MID-STATES CORRIDOR

APPENDIX LL- Mineral resources

Mid-States Corridor
Tier 1 Environmental Impact Statement

Prepared for

Indiana Department of Transportation

Mid-States Regional Development Authority

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Prepared by

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INDIANA DEPARTMENT OF TRANSPORTATION INDOT

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TABLE OF CONTENTS

TABLES

FIGURES

1. INTRODUCTION

This appendix provides additional details regarding mineral resource impacts by the Mid-States alternatives. The tables in this appendix report impacts by individual working alignment variations including local improvements and sections. It contains resource maps. As described in **Volume I – Section 3.22**, mineral resources potentially impacted include hydrocarbon fuels (oil and gas, gas storage and coal), clay, sand and gravel, limestone and gypsum. Mineral resource calculations are provided for coal, oil and gas, clay, sand and gravel.

2. RESOURCE ANALYSIS

Coal

Active mining permits are valid for five years and can be renewed for additional five-year terms. Information on active coal mine permits was obtained from the Indiana Department of Natural Resources (IDNR) Coal Mine Information System (CMIS) website, CMIS Map Viewer (http://dnrmaps.dnr.in.gov/apps/cmis.htm) (**Table 1, Figure 1**). The mine operating entity may control other parcels of mineable coal within a 5-mile buffer that are unpermitted for mining. Applications for these resources may be pending or filed in the future. Determining such future plans would require consultation with coal operators during Tier 2 studies.

Coal resources for the western margin of the Study Area was analyzed directly from spatial data, maps of past mining activities and interpretation of known coal seams. Smaller area coal resources in the central and eastern part of the Study Area were analyzed by georeferencing a 1964 coal map from the Indiana Geological Survey (IGS). All impacts are associated with Alternatives B, C and P. The reserves in central Dubois County west of Jasper and Huntingburg (Alternative B area) are smaller and discontinuous. It is less likely that these will be mined in the future. Alternative B impacts occur in Section 2, while Alternative C impacts occur in Section 3. **Table 2** presents coal resources in the working alignment right-of-way for unique alternative variations and sections, while **Figure 2** displays the distribution of coal resources in the Study Area.

TABLE 1: ACTIVE MINE PERMITS NEAR MID-STATES ALIGNMENTS

Active Surface Coal Mine Permits Near Working Alignments*			
Nearby Routes	**Status**	**Permit**	**Name**
C	Active	S298	Solar Sources Cannelburg Mine
C	Reclaimation	S308	Peabody Midwest Mining, Viking, Corning Pit
B	Active	S340	Solar Sources Shamrock Mine
C	Active	S355	Solar Sources Antioch Mine
C, P	New	S364	Solar Sources Alfordsville Mine
B, C	New	S371	Trust Resources LLC, Vigo Captain Daviess Mine

* Indiana Department of Natural Resources (IDNR) Coal Mine Information System (CMIS) website, CMIS Map Viewer (http://dnrmaps.dnr.in.gov/apps/cmis.htm)

