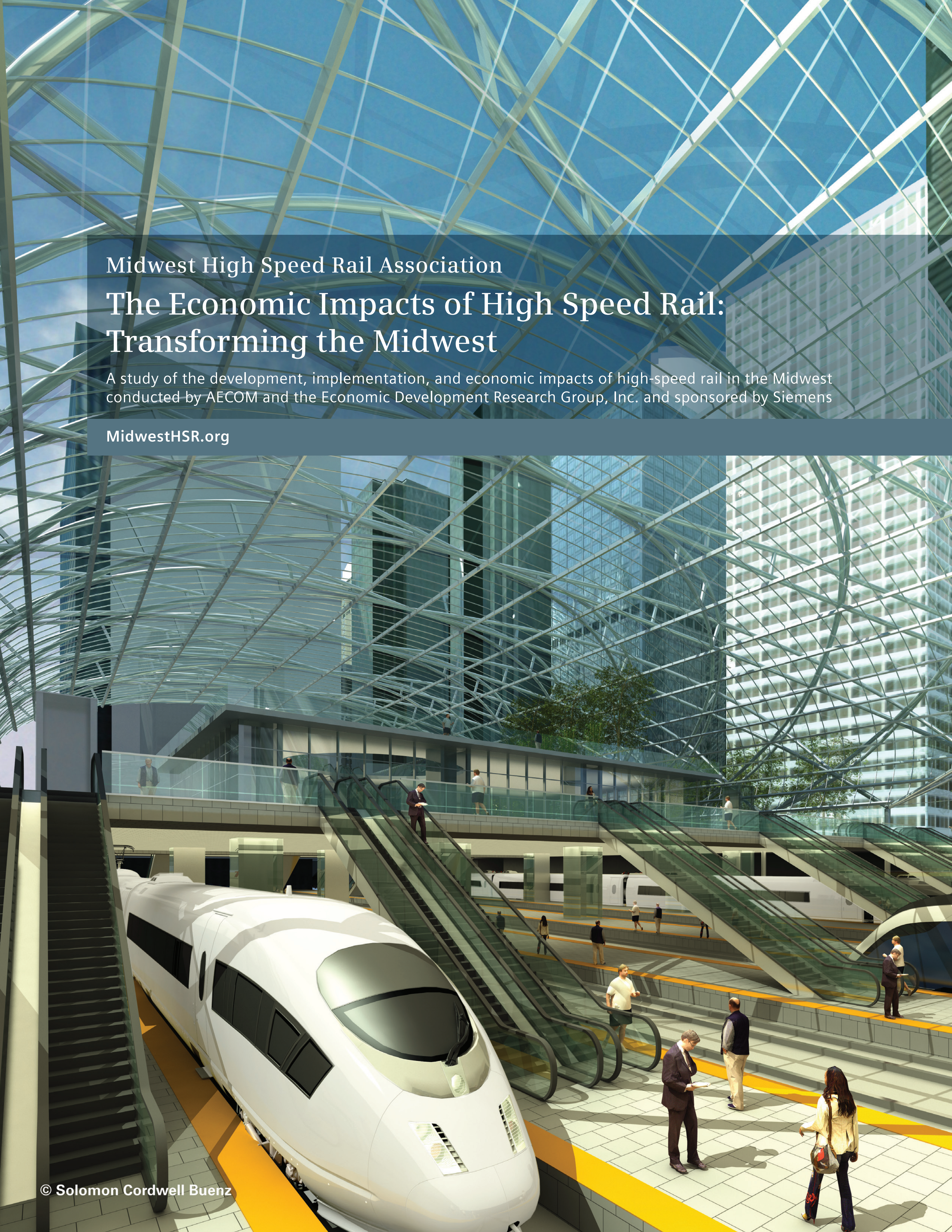
Midwest High Speed Rail Association

The Economic Impacts of High Speed Rail: Transforming the Midwest

A study of the development, implementation, and economic impacts of high-speed rail in the Midwest conducted by AECOM and the Economic Development Research Group, Inc. and sponsored by Siemens

MidwestHSR.org



"The Economic Impacts of High Speed Rail: Transforming the Midwest"

Technical Report

Prepared for:

Midwest High Speed Rail Association

Prepared by:

