



# Economic Analysis of Completing the Appalachian Development Highway System: Executive Summary



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Appalachian Regional Commission



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The report was prepared by a team of researchers from Economic Development Research Group (EDR Group), and WSP/Parsons Brinckerhoff. Chandler Duncan (of EDR Group) was the project manager and Glen Weisbrod was the project director. Major sections of the report were developed by Chandler Duncan, Glen Weisbrod, Mark Sieber, and Derek Cutler of EDR Group. Additional staff who also contributed to the analysis and report were: Lisa Petraglia, Kyle Schroeckenthaler, and Lesly Adkins-Shellie of EDR Group, and Rhett Fussell and Greg MacFarlane of WSP/PB.

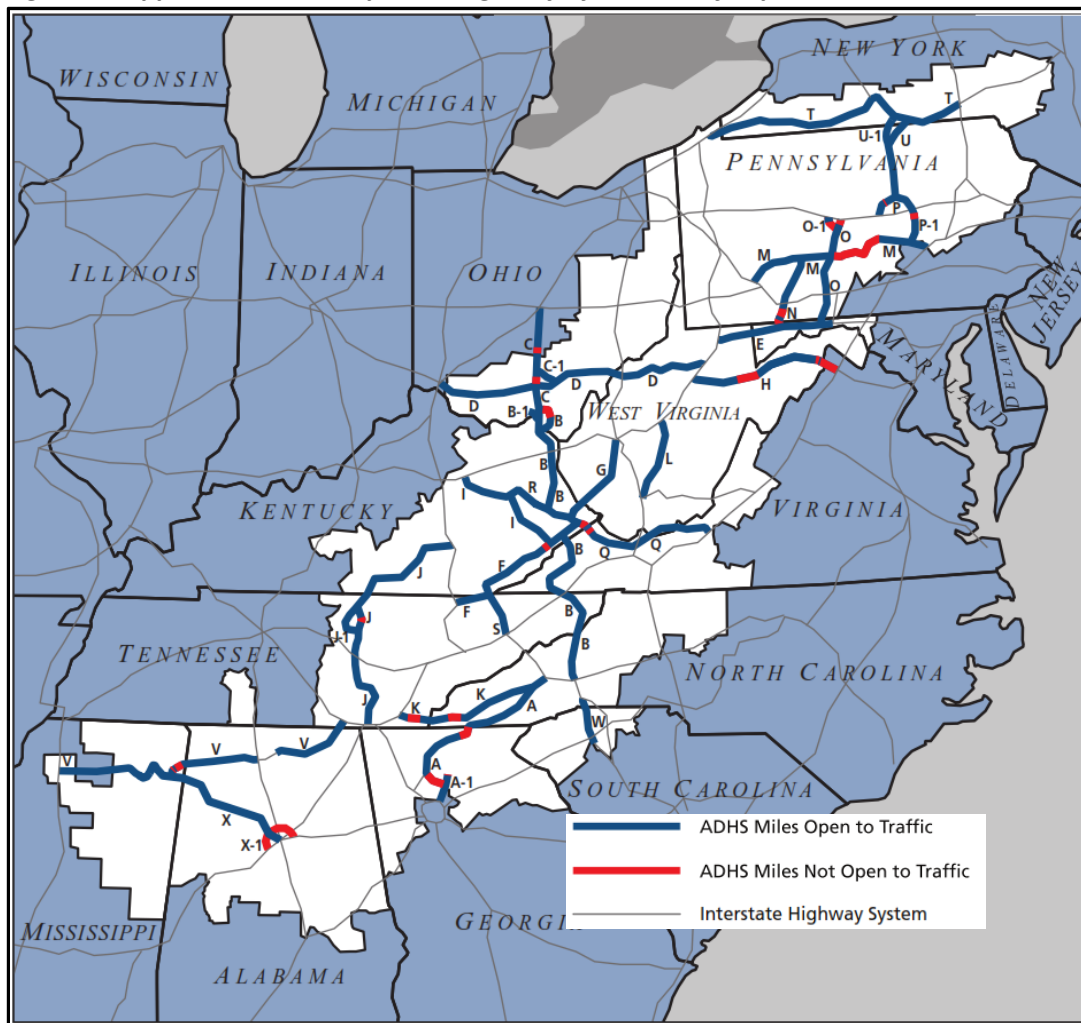
The research, analysis, and report development were guided by Scott Hercik, ARC Intermodal Transportation Manager, and Daniel Hodge of Hodge Economic Consulting (research contract manager for ARC). Other ARC staff contributing to this project included Kostas Skordas, Director of Planning and Research; Keith Witt, Geographic Information Systems Analyst; Jason Wang, Senior Transportation Specialist; and Thomas Smith, Senior Transportation Advisor. Daniel Hodge also contributed written material for chapters 1 and 3.

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# 1 Introduction and Study Objectives

The 2017 Economic Analysis of Completing the Appalachian Development Highway System (henceforth referred to as “full report”) was sponsored by the Appalachian Regional Commission (ARC) to estimate the economic impacts, benefits, and costs of completing the Appalachian Development Highway System (ADHS). The ADHS was authorized by Congress with the purpose of stimulating economic development by reducing isolation and improving access for an economically depressed region that had been largely left unserved by the interstate highway system. A 3,662-mile system, the ADHS is composed of 32 corridors located in 13 Appalachian states with 3,090 eligible miles (see Figure 1). At the end of FY 2016, a total of 2794.7 miles, or 90.4 percent of the authorized network, were either complete or open to traffic, or under construction. ADHS completion will link the whole system into an integrated transportation network connecting Appalachia to domestic and global markets. The analysis in this report is based on economic data and forecasts from 2015, the most recent complete year for which data were available as the report was being developed.

**Figure 1: Appalachian Development Highway System, as of September 30, 2016.**



Source: Appalachian Regional Commission, 2016.

The purposes of this study are to:

- (1) Describe the effects that historical completion of the ADHS to date has had (and continues to have) on connecting Appalachian people and businesses to economic markets, and consequently the impacts it has had on improving the Region's economy.
- (2) Assess the additional future improvements in travel performance, trade, and economic development that can be expected from completion of the remaining elements of the ADHS.
- (3) Calculate the relative benefits and costs of completing the ADHS system, evaluate how those benefits are likely to be experienced on particular corridors, and estimate how accelerating ADHS completion would generate larger transportation benefits and economic impacts much sooner.

This study both extends and improves upon prior studies of the economic benefits and impacts of ADHS completion. Before this study, the most recent extensive economic analysis of the ADHS was a June 2008 report, which estimated the future economic and travel efficiency returns to ADHS investments. Key enhancements in the current study include:

- (1) Integration of national data sources, such as the Freight Analysis Framework (FAF) and the Highway Performance Monitoring System (HPMS), with statewide transportation performance modeling and data systems for each Appalachian state;
- (2) New quantitative analysis of the transportation and economic impacts of ADHS completion to date (1965 to 2015);
- (3) Estimates of how accelerating ADHS completion to 2035 (compared to 2045) would change the economic impacts and benefits for Appalachia; and
- (4) Return on investment (ROI) analysis of five major ADHS corridors with major sections remaining to be built.

Results of this study include a full range of transportation performance and economic development indicators. These are defined and organized as follows:

- Transportation System Performance Benefits: Including travel-time savings, route diversion and resulting reduced mileages, and increased ranges of workforce and business accessibility;
- Valuation of Economic Benefits: Including the dollar value of travel time, reliability, operating costs, logistical costs, environmental and safety costs, as well as enhanced productivity;
- Total Economic Impacts: Including full economic development impacts on the economy of the Appalachian Region in terms of employment by industry, gross regional product, and personal income; and
- Benefit-Cost Analysis: Benefit-cost ratios to measure expected return on investment.

Complete documentation of methods, sources and assumptions as well as detailed findings are available in the full report located at [www.arc.gov/research](http://www.arc.gov/research).

## **2 Backcasting—Effects of ADHS to Date (1965–2015)**

It is helpful to understand the extent to which historic development of the Appalachian Development Highway System (ADHS) has supported the development of the Appalachian Region’s economy from the program’s inception in 1965 through the start of 2016. The ADHS is currently planned to comprise 3,090 miles, and as of the end of fiscal year 2016, 90.4 percent of those miles was either complete or open to traffic or under construction. This retrospective analysis is designed to provide insight into how the incremental development of the ADHS has led to a significantly more productive and competitive Appalachian economy, with more jobs, people and income than would be the case without it.

The analysis represents a significant enhancement beyond prior studies in estimating the impacts to date of ADHS. It was developed using rigorous economic modeling that controlled for variation in both transportation patterns and the economy of Appalachian counties and the broader 13 Appalachian states over a span of 50 years. It also used a modeling framework (in terms of both highway network models and economic models) that was fully consistent with the forward-looking forecast analysis of ADHS completion that are addressed later in this report.

The retrospective analysis process used in this report is known as “backcasting,” as opposed to the usual “forecasting” process that is normally used in transportation economic analysis. Forecasting studies normally start with a baseline forecast and then assess what would be the future effects of a hypothetical scenario in which a proposed new project is added. Backcasting studies, in contrast, start with a history in which planned (ADHS) investments have already been made, and assess what would have been the past effects of a hypothetical scenario if those investments were not made. The results of this backcasting exercise are then discussed in the broader context of how the ADHS system has complemented and reinforced other ARC economic development programs to enhance the Region’s overall productivity and attractiveness for business investment.

### **2.1 ADHS System Construction to Date**

#### **Completion over Time**

Over the 1965 to 2015 period, significant progress has been made in the development of the ADHS. Investment in this period has totaled \$11.2 billion resulting in the completion of 5,119 lane-miles of highway added to the transportation system in the 13 states of the Appalachian Region. Table 1 shows the overall investment and infrastructure additions made over time, and Figure 2 shows the geographic location of corridors associated with each of three time periods defined for this study.

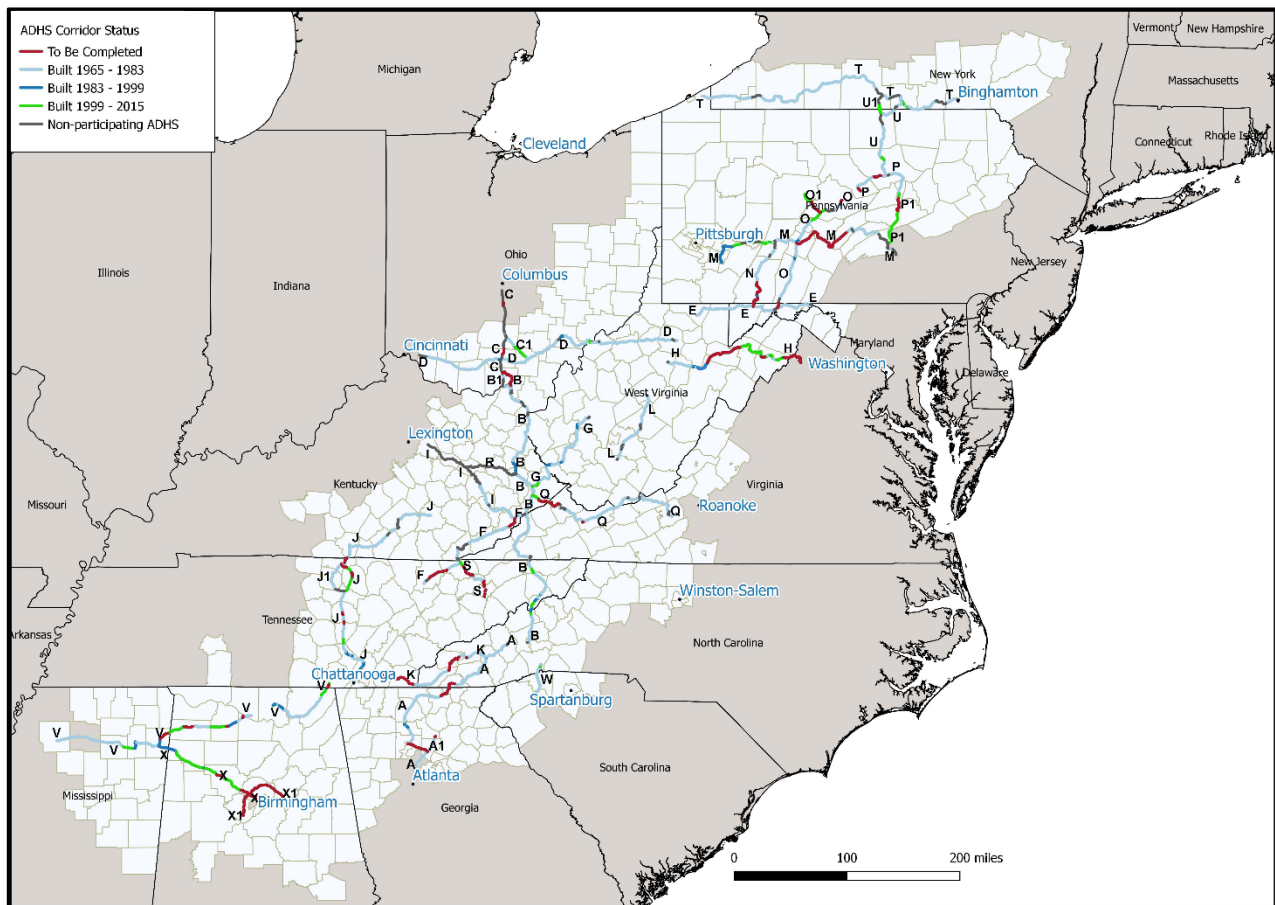
**Table 1: ADHS Historic Development Periods**

	1965–1983	1983–1999	1999–2015	All Periods
ADHS Investment (\$M)	\$3,255	\$1,661	\$6,287	\$11,203
ADHS Lane Miles Added	4,356	267	496	5,119

Source: ARC. Note that all investment numbers reflect total actual dollars spent in various years within the specified time periods; they are not modified or adjusted to any constant dollar concept (and thus would be significantly larger if inflated to today’s dollars).