FIGURE 1: ACTIVE MINE PERMITS NEAR MID-STATES ALIGNMENTS

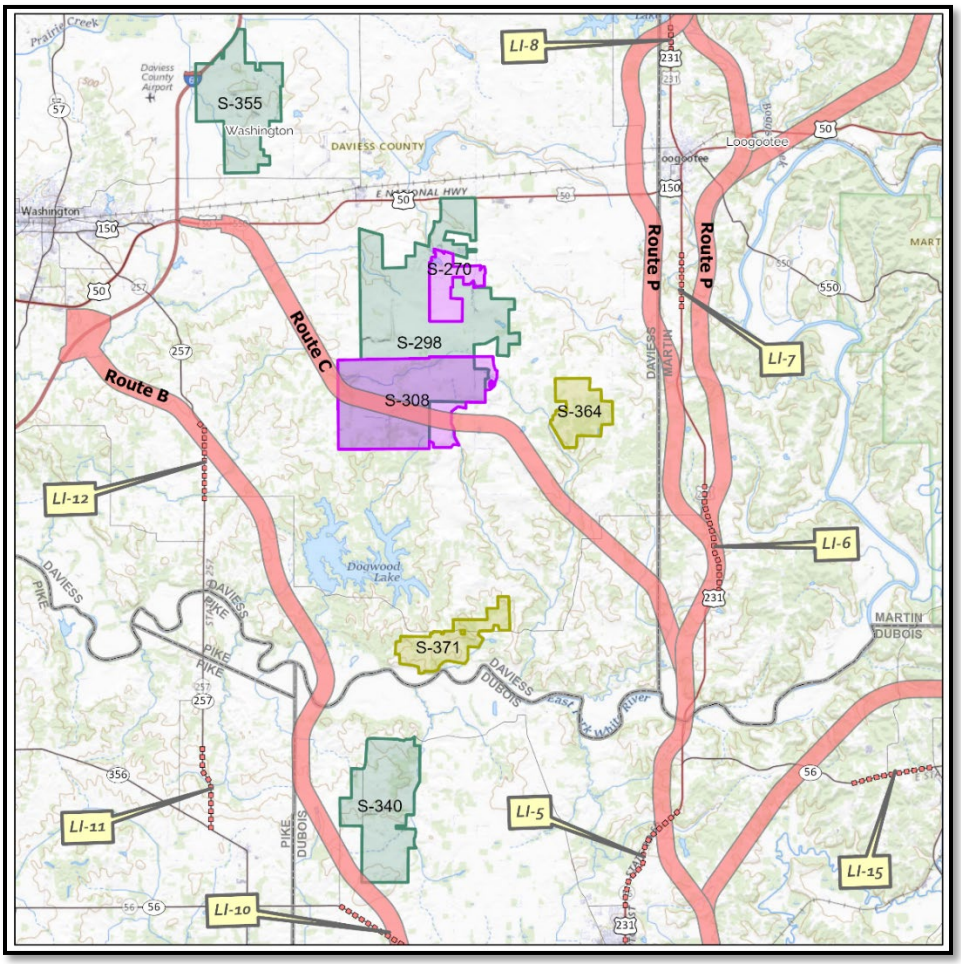


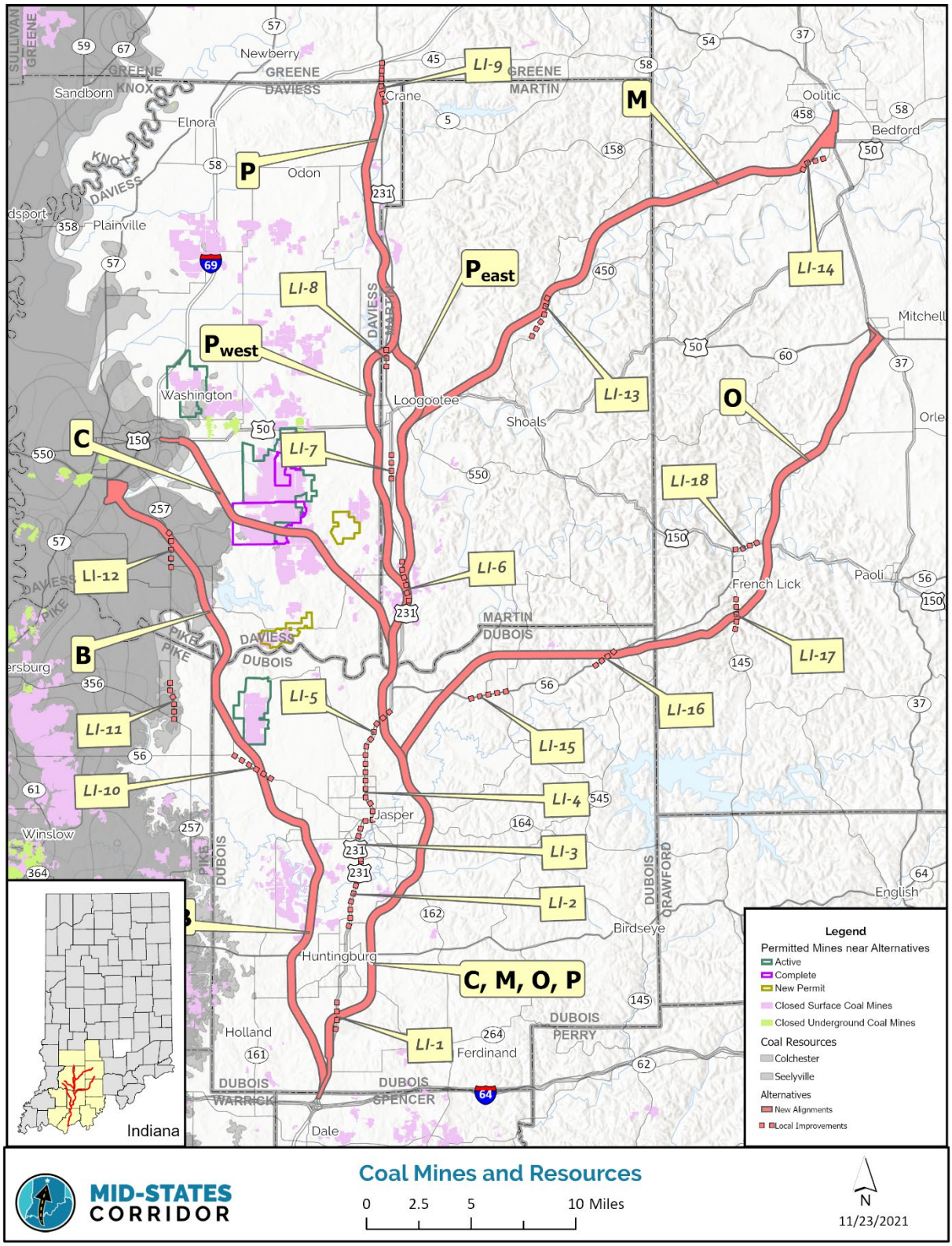
TABLE 2: COAL RESOURCES IN THE ALTERNATIVES BY SECTION

Coal Mine Impacts (Acres)												
Alternative*	B		C		M		O		P			
Variation	B2	B3	C2	C3	M2	M3	O2	O3	P2e	P2w	P3e	P3w
Active Coal Mine Permit Areas												
Section 2	-	-	-	-	-	-	-	-	-	-	-	-
Section 2 - LI**	-	-	-	-	-	-	-	-	-	-	-	-
Section 3	-	-	251	204	-	-	-	-	-	-	-	-
Section 3 - LI	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-	-	-
Total - LI	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total	-	-	251	204	-	-	-	-	-	-	-	-
Surface Mines (1880s - 2016) (Acres)												
Section 2	156	131	-	-	-	-	-	-	-	-	-	-
Section 2 - LI	-	-	-	-	-	-	-	-	-	-	-	-
Section 3	12	10	272	225	0.4	0.2	-	-	0.4	2	0.3	1
Section 3 - LI	-	-	-	-	4	4	-	-	4	4	4	4
Total	167	140	272	225	0.4	0.2	-	-	0.4	2	0.3	1
Total - LI	-	-	-	-	4	4	-	-	4	4	4	4
Grand Total	167	140	272	225	4	4	-	-	4	5	4	5
Underground Mines (1880s - 2016) (Acres)												
Section 2	17	14	0.4	0.4	0.4	0.4			0.4	0.4	0.4	0.4
Section 2 - LI			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Section 3	0.2	0.2							0.02	0.02	0.02	0.02
Section 3 - LI					0.4	0.4	0.1	0.1	0.4	0.4	0.4	0.4
Total	17	14	0.4	0.4	0.4	0.4	-	-	0.4	0.4	0.4	0.4
Total - LI			0.1	0.1	0.5	0.5	0.2	0.2	0.5	0.5	0.5	0.5
Grand Total	17	14	0	0	1	1	0	0	1	1	1	1

* 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.

** LI = Local Improvement

FIGURE 2: COAL RESOURCES IN THE MID-STATES STUDY AREA



Oil, Gas, and Gas Storage

Oil, gas, and gas storage sites were analyzed directly from spatial layers. Oil and Gas wells and fields were mapped by the IGS (2015) from its Petroleum Database Management System (PDMS) (**Figure 3**). GIS analysis was used to identify and count all well locations that intersected alternatives. Analysis of petroleum fields within alignment variations are presented in **Tables 3 – 5.** Petroleum fields are a generalized occurrence method of analysis. Given current technology and extraction processes, the construction of any alternative should not impact access to these petroleum field resources at depth below ground. Individual well count analysis is a more specific analysis where potential impacts may exist in the manner of loss of production or direct cost of production or plugging of wells located within a final right-of-way.

TABLE 3: PETROLEUM FIELD RESOURCES IN THE ALTERNATIVES BY SECTION

Petroleum Fields Impacts (acres)								
Alternative*	Variation	Section 2	Section 2 - LI**	Section 3	Section 3 - LI	Total	Total - LI	Grand Total
B	B2	288	4	506	29	794	33	**826**
	B3	221	4	440	29	661	33	**693**
C	C2	238	1	118	-	356	1	**356**
	C3	152	1	101	-	253	1	**254**
M	M2	238	1	67	27	305	28	**333**
	M3	152	1	57	27	209	28	**237**
O	O2	261	1	386	18	647	19	**666**
	O3	199	1	339	18	538	19	**558**
P	P2e	238	1	273	44	511	45	**556**
	P2w	238	1	485	44	723	45	**768**
	P3e	152	1	217	44	369	45	**415**
	P3w	152	1	378	44	530	45	**575**

* 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.

