region area are associated with the lower Mississippi Valley. Natural communities within the region include bottomland forest, swamps, marshes, sloughs, and wet prairie. Bottomland forest can be further divided into three distinct types of forest: swamp forest, hardwood bottoms, and ridge bottoms. The swamp forest occurs in areas of the floodplain where water stands throughout the year except during periods of extreme drought. The hardwood bottom zone is a diverse forest type that is frequently flooded and generally remains covered with water through the late winter and spring. Ridge bottom habitat is located along slightly higher elevations than hardwood bottoms. It contains some of the same tree species as hardwood bottoms but also contains species that are more sensitive to prolonged flooding.

Plants associated with these natural communities are all adapted to tolerate some degree of seasonal flooding. Trees often associated with these natural communities include pecan, bald cypress, black gum, bur oak, green ash, overcup oak, pin oak, red maple, shellbark hickory, silver maple, swamp white oak and sweet gum. Many other species of plants and animals are restricted to this region, including giant cane, American featherfoil, bloodleaf, cottonmouth, hieroglyphic turtle, diamond-backed watersnake, eastern mud turtle, northern copperbelly, swamp rabbit and yellow-crowned night heron.

Southwestern Lowlands Natural Region

The Southwestern Lowlands Natural Region is characterized by low relief and extensive aggraded valleys. It is bounded by the Shawnee Hills Natural Region to the east, the Wisconsinan glacial border to the north, the Southern Bottomlands Natural Region (along the Ohio River) to the south and the Wabash River (north of Vincennes) to the west. Much of the region is nearly level, undissected and poorly drained, although in several areas the topography is hilly and well drained. This region, except for the southern portion, was glaciated by the Illinoian ice sheet. Extant natural communities are mostly forest types. They are dominated by mixed hardwood forest composed of northern red oak, white oak, black walnut, wild black cherry, sugar maple, white ash, Virginia pine, eastern white pine and tulip poplar. Other habitats were historically present, including numerous barrens in the Plainville Sand subregion, and large areas of prairie occurred in the Glaciated subregions; but today they are rare. The region is divided into three subregions: the Plainville Sand Subregion, the Glaciated Subregion and the Driftless Subregion.

Plainville Sand Subregion

The Plainville Sand Subregion is a small but unique area of eolian sand dunes east of the Wabash River and the White River. The sandy, acid soils are mostly in the Princeton, Bloomfield and Ayrshire series. The barrens natural community type, now virtually gone from the landscape, was predominant on the ridges and well drained sites. Swamp, marsh, and wet prairie occupied the swales. The barrens vegetation consisted mostly of prairie species, along with a collection of sand dwelling species of western and southern affinities including beard grass, Carolina anemone, tube penstemon, clustered poppy-mallow, hairy golden-aster, narrowleaf dayflower, black hickory, sand hickory and rose gentian. Animal species geographically restricted here include bull snake, ornate box turtle and six-lined racerunner.

Glaciated Subregion

The Glaciated Subregion coincides with the advance and retreat of the Illinoian glaciers. The soils are predominantly silt loams with a thick layer of loess. Forest was historically dominant in the region, but several types of prairies also occurred. The flatwoods community type is common in this subregion. These include species such as shagbark hickory, shellbark hickory, pin oak, shingle oak, hackberry, green ash, red maple and silver maple.

Driftless Subregion

This subregion is south of the Illinoian glacial border and is characterized by a topography of low hills and broad valleys. This subregion has the longest growing season and highest average summer temperature in the state. Most natural communities are upland forest types, occupying well drained slopes. Southern flatwoods occupy the lacustrine plains and river terraces, which are characterized by cherry bark oak, sweetgum, shellbark hickory, pin oak, swamp white oak, Shumard's oak, green ash, black gum and post oak. Several state restricted species also occur within these southern flatwoods including Indian pink, black quillwort and lesquerella. The upland forest sites of this subregion are dry, oak-hickory dominated communities. The occurrence and abundance of southern red oak, post oak, blackjack oak and chestnut oak differentiate the upland forests of this section from those of the Glaciated Subregion. At least one acid seep spring community is known from this natural region. Other natural community types include marsh, swamp, sandstone cliff and low to medium-gradient streams.