**Figure 2: ADHS Corridor Segments, by Time Period**

Sources: Appalachian Regional Commission



A large share of ADHS construction occurred in the first 18 years of the program, as the Region built high priority corridors and completed those highway segments that had fewer technical or environmental concerns. Additional progress on the more challenging and difficult segments has continued in subsequent periods through 2015, and is proposed to continue until completion of the system by 2045. While ARC records enable this general illustration of where and when progress on the ADHS has been most concentrated, it is important to note that the specific limits and characteristics of each individual highway improvement are beyond the available data and scope of the current report.



## 2.2 Transportation System Performance

The ADHS enables both transportation system efficiencies and productivity gains from expanded market access. These benefits repeat every year and grow over time. They represent the value of:

- a) reduced average travel times and travel distance changes (enabled by less circuitous and faster speed trips into, out of and through Appalachia);
- b) enhanced reliability and reduced uncertainty (a reduction in the “reliability” or “schedule time” that households and businesses build into their schedules to allow for arrival time uncertainties on rural and local roads that are highly susceptible to inclement weather, crash delay, slow moving vehicles, or impassible conditions); and
- c) enhanced business productivity (due to broader access to workers, customers, and trade partners).

### Travel System Efficiency Benefits

**Travel Time and Reliability Savings.** The transportation network efficiency benefits of the ADHS are primarily in the form of travel time and reliability benefits.

Table 2 below shows the daily vehicle hours of travel (VHT) time, and hours of reliability time saved due to ADHS improvements as of four points in time. The numbers shown for each year reflect the cumulative effect of corridor projects completed prior to and within that year.

**Table 2: Travel Time and Reliability Savings from Completed Projects**  
(Millions of hours saved, annually)

For all projects completed →	As of 1983	As of 1999	As of 2015
Total VHT Time Savings (millions of hours)	208.1	218.3	231.0
Car and Light Trucks	179.8	188.6	199.5
Freight Trucks	28.3	29.7	31.5
Total Reliability Time Savings (millions of hours)	116.3	122.0	129.1
Car and Light Trucks	100.5	105.4	111.5
Freight Trucks	15.8	16.6	17.6
<b>Total Hours Saved (Reliability and VHT)</b>	<b>324.4</b>	<b>340.3</b>	<b>360.1</b>

Source: EDR Group Analysis utilizing consolidated travel models compiled by Parsons Brinckerhoff, with HPMS and Federal Highway Statistics.

The analysis reveals that the ADHS now saves 231 million hours per year of travel time each year, representing 632,000 hours per day, compared to what would have been the case without the ADHS. This travel benefit is a product of faster speeds and growing traffic volumes over time (meaning that more travelers benefit from highway completion). In addition to the hours of time saved by increased travel speeds and shorter routes on the ADHS, it is estimated that 129 million hours of “reliability time” are saved annually, representing another 360,000 hours saved daily due to greater reliability (reduced travel time uncertainty). This is slack time that businesses and people build into their schedules to allow for uncertainty in arrival times, which they could more productively use if they can gain greater certainty



about their arrival time. The total transportation system efficiency savings is equal to 360 million vehicle hours saved annually.

While the overall travel time savings are widely distributed geographically, the reliability time gains are located primarily within Appalachia as they result from the addition of passing lanes (which are most important on steep grades where some trucks cannot maintain full speed) and from the improved routing that reduces reliance on local roads, collectors, and minor arterials (that were formerly necessary to get from the heart of Appalachia to the larger national highway system). Combined, these two kinds of travel time savings equate to over 986,000 hours each day, representing 360 million hours each year that are saved because of the completed ADHS segments.

**Spatial Distribution of Time Savings Benefit.** The benefits of ADHS investments accrue to all highway travelers, but are particularly important for long distance freight movements. Freight-carrying trucks account for just 4.3 percent of all traffic on the road systems of the 13 Appalachian states, but represent approximately 14 percent of all vehicle-hours of travel time savings attributable to these ADHS routes.

A further breakdown of car and freight truck benefits is shown in Table 3, categorized by the mode and trip origin/destination. It shows that while nearly 68 percent of the car trips have an origin and/or destination within Appalachian counties, the ratio drops to 60 percent for freight truck trips. The importance of long-distance travel is also shown by the fact that 20 percent of car VHT savings and 31 percent of freight truck VHT savings accrue to trip ends located outside of the 13 Appalachian states. This indicates that the ADHS plays a particularly important role serving longer-distance goods movement and trade, connecting the Region to destinations throughout the U.S.

**Table 3: Travel Time and Reliability Savings from Completed Projects, by Trip Origin/Destination Location (millions of hours saved annually)**

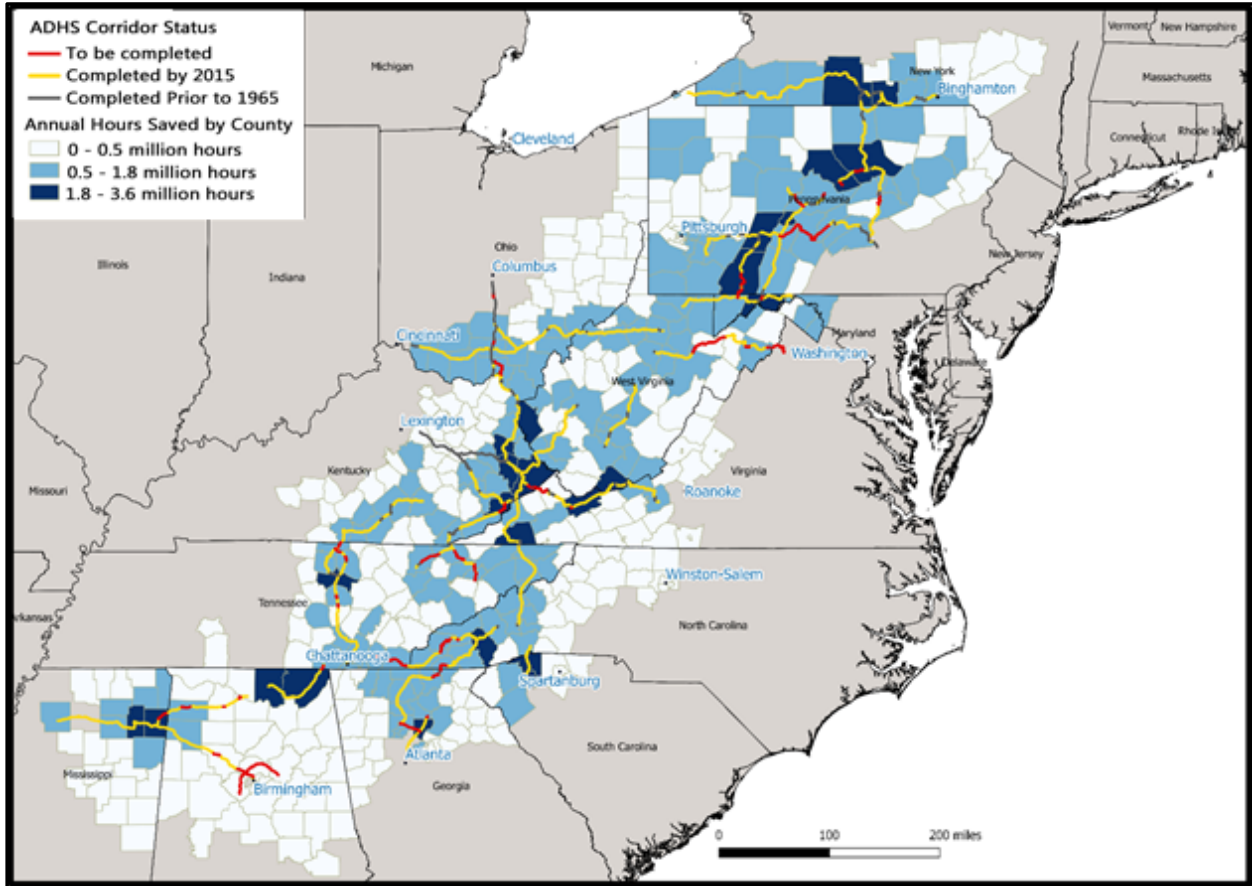
Savings as of 2015	Appalachian Counties	Appalachian States	Rest of U.S. States	Total
Total (millions of hours saved)	240.3	282.8	77.3	360.1
Car and Light Trucks	211.0	248.8	62.1	311.0
Freight Trucks	29.3	34.0	15.1	49.1
Percent of Total: Cars + Lt. Trucks only	67.8%	79.9%	20.1%	100%
Percent of Total: Freight Trucks only	59.6%	69.2%	30.8%	100%

*Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and Federal Highway Statistics.*

Travel efficiency benefits of the ADHS are spatially distributed broadly throughout the entire region, as shown in Figure 3, and generally track with the location of completed ADHS segments.

**Figure 3: Annual Travel Efficiency Benefits in 2015 from Past ADHS Improvements**

Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and



Federal Highway Statistics.

## Market Access Benefits

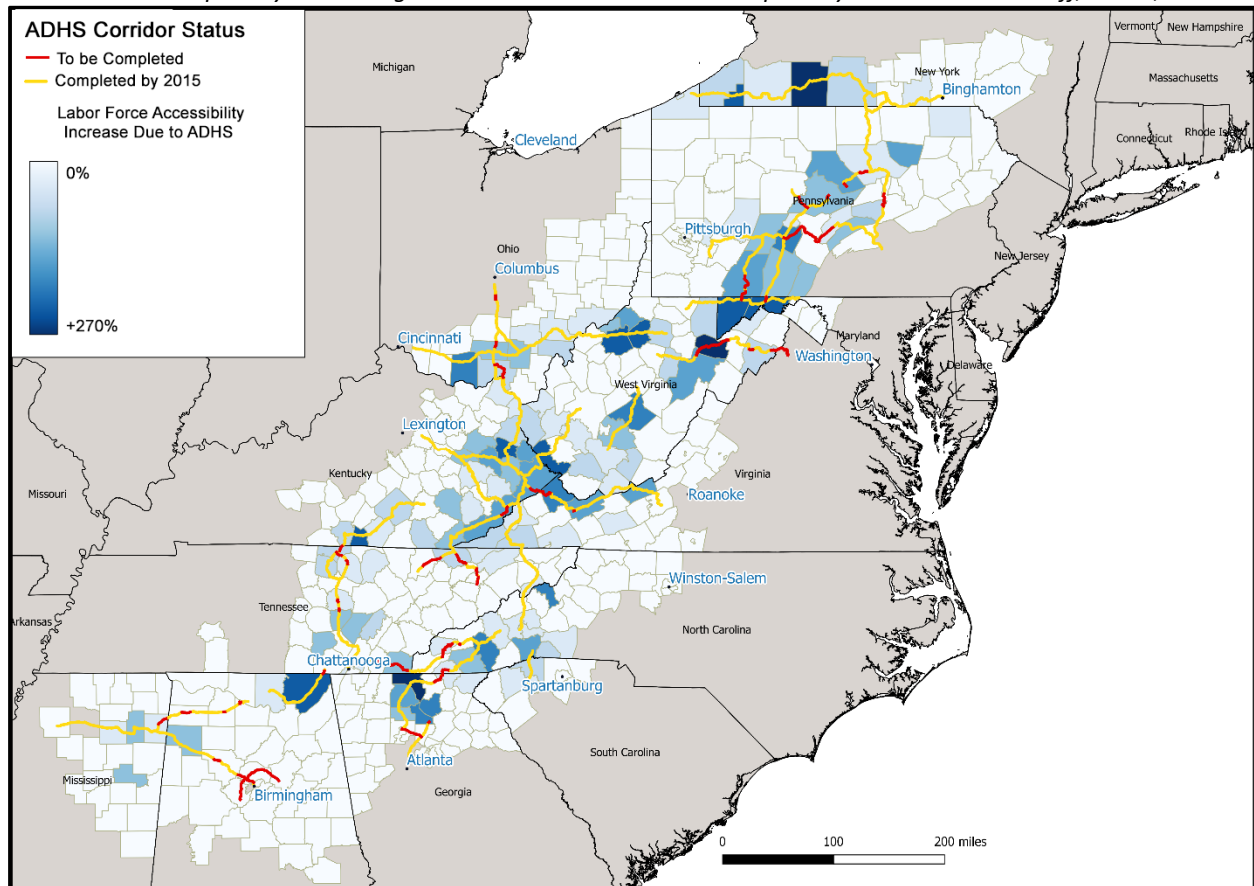
Besides providing travel efficiency (cost savings) due to travel time and reliability improvements, the ADHS has had substantial impacts on the accessibility of Appalachian communities to (1) labor markets, (2) truck delivery markets and (3) intermodal terminals—both within and outside the periphery of Appalachia.

**Labor Market Access.** The ADHS investments enable firms located in counties served by ADHS corridors to gain access to more workers. That allows them to draw from a wider pool of highly qualified workers and access workers with specialized skills that match the products and services that they produce. This effect can be viewed in terms of the increases in the number of workers that can reach an Appalachian business within a one-hour commute. Alternatively, it can be viewed in terms of increases in the number of job opportunities that can be reached within one hour by an Appalachian resident. In addition, the ADHS also affected access to broader product delivery markets.

Figure 4 illustrates the extent of greater workforce access available to each county in the ADHS (as of 2015), that can be attributed to ADHS investment to date. For these measures, the improvement in access to population is used as a proxy to measure workforce access.