** LI = Local Improvement

TABLE 4: PETROLEUM FIELD RESOURCES IN THE LOCAL IMPROVEMENTS

Local Improvements*				Petroleum Fields Impacts (acres)
LI-#	Existing Road	Alternatives	Section	
LI-1	US 231	B, C, M, O, P	2	
LI-2	US 231	B, C, M, O, P	2	
LI-3	US 231	B, C, M, O, P	2	
LI-4	US 231	C, M, O, P	2	1
LI-5	US 231	C, M, O, P	2	
LI-6	US 231	M, P	3	12
LI-7	US 231	M, P	3	15
LI-8	US 231	P	3	17
LI-9	US 231	P	3	
LI-10	SR 56	B	2	2
LI-11	SR 257	B	2	2
LI-12	SR 257	B	3	29
LI-13	SR 450	M	3	
LI-14	SR 450	M	3	
LI-15	SR 56	O	3	18
LI-16	SR 56	O	3	
LI-17	SR 145	O	3	
LI-18	US 150	O	3	

* Local Improvements are associated with the alternative and do not change for variations within alternatives.

TABLE 5: OIL AND GAS WELL RESOURCES IN THE ALTERNATIVES BY SECTION

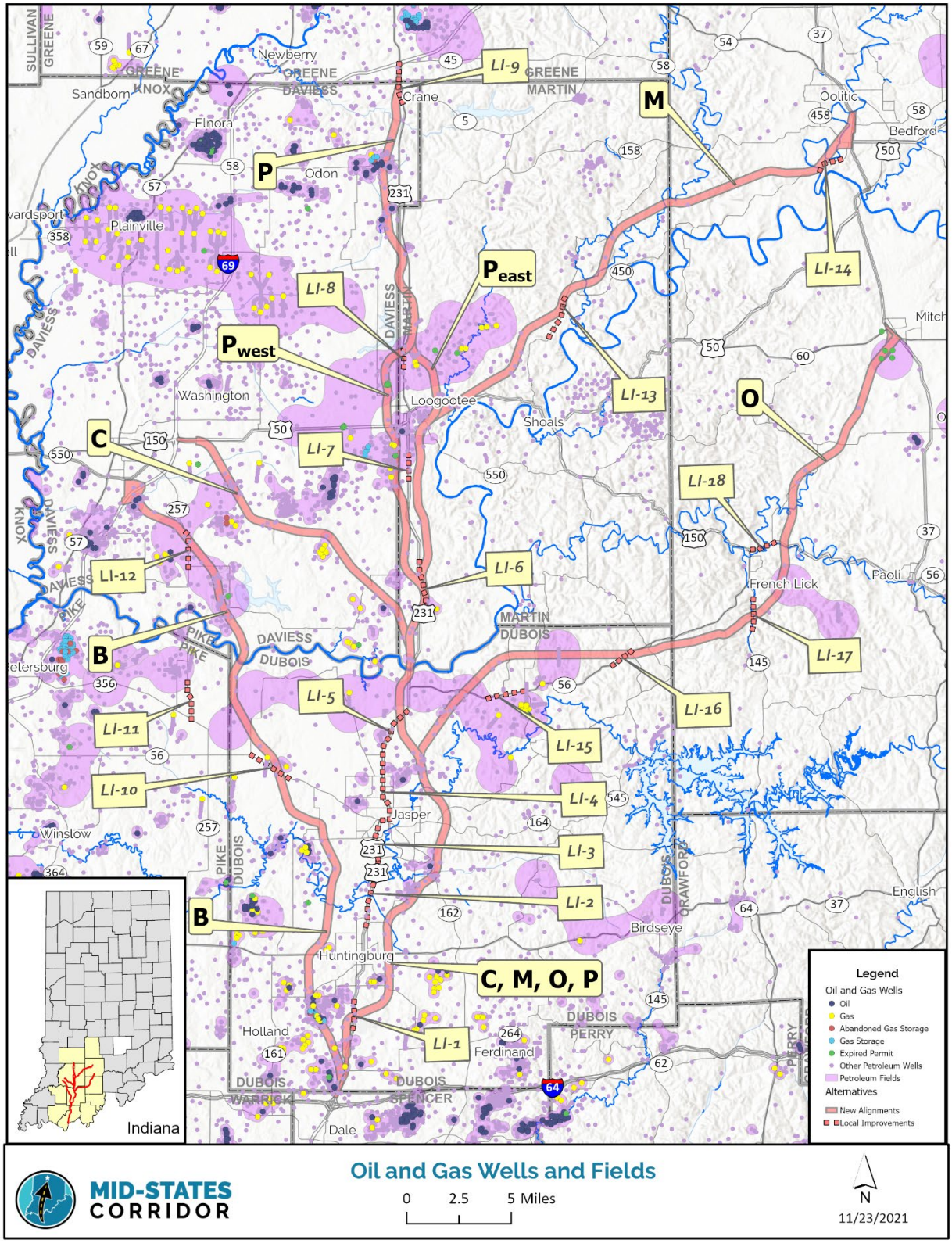
Impacts to Petroleum Wells (Oil, Gas, and Gas Storage)							
Alternatives*	Variation	Section	Abandoned Gas Storage Wells (count)	Gas Wells (count)	Gas Storage Wells (count)	Oil Wells (count)	Other Petroleum Test Wells** (count)
B	B2	2		3	4	1	6
		3	1			2	6
		Total	1	3	4	3	12
	B3	2		3	3	1	5
		3	1			2	6
		Total	1	3	3	3	11
C	C3	2					4
		3					7
		Total					11
	C3	2					2
		3					6
		Total					8
M	M2	2					4
		3					7
		Total					11
	M3	2					2
		3					7
		Total					9
O	O2	2					6
		3					5
		Total					11
	O3	2					3
		3					6
		Total					9
P	P2east	2					4
		3					7
		Total					11
	P2west	2					4
		3	1				13
		Total	1				17
	P3east	2					2
		3					6
		Total					8
	P3west	2					2
		3	1				10
		Total	1				12

*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.
No impacts to petroleum wells occur in the Local Improvements segments of the Alternatives.

** The "Other Test Wells" category includes dry holes, abandoned injection wells, borings, structure tests, and abandoned oil wells. Impacts to these wells will not impact the resource, but may require more detailed hazardous materials investigation before construction.

*** Petroleum fields can be accessed deep in the ground, even if some working alignments overlay their location. No resource impacts are expected.