Economic Development Research Group

AECOM

Sponsored by:

SIEMENS

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1.0 Introduction

The Midwest High Speed Rail Association (MHSRA) is continuously striving to improve rail transportation in the Midwest and in particular implement a High Speed Rail (HSR) vision for the Midwest. They were pleased to team up with Siemens in sponsoring this study which was prepared by Economic Development Research Group, Inc. (EDRG) of Boston, MA and AECOM. This study assesses the economic impacts of HSR on the Chicago metropolitan area. These economic changes will be created by investments in the current Chicago area rail system and other transportation facilities required to support a true high-speed intercity passenger train system. The study is structured to provide an independent look – beyond existing regional HSR plans – to a time in the future when high-speed intercity train service, currently enjoyed by other developed and developing post-industrial economies, becomes a reality in the United States.

The goal of the study is to provide a candid and impartial assessment of a wide range of investments that will need to be made into railroads, commuter rail and transit to support a (HSR) hub downtown, and to help envision the types of land use and development potential that a well-designed, integrated high-speed system could produce for Chicago and its surrounding communities. The study provides a basis for understanding of the range of infrastructure investments, HSR-oriented development potential, and supportive transportation services required to achieve multimodal integrated HSR transportation systems in core metropolitan centers in the U.S.

The overall study area is defined by the location of major metropolitan areas within 300 to 450 miles of Chicago, which corresponds to a two- to three-hour one-way HSR trip. This is the same area covered by the Midwest Regional Rail Initiative (MWRRI) plan to develop a system of 110-miles per hour (mph) "emerging" HSR corridors radiating from Chicago. This plan was most recently documented in the MWRRI Executive Report published in September 2004. Though the participating states – Illinois, Indiana, Iowa, Ohio, Wisconsin, Michigan, Minnesota, Missouri, and Nebraska – have conducted studies of a number of individual corridors since its publication, the 2004 Executive Report remains the basis for the cooperative vision of 110-mph emerging HSR service in the study area, including the participating states'[1] recent applications for federal HSR funding.

The MWRRI plan would provide trains approximately every two hours between major destinations at average operating speeds of 70 to 80 mph. This is a significant near-term upgrade that offers intercity travelers a choice of rail travel times that are reasonable alternatives to auto travel and lays the groundwork for a robust regional network for the future. However, true HSR service operating at top speeds of 150 to 220 mph or more is a different product than the upgraded conventional passenger rail service envisioned in the MWRRI plan.

True HSR service in the Midwest has been addressed in three recent proposals. Via their website, the Midwest High Speed Rail Association (MHSRA) had proposed a 220-mph Midwest network that included corridors serving Minneapolis/St. Paul, St. Louis, Cincinnati, Toledo, Detroit, Cleveland, Columbus, and Pittsburg. In 2009, the MHSRA commissioned a study of 220-mph service in the Chicago-St. Louis corridor. Also in 2009, SNCF (French National Railway Corporation) prepared a proposal for implementing true HSR service in the four corridors serving Minneapolis/St. Paul, St. Louis, Cincinnati, Toledo, Detroit and Cleveland.

This Technical Report presents more detailed information than it was possible to present in the Executive Summary. The objectives of this report are to provide background discussion, data and other graphic information that can be used in conjunction with the findings presented in the Executive Summary. The

[1] With the exception of Nebraska which has not applied for federal HSR funding.

report is organized so that there is a companion section in the Technical Report for each section in the Executive Summary.

1.1 Study Area

The overall study area is defined by the location of major metropolitan areas within 400 - 500 miles of Chicago. This corresponds to a two to three-hour one-way HSR trip. Study area "windows" lying within this region have also been defined. The analysis will vary in level of detail in accordance with the size of the study area window: the Intercity Range analysis will identify overall corridor feasibility issues and service potentials linking Chicago with principal Midwest cities, the Metropolitan Range will consider implications associated with overlaying regional (commuter) rail service with potential HSR routes and the Chicago Range will identify issues relative to providing access to downtown Chicago with a focus on Chicago Union Station (CUS).

Source: AECOM, 2010.