**Figure 4: Increases in Accessible Workforce in 2015 from Past ADHS Improvements**

Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and



*Federal Highway Statistics.*

In this map for 2015, the shades of blue represent the ratio of people accessible to each Appalachian county within a 60-minute drive time in comparison to the number that would be available if ADHS were not in place. The darkest shade of blue correlates to counties where there are from 1.9 to 2.7 times as many people within a 60-minute drive of the indicated county in 2015 than would be the case without ADHS. It is notable (and expected) that the largest workforce access improvements occur near the location of now completed ADHS segments, and that they are mostly in remote areas away from the major population centers. Most of the workforce access gains are to distressed counties. The map indicates that workforce accessibility gains tend to be greatest in those counties where ADHS links were constructed (or adjacent counties to them), but it also shows that some surrounding counties also benefit from this access.

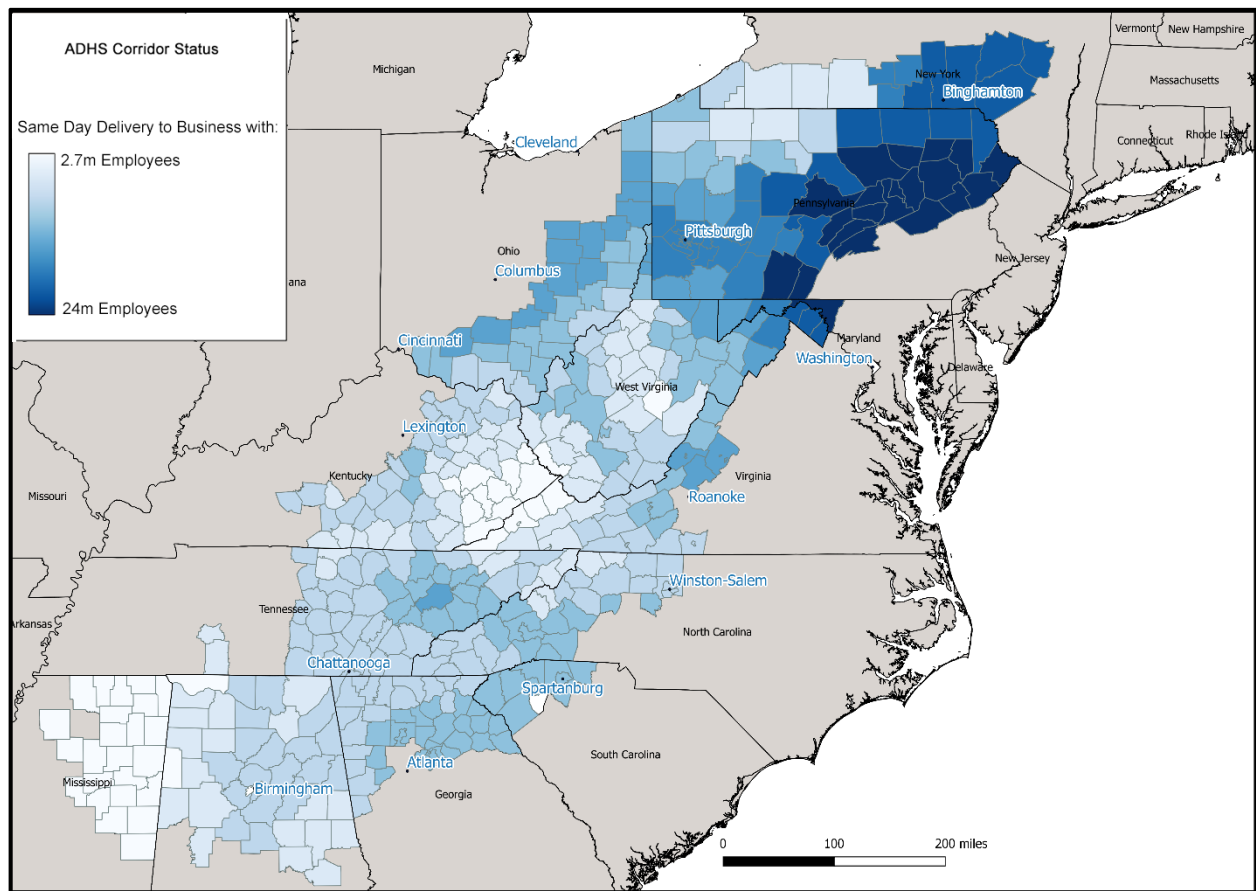
**Same-Day Visit and Delivery Market Access.** The ADHS system, by connecting with other Interstate highways and U.S. highways, also broadens the range of same-day markets for tourism travel and truck deliveries. By connecting the core of the Appalachian Region with outlying population markets, residents of outside areas have greater opportunities to visit recreation and tourism destinations in Appalachia. At the same time, Appalachian business locations can serve broader customer markets (both business-to-

business markets and consumer markets) via same-day truck deliveries. For this study, the same-day market was measured in terms of the area that can be reached within a four-hour one-way trip.

Figure 5 illustrates the size of same-day markets reachable from Appalachian counties as of 1965, before the ADHS program started. Truck delivery markets are measured on the basis of the number of business employees (a proxy for business activity and potential trading partners) reachable from any given county within four hours of one-way travel (representing a same-day round trip). The darker shaded counties represent larger size markets accessible via same-day truck delivery. Not surprisingly, counties that could already serve major metropolitan area markets at the periphery of Appalachia are shaded. The white space (lack of delivery market) in the central region is very striking.

**Figure 5: Relative Size of Same-Day Market Accessible from Appalachian Counties as of 1965**

Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and

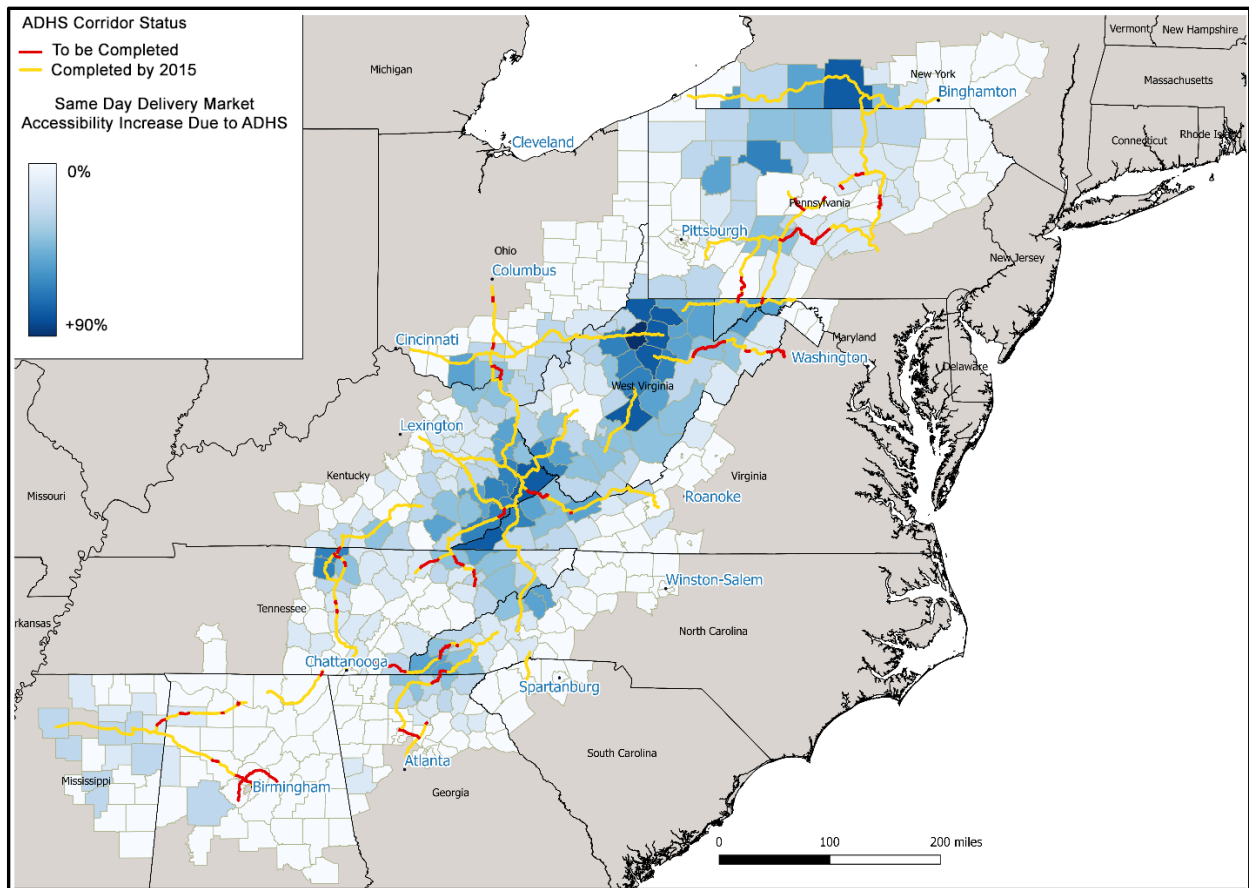


Federal Highway Statistics.

Figure 6 shows the counties that in 2015 have enhanced access to same-day markets as a result of ADHS improvements over the 1965-2015 period. The filling in of access for the central areas (which were white in Figure 5) is quite striking. The shades of blue in this graphic indicate variations in the ratio of workers within a four-hour drive time in 2015 with ADHS in place relative to the number that would be accessible without ADHS. As shown in the legend, the darkest shade of blue corresponds to counties that have experienced an increase of 63.8 to 89.3 percent in the economic activity (number of jobs) accessible within four hours with ADHS (compared to without ADHS) in 2015.

**Figure 6: Increase in Same-Day Delivery Market in 2015 from Past ADHS Improvements**

Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and

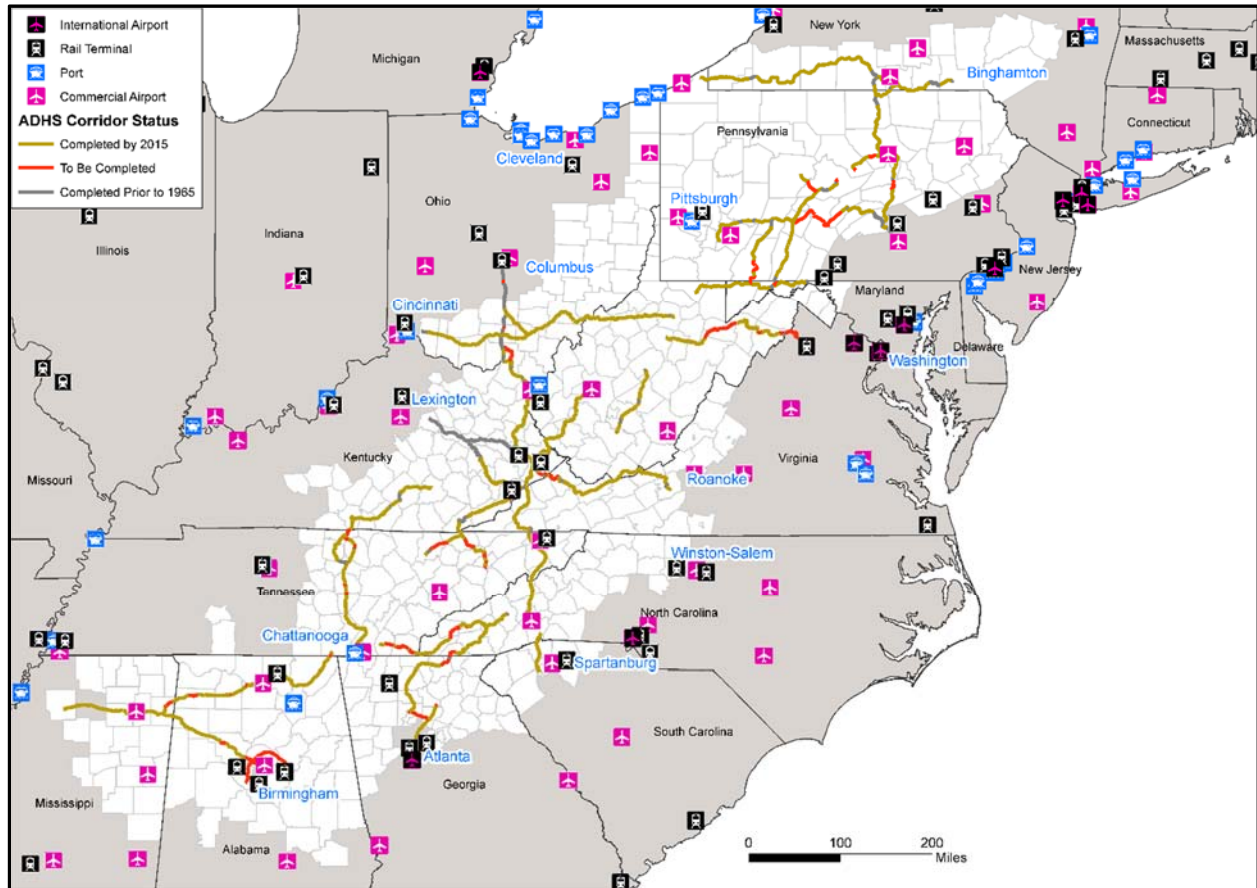


Federal Highway Statistics.



**Intermodal Terminal Access.** An important aspect of the ADHS is that its highways provide connectivity to broader interstate routes (e.g., east-west links across the mountains) and thus enable access from the core of Appalachia to intermodal terminals—major airports, marine ports, and intermodal rail facilities. The locations of these intermodal facilities, relative to the ADHS, is shown in Figure 7.

**Figure 7: Locations of Intermodal Terminals Affected by ADHS Access**



Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and Federal Highway Statistics.

## 2.3 Valuation of Transportation Benefits

The travel efficiency benefits are valued in dollars, stemming from the travel efficiency impacts. The travel savings (hours and miles) translate into reduced vehicle operating costs, business labor costs and shipper logistics costs. The savings in personal travel time does not affect the flow of money in the economy, but has a very real value to the people involved, and is included in the benefit-cost analysis. Table 4 shows the annual transportation cost savings occurring in 2015 as a result of ADHS completion to date.