FIGURE 3: PETROLEUM RESOURCES IN THE MID-STATES STUDY AREA



Clay Minerals

Clay resources were analyzed with spatial data created by IGS from the ilITH Database of water well drilling logs through year 2000. The point data were interpolated to estimate clay thickness for the Study Area (**Figure 4**). Clay resources were analyzed by acres and the percentage of the alignment containing resources in three thickness ranges below the ground (**Tables 6 - 8**). Local Improvements were analyzed for acres of resource and percentage in the ROW (**Table 6**). For all alternatives, Section 3 contains a large majority of the clay resources (**Table 7)**. For Alternative B, clay resources are most abundant in the 20-50 foot thick group in Section 3. In Alternatives M and O, the 10-20 foot thickness is most abundant. Alternatives C and P have similar distributions across the 10-20 and 20-50 foot thickness groups. All alternatives have few resources in the >50 feet thick category. The largest such area is associated with Alternative C near Washington. The thick clay deposits of Alternative C are associated with both the glacial alluvial deposits and with the much earlier coal swamp sedimentation sequences associated with coals. Alternative M contains the most clay mineral resources. These are associated with the East Fork of White River and its tributaries in Martin and Lawrence counties. Other clay resources are interbedded with shales and coal seams in the area. Alternative B has the smallest range of clay acres between variations (129 acres).

TABLE 6: CLAY RESOURCES BY THICKNESS IN THE LOCAL IMPROVEMENTS

Local Improvements*					Clay Resource Impacts							
LI-#	Existing Road	Alternatives	Section	ROW (acres)	10 -20 Feet Thick		20-50 Feet Thick		> 50 Feet Thick		Total Clay	
					Acres	% of LI ROW	Acres	% of LI ROW	Acres	% of LI ROW	Acres	% of LI ROW
LI-1	US 231	B, C, M, O, P	2	275	0	0%	0	0%	0	0%	0	0%
LI-2	US 231	B, C, M, O, P	2	1337	377	28%	435	33%	175	13%	987	74%
LI-3	US 231	B, C, M, O, P	2	649	119	18%	345	53%	163	25%	627	97%
LI-4	US 231	C, M, O, P	2	351	96	27%	137	39%	4	1%	237	67%
LI-5	US 231	C, M, O, P	2	552	58	11%	127	23%	315	57%	500	91%
LI-6	US 231	M, P	3	505	60	12%	159	32%	22	4%	241	48%
LI-7	US 231	M, P	3	180	1	0.3%	166	92.3%	0	0%	167	92.6%
LI-8	US 231	P	3	68	68	100%	0	0%	0	0%	68	100%
LI-9	US 231	P	3	187	12	6%	172	92%	0	0%	184	98%
LI-10	SR 56	B	2	66	12	18%	1	2%	3	4%	16	24%
LI-11	SR 257	B	2	69	6	9%	41	60%	17	25%	64	93%
LI-12	SR 257	B	3	58	23	40%	35	60%	0	0%	58	100%
LI-13	SR 450	M	3	106	31	29%	0	0%	0	0%	31	29%
LI-14	SR 450	M	3	82	3	4%	74	91%	0	0%	77	94%
LI-15	SR 56	O	3	84	1	1%	0	0%	0	0%	1	1%
LI-16	SR 56	O	3	56	38	68%	13	23%	0	0%	51	91%
LI-17	SR 145	O	3	60	58	97%	2	3%	0	0%	60	100%
LI-18	US 150	O	3	45	31	69%	14	31%	0	0%	45	100%

* Local Improvements are associated with the alternative and do not change for variations within alternatives.

TABLE 7: CLAY MINERAL RESOURCES (ACRES) IN THE ALTERNATIVES BY SECTION

Clay Resources Impacts (acres)												
Alternative*	B		C		M		O		P			
Variation	B2	B3	C2	C3	M2	M3	O2	O3	P2e	P2w	P3e	P3w
10-20 Foot Thickness (acres)												
Section 2	299	250	271	192	271	192	362	289	271	271	192	192
Section 2 - LI**	50	50	57	57	57	57	57	57	57	57	57	57
Section 3	152	131	281	233	1,332	1,180	1,246	1,088	602	624	483	497
Section 3 - LI	11	11	-	-	27	27	64	64	30	30	30	30
Total	451	381	552	425	1,603	1,372	1,608	1,377	873	895	675	689
Total - LI	61	61	57	57	84	84	121	121	87	87	87	87
Grand Total	**512**	**443**	**609**	**482**	**1,686**	**1,456**	**1,729**	**1,497**	**960**	**982**	**762**	**776**
20-50 Foot Thickness (acres)												
Section 2	78	61	247	170	247	170	138	108	247	247	170	170
Section 2 - LI	86	86	91	91	91	91	91	91	91	91	91	91
Section 3	895	853	309	250	803	693	132	49	397	418	326	313
Section 3 - LI	17	17	-	-	91	91	14	14	97	97	97	97
Total	973	914	556	420	1,050	863	270	157	644	665	496	483
Total - LI	103	103	91	91	182	182	105	105	188	188	188	188
Grand Total	**1,077**	**1,017**	**648**	**512**	**1,232**	**1,045**	**375**	**263**	**832**	**853**	**684**	**672**
> 50 Foot Thickness (acres)												
Section 2	-	-	33	24	33	24	17	14	33	33	24	24
Section 2 - LI	39	38	60	60	60	60	60	60	60	60	60	60
Section 3	1	2	182	149	88	63	-	-	64	25	48	21
Section 3 - LI	-	-	-	-	4	4	-	-	4	4	4	4
Total	1	2	215	173	121	87	17	14	97	58	72	45
Total - LI	39	38	60	60	64	64	60	60	64	64	64	64
Grand Total	**40**	**40**	**275**	**233**	**185**	**151**	**77**	**74**	**160**	**122**	**136**	**109**
Total Clay (acres)												
Section 2	377	311	551	386	550	386	516	411	551	551	386	386
Section 2 - LI	175	175	208	208	208	208	208	208	208	208	208	208
Section 3	1,049	985	773	632	2,223	1,935	1,379	1,136	1,063	1,067	857	831
Section 3 - LI	29	29	-	-	122	122	78	78	131	131	131	131
Total	1,426	1,296	1,324	1,018	2,773	2,321	1,895	1,547	1,614	1,618	1,243	1,217
Total - LI	204	204	208	208	330	330	286	286	339	339	339	339
Grand Total	**1,629**	**1,500**	**1,532**	**1,226**	**3,103**	**2,651**	**2,181**	**1,834**	**1,953**	**1,957**	**1,582**	**1,556**

* 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.