Figure 1: Midwest Region

1.1.1 Intercity Range

Chicago is the center of a vast economic region, comprised of nine Great Lakes/Midwest states with nearly 100 million residents within 500 miles of the City. These states include Illinois, Wisconsin, Minnesota, Iowa, Nebraska, Missouri, Indiana, Ohio and Michigan. The governors of these states signed an agreement to work together to bring HSR to the region through a set of rail lines based on a common Chicago hub (see Figure 1). Amtrak currently provides conventional 70-mph intercity passenger rail service to much of this area. Besides Chicago, the major metropolitan areas include Milwaukee, Madison, Minneapolis/St. Paul, Des Moines, Omaha, St. Louis, Kansas City, Indianapolis, Cincinnati, Cleveland and Detroit. The Intercity Range is the primary market area for HSR service serving the Chicago hub.

1.1.2 Metropolitan Range

The greater Chicago metropolitan area is a study area window for investigating the role of commuter rail services as feeders to HSR service, and for identifying alternate HSR routes to serve airports or bypass downtown (see Figure 2). This area extends approximately 30-miles outward from downtown Chicago and can be represented by the service area of Metra, the Chicago-area commuter rail operator. There are 11 commuter rail lines radiating to the north, west and south of Chicago operated by Metra, and one extending east into Indiana operated by the Northern Indiana Commuter Transportation District. Cities at the outer edge of the Metropolitan Range include Waukegan, Fox Lake, Elgin, Aurora, Joliet, University Park and Gary. O'Hare International (O'Hare) and Midway Airports are also within the Metropolitan Range.

1.1.3 Chicago Range

The City of Chicago, and specifically the downtown district within a two-mile radius from the Loop, is a study area window for investigating the role of convenient rapid transit connections to HSR service (see Figure 3). Chicago Transit Authority's (CTA) 'L' system train routes are concentrated in this area, providing excellent coverage and access. New development has occurred on the outer edges of this area over the past decade, including office development along Wacker Drive and in the West Loop, and residential development in the River North area (Streeterville) and the South Loop areas. The eastern edge of the Loop (east of State Street) is characterized by civic facilities such as Millennium and Grant Parks and the Art Institute of Chicago. Healthcare development has focused on the Streeterville area around the Northwestern University campus.