**Table 4: Value of Travel Efficiency Savings from Completed Projects as of 2015 (\$ millions/yr.)**

Category of Value	Freight Truck	Car + Lt. Truck	Total
Vehicle Operating Cost Savings	\$930	\$2,473	\$3,403
Business Travel Time Cost Savings	\$1,431	\$2,261	\$3,692
Shipper/ Logistics Cost Savings	\$555	\$0	\$555
Personal Travel Time Savings	\$0	\$3,059	\$3,059
<b>Total</b>	<b>\$2,916</b>	<b>\$7,793</b>	<b>\$10,709</b>

Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and Federal Highway Statistics. Valuation factors are defined in the full report.

Note: All dollar values are in 2015 constant dollars.

## 2.4 Economic Development Impacts

**Analysis Overview.** The travel efficiency and access benefits discussed previously affect business operating costs, household spending and economic productivity within the Appalachian Region, the broader 13 Appalachian states (including areas not in Appalachia), as well as in other adjacent states.

**Annual Effect.** Overall, ADHS investment made over the 1965-2015 period enable the 13-state region to attract business investment and grow its economy. The result is that it is now estimated to produce over \$24 billion per year of added business sales representing over \$11 billion per year of added gross regional product (GRP) as of 2015, compared to what would be the case without the ADHS. This increased economic activity has helped create or support over 168,000 jobs with nearly \$7.3 billion/year of added worker income as of 2015.

Table 5 summarizes these economic impacts and Figure 8 shows how they have grown over time. It is notable that while the economic growth impact was most rapid in the 1965-1983 period when the largest initial investment in ADHS construction was made, the economic growth effect is recurring year after year and will grow larger in the future as economic gains from highway investment continue to be realized.

**Table 5: Impact of ADHS Projects on the Economy of Appalachia and Appalachian States**

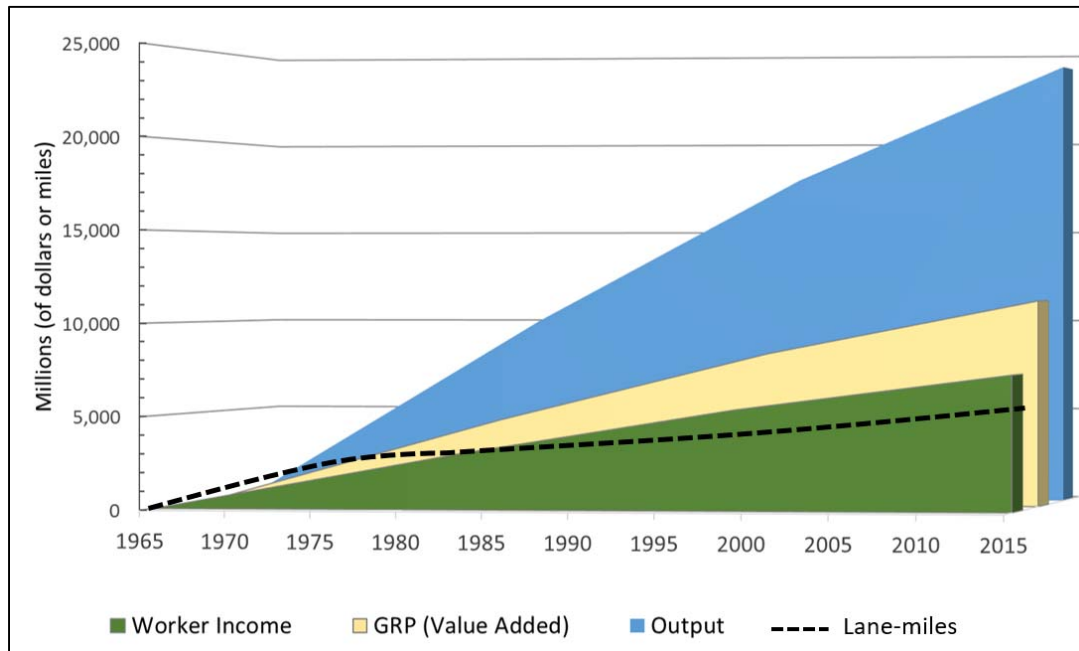
Increase compared to “no build” case	As of 1983	As of 1999	As of 2015
<b>13-State Appalachian Region</b>			
Business Output (Revenue) in \$M/year	\$9,959	\$15,207	\$24,183
GRP (Value Added) in \$M/year	\$4,611	\$7,037	\$11,173
Worker Income in \$M/year	\$3,006	\$4,587	\$7,282
Employment level (single year)	69,385	105,897	168,336
Lane-Miles Built to date	4,356	4,623	5,119
<b>Appalachian Region</b>			
Business Output (Revenue) in \$M/year	\$8,063	\$12,312	\$19,578
GRP (Value Added) in \$M/year	\$3,733	\$5,697	\$9,046
Worker Income in \$M/year	\$2,434	\$3,714	\$5,895
Employment level (single year)	56,174	85,734	136,284
Lane-Miles Built to date	3,527	3,743	4,144

Source: Analysis by EDR Group using the TREDIS economic impact model for the 13 Appalachian states.

Note: All dollar values are in 2015 constant dollars.



**Figure 8: Impact of ADHS Completion to Date on the Economy of Appalachian States**



Source: Analysis by EDR Group using the TREDIS economic impact model for the 13 Appalachian states.

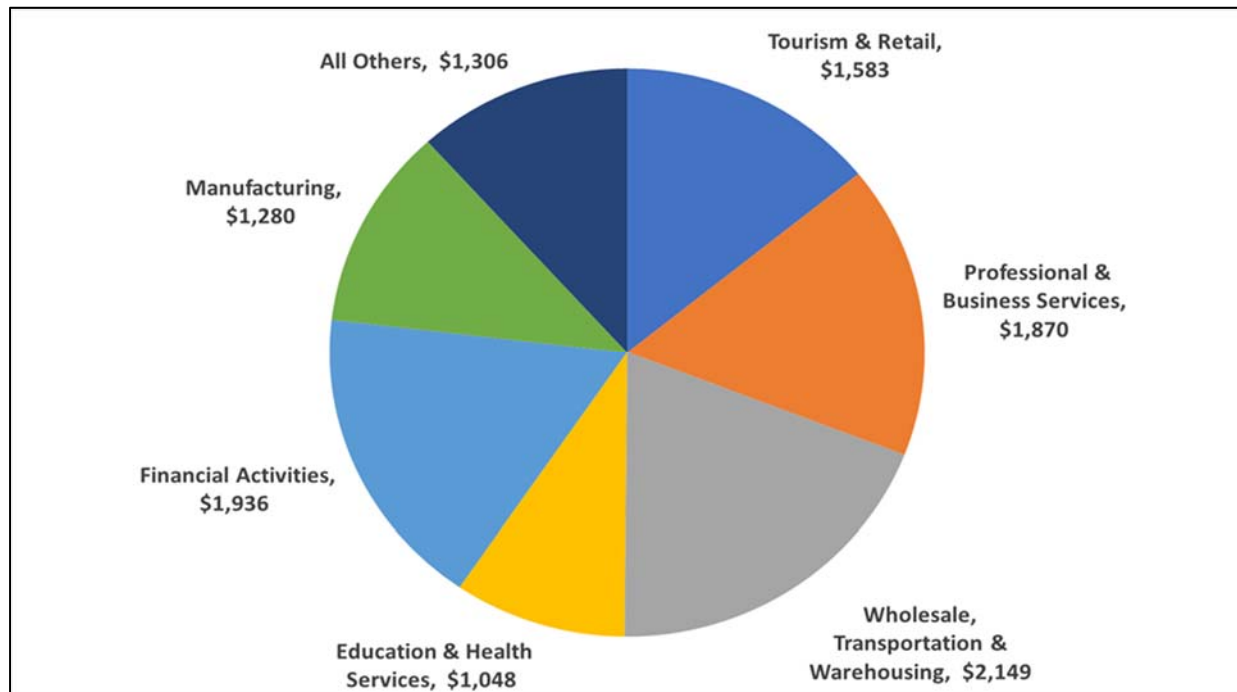
Note: All dollar values are in 2015 constant dollars.

**Cumulative Effect.** Adding up the impact for every year from 1965 to 2015 (in constant 2015 dollars) yields a cumulative impact of approximately \$388 billion more GRP generated in the 13-state region over 50 years, compared to what would otherwise be expected to occur over that time period. This result also reflects a total of 5.8 million additional job-years of employment generated over that same period. Note that this is a total effect and does not reflect any discount rate adjustment to represent a net present value.

## Economic Impacts by Industry

The estimated industry mix of GRP impacts are shown in Figure 9. This industry distribution of economic impact is notably different from the pattern of underlying industries concentrated in the Region, since the most affected industries (in terms of jobs and GRP) are those industries with the highest growth rate *and* greatest sensitivity to relative costs and market access improvements. This finding supports a conclusion that the ADHS has helped the Region to better converge with national trends, shifting from a resource based economy to a knowledge-intensive and service-based economy. The second largest share of employment gain (available in full technical report) is in leisure and recreational services, indicating that the access enabled by ADHS has supported growth of the Appalachian tourism economy. Among other top affected industries are education and health services, financial activities, and manufacturing, all of which are integral to attracting and retaining the firms and workforce needed to sustain overall economic growth. It is also notable that in terms of GRP growth, financial services, and manufacturing produce disproportionately more GRP income for the Region than their job impacts, a sign of their importance. Finally, there are significant GRP gains for wholesale and warehousing industries, which reflect the benefit of better transportation for supply chains.

**Figure 9: GRP Income Growth by Industry Sector Due to ADHS**



Source: Analysis by EDR Group using the TREDIS economic impact model for the 13 Appalachian states.

Note: All dollar values are in millions of 2015 constant dollars.

While it has been shown how past ADHS investments have provided transportation system benefits and economic growth impacts, additional progress to complete the system will provide further transportation benefits and economic growth consequences.

## 2.5 Case Studies: ADHS Connectivity to Inland Logistics Facilities and Global Trade

There is a growing recognition of the importance of inland intermodal logistics facilities which are the meeting point for highways with rail, waterways, and airports. In Appalachia, a number of these facilities have now been developed providing vital connections between modes, offering up cost and time savings for shippers, and connecting Appalachia to seaports and global markets. To highlight how the ADHS plays an important role in trade and economic development, the ARC team visited two Appalachian logistics facilities to better understand how they operate, link to the ADHS, and generate economic opportunities for the Region.

### Port of Huntsville (Alabama)–International Intermodal Center

The Port of Huntsville is in northern Alabama and includes multiple freight and passenger travel functions and economic development activities within a single 7,000 acre facility:

- Huntsville International Airport – providing passenger air transportation to numerous domestic and international destinations;
- International Intermodal Center – a multimodal freight logistics facility with both intermodal rail (truck-rail) activity and warehousing, as well as dedicated air cargo operations and facilities; and
- Jetplex Industrial Park – a 4,000 acre business park hosting 70 companies and providing 6,100 jobs for Huntsville area workers.

**Figure 10: Port of Huntsville International Intermodal Center**



A key enabler of this facility was the construction of Corridor V, running east-west from northern Mississippi through Alabama and into Tennessee. Corridor V provides direct access to the Port of Huntsville and is a full interstate (I-565) in this segment of the corridor, with easy linkages to the I-65 corridor with Nashville to the north and Birmingham to the south.

The international intermodal center (IIC) opened in 1986, assisted by an earlier industrial rail extension grant that was funded by a combination of local, ARC and Economic Development Administration (EDA) resources.

The rail facility serves a Norfolk Southern east-west mainline route that provides inbound freight rail service directly from the ports of Charleston and Savannah, along with outbound rail to the northeast and connections to west coast markets. The heaviest freight rail volumes to the facility represent international goods from the ports that are then warehoused and distributed via truck to the Appalachian Region. But the facility has also allowed local companies to locate near the facility to receive and ship goods throughout the country.

The air cargo facility sits directly next to the rail facility, and handles ten 747 dedicated air cargo planes per week helping Huntsville become the 17<sup>th</sup> largest airport for international air cargo in the U.S. The facility has included a foreign trade zone (FTZ) designation since 1983, establishing it as a permanent port of entry. The port would like to see more ADHS corridors upgraded to full interstate status with limited access and no traffic lights, as Corridor V is predominantly U.S. highway 72 which limits the effectiveness of the corridor for long-distance freight trucking.

## **Greer Inland Port (South Carolina)**

A more recently developed facility, the Greer Inland Port in South Carolina opened in 2013 to serve a very specific logistics opportunity in the Spartanburg/Greenville area. The BMW auto assembly plant located here in 1995 kick-started industrial development in the Region and was the original impetus to develop an inland port to facilitate imports and exports by container. Owned and operated by the South Carolina Ports Authority, Greer lies 212 miles inland from the Charleston deep water seaport. Similar to the Virginia Inland Port in Front Royal, VA, Greer has a dedicated Norfolk Southern “shuttle train” between the seaport and inland port that sends 200 containers (“boxes”) each way every day. The inland port provides a

reliable, cost competitive service to handle a 50/50 mix of: 1) exports (goods from the Region trucked to Greer that go by rail to the Charleston seaport bound for global markets); and 2) imports (goods arriving at Charleston, travel by rail to Greer for inland distribution).

**Figure 11: Greer Inland Port**



Constructed at a cost of \$47 million and employing about 55 employees on-site, the Greer Inland Port handles 100,000 container lifts per year, ahead of forecast and already at 80 percent of current capacity. The facility is served by multiple highway connections which expands the customer base that is served by the inland port. For example, two of the largest

shippers using the Greer Inland Port – the Eastman chemical company and John Deere (both in Tennessee) – use ADHS Corridor W (U.S. 25) to truck commodities to Greer for export. Greer has 50 acres of paved facility, including container storage space, and has another 100 acres for potential expansion.