Shawnee Hills Natural Region

The Shawnee Hills Natural Region is in the highly dissected southern portion of Indiana. This region is rugged and generally sparsely populated. Most natural communities within the region are upland forest types, although there are a few sandstone and limestone glades, gravel washes and barrens. This region represents general pre-settlement conditions better than any other terrestrial region in the state. The Shawnee Hills Natural Region was primarily upland forested (90 percent) prior to settlement. Forest composition varied based on physiography and whether the soils were derived from limestone, sandstone and/or shale. Many soils, particularly on broad ridges, also had fragipans causing seasonally high-water tables. Forest/wetland complexes historically covered seven percent and forest/prairie (i.e., savannah) covered about 3 percent of the region. Today, land cover within the region has been altered. Nearly 40 percent of the region has been converted from forest to agriculture or grassland, leaving only 57 percent in some type of forest cover. It has two subregions, the Crawford Upland Subregion and the Escarpment Subregion.

Crawford Upland Subregion

The Crawford Upland Subregion is distinguished by rugged hills with sandstone cliffs and rockhouses. The forest vegetation consists of an oak-hickory association of the upper slopes, while the coves have a mesic component. Characteristic upper slope tree species include black oak, white oak, chestnut oak, scarlet oak, post oak, pignut hickory, small-fruited hickory and shagbark hickory. There also are rare instances of sourwood. Cove forests, especially those associated with rockhouses, most resemble the mixed mesophytic forest communities. Characteristic species of these mesic forests include beech, tulip tree, red oak, sugar maple, black walnut and white ash. In this region yellow buckeye, white basswood, umbrella magnolia, hemlock and yellow birch also are found. The sandstone cliff and rockhouse communities provide an environment for several species with Appalachian affinities, making them a unique habitat type within the Shawnee Hills Natural Region.

Escarpment Subregion

The Escarpment Subregion includes the rugged hills situated along the eastern border of the Shawnee Hills Natural Region. It is a complex of the Crawford Upland and the Mitchell Karst Plain subregions of the Highland Rim. Sandstone and sandstone-derived soils cap most of the hills, and soils within the lower elevations are limestone-derived. Karst features are present within this subregion, especially in the lower and middle elevations where limestone is dominant. The natural communities consist of various upland forest types, especially dry-mesic and mesic complexes. The species composition is like that of the Crawford Upland Subregion, except that certain species such as post oak and black oak commonly replace chestnut oak in the dry sites. Some of the mesic cove species, especially those with Appalachian affinities, are absent. Limestone glades and barrens occur in this section but are not as common as in the Highland Rim Natural Region.

Highland Rim Natural Region

The Highland Rim Natural Region is located along the hilly terrain from the Bloomington-Nashville area south to the Ohio River. This region is dissected into relatively steep valleys with prominent karst topography typified by many sinkholes, dissolution valleys and a lack of surface water drainage. The bedrock is primarily limestone with some chert present. Weathered sandstone, siltstone, shale and some wind-blown loess are parent materials for these soils. Steep topography results in thin soils and many areas of exposed bedrock. Historically forest complexes covered 85 percent of the Highland Rim Natural Region. Forest composition varied across the region by physiographic position and soil parent materials. Today, approximately 49 percent of the region is forested, with over 45 percent of the land now agriculture or grasslands. This natural region is divided into three subregions: the Mitchell Karst Plain, the Brown County Hills and the Knobstone Escarpment. Only the Mitchell Karst Plain and Knobstone Escarpment subregions are located within the project study area.

Mitchell Karst Plain Subregion

The Mitchell Karst Plain Subregion is characterized by its large number of sinkholes and caves and very few surface streams. Several rare and unique natural communities exist in this subregion including caves, sinkholes, ponds, swamps, flatwoods, barrens, limestone glades and several upland forest types. The Karst Plain is relatively level, although limestone cliffs and rugged hills are present in some places, especially near the borders of the subregion. The soils are generally well drained silty loams derived from loess and weathered limestone. This subregion also contains numerous state restricted species including quillwort, netted chain fern, monkshood, mannagrass, blackstem spleenwort and glade violet. There also are many cave dwelling species, such as the Hoosier cavefish.