** LI = Local Improvement

TABLE 8: CLAY MINERAL RESOURCES (PERCENTAGE) IN THE ALTERNATIVES BY SECTION

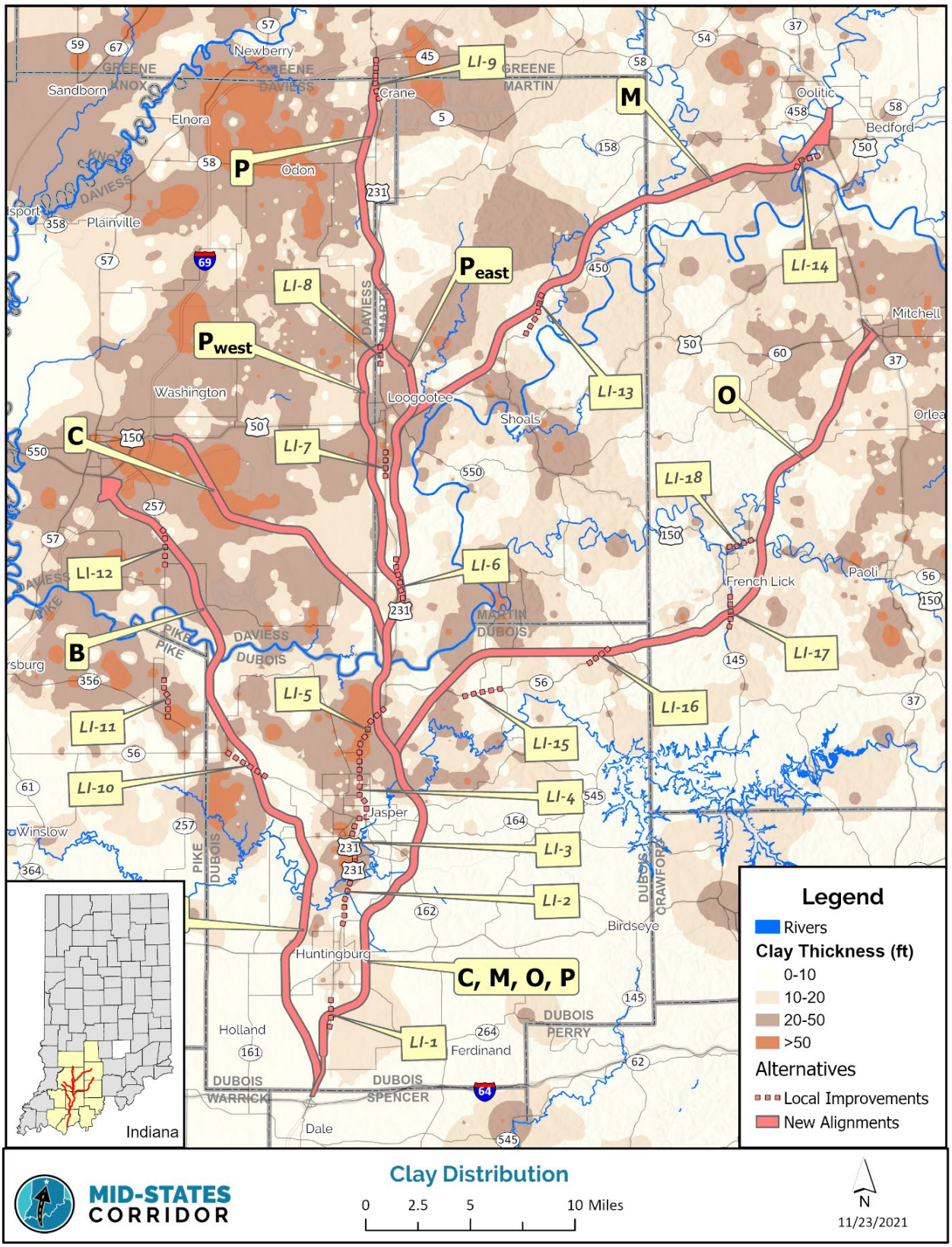
Clay Resources Impacts (% of ROW Subsection)												
Alternative*	**B**		**C**		**M**		**O**		**P**			
Variation	**B2**	**B3**	**C2**	**C3**	**M2**	**M3**	**O2**	**O3**	**P2e**	**P2w**	**P3e**	**P3w**
10-20 Foot Thickness (% of ROW Subsection)												
Section 2	26%	27%	22%	22%	22%	22%	30%	31%	22%	22%	22%	22%
Section 2 - LI**	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Section 3	14%	13%	32%	32%	42%	43%	59%	60%	39%	42%	39%	43%
Section 3 - LI	38%	38%			13%	13%	52%	52%	17%	17%	17%	17%
Total	20%	20%	26%	26%	36%	38%	48%	50%	32%	33%	32%	34%
Total - LI	21%	21%	20%	20%	17%	17%	30%	30%	19%	19%	19%	19%
Grand Total	**20%**	**20%**	**25%**	**25%**	**34%**	**35%**	**46%**	**47%**	**30%**	**31%**	**30%**	**31%**
20-50 Foot Thickness (% of ROW Subsection)												
Section 2	7%	7%	20%	19%	20%	19%	11%	12%	20%	20%	19%	19%
Section 2 - LI	34%	34%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%
Section 3	82%	83%	35%	34%	25%	25%	6%	3%	26%	28%	26%	27%
Section 3 - LI	59%	59%			44%	44%	11%	11%	54%	54%	54%	54%
Total	43%	47%	26%	26%	24%	24%	8%	6%	23%	25%	23%	24%
Total - LI	36%	36%	33%	33%	37%	37%	26%	26%	41%	41%	41%	41%
Grand Total	**43%**	**46%**	**27%**	**27%**	**25%**	**25%**	**10%**	**8%**	**26%**	**27%**	**27%**	**27%**
> 50 Foot Thickness (% of ROW Subsection)												
Section 2			3%	3%	3%	3%	1%	1%	3%	3%	3%	3%
Section 2 - LI	15%	15%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%
Section 3			20%	20%	3%	2%			4%	2%	4%	2%
Section 3 - LI					2%	2%			2%	2%	2%	2%
Total			10%	11%	3%	2%	1%	1%	4%	2%	3%	2%
Total - LI	14%	13%	22%	22%	13%	13%	15%	15%	14%	14%	14%	14%
Grand Total	**2%**	**2%**	**11%**	**12%**	**4%**	**4%**	**2%**	**2%**	**5%**	**4%**	**5%**	**4%**
Total Clay (% of ROW Subsection)												
Section 2	33%	34%	45%	43%	45%	43%	42%	44%	45%	45%	43%	43%
Section 2 - LI	68%	68%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Section 3	96%	96%	87%	86%	70%	70%	65%	62%	69%	73%	70%	72%
Section 3 - LI	100%	100%			59%	59%	64%	64%	74%	74%	74%	74%
Total	64%	67%	62%	63%	63%	64%	57%	56%	58%	60%	59%	60%
Total - LI	72%	72%	75%	75%	68%	68%	71%	71%	74%	74%	74%	74%
Grand Total	**65%**	**68%**	**64%**	**65%**	**63%**	**64%**	**58%**	**58%**	**61%**	**62%**	**61%**	**62%**

Percentages are calculated using the acres of resource in a subsection divided by the acres of that subsection. For example, B2 Section 2-LI is calculated by dividing the amount of impact acres in Alt B2, Section 2-LI by the total acres of LI ROW in Section 2.