The relatively abundant land for industrial development and strong highway system (combined with the Greer Inland Port) have helped the area attract major distribution centers such as Rite-Aid and Dollar Tree, with Michelin and Adidas two other major area shippers benefiting from Greer. BMW provided an initial anchor tenant and is the largest single customer generating about 65 percent of total volume at Greer. The success at Greer is leading South Carolina to develop a second inland port in Dillon.

## **Common Features of the Two Case Studies**

As demonstrated by the two case studies, ADHS corridors play a direct role in helping Appalachia and its businesses connect to global and domestic trade, and world-class logistics facilities. An integrated multi-modal transportation system is necessary to successfully link Appalachian businesses to export opportunities and distribution to inland markets. The ADHS continues to play an important role in enabling inland logistics facilities, with trade and economic development benefits for the Region.

# 3 Forecasting—Effects of ADHS System Completion (2016–2045)

## 3.1 ADHS System Links Remaining to be Completed

### Mileage Remaining by Corridor

Just 295 miles of the authorized ADHS network remain to be completed (Table 6), though many of these remaining highway segments have not yet been completed because they are located in challenging topography (which makes them more expensive to complete) and/or face significant environmental challenges (which makes design and approval more difficult to achieve). This section examines the travel-related benefits and economic impacts of completing these remaining highway segments. The analysis assumes completion of all segments by 2045 (if not sooner), which reflects input provided by the states for the most recent *Appalachian Development Highway System Completion Plan Report* (2013).

**Table 6: Future Completion of the ADHS by Investment and Miles Over Time**

	2016–2025	2026–2035	2036–2045	Total
ADHS Cost to Complete (\$M)	\$3,374.0	\$2,192.4	\$5,348.4	\$10,914.8
Highway Miles to be Completed	120.6	57.3	117.4	295.3

Source: ARC. Note that all future cost numbers reflect actual dollars spent in various years within the specified time periods; they are not modified or adjusted to any constant dollar concept.

Note: Costs are in millions of constant 2015 dollars.

## 3.2 Transportation System Performance

ADHS completion will generate changes in travel mileage as well as travel time and reliability. Travel mileage changes include the offsetting effects of (a) providing more direct routes for some travelers, and (b) providing faster speeds that attract some travelers to go out of their way to shift from existing slow routes to the newer faster routes. The first effect generates reductions in total vehicle-miles of travel, while the second effect generates additions to vehicle-miles of travel, although they are offset by the value of time savings. Ultimately, travel models indicate that net changes in total vehicle mileage will be small, but travel time and reliability improvements will be significant. Therefore, this section focuses on benefits of improved travel time and reliability.

**Travel Time and Reliability Savings.** Table 7 shows the daily hours of vehicle travel time and hours of “reliability time” expected to be saved by 2045 as a result of ADHS completion by that year. The table presents savings for three points in time leading up to 2045, demonstrating the gains from incremental completion of projects after 2016.

**Table 7: Forecast Travel Time & Reliability Savings from Phased Completion of ADHS by 2045**

Millions of Vehicle-Hours Saved/Year as of →	2025	2035	2045
Total VHT Time Savings	19.9	24.5	78.1
Car and Light Trucks	17.8	21.8	68.9
Freight Trucks	2.1	2.7	9.1
Total Reliability Savings	11.0	13.5	43.0
Car and Light Trucks	10.5	12.8	40.7
Freight Trucks	0.5	0.7	2.3
<b>Total Hours Saved (Reliability and VHT)</b>	<b>31.0</b>	<b>38.0</b>	<b>121.0</b>

Source: EDR Group Analysis Using Consolidated Travel Models compiled by Parsons Brinckerhoff with further data on travel characteristics from HPMS, and Federal Highway Statistics.

The table demonstrates that when completed in 2045, the ADHS is expected to save over 78 million vehicle hours per year of travel time, representing nearly 214,000 vehicle hours per day, compared to what would be the case without ADHS completion. This effect is a product of faster speeds and growing traffic volumes over time. In addition, it is estimated that over 43 million vehicle hours will be saved annually due to greater reliability (reduced travel time uncertainty). This is slack time that businesses and people build into their schedules to allow for uncertainty in arrival times. It is time that could be used more productively if travelers gain certainty about travel times due to increased reliability of the highway network. The total transportation system efficiency savings is equal to over 121 million vehicle hours saved annually.

**Spatial Distribution of Time Savings and Reliability Benefit.** The benefits of ADHS investments accrue to all travelers, but are particularly important for long distance freight movements. Freight-carrying trucks account for just 4.3 percent of all traffic on the road systems of the 13 Appalachian states, but nearly 10 percent of all vehicle hours of travel time savings attributable to completing the ADHS by 2045.

A further breakdown of car and freight truck benefits is shown in Table 8, categorized by the mode and trip origin and destination. It shows that 56 percent of the hours saved for car travel is for trips that have origins and/or destinations within Appalachian counties. The corresponding figure for freight truck trips is 44 percent, meaning that 56 percent of all freight truck trips affected by ADHS completion have an origin or destination beyond Appalachia. This highlights the national trade benefits of the ADHS. The national importance of ADHS travel time savings for long-distance travel is shown by the fact that 16 percent of the car VHT savings and 20 percent of the freight truck VHT savings accrue to trip ends located fully outside of the 13 Appalachian states.



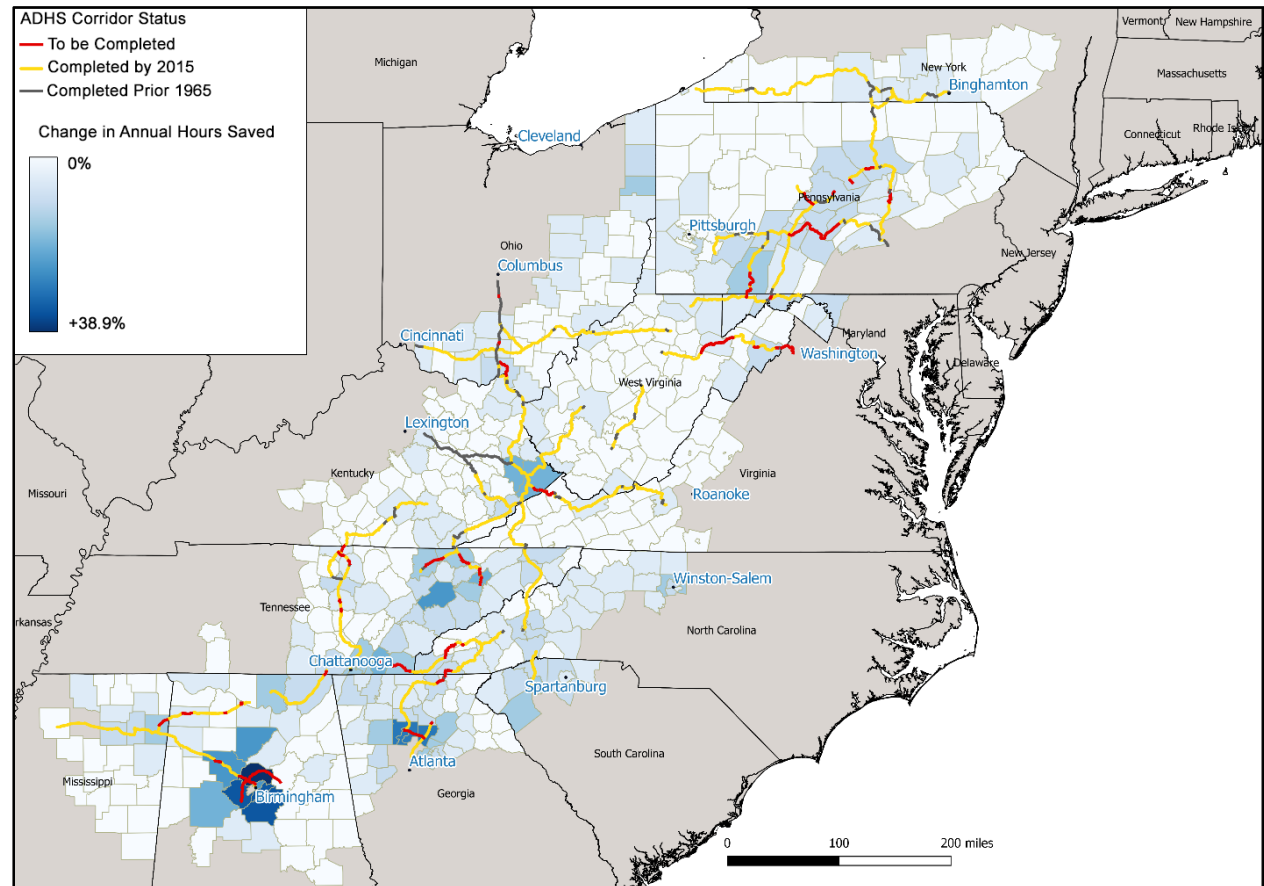
**Table 8: Forecast Travel Time & Reliability Savings from ADHS Completion, by Location of Trip Ends**

Millions of Vehicle-Hours Saved/Year as of 2045	Appalachian		Rest of U.S. States	Total
	Counties	States		
Total (millions of vehicle hours saved)	66.9	101.2	19.8	<b>121.0</b>
Car and Light Trucks	61.9	92.1	17.5	<b>109.6</b>
Freight Trucks	5.0	9.1	2.3	<b>11.4</b>
Percent of Total: Cars and Light Trucks only	56%	84%	16%	<b>100%</b>
Percent of Total: Freight Trucks only	44%	80%	20%	<b>100%</b>

Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and Federal Highway Statistics.

While the travel time and reliability savings accrue throughout the United States, Figure 12 demonstrates that travel time savings and reliability gains from completion of the ADHS are expected to be most concentrated within the counties most directly served by the system. Of particular interest is Corridor X1, which offers robust cost savings due to its large market in the area surrounding Birmingham, AL.

**Figure 12: Distribution of Travel Efficiency Benefits for Completing ADHS (2045)**



Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and Federal Highway Statistics.



It is also worth noting that while the overall travel time savings are widely distributed, the reliability time gains are located primarily within Appalachia. This stems from the fact that reliability improvements result from the addition of passing lanes (which are most important on steep grades where some trucks cannot maintain full speed) and from improved routing that reduces reliance on local roads, collectors, and minor arterials.

## **Access Benefits**

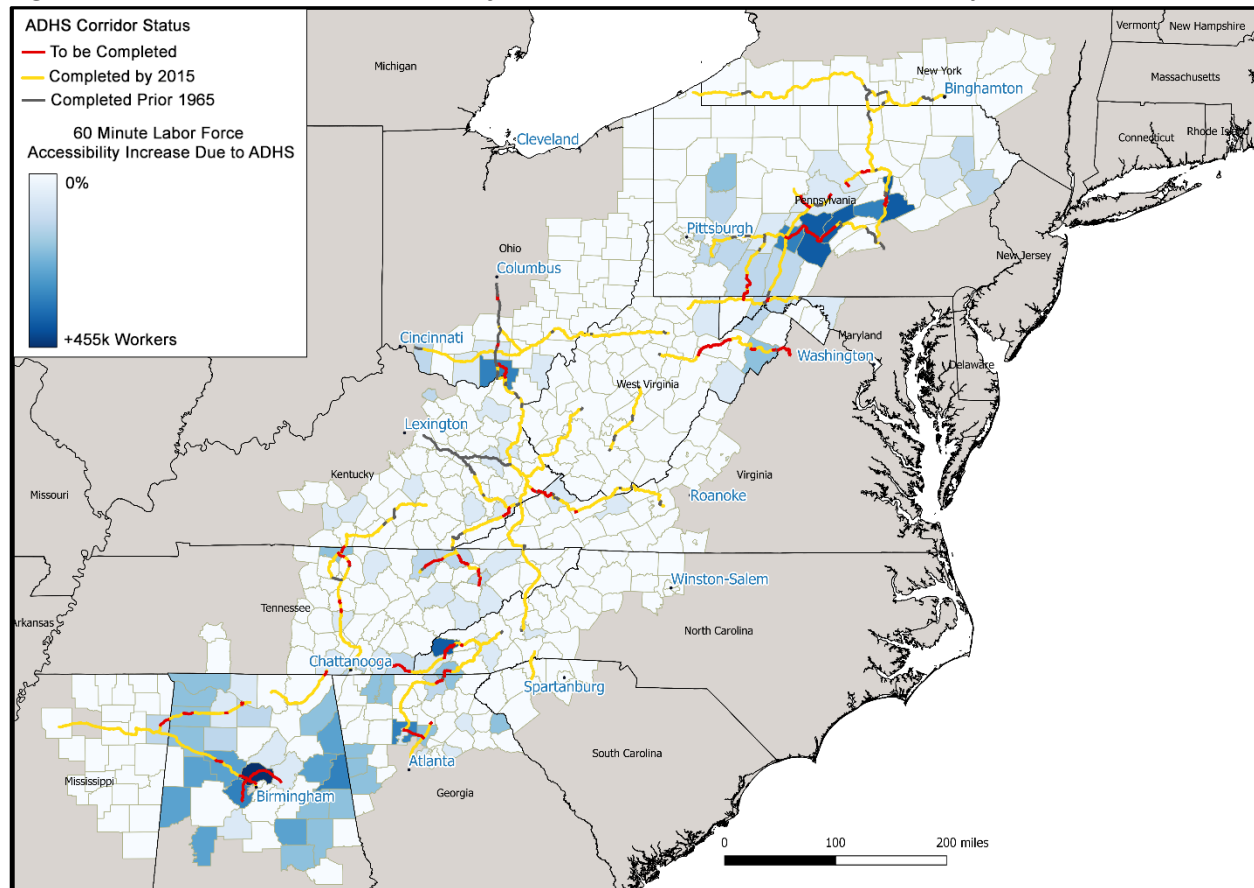
In addition to travel efficiency (cost savings) due to travel time and reliability improvements, the completion of the ADHS is expected to have substantial impacts on the accessibility of Appalachian communities to (1) labor markets, (2) truck delivery markets and (3) intermodal terminals – both within and beyond the Appalachian states. Each category of access benefit is described in the following pages.