Knobstone Escarpment Subregion

The Knobstone Escarpment Subregion is composed of deeply dissected uplands underlain by siltstone, shale and sandstone. The soils are well drained acid silt loams with minor amounts of loess. Bedrock is near the surface but is rarely exposed. The natural communities are distinguished by the presence of Virginia pine in the upland forest communities. The pine is commonly a co-dominant with chestnut oak on many of the ridge crests and south facing slopes. American chestnut was dominant historically, given the frequency that it was mentioned in the General Land Office survey field notes. It has a continued presence today as stump sprouts. Its place has been taken by chestnut oak. Species restricted to this section include stout goldenrod, rattlesnake-weed, Virginia pine, red salamander, scarlet snake and crowned snake. Small and ephemeral high-gradient streams are the major aquatic features of this section.

ROADS AND THEIR ECOLOGICAL EFFECTS

Public roadways and their associated rights-of-way are a ubiquitous feature of the United States, covering nearly 1.5 percent of the land area (Turrentine et al 2001). Local roads make up nearly 70 percent of the of the 8.2 million lane miles yet carry only 13 percent of traffic. Most roadway networks in Indiana are located along surveyed section lines to provide humans a homogenous means of accessing land. This unnatural network interrupts landscape connectivity, disrupts natural hydrological process and inhibits ecological flow.

Construction of new roadways can create a series of ecological effects to ecosystems that have been well documented by numerous research studies (Forman and Alexander 1998, Trombulak and Frissell 2000, Donaldson 2005, Jaeger et al 2005, IOCOET 2001). Roadway construction removes the existing vegetation and creates disturbed soils that are prime areas for non-native vegetation to establish and become noxious. Building a new road can directly impact wildlife populations by habitat loss during construction. New roads often bisect pieces of intact habitat and fragment the existing habitat into two smaller pieces, creating edge effects. See "Habitat Fragmentation" section below for further discussion of edge effects. Fragmented habitats cause habitat patch size reduction and can result in resource inaccessibility for some species of wildlife. New roads can also create long distance effects from traffic noise. Effect-distances (i.e., the distance from a road in which a population density decrease is detected) for noise related impacts differ for various traffic densities and across species but can extend out several thousand feet from the edge of the road. Noise impacts can often be the greatest type of impact from new construction, especially in sensitive habitats.

Plants and Vegetation

Right-of way (ROW) surrounding paved roadways can be defined as an intensively managed strip that varies in width but generally measures less than 50 feet for most roadways. Management of ROW vegetation is usually in the form of periodic mowing for safety and aesthetic purposes. Very few ROW habitats are managed for wildlife; however, native prairie grasses have been introduced to numerous roadways with success and do represent deliberate management to support wildlife. Most often, ROW habitats maintain a sequence of poorly managed non-native and invasive vegetation patches that are of little value to most wildlife. The nature of these corridors provides perfect colonizing opportunities for many invasive plant species that can pose serious threats to adjacent and nearby natural habitats. Conversely in some landscapes such as intensive row crop agriculture areas, roadside vegetation can provide the only remaining natural habitat and may attract or harbor the only animal diversity. Roadside drainage ditches are often remnant stream features and can also harbor some of the only aquatic or wetland vegetation and thus attract a wide diversity of wildlife.

Wildlife Population Effects

Roadway corridors are not used by most wildlife for dispersal, movement or foraging. Most maintenance mowing regimes are too intense for most wildlife populations to persist. In cases where ROW maintenance is targeted for a specific habitat type, certain wildlife populations may succeed and thrive. One example is that planting native shrubs can increase nesting bird density and species richness. Adjacent ecosystems exert significant influences on wildlife populations within ROW as well.

Wildlife population effects can be broken down into several categories or types. Direct effects occur when there is a direct vehicle strike resulting in injury or mortality, often referred to as roadkill. A second category of impacts is avoidance. Species that purposely avoid roadways may be impacted by habitat inaccessibility. A third type of effect is the barrier or fragmentation effect, where species movements and dispersal are disrupted, which may lead to isolation of populations.