* 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.

** LI = Local Improvement

FIGURE 4: CLAY MINERAL THICKNESS IN THE MID-STATES STUDY AREA



Sand and Gravel

Sand and gravel are commonly recovered from a mixed deposit which is sorted by particle size, although some sand-only deposits may be found. Large areas of sand and gravel deposits occur adjacent to and along major rivers in Southern Indiana where they washed out of melting glaciers upstream (**Figure 5**). The melt waters flowing in the stream channels further winnowed these deposits, separating the constituents by grain size. These include gravels, sands and clay muds. Segregated by particle size, these deposits have been subsequently eroded and resorted, as they continue to migrate down river valleys. Economic concentrations of sand and gravel were analyzed for the alternatives using spatial data created by IGS (**Table 9 – 11**).

These spatial data were derived by assigning qualitative permissive tract assessments to each outcrop area in Gray, H. H., 1989, "Quaternary geologic map of Indiana: Indiana Geological Survey Miscellaneous Map 49". The data set identified areas likely to contain economic concentrations of the resource as "potential" and areas that may contain economic concentrations of the resource as "low potential". The majority of impacts for all alternatives are "low potential" resource areas (**Table 10**). Most acres of "potential" resource occur in Section 2. Only Alternative P has likely potential resources in Section 3.

TABLE 9: SAND AND GRAVEL RESOURCES (ACRES AND PERCENTAGE) IN THE LOCAL IMPROVEMENTS

Local Improvements*					Impacts to Sand and Gravel Potential Resources^					
LI-#	Existing Road	Alternatives	Section	ROW (acres)	Potential^^ Resource		Low Potential Resource		Total Resource	
					Acres	% of LI ROW	Acres	% of LI ROW	Acres	% of LI ROW
LI-1	US 231	B, C, M, O, P	2	275			72	26%	72	26%
LI-2	US 231	B, C, M, O, P	2	1337			729	55%	729	55%
LI-3	US 231	B, C, M, O, P	2	649			649	100%	649	100%
LI-4	US 231	C, M, O, P	2	351	77	22%	143	41%	220	63%
LI-5	US 231	C, M, O, P	2	552	139	25%	308	56%	447	81%
LI-6	US 231	M, P	3	505						
LI-7	US 231	M, P	3	180						
LI-8	US 231	P	3	68						
LI-9	US 231	P	3	187	137	73%	19	10%	156	83%
LI-10	SR 56	B	2	66			66	100%	66	100%
LI-11	SR 257	B	2	69			24	34%	24	34%
LI-12	SR 257	B	3	58			22	39%	22	39%
LI-13	SR 450	M	3	106			3	3%	3	3%
LI-14	SR 450	M	3	82						
LI-15	SR 56	O	3	84						
LI-16	SR 56	O	3	56						
LI-17	SR 145	O	3	60			46	77%	46	77%
LI-18	US 150	O	3	45			45	100%	45	100%

^Indiana Geological Survey created the sand and gravel resource potential data in 2003 by assigning qualitative permissive tract assessments to each outcrop area in Gray, H. H., 1989, Quaternary geologic map of Indiana: Indiana Geological Survey Miscellaneous Map 49. The attribute table data was derived from Gray, H. H., 1973, Properties and uses of geologic materials in Indiana: Indiana Geological Survey Regional Geologic Map Supplementary Chart 1 and Carr, D. D., and Webb, W. M., 1970, Sand and gravel resources of Indiana: Indiana Geological Survey Bulletin 42-D, 31 p.

^^ "Potential resource" indicates that the surficial unconsolidated deposits are likely to contain economic concentrations of sand and gravel, "low potential" indicates that the surficial unconsolidated deposits may contain economic concentrations of sand and gravel.

* Local Improvements are associated with the alternative and do not change for variations within alternatives.

TABLE 10: SAND AND GRAVEL RESOURCES (ACRES) IN THE ALTERNATIVES BY SECTION

Impacts to Sand and Gravel Potential Resources^												
Alternative*	B		C		M		O		P			
Variation	B2	B3	C2	C3	M2	M3	O2	O3	P2e	P2w	P3e	P3w
Potential^^ Resource (acres)												
Section 2	125	106	71	44	71	44	2	2	71	71	44	44
Section 2 - LI**	-	-	22	22	22	22	22	22	22	22	22	22
Section 3	-	-	-	-	-	-	-	-	40	40	31	31
Section 3 - LI	-	-	-	-	-	-	-	-	34	34	34	34
Total	125	106	71	44	71	44	2	2	111	111	75	75
Total - LI	-	-	22	22	22	22	22	22	56	56	56	56
Grand Total	**125**	**106**	**93**	**66**	**93**	**66**	**24**	**24**	**167**	**167**	**131**	**131**
Low Potential Resource (acres)												
Section 2	492	378	342	249	342	249	304	227	342	342	249	249
Section 2 - LI	166	166	166	166	166	166	166	166	166	166	166	166
Section 3	319	301	104	84	382	334	92	80	245	285	202	217
Section 3 - LI	11	11	-	-	2	2	45	45	5	5	5	5
Total	811	679	446	333	724	583	396	307	587	627	451	466
Total - LI	177	177	166	166	168	168	211	211	171	171	171	171
Grand Total	**988**	**856**	**612**	**499**	**892**	**751**	**607**	**518**	**758**	**798**	**622**	**637**
Total Resource (acres)												
Section 2	617	484	414	294	414	294	306	229	414	414	294	294
Section 2 - LI	166	166	188	188	188	188	188	188	188	188	188	188
Section 3	319	301	104	84	382	334	92	80	286	325	233	248
Section 3 - LI	11	11	-	-	2	2	45	45	39	39	39	39
Total	936	785	518	378	796	628	398	309	700	739	527	542
Total - LI	177	177	188	188	190	190	233	233	227	227	227	227
Grand Total	**1,113**	**962**	**705**	**566**	**985**	**817**	**630**	**541**	**927**	**965**	**753**	**769**

^Indiana Geological Survey created the sand and gravel resource potential data in 2003 by assigning qualitative permissive tract assessments to each outcrop area in Gray, H. H., 1989, Quaternary geologic map of Indiana: Indiana Geological Survey Miscellaneous Map 49. The attribute table data was derived from Gray, H. H., 1973, Properties and uses of geologic materials in Indiana: Indiana Geological Survey Regional Geologic Map Supplementary Chart 1 and Carr, D. D., and Webb, W. M., 1970, Sand and gravel resources of Indiana: Indiana Geological Survey Bulletin 42-D, 31 p.