**Labor Market Access.** Completion of the ADHS will enable firms located in counties served by the ADHS corridors to gain access to 27 percent more workers within a one-hour commute. This change can enable them to draw from a wider pool of highly-qualified workers and obtain workers with specialized skills necessary for the products and services they produce. These effects are measured in terms of increases in the number of people who are reachable within a one-hour commute from each Appalachian county.

Figure 13 demonstrates the extent and location of greater workforce access for each county in Appalachia as a result of ADHS completion in 2045. For these measures, the improvement in access to population is used as a proxy for what is more technically a measure of access to working age individuals. It is especially notable that due to the reach of Corridor X1 and the size of the Birmingham metropolitan area, that highway improvement is expected to boost workforce accessibility for a wide-range of counties in Alabama.

In this map, the shades of blue represent the ratio of people in 2045 expected to be accessible to the respective Appalachian county within a 60-minute drive-time in comparison to the number that would be accessible if ADHS was not in place. The darkest shade of blue correlates to counties where there is the largest increase in labor market access enabled by ADHS completion. Consistent with the pattern of historic investment shown previously, completion of the ADHS is expected to achieve the largest workforce access improvements in those areas most directly served by ADHS, i.e., areas that are remote from major population centers.

**Figure 13: Increases in Accessible Workforce in 2045 Attributable to ADHS Completion**

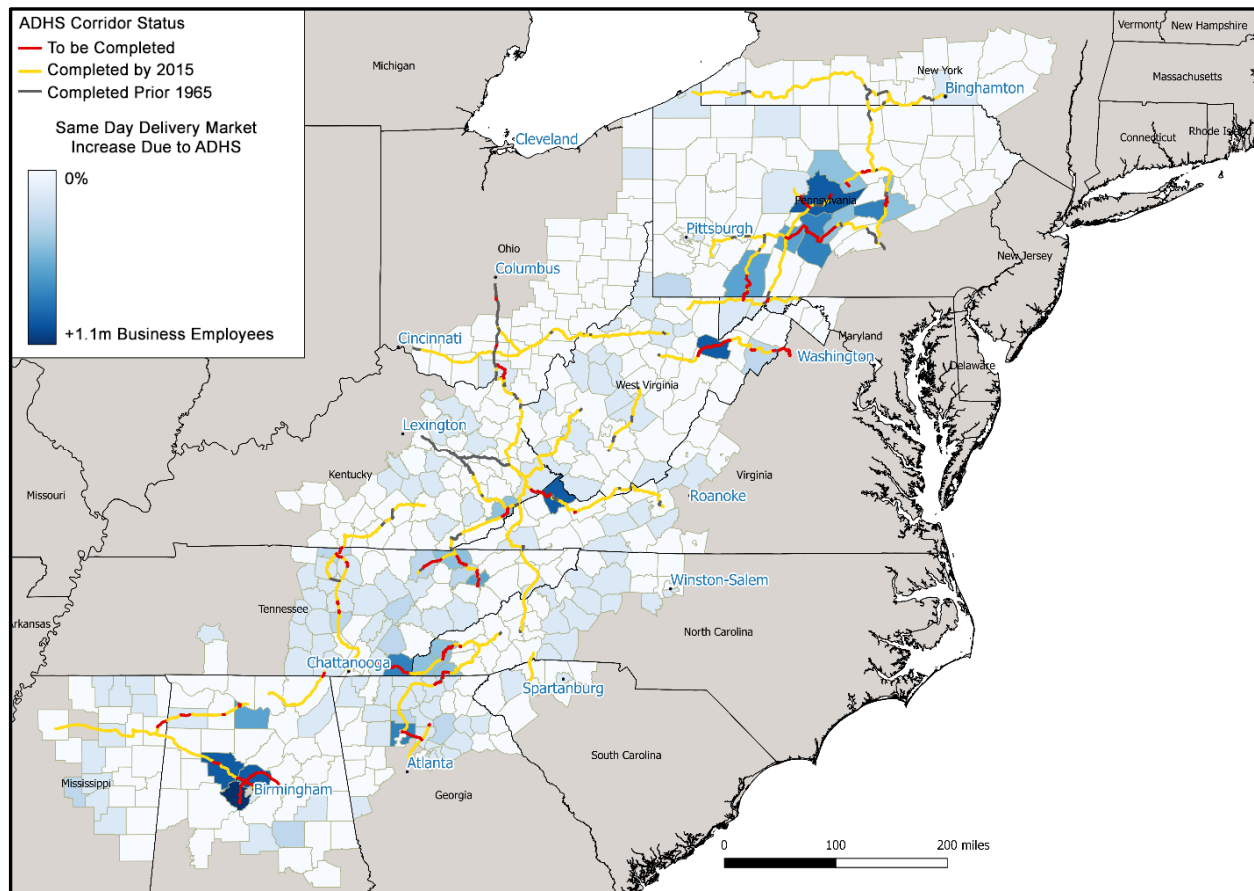


Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and Federal Highway Statistics.

**Same-Day Visit and Delivery Market Access.** By connecting with other interstate highways and other principal arterials, ADHS broadens the range of same-day markets for tourism-related travel and truck deliveries. Because of the ADHS, residents of outlying population markets will have greater opportunities to visit recreation and tourism destinations in Appalachia. At the same time, Appalachian business locations can serve broader customer markets (both business-to-business markets and consumer markets) via same-day truck deliveries. For this study, the same-day market is measured in terms of the area that can be reached within a four-hour one-way trip.

Figure 14 illustrates the increase in the size of the same-day markets accessible by counties affected by the ADHS relative to the expected level of access if the ADHS is not completed. Truck delivery market gains are calculated here on the basis of the number of business employees (a proxy for business activity and potential trading partners) reachable from any given county within a four-hour one-way travel radius. Altogether, firms located in counties served by the ADHS corridors are projected to gain access to 3 percent more same-day customers. While this figure may seem small, it represents a substantial potential impact on business profits. The darker shaded counties represent business locations with the highest percentage gain in accessible trading partners in 2045.

**Figure 14: Increase in Same-Day Market Access Attributable to ADHS Completion in 2045**



Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and Federal Highway Statistics.

The figure shows that completion of ADHS corridors will provide currently missing “links” between key markets served by ADHS and vital inter-modal facilities. Examples include Corridor X1 enhancing access to the inter-modal rail facility in Birmingham, Alabama and Corridor H improving connections from West Virginia to the Virginia Inland Port in Front Royal.

### 3.3 Valuation of Transportation Benefits

The travel efficiency benefits, such as hours of travel time saved, are valued in monetary (dollar) terms. For freight and business-related trips, the value of time represents business and labor costs and shipper logistics costs. Savings in personal travel time do not affect the flow of money in the economy, but have a very real value to the people involved (and are included in the benefit-cost analysis). Only the “productivity effect” of market access is counted for the purposes of valuing net national benefits. However, the subsequent section on wider economic impacts will further address the role of market access with regard to regional competitiveness, business attraction and economic performance. As shown below, it is notable that the largest source of benefit for car travel is time savings, while logistics cost savings are as important as time savings for truck travel.

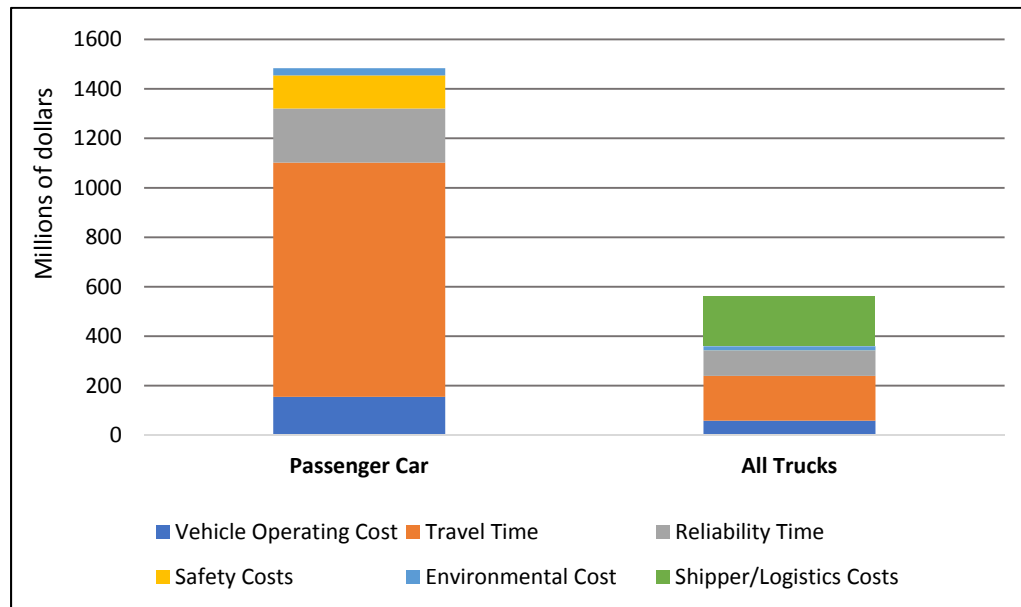
Table 9 and Figure 15 show the value of travel efficiency savings and market access productivity gains expected in 2025, 2035 and 2045 (in terms of annual savings per year) from vehicle miles of travel (VMT) and VHT reductions. Increasing levels of system completion, combined with overall growth in the market for ADHS travel, brings the annual undiscounted value of travel efficiency gains from just over \$587 million by 2025 to over \$2.8 billion in 2045, with the largest gains represented by travel time and reliability savings. As shown visually in the figure, it is notable that the largest source of benefit for car travel is time savings, while logistics cost savings are as important as time savings for truck travel.

**Table 9: Travel Efficiency Savings from Future ADHS Completion (in millions of constant 2015 dollars)**

Category of Value	2025	2035	2045
Vehicle Operating Cost	\$48.2	\$59.7	\$212.5
Travel Time	\$259.1	\$319.0	\$1,128.1
Reliability Time	\$72.4	\$89.8	\$321.0
Safety Costs	\$29.8	\$36.4	\$127.9
Environmental Cost	\$6.9	\$10.4	\$45.7
Shipper/Logistics Costs	\$42.6	\$54.7	\$201.4
Market Access (productivity gain only)	\$128.1	\$230.0	\$248.9
<b>Total</b>	<b>\$587.1</b>	<b>\$799.9</b>	<b>\$2,285.6</b>

Source: EDR Group Analysis Using Consolidated Travel Models compiled by Parsons Brinckerhoff, Federal Highway Statistics, and HPMS; valuation factors are defined in the full report. All numbers are expressed in millions of constant 2015 dollars.

**Figure 15: Sources of Benefit Associated with ADHS Completion (2045)**



Source: Source: EDR Group Analysis Utilizing Consolidated Travel Models compiled by Parsons Brinckerhoff, HPMS, and Federal Highway Statistics. And valuation factors are defined in the full report.

## **3.4 Economic Development Impacts**

**Analysis Overview.** The transportation benefits discussed in the prior section affect business operating costs, household spending, and economic productivity within Appalachia. These changes in money flows enable greater economic growth and development within the Appalachian Region, as well as broader economic impacts on the 13 Appalachian states as well as other nearby states.

This study estimates the wider economic impacts of ADHS completion using a multi-regional economic impact model that has been calibrated to show effects of transportation cost, access, and connectivity improvements. First, the transportation impacts (including travel time, travel cost savings, reliability improvements, labor market and truck delivery market enhancements, and intermodal connectivity) are applied to specific industries in each of the 13 Appalachian states to assess the relative impact on the productivity and competitiveness of that industry within the Region. This reflects the fact that some industries in some areas are more sensitive than others to changes in relative costs, reliability, or market size. The second step is to apply statistically validated cost-impact relationships and inter-industry trade relationships to calculate the expected impact on economic growth in each industry in the Region.

The analysis focuses on impacts for the Appalachian Region and the broader 13 Appalachian states. However, it should be noted that approximately 20 percent of the truck-related efficiency benefits and 16 percent of the car-related efficiency benefits actually accrue to parties located outside of the Appalachian states, who use the ADHS as part of longer distance trips going to/from or passing through the 13-state region. The additional market access and economic development benefits for outside areas have not been calculated as the economic development impacts are focused on the 13 states.

### **Economic Impacts Over Time**

Completion of the ADHS is expected to generate significant economic impacts. For example, the combined economy of the 13 Appalachian states is estimated to be able to produce and sell \$8.7 Billion more in goods and services per year (output), over \$4.2 Billion more in gross regional product, paying workers nearly \$2.7 Billion more in wages, and adding over 46,000 more jobs than if the ADHS is not completed (Table 11).

Table 10 and Figure 16 shows how the business output (sales), value added (GRP), wage income and employment impacts are projected to develop from 2015 to 2045. It is notable that economic growth is particularly pronounced in later years, reflecting the phased completion of ADHS segments and the fact that economic development impacts accumulate over time.