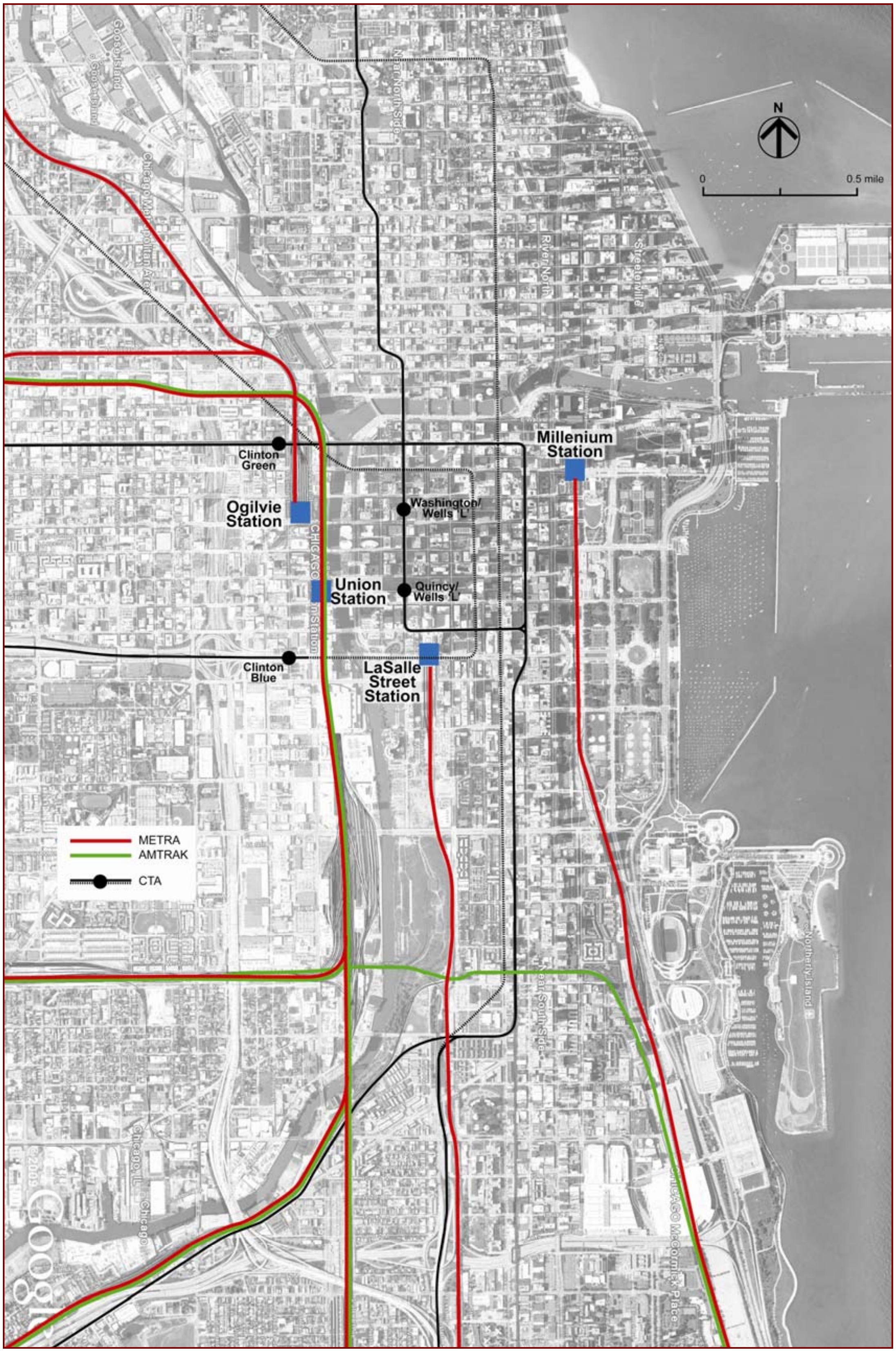
1.2 Study Corridors

This section describes the corridors included in this study. In the Intercity Range, corridors are defined based on those designated for 110-mph operation in the *MWRRI Executive Report*. Though the MWRRI states have conducted studies of a number of individual corridors since its publication, the 2004 *Executive Report* remains the basis for the cooperative vision of 110-mph emerging HSR service in the study area. Corridors for the 220-mph maximum speed scenario are built upon most of the 110-mph corridors, with some key differences where efficiencies can be obtained by branching from a trunk route. In the Metropolitan and Chicago Ranges, corridors have been selected to serve desirable HSR trip generators, such as airports and convention centers. The types of feeder service to the HSR network are defined in terms of the three study area ranges.

The MWRRI plan would provide daily train frequencies similar to Amtrak's existing service in California and the Pacific Northwest, but at higher average speeds. While this would be a significant improvement over existing Amtrak service in the Midwest, it does not compare to the service level planned for California's 220-mph HSR system. The MWRRI plan would provide trains approximately every two hours between major destinations at average operating speeds of 70 - 80 mph. The California system would provide several trains each hour at average speeds of 125 mph, similar to the true 200-mph HSR services operating in Europe and Asia.

Source: IDOT Illinois Railroad Map, 2006.

Figure 2: Metropolitan Range Study Area



Source: AECOM (Base provided by Google), 2010.

Figure 3: Chicago Range Study Area

The key attribute of true HSR as it is envisioned in this study is that it cuts travel time between major city pairs to under three hours, making day trips by rail possible and rail door-to-door travel time complementary to air travel by providing feeder service for cities within 450 miles of Chicago. Frequent trains, high-capacity and clockface schedules remove worries about running late and missing the train, because another train will be leaving within an hour. Where HSR has been introduced in Europe and Asia, the quantum leap in frequency, speed and capacity inherent in true HSR service, along with commensurate feeder services, has produced a “sea change” in travel behavior. With true HSR service, the train becomes the preferred mode of travel for business and pleasure between destinations along the route, and the three-hour travel time allows rail to capture overall market shares of 30% or more.

In the context of a future Midwest passenger HSR system, which includes some corridors that operate at speeds up to 220 mph, the MWRRI plan is a cost-effective initial investment. The high construction and operating cost of true high-speed service can only be commercially justified in a few high-volume travel markets. Medium and small markets will continue to be served by conventional passenger rail routes that serve as feeders to the true high-speed lines. Therefore, the prototypical HSR corridors evaluated in this study have been fully integrated into the MWRRI plan. This study also describes how HSR (with 150 to 200+ mph top speeds) can be introduced incrementally through infrastructure upgrades over a number of years, while the MWRRI-proposed system of 79 to 110-mph service continues to provide improved rail service to the Midwest.