^^ "Potential resource" indicates that the surficial unconsolidated deposits are likely to contain economic concentrations of sand and gravel, "low potential" indicates that the surficial unconsolidated deposits may contain economic concentrations of sand and gravel.

* 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.

** LI = Local Improvement

TABLE 11: SAND AND GRAVEL RESOURCES (PERCENTAGE) IN THE ALTERNATIVES BY SECTION

Impacts to Sand and Gravel Potential Resources^												
Alternative*	B		C		M		O		P			
Variation	B2	B3	C2	C3	M2	M3	O2	O3	P2e	P2w	P3e	P3w
Potential^^ Resource (% of ROW Subsection)												
Section 2	11%	12%	6%	5%	6%	5%	0%	0%	6%	6%	5%	5%
Section 2 - LI**			8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Section 3									3%	3%	3%	3%
Section 3 - LI									19%	19%	19%	19%
Total	6%	5%	3%	3%	2%	1%	0%	0%	4%	4%	4%	4%
Total - LI			8%	8%	5%	5%	5%	5%	12%	12%	12%	12%
Grand Total	**5%**	**5%**	**4%**	**3%**	**2%**	**2%**	**1%**	**1%**	**5%**	**5%**	**5%**	**5%**
Low Potential Resource (% of ROW Subsection)												
Section 2	43%	41%	28%	28%	28%	28%	25%	24%	28%	28%	28%	28%
Section 2 - LI	65%	65%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Section 3	29%	29%	12%	11%	12%	12%	4%	4%	16%	19%	16%	19%
Section 3 - LI	38%	38%			1%	1%	37%	37%	3%	3%	3%	3%
Total	36%	35%	21%	21%	16%	16%	12%	11%	21%	23%	21%	23%
Total - LI	62%	62%	60%	60%	35%	35%	53%	53%	37%	37%	37%	37%
Grand Total	**39%**	**39%**	**25%**	**26%**	**18%**	**18%**	**16%**	**16%**	**23%**	**25%**	**24%**	**26%**
Total Resource (% of ROW Subsection)												
Section 2	54%	53%	34%	33%	34%	33%	25%	24%	34%	34%	33%	33%
Section 2 - LI	65%	65%	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%
Section 3	29%	29%	12%	11%	12%	12%	4%	4%	19%	22%	19%	22%
Section 3 - LI	38%	38%			1%	1%	37%	37%	22%	22%	22%	22%
Total	42%	41%	24%	23%	18%	17%	12%	11%	25%	27%	25%	27%
Total - LI	62%	62%	67%	67%	39%	39%	58%	58%	50%	50%	50%	50%
Grand Total	**44%**	**43%**	**29%**	**30%**	**20%**	**20%**	**17%**	**17%**	**29%**	**31%**	**29%**	**31%**

Percentages are calculated using the acres of resource in a subsection divided by the acres of that subsection. For example, B2 Section 2-LI is calculated by dividing the amount of impact acres in Alt B2, Section 2-LI by the total acres of LI ROW in Section 2.

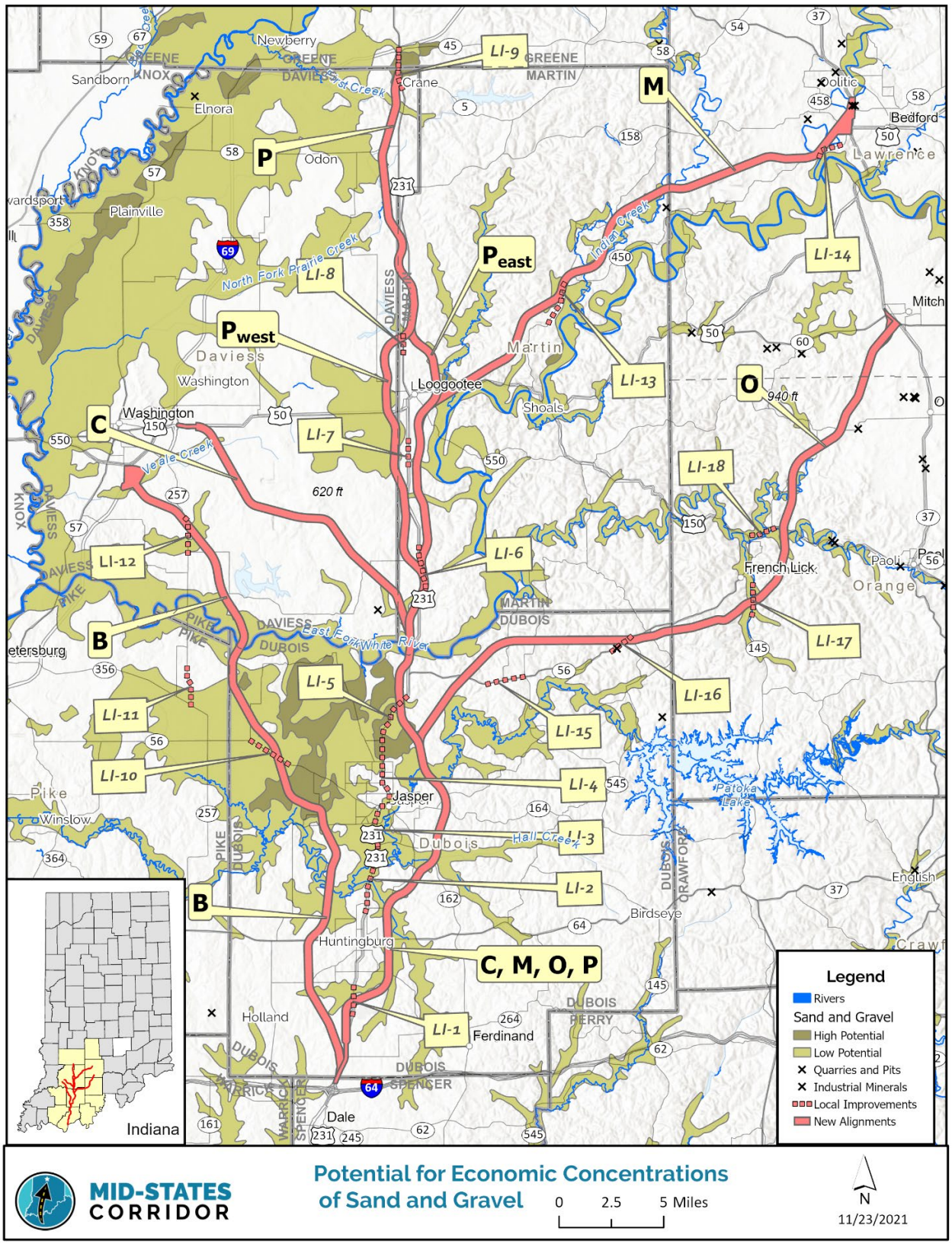
^Indiana Geological Survey created the sand and gravel resource potential data in 2003 by assigning qualitative permissive tract assessments to each outcrop area in Gray, H. H., 1989, Quaternary geologic map of Indiana: Indiana Geological Survey Miscellaneous Map 49. The attribute table data was derived from Gray, H. H., 1973, Properties and uses of geologic materials in Indiana: Indiana Geological Survey Regional Geologic Map Supplementary Chart 1 and Carr, D. D., and Webb, W. M., 1970, Sand and gravel resources of Indiana: Indiana Geological Survey Bulletin 42-D, 31 p.