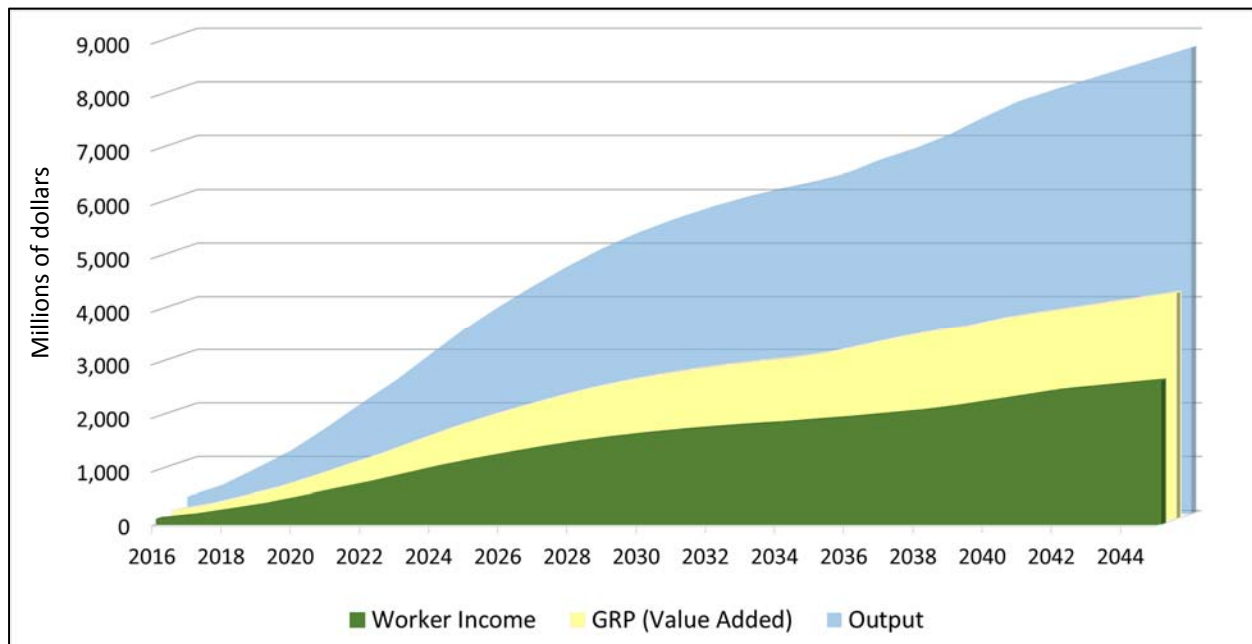
**Table 10: Annual Economic Impacts of ADHS Completion (In Constant Dollars)**

Annual Economic Impact of Completing ADHS *	Appalachia			Appalachian States		
	As of 2025	As of 2035	As of 2045	As of 2025	As of 2035	As of 2045
Business Output (\$M Sales)	\$2,982	\$4,855	\$6,717	\$3,875	\$6,299	\$8,704
Value Added (\$M GRP)	\$1,450	\$2,356	\$3,269	\$1,883	\$3,056	\$4,236
Wage Income (\$M Earned)	\$909	\$1,474	\$2,063	\$1,181	\$1,913	\$2,673
Employment (Jobs)	19,821	29,674	36,156	25,751	38,502	46,849

Source: Analysis by EDR Group using the TREDIS economic impact model.

\*Note: All values are in constant 2015 dollars.

**Figure 16: Future Economic Impacts of ADHS Completion**

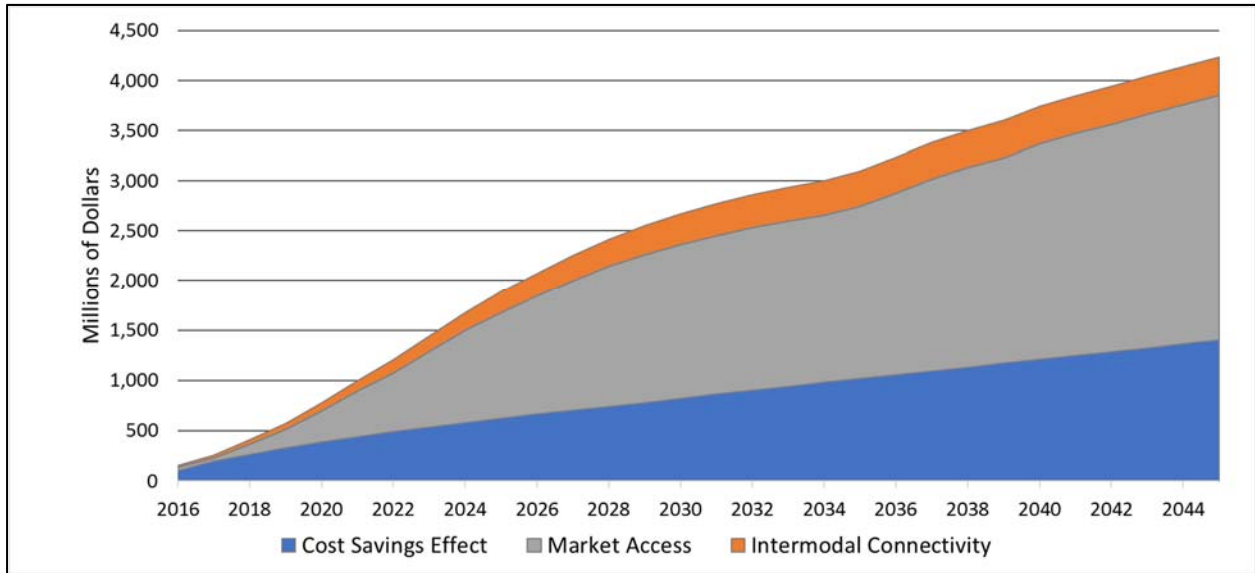


Source: Analysis by EDR Group using the TREDIS economic impact model for the 13 Appalachian states.

Note: All values are in constant 2015 dollars.

In addition, the relative role of transportation efficiency, market access, and intermodal connectivity in the growth of Gross Regional Product (GRP) is illustrated in Figure 17. The GRP impact of cost savings reflects an assumption of linear, gradual completion of ADHS segments over the period from 2016 to 2045. The GRP impact of market access enhancement reflects both time lags and cumulative growth effects of improving market access over time.

**Figure 17: Factors Driving Economic Growth (GRP) Impacts of ADHS Completion**



Source: Analysis by EDR Group using the TREDIS economic impact model for the 13 Appalachian states.

Note: All values are in constant 2015 dollars.

## Economic Impacts by Industry

The estimated industry mix of jobs and GRP impacts for ADHS system completion is shown in Table 11 and Figure 18. In general, the most affected industries (in terms of jobs and GRP) are those with the highest underlying growth rates and the greatest sensitivity to the relative costs of transportation or access to the enhanced labor and supply markets enabled by ADHS. The table shows a continuation of the historical effect of ADHS, whereby the ADHS facilitates the most significant growth in Appalachia’s service and knowledge economy, with professional and business services, education and healthcare, and financial services among the sectors most stimulated by the system.



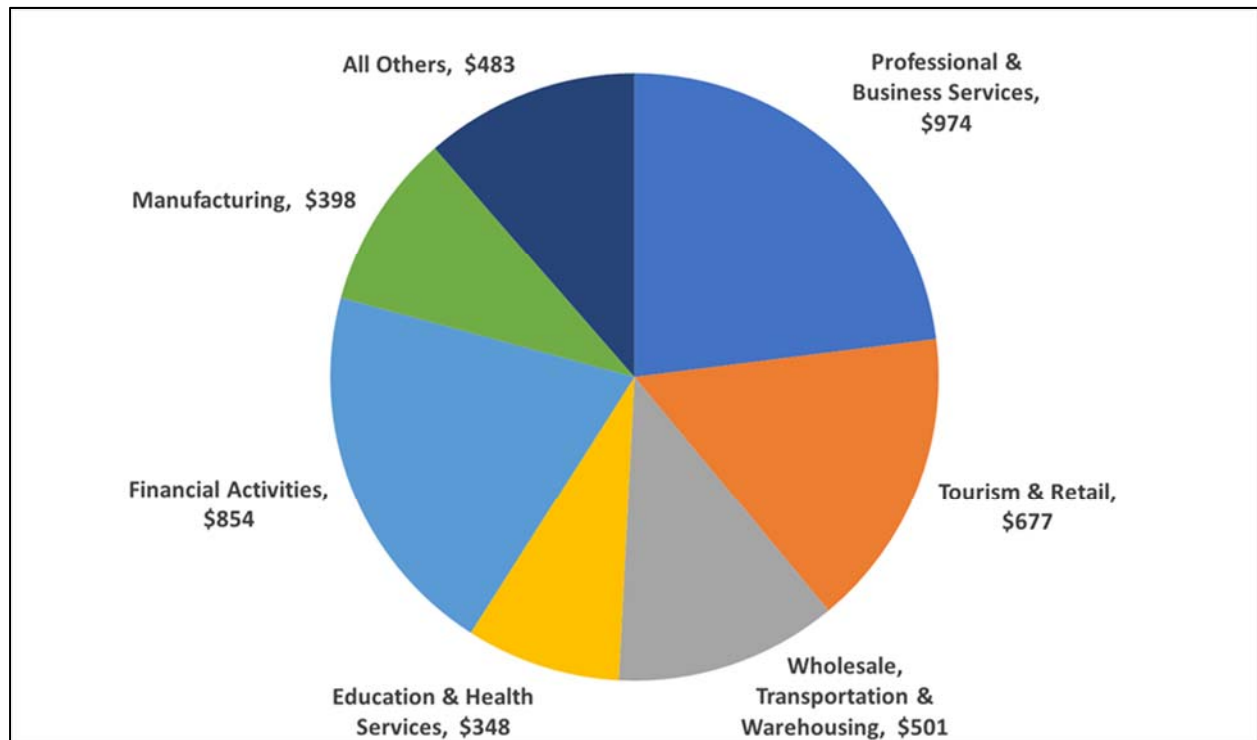
**Table 11: Projected 2045 Employment and GRP Impact due to ADHS Completion, by Industry**

Industry	Added Jobs	Added GRP *
	(annual impact)	(in \$ millions/year)
Professional and Business Services	14,619	\$974.4
Leisure and Hospitality (Tourism)	6,249	\$385.5
Education and Health Services	5,405	\$348.4
Financial Activities	4,264	\$853.7
Retail Trade	3,520	\$291.7
Manufacturing	3,041	\$398.1
Warehousing	2,735	\$165.0
Transportation	2,358	\$171.5
Construction	1,453	\$86.9
Wholesale Trade	1,038	\$164.7
Media and Information	836	\$147.5
Agriculture and Extraction	622	\$138.2
Utilities	489	\$97.0
Government	219	\$13.2
<b>Total in Year 2045</b>	<b>46,849</b>	<b>\$4,236</b>

Source: Analysis by EDR Group using the TREDIS economic impact model for the 13 Appalachian states.

\*Note: All values are in constant 2015 dollars.

**Figure 18: Top Economic Sectors Impacted Due to ADHS Completion (in Millions of Dollars of GRP)**



Source: Analysis by EDR Group using the TREDIS economic impact model for the 13 Appalachian states.

## 3.5 Benefit-Cost Analysis

This section presents the results of a return-on-investment analysis that compares the benefits of system completion, with remaining investment costs. Following the standards of traditional benefit-cost analysis, the benefits are measured in terms of their “social valuation”—representing financial gains (for actual cost savings), productivity gains (for business activity) and “willingness to pay” valuation for non-money benefits including personal time, safety, and the environment. Further impacts on attracting greater economic investment and growth into the economy are not included (except when viewed as a separate regional perspective analysis). These benefits are compared to construction and operating costs over time, and expressed in terms of their discounted net present values. Overall, the analysis shows that completing the ADHS can provide benefits equivalent to approximately four times the cost, when benefits are carried out to 2075 (allowing for a 30-year life after 2045 completion) and discounted at seven percent.

### Cost Estimates

Table 12 presents the estimated cost to complete the remaining ADHS corridor projects. While the baseline scenario of the benefit-cost analysis presumes a 2045 completion date, an alternative scenario is also considered with an accelerated 2035 completion date.

**Table 12: Estimated Corridor Completion Schedules Under Accelerated and Non-Accelerated Schedules**

Corridor Name	State	Estimated Completion Year (2045 or sooner)	Assumed Completion Accelerated Schedule (2035 or sooner)	Estimated Cost (Undiscounted) \$M
Corridor H	West Virginia	2042	2035	\$810.0
	Virginia	2026	2026	\$138.3
Corridor K	Tennessee	2025	2025	\$535.5
	North Carolina	2028	2028	\$760.5
Corridor M	Pennsylvania	2045*	2035	\$1,477.1
Corridor N	Pennsylvania	2045*	2035	\$510.1
	Maryland	2022	2022	\$183.9
Corridor Q	Virginia	2021	2021	\$474.1
	Kentucky	2019	2019	\$371.2
Corridor X1	Alabama	2045	2035	\$2,966.4
Other Corridors	Multiple States	varies	varies	\$2,687.7
<b>All Corridors</b>	<b>Multiple States</b>	<b>varies</b>	<b>Varies</b>	<b>\$10,914.8</b>

\*Pennsylvania DOT currently has no plans to complete this corridor, so the year 2045 was assumed for analysis purposes only

Source: Appalachian Development Highway System Cost-to-Complete Report, 2012, and Completion Plan Report, 2013.

## Benefit-Cost Analysis Results

Benefit-cost analysis results are presented from both a regional and a national perspective.

- *Regional Perspective:* This includes only the share of transportation efficiency gains that accrue within the Appalachian Region, and also includes the economic development gains to the Region associated with both local productivity and inward investment.
- *National Perspective:* This includes all transportation efficiency gains accruing in the United States, but only includes the market access gains that result in national productivity growth (about 22 percent of market access effects). Market access gains attributable to inward investment and business in-migration to Appalachia (about 78 percent of market access effects) are shown in the regional perspective only.

Table 13 shows the present value of future project cost streams and benefit streams. It accounts for specific sources of benefit, phasing of project costs, traffic growth rates, and the timing of benefits. It shows that, from the national perspective, ADHS completion is expected to generate societal benefits 3.7 times its cost when a 7 percent discount rate is assumed. From the regional perspective, benefits are approximately 2.7 times the costs. The benefit/cost ratios are even higher when a smaller discount rate is assumed.

The effect of discount rate assumptions (which are consistent with U.S. DOT guidance) is considerable due to the disproportionate share of benefits associated with Corridor X1 (which is not anticipated for completion until 2045). With X1 accounting for over 36 percent of total investment costs, a significant reduction in the discounting of these long-term benefits (accruing between 2045 and 2075) causes the lower discount rate to greatly magnify benefits in present-value terms. Consequently, the 7 percent discount rate may be more useful in reflecting effects of completing the overall system, accounting for the value of the likely time it will take before the benefits of X1 are expected to occur.