Vehicle Strikes

It is estimated within the United States there are between one to two million wildlife-vehicle collisions (WVC) in the US each year. The most common wildlife stuck by vehicles are large mammals, especially deer; however, smaller mammals and birds also are vulnerable to this type of impact. New roadway construction will inevitably lead to WVC. Strategically designed mitigation can reduce WVC. However, it generally is costly, and it is hard to prove or document its effectiveness. Populations of sensitive or rare species can be dramatically altered by WVC and must be included in planning and design of mitigation measures. Some animals are especially sensitive to WVC. These include species that have daily or seasonal migratory movements between local habitats, reptiles and amphibians' seasonal movement to and from breeding habitat, and rare species with small local populations and extensive individual home ranges.

Road Avoidance

Wildlife populations tend to avoid roads. Most species will avoid roads regardless of their surface or traffic volume, suggesting the response is based on "learned" behaviors that linear infrastructures are not habitat and to be avoided. The overall behavioral response can substantially decrease adjacent habitat quality over large scales, including nearby protected areas. Area sensitivity impacts to wildlife is well documented for many species and may result in significant impacts. Wildlife adapts to habitat types (e.g., grasslands, deciduous or coniferous forests, etc.) to maximize resources within that system. The adaptations occur slowly over generations developing the unique requirements for a given species to persist in its associated habitat. Once these requirements are impacted, the species no longer persists.

Habitat Fragmentation

Another direct effect from habitat fragmentation is known as the 'edge effect.' The edge effect occurs when the percentage of the habitat area exposed to an adjacent habitat type increases. Creating more exposed edges of non-similar habitat increases a host of impacts including invasive species encroachment, predation, changes to microclimate conditions and disease. Numerous studies have described the impact of edge effects on wildlife population dynamics and species persistence in fragmented landscapes (Cunningham and Johnson 2006; Fletcher and Koford 2003). Depending on the degree, the edge effect can effectively render habitat useless due to a wide range of ecological mechanisms that are hard to mitigate.

Barrier Effects

Barrier effects of roads are tied to dispersal and connectivity. The dispersal ability of individual organisms is a key factor in species survival. For most larger mammals roadways become a complete barrier only if fenced. For smaller animals, especially invertebrates, amphibians and reptiles, the road surface is a significant physical barrier. Similarly, aquatic species may be physically isolated upstream and downstream of an improperly installed culvert.

MITIGATION

Mitigation for impacts to habitat/species within the various natural regions will be included as part of the Tier 2 studies. General mitigation strategies have been developed to guide mitigation activities for Tier 2 studies to ensure that negative effects are minimized to the greatest extent possible.

Mitigation Strategies

Mitigation is a tool to offset impacts from construction of a new roadway. Creating, enhancing and/or protecting natural habitat are the three primary mechanisms for mitigating impacts. Mitigation planning during Tier 1 involves identifying strategies to implement for Tier 2 studies. Five general strategies have been developed and are detailed in the paragraphs below.

Identifying Appropriate Mitigation

Successful mitigation begins by planning and identifying appropriate mitigation. All mitigation is not equal. In some cases, compensatory mitigation is most beneficial to the species inhabiting the area if the mitigation is accomplished on site, such as impacts to streams. However, in other situations compensatory mitigation will be most meaningful and successful if accomplished at a location away from the impact areas. An example of this type of mitigation is the creation/enhancement/preservation of a large tract of land that is adjoining an existing natural community.

Mitigate for Multiple Species at a Single Location

Mitigation for multiple species at a single location, to achieve more ecologically significant results, is the first option after avoidance. An example of this is restoration of degraded woodland surrounding a channelized stream habitat and its associated riparian wetlands. This potentially would provide habitat for multiple species currently not supported within the degraded habitat.

Prioritize Special-Status Species

Special-status species will be prioritized for mitigation consideration because of their rarity, vulnerability to extirpation due to development pressures, habitat loss/degradation, and other anthropogenic pressures. Steps will be taken to ensure the Mid-States Project will not contribute to the escalation of federal or state listing status of critically imperiled, imperiled, and vulnerable species.

Address Water Quality and Erosion

The Tier 2 studies will develop a strategy to proactively address road related water quality and runoff. Plans will include specifications for the use and design of appropriate best management practices. Protection of high-quality rivers and streams from effects during and after construction is also a priority for the mitigation strategies.