^^ "Potential resource" indicates that the surficial unconsolidated deposits are likely to contain economic concentrations of sand and gravel, "low potential" indicates that the surficial unconsolidated deposits may contain economic concentrations of sand and gravel.

* 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.

** LI = Local Improvement

FIGURE 5: SAND AND GRAVEL DISTRIBUTION IN THE MID-STATES STUDY AREA



Limestone

There are two types of limestone resources in the Study Area. They are surface resources and shallow bedded deposits (of the Mississippian age Blue River Group). Shallow deposits are typically quarried in surface mine pits in Southern Indiana. Quarries start on a hillside and excavate downward, extending into the valley floor at drainage level. That limestone can be mined below the ridges or valleys. There is no specific map showing where prospective limestone reserves are located in the Mid-States Study Area. Surface and underground limestone is pervasive in the Study Area. No definitive mapping of thickness or quality is available showing potentially mineable resources. No alternative impacts active limestone quarries. Regional bedrock geology containing limestone is mapped in **Figure 6**.

Gypsum

Indiana Geological Survey, Bulletin 42-A, "Gypsum Resources of Indiana," (1969) gives a general overview of the resources in Southern Indiana and where they may occur (**Figure 7**). Quantification of these gypsum deposits as mineable reserves has not been proven with drilling and testing. No Spatial data are available to determine whether potentially mineable areas of gypsum may exist along the alternative variations. The U.S. National Gypsum company mine and Processing Plant east of Shoals in Martin County is the only gypsum producer in Southern Indiana. It is located along U.S. 50 between alternatives M and O. No impacts to gypsum resources are expected from any alternative.

FIGURE 6: DOMINANT LITHOLOGY OF THE MID-STATES STUDY AREA, HIGHLIGHTING LIMESTONE GROUPS

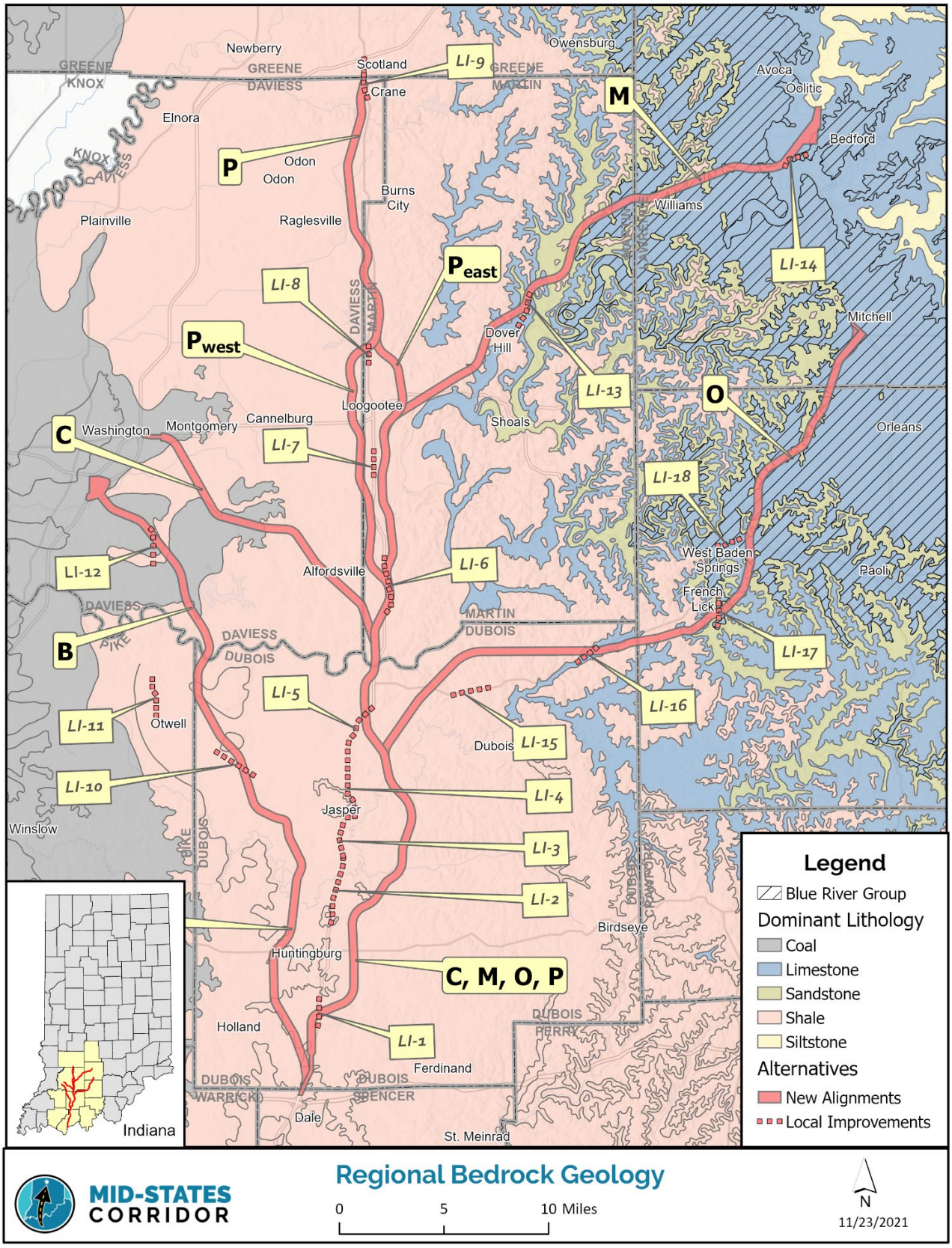


FIGURE 7: GYPSUM POTENTIAL DISTRIBUTION IN THE MID-STATES STUDY AREA