**Table 13: Benefit-Cost Analysis of ADHS Completion by 2045 (Present Value)\***

Benefit and Cost Elements	Regional Perspective		National Perspective	
	with 3% discount rate	with 7% discount rate	with 3% discount rate	with 7% discount rate
Vehicle Operating Cost Savings	\$3,195	\$1,053	\$5,042	\$1,659
Travel Time Saved	\$16,919	\$5,602	\$26,069	\$8,622
Reliability Time Saved	\$4,830	\$1,589	\$7,692	\$2,526
Safety Benefit	\$1,914	\$637	\$2,853	\$950
Environmental & Emissions Benefit	\$804	\$223	\$1,292	\$358
Logistics and Supply Chain Savings	\$3,073	\$986	\$5,566	\$1,786
Market Access (Productivity Gain)	\$4,993	\$1,994	\$1,049	\$419
<b>Total Cumulative Benefits</b>	<b>\$35,727</b>	<b>\$12,083</b>	<b>\$49,563</b>	<b>\$16,320</b>
<b>Total Cumulative Costs</b>	<b>\$7,005</b>	<b>\$4,471</b>	<b>\$7,005</b>	<b>\$4,471</b>
<b>Benefit-Cost Ratio</b>	<b>5.1</b>	<b>2.7</b>	<b>7.1</b>	<b>3.7</b>

\*Note: All values are net present values of cost or benefit streams covering the period of 2016-2075, using the specified 3 percent or 7 percent discount rate, and presented in terms of their 2015 value (millions of dollars)

### 3.6 Accelerating ADHS Completion

This section explores the effect of accelerating ADHS completion. It presents effects of a hypothetical analysis in which it is assumed that all ADHS corridors are completed by 2035 rather than 2045. The purpose is to assess potential gains associated with completing the ADHS sooner (as could be accomplished if more funding was made available sooner). Alternatively, it can be viewed as showing the lost economic opportunities associated with delay and longer time required to complete the system.

Table 14 demonstrates how acceleration would allow the Region to experience nearly \$8 billion in additional undiscounted cumulative benefits by 2035 in comparison to a scenario that would not complete the ADHS system until 2045. Figure 19 shows how acceleration speeds the development of societal benefits for future years.

**Table 14: Comparative Benefits of 2035 Completion vs. 2045 Completion (Undiscounted \$M)**

Benefit and Cost Elements	Cumulative Value (2015-2035)	
	2045 Completion	2035 Completion
Vehicle Operating Cost Savings	\$820	\$1,537
Travel Time Saved	\$4,396	\$8,231
Reliability Time Saved	\$1,231	\$2,315
Safety Benefit	\$505	\$944
Environmental and Emissions Benefit	\$125	\$243
Logistics and Supply Chain Savings	\$732	\$1,382
Market Access (Productivity Gain)	\$2,511	\$3,497
<b>Total Cumulative Benefits</b>	<b>\$10,320</b>	<b>\$18,149</b>

**Figure 19: Development of Benefits 2035 Completion vs. 2045 Completion**

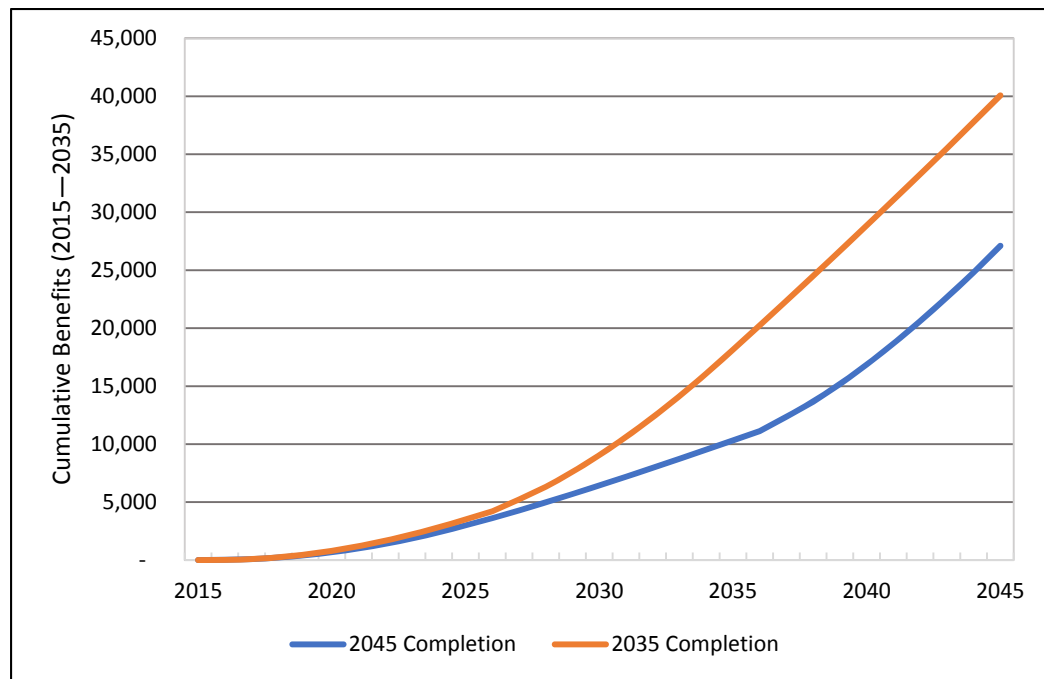


Table 15 shows the annual economic impact for the 2045 ADHS completion and the accelerated completion until 2035. The table shows that by 2035 the Region is estimated to gain over 11,000 more jobs as a result of accelerating completion of ADHS, as well as over \$1 billion more in GRP and more than \$2 billion in additional annual business sales (output).

**Table 15: Economic Impacts of Completing ADHS**

Economic Impacts of Completing ADHS	Annual Impact in 2035 (2045 Completion)	Annual Impact in 2035 (Accelerated)
Employment	38,502	49,700
Business Output	\$6,299	\$8,439
Value Added (GRP)	\$3,056	\$4,111
Wage Income	\$1,913	\$2,592

### 3.7 Analysis of Major Remaining ADHS Corridors

The local context of corridor investments yields insight into localized effects of intended improvements. For this reason, five corridors with substantial unbuilt segments and total combined cost of 75 percent of the entire ADHS system’s completion are analyzed specifically.

The five corridors show a variety of geographical and socioeconomic situations in which highway improvements are planned to be undertaken within the ADHS. While Corridor X1 comprises a major bypass highway for the Metropolitan area of Birmingham, Alabama, the analyzed corridors H, K, N, and Q serve as connections between rural areas within Appalachia and neighboring urban areas, with the unbuilt segments typically being in the mountainous parts and therefore more challenging to build. Corridor N is a connection between East-West-oriented corridors: Corridor M, the Pennsylvania Turnpike, and Interstate Highway 68. These different characteristics are reflected by the expectation of different results. The corridors are shown in Figure 1, appearing in the Introduction chapter of this report. The results of the analysis for these five corridors are presented in Table 16.

**Table 16: Benefit-Cost Analysis and Economic Impact Analysis for Five ADHS Corridors**

	H	K	N	Q	X1
Investment Cost (\$ mil)	948	1,296	694	845	2,966
<b>Benefit-Cost Analysis</b>					
Societal Benefits (\$ mil, discounted 7%)	761	1,623	373	1,458	3,078
Cost (\$ mil, discounted 7%)	278	887	239	739	727
Benefit-Cost Ratio	2.7	1.8	1.6	2.0	4.2
<b>Economic Impact Analysis</b>					
Gross Regional Product (after 10 yrs) (\$ mil)	166	205	61	97	1,395
Employment Change (after 10 Yrs)	1,852	2,368	700	987	13,937

In many cases, the completion of the remaining segments on these corridors is relatively expensive as they represent challenging highway segments to construct due to the topography and environmental concerns. However, all of the corridors comfortably reach a favorable benefit/cost ratio greater than 1.0,

most of them exceeding a ratio of 2.0. With the largest upfront capital investment cost, Corridor X1 is also expected to generate the largest travel and societal benefits, and economic impact.

The market for the ADHS and the scope of its potential impacts and benefits extend far beyond the immediate vicinity of any given project. For this reason, it is notable that the ultimate source of travel time savings, mileage savings and productivity gain represent not only changes in regional travel patterns within the scope of any given corridor, but also wider implications such as:

- 1) Savings and productivity gains enjoyed by households and firms that could relocate to the Region thereby reducing the need to exchange people and goods with remote locations far outside of specific corridor areas;
- 2) Savings enjoyed by the movement of people and goods currently using county, municipal and minor arterial roadways to access the Region from areas outside of the direct vicinity of each specific corridor; and
- 3) Redistribution and re-routing of national traffic exchanged between locations outside of the immediate corridor vicinity, using the corridor described.

Because the ADHS is a national system, representing entirely new connections for markets not currently served by other systems, the localized conditions of any given corridor are not intended to exhaustively encompass or represent all of the benefits and impacts enabled by any given corridor. In other words, part of the benefit of completing the ADHS is creating a fully-connected network of highways (which is difficult to capture in analysis of individual highway projects).

# 4 Conclusions

## 4.1 Effectiveness of ADHS Investment to Date

From this retrospective analysis of the economic impacts of the ADHS to date, it is clear that system has had, and continues to have, a profound impact on the Region's economic performance. Most notably, a historical view of the economic impact of the ADHS from 1965 to 2015 finds:

- Since 1965, areas served by the ADHS have enjoyed significant travel time savings and significantly enhanced workforce access and same-day truck delivery access. As of 2015, annual VHT and travel reliability savings due to ADHS corridor investments are estimated to be 360 million hours per year. These travel efficiency gains affect almost all sectors of the economy, leading to increased business productivity and competitiveness. The benefitting areas are largely rural and economically distressed counties.
- As of 2015, the value of transportation cost savings and productivity gains amounts to \$10.7 billion per year. These gains extend beyond the Appalachian Region, benefiting the entire U.S. Economy. Twenty percent of car vehicle hours saved and 31 percent of freight truck vehicle hours saved accrue to trips with at least one end located outside of the 13 Appalachian states. This indicates that the ADHS plays a particularly important role serving longer-distance goods movement and trade, connecting the Region to destinations throughout the U.S.
- The accessibility and transportation cost savings enabled by ADHS system completion to date can be directly linked to the creation of over 168,000 added jobs and over \$11 billion in annual GRP growth as of 2015. The cumulative effect of GRP growth continuing year after year, for over fifty years (from 1965 to 2015), adds up to \$388 billion. Those counties with the greatest travel efficiency and access benefits have also shown the highest rates of employment growth over time.
- The impact of ADHS completion on regional GRP and employment has continued to grow in every period of ADHS development. While the largest share of economic impact is attributable to a large block of highway system improvements made between 1965 and 1983, there is still significant ongoing growth in benefits and economic impacts from ADHS system investment, which can be expected to grow as the system is completed in the first part of the 21st century.

## 4.2 System-wide ADHS Completion Effects

Looking into the future, a separate analysis of ADHS completion impacts demonstrates a compelling case for additional investment to complete the highway network, and if possible accelerating completion of this system. Notable findings include:

- Completion of remaining ADHS corridor projects will bring savings in vehicle operating costs, traveler time and reliability. For example, by 2045 ADHS completion is expected to result in 121 million additional hours of travel time and reliability gains for the U.S., leading



to over \$1.8 billion in annual transportation efficiency, safety and environmental cost savings. However, there are also substantial connectivity benefits from completing the entire ADHS network, which will further enhance freight logistics, the scale of labor and business markets, and overall business productivity.

- ADHS system completion will generate a strong ROI (return on investment) for both the Region and U.S. The present value of benefits – including travel time, travel cost, safety, logistics, market access and environmental benefits – is estimated to exceed \$16.3 billion. That is 3.7 times greater than the present value of costs associated with system completion with benefits larger than costs in all scenarios tested in this study. National gains will also include effects on facilitating long-distance trips and intermodal connectivity.
- The impact of fully completing the ADHS system will be in the form of increased economic competitiveness, which will support more inward investment into the Region as well as more exports from the Region to the rest of the world. The overall impact is estimated to be nearly 47,000 additional jobs and \$4.2 billion per year in additional GRP realized within ten years after system completion. Around 77 percent of those impacts will occur within the Appalachian counties; the rest will be disbursed elsewhere in the 13 Appalachian states.
- Accelerated completion by 2035 rather than 2045 would help the Region realize economic growth and development impacts more quickly. For instance, it would lead to over 11,000 more jobs and over \$1 billion of additional GRP per year within the same study period.
- More than half of the jobs created by ADHS completion will be in the high-value knowledge or service sectors of the economy such as professional services, health-care, and financial services.

## **Bottom Line – Economic Impacts, Benefits and Costs of ADHS**

The ADHS investments to date have provided 5,119 additional lane-miles of highway, achieving \$10.7 billion in annual benefits—in terms of transportation system performance, access improvement (isolation reduction), and resulting economic growth on the order of 168,000 jobs and \$11.2 billion in annual GRP. Completion of the system will also have substantial benefits, in terms of achieving network connectivity to economic markets and intermodal facilities, and in terms of enabling trade and regional economic growth to the effect of nearly 47,000 additional jobs and over \$4.2 billion in additional GRP growth. Based on available cost estimates, the achievement of ADHS system completion will bring a strong ROI (return on investment) for Appalachia as well as the broader set of Appalachian states and the nation, realizing \$3.65 of benefit for every dollar spent on the system. An examination of five major ADHS corridors that are not yet completed also indicates a positive ROI for each, helping support the benefits of completing each element of the ADHS. While future costs and timing remain uncertain, the analysis shows that efforts to accelerate ADHS completion can help the Region enjoy significantly higher benefits much sooner.