1.2.1 Intercity Range

The primary corridors addressed in this study area link Chicago with the surrounding major metropolitan areas in the Great Lakes and upper Midwest region. For HSR service to achieve commercial success, it generally needs to connect major metropolitan areas that are located 100 - 500 miles apart, corresponding to a two to three-hour one-way travel time, and serve other cities along its route. As shown in Table 1, the major metropolitan areas within HSR distance of Chicago include Minneapolis/St. Paul, St. Louis, Indianapolis, Cincinnati, Detroit and Cleveland.

The corridors studied for the 220-mph service were designated for 110-mph operation by the various planning efforts growing out of the Midwest Regional Rail Initiative (MWRRI). In fact, the only corridor designated for 110-mph operation in the MWRRI plan that is not included in this study is from Milwaukee to Green Bay. That corridor does not meet the criteria described above for a major metropolitan area at one end of the route.

The MWRRI plan is a vision for a regional passenger rail system using existing rail rights-of-way shared with freight and commuter rail to connect nine Midwest states. The system would provide for better equipment utilization, more efficient employee utilization and lower unit costs for equipment purchases due to volume discounts. The system would be designed in a hub-and-spoke configuration centered on Chicago operating at speeds up to 110 mph. Travel times would be significantly reduced and train frequencies substantially increased. Service and schedule reliability would also be significantly improved. Stations and intermodal connections would be upgraded, and a feeder bus network would extend the range of the rail system to outlying areas.

Capital improvements required for implementation of the MWRRI vision include a new fleet of approximately 60 trainsets capable of speeds up to 110 mph, track replacement and upgrades, additional sidings, signal and communications systems and highway-railroad grade-crossing improvements. These infrastructure improvements would allow 110-mph operations, add track capacity, provide operations consistent with freight railroad policy and Federal Railroad Administration (FRA) safety regulations and improve safety at highway-railroad grade crossings.

Table 1: Population of Midwest Metropolitan Areas

Metropolitan Areas within 350 miles of Chicago (ranked by size)		Population (2009 Est.)	HSR Corridor	Ranking (U.S.)
1	Chicago-Naperville-Joliet, IL-IN-WI	9,580,567	all	3
2	Detroit-Warren-Livonia, MI	4,403,437	Detroit/Cleveland	11
3	Minneapolis-St. Paul-Bloomington, MN-WI	3,269,814	Minneapolis/St. Paul	16
4	St. Louis, MO-IL	2,828,990	St. Louis	18
5	Cincinnati-Middletown, OH-KY-IN	2,171,896	Cincinnati	24
6	Cleveland-Elyria-Mentor, OH	2,091,286	Detroit/Cleveland	26
7	Columbus, OH	1,801,848	—	32
8	Indianapolis-Carmel, IN	1,743,658	Cincinnati	34
9	Milwaukee-Waukesha-West Allis, WI	1,559,667	Minneapolis/St. Paul	39
10	Louisville/Jefferson County, KY-IN	1,258,577	—	42
…				
14	Toledo, OH	672,220	Detroit/Cleveland	79
15	Madison, WI	570,025	Minneapolis/St. Paul	88
…				
20	Fort Wayne, IN	414,315	Detroit/Cleveland	117

Sources: U.S. Census Bureau, 2010; AECOM, 2010.

Implementation is planned for a 10-year period using a phased approach, and would be the responsibility of the individual states. Upgraded service would be implemented consistent with market demand and each state's financial capacity to pay for the improvements. Corridors with the highest ridership potential per dollar invested would be implemented first, but broad geographic coverage would be achieved as early as possible. Successful implementation will require a strong working relationship among the states, federal and local governments, Amtrak, freight and commuter railroads, railroad labor and private bus companies. The following sections describe the 110-mph corridors of the MWRRI plan that were subject to further investigation in this study.