Develop, Implement and Document

Impacts to habitats may occur within the four major natural regions and their associated subregions. At the beginning of Tier 2 Studies, field surveys will be conducted within the preferred corridor, to identify and map the types of natural habitats present and develop mitigation actions that specifically address each category of habitat that will be impacted. Habitats such as streams, rivers, wetlands, floodplains and forest will have specific mitigation goals and objectives based on actual impacts. Implementation of the recommended and approved mitigation needs will be outlined in detail to describe a successful mitigation action. Specific performance measures will be developed during the implementation phase that indicate if the mitigation goals and objectives are being met as intended. Additional activities for Tier 2 include a mitigation compliance documentation plan. Like the implementation plan, it will detail the required documentation and management actions.

Additional Mitigation Actions

Suggested mitigation studies/actions for Tier 2 include: culvert and bridge designs which allow for upstream movement of aquatic life, design lighting and fencing to reduce roadkill, and avoidance and minimization of forest fragmentation to the greatest extent possible. Also, the design of strategically placed wildlife crossings to permit the movements of reptiles, amphibians and mammals in areas with the highest potential for impacts.

Table 1: Potential Ecosystem Natural Region Impacts, Alternative B

*Alternatives		Section 2						Section 3							
Alternative	Variation*	SOUTHERN BOTTOMLANDS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION				SOUTHERN BOTTOMLANDS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION				**GRAND TOTALS	
		SOUTHERN BOTTOMLANDS SUBREGION		DRIFTLESS SUBREGION		GLACIATED SUBREGION		SOUTHERN BOTTOMLANDS SUBREGION		GLACIATED SUBREGION		PLAINVILLE SAND SUBREGION			
		miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres
B	B2-Expressway	7.94	378	14.14	722	0.99	47	2.41	127	7.66	467	0.30	498	33.44	2,239
	B3-Super 2	7.94	318	14.14	553	0.99	40	2.41	112	7.66	409	0.30	502	33.44	1,934
	LI-Local Improvements	3.55	119	6.16	136	0.04	1	- - -	- - -	1.66	29	- - -	- - -	11.41	285

* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and bypass variations. Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 are anticipated.
**Sections 2 and 3 only

Table 2: Potential Ecosystem Natural Region Impacts, Alternative C

*Alternatives		Section 2						Section 3							
Alternative	Variation*	SOUTHERN BOTTOMLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION		SOUTHERN BOTTOMLANDS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION		**GRAND TOTALS	
		SOUTHERN BOTTOMLANDS SUBREGION		CRAWFORD UPLAND SUBREGION		DRIFTLESS SUBREGION		CRAWFORD UPLAND SUBREGION		SOUTHERN BOTTOMLANDS SUBREGION		GLACIATED SUBREGION			
		miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres
C	C2 - Expressway	9.96	547	6.55	390	6.66	299	4.75	261	0.25	13	12.22	615	40.39	2,125
	C3 - Super 2	9.96	410	6.55	267	6.66	213	4.75	222	0.25	11	12.22	498	40.39	1,621
	LI-Local Improvements	4.16	124	0.30	7	7.14	148	- - -	- - -	- - -	- - -	- - -	- - -	11.6	279

* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and bypass variations. Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 are anticipated.
**Sections 2 and 3 only

TABLE 3: POTENTIAL ECOSYSTEM NATURAL REGION IMPACTS, ALTERNATIVE M

*Alternatives		Section 2						Section 3									
Alternative	Variation*	SOUTHERN BOTTOMLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION				HIGHLAND RIM NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION			
		SOUTHERN BOTTOMLANDS SUBREGION		CRAWFORD UPLAND SUBREGION		DRIFTLESS SUBREGION		CRAWFORD UPLAND SUBREGION		ESCARPMENT SUBREGION		MITCHELL KARST PLAIN SUBREGION		GLACIATED SUBREGION		**GRAND TOTALS	
		miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres
M	M2 - Expressway	9.96	547	6.55	390	6.66	298	32.23	2,134	2.91	202	4.09	838	^	4	62.40	4,413
	M3 -Super 2	9.96	410	6.55	267	6.66	213	32.23	1,795		182	4.09	784	^	1	59.49	3,652
	LI-Local Improvements	4.16	124	0.30	7	7.14	148	5.78	167	- - -	- - -	1.17	41	- - -	- - -	18.55	487

* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and bypass variations. Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 are anticipated.
**Sections 2 and 3 only
^ Less than 0.05 mile

TABLE 4: POTENTIAL ECOSYSTEM NATURAL REGION IMPACTS, ALTERNATIVE O

Alternatives		Section 2						Section 3							
Alternative	Variation*	SOUTHERN BOTTOMLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION				HIGHLAND RIM NATURAL REGION			
		SOUTHERN BOTTOMLANDS SUBREGION		CRAWFORD UPLAND SUBREGION		DRIFTLESS SUBREGION		CRAWFORD UPLAND SUBREGION		ESCARPMENT SUBREGION		MITCHELL KARST PLAIN SUBREGION		**GRAND TOTALS	
		miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres
O	O2 - Expressway	9.93	543	7.86	458	4.98	218	19.96	1,414	7.25	386	3.53	310	53.51	3,329
	O3 -Super 2	9.93	407	7.86	374	4.98	157	19.96	1,303	7.25	374	3.23	145	53.21	2,760
	LI-Local Improvements	4.16	124	0.30	7	7.14	148	5.26	122	- - -	- - -	- - -	- - -	16.86	401

* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and bypass variations. Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 are anticipated.
**Sections 2 and 3 only

TABLE 5: POTENTIAL ECOSYSTEM NATURAL REGION IMPACTS, ALTERNATIVE P

Alternatives			Section 2						Section 3					
Alternative	Variation*		SOUTHERN BOTTOMLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION			
			SOUTHERN BOTTOMLANDS SUBREGION		CRAWFORD UPLAND SUBREGION		DRIFTLESS SUBREGION		CRAWFORD UPLAND SUBREGION		GLACIATED SUBREGION		**GRAND TOTALS	
			miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres
P	Expressway	P2e – East Variation	9.96	547	6.55	390	6.66	299	21.16	1,087	9.48	447	53.81	2,770
		P2w – West Variation	9.96	547	6.55	390	6.66	299	17.18	843	13.71	682	54.06	2,761
	Super 2	P3e – East Variation	9.96	410	6.55	267	6.66	213	21.16	869	9.48	363	53.81	2,122
		P3w – West Variation	9.96	410	6.55	267	6.66	213	17.18	668	13.71	482	54.06	2,040
	LI-Local Improvements		4.16	124	0.30	7	7.14	148	4.56	131	1.85	47	18.01	457

* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and bypass variations. Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 are anticipated.
** Sections 2 and 3 only

Table 6: Potential Ecosystem Natural Region Impacts, RPA P

Alternatives			Section 2						Section 3					
Alternative	Variation*		SOUTHERN BOTTOMLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION		**GRAND TOTALS	
			SOUTHERN BOTTOMLANDS SUBREGION		CRAWFORD UPLAND SUBREGION		DRIFTLESS SUBREGION		CRAWFORD UPLAND SUBREGION		GLACIATED SUBREGION			
			miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres
RPA P	Expressway	RPA P1	9.96	547	6.55	390	6.66	298	17.18	843	13.72	628	54.07	2,706
		RPA P3	9.96	547	6.55	390	6.66	298	19.46	894	11.73	504	54.35	2,634
		RPA P4	9.96	547	6.55	390	6.66	298	20.17	1008	11.42	509	54.76	2,761
	Super 2	RPA P1	9.96	410	6.55	267	6.66	213	17.18	668	13.73	482	54.08	2,040
		RPA P2	9.96	410	6.55	267	6.66	213	17.64	621	13.03	403	53.83	1,913
		RPA P3	9.96	410	6.55	267	6.66	213	19.46	678	11.73	396	54.35	1,964
		RPA P4	9.96	410	6.55	267	6.66	213	20.17	794	11.42	401	54.76	2,085
	LI-Local Improvements		4.16	124	0.30	7	7.14	148	4.56	131	1.85	47	18.01	457

* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and bypass variations. Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 are anticipated.