Chicago to Minneapolis/St. Paul

This corridor is approximately 400 miles long and lies within the states of Illinois, Wisconsin and Minnesota. Major intermediate stops would be located at Milwaukee, Madison and La Crosse. Under the MWRRI plan, six daily round trips would operate between Chicago and Minneapolis/St. Paul, four additional daily round trips between Chicago and Madison and seven additional round trips between Chicago and Milwaukee as part of a service between Chicago and Green Bay. Therefore, the Chicago to Milwaukee segment would have hourly service (assuming trains depart 6:00 AM to 10:00 PM), and the Chicago to Madison segment would have trains approximately every two hours. Trains would depart Minneapolis/St. Paul approximately every three hours. Chicago to Milwaukee travel time would be approximately one hour at an average speed of 90 mph, and Chicago to Minneapolis/St. Paul would be approximately five and one-half hours at an average speed of 75 mph.

Amtrak currently operates *Hiawatha Service* providing seven daily round trips between Chicago and Milwaukee. The 86-mile trip takes approximately one and one-half hours and operates at an average speed of 57 mph. Amtrak's Empire Builder train provides one daily round trip between Chicago and Minneapolis/St. Paul. Amtrak does not sell tickets on the Empire Builder for trips between Milwaukee and

Chicago. The 418-mile trip takes approximately eight hours and operates at an average speed of 52 mph. The route uses Metra tracks between Chicago and Rondout, Ill., and the Canadian Pacific between Rondout and Minneapolis/St. Paul. Amtrak does not currently provide service to Madison.

Chicago to St. Louis

This 284-mile corridor lies primarily within the State of Illinois, with a small section in Missouri. Major intermediate stops are Bloomington-Normal and Springfield. The route uses the Canadian National Railway (CN) between Chicago and Joliet, and the Union Pacific Railroad (UP) between Joliet and St. Louis. Under the MWRRI plan, eight daily round trips would operate between Chicago and St. Louis. This would provide departures every two hours at each end of the route, assuming trains depart 6:00 AM to 10:00 PM. Chicago to St. Louis travel time would be approximately four hours at an average speed of 70 mph. In January 2010, the State of Illinois received $1.1 billion in ARRA funding for upgrades to infrastructure, stations and signaling systems between Chicago and St. Louis.

Currently, Amtrak operates five daily round trips between Chicago and St. Louis, comprised of four Lincoln Service trains and one Texas Eagle train. The trip takes five and one-half hours and operates at an average speed of 52 mph.

Chicago to Cincinnati

This 319-mile corridor lies within Illinois and Indiana with a small section in Ohio. Major intermediate stops are located at Lafayette and Indianapolis. Under the MWRRI plan, six daily round trips would operate between Chicago and Cincinnati. Therefore, there would be a departure every three hours from each end of the corridor, assuming trains depart 6:00 AM to 10:00 PM. Travel time would be approximately four hours at an average speed of 80 mph.

Amtrak currently uses Norfolk Southern tracks between Chicago and Dyer, Ind., and CSX between Dyer and Cincinnati. Amtrak operates one daily round trip between Chicago and Indianapolis, comprised of the Hoosier State train four days a week and the Cardinal train three days a week. The trip between Chicago and Indianapolis is 196 miles long, averages five hours and operates at an average speed of 39 mph. The Cardinal also serves Cincinnati, but only stops during the early morning hours, making it impractical for trips to Indianapolis or Chicago. The Cincinnati to Chicago trip currently takes approximately eight and one-half hours at an average speed of about 37 mph.

Chicago to Cleveland

This corridor is approximately 350 miles long and lies within the states of Illinois, Indiana and Ohio. Major intermediate stops would be located at Fort Wayne and Toledo.

Under the MWRRI plan, eight daily round trips would operate between Chicago and Cleveland. Assuming trains depart 6:00 AM to 10:00 PM, this works out to a departure approximately every two hours. Travel time would be approximately four and one-half hours at an average speed of about 78 mph.

Though Amtrak currently operates two round trips between Chicago and Cleveland, they only stop in Cleveland during the early morning hours, making Amtrak impractical for trips to Toledo or Chicago. This service is provided by the Lake Shore Limited and Capitol Limited trains. The 341-mile trip averages six and one-half hours and operates at an average speed of 52 mph. The route uses Norfolk Southern tracks. Amtrak does not