** Sections 2 and 3 only

Table 7: Potential Ecosystem Natural Region Impacts, Alternative R

Alternatives			Section 2						Section 3					
Alternative	Variation*		SOUTHERN BOTTOMLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION		SHAWNEE HILLS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION		**GRAND TOTALS	
			SOUTHERN BOTTOMLANDS SUBREGION		CRAWFORD UPLAND SUBREGION		DRIFTLESS SUBREGION		CRAWFORD UPLAND SUBREGION		GLACIATED SUBREGION			
			miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres
R	Super 2	R	4.27	127	2.28	65	14.73	302	18.16	427	11.66	277	51.10	1,198

* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types, and bypass variations. Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 are anticipated.

** Sections 2 and 3 only

TABLE 8: POTENTIAL ECOSYSTEM NATURAL REGION IMPACTS, LOCAL IMPROVEMENTS

Local Improvements*				HIGHLAND RIM NATURAL REGION		SHAWNEE HILLS NATURAL REGION				SOUTHERN BOTTOMLANDS NATURAL REGION		SOUTHWESTERN LOWLANDS NATURAL REGION						GRAND TOTALS	
LI-#	Existing Road	Alternatives	Section	MITCHELL KARST PLAIN SUBREGION		CRAWFORD UPLAND SUBREGION		ESCARPMENT SUBREGION		SOUTHERN BOTTOMLANDS SUBREGION		DRIFTLESS SUBREGION		GLACIATED SUBREGION		PLAINVILLE SAND SUBREGION			
				miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres	miles	acres
LI-1	US 231	B, C, M, O, P, RPA P	2	---	---	---	---	---	---	---	---	1.27	23	---	---	---	---	1.27	23
LI-2	US 231	B, C, M, O, P, RPA P	2	---	---	---	---	---	---	2.53	84	0.63	27	---	---	---	---	3.16	11
LI-3	US 231	B, C, M, O, P, RPA P	2	---	---	---	---	---	---	0.85	33	0.64	21	---	---	---	---	1.50	54
LI-4	US 231	C, M, O, P, RPA P	2	---	---	---	---	---	---	0.78	7	2.43	28	---	---	---	---	3.20	35
LI-5	US 231	C, M, O, P, RPA P	2	---	---	0.30	7	---	---	---	---	2.17	48	---	---	---	---	2.46	55
LI-6	US 231	M, P, RPA P	3	---	---	2.65	84	---	---	---	---	---	---	---	---	---	---	2.65	84
LI-7	US 231	M, P, RPA P	3	---	---	1.13	30	---	---	---	---	---	---	---	---	---	---	1.13	30
LI-8	US 231	P, RPA P	3	---	---	0.78	17	---	---	---	---	---	---	---	---	---	---	0.78	17
LI-9	US 231	P, RPA P	3	---	---	---	---	---	---	---	---	---	---	1.85	47	---	---	1.85	47
LI-10	SR 56	B	2	---	---	---	---	---	---	0.17	3	1.87	31	---	---	---	---	2.04	33
LI-11	SR 257	B	2	---	---	---	---	---	---	---	---	1.74	34	0.04	1	---	---	1.78	35
LI-12	SR 257	B	3	---	---	---	---	---	---	---	---	---	---	1.66	29	---	---	1.66	29
LI-13	SR 450	M	3	---	---	1.99	53	---	---	---	---	---	---	---	---	---	---	1.99	53
LI-14	SR 450	M	3	1.17	41	---	---	---	---	---	---	---	---	---	---	---	---	1.17	41
LI-15	SR 56	O	3	---	---	1.69	42	---	---	---	---	---	---	---	---	---	---	1.69	42
LI-16	SR 56	O	3	---	---	1.07	28	---	---	---	---	---	---	---	---	---	---	1.07	28
LI-17	SR 145	O	3	---	---	1.42	30	---	---	---	---	---	---	---	---	---	---	1.42	30
LI-18	US 150	O	3	---	---	1.08	22	---	---	---	---	---	---	---	---	---	---	1.08	22

*Local Improvements are associated with the alternatives, although variations may be developed in Tier 2 for these local improvements, they are estimated as having the same impact regardless of which alternative it is associated with in Tier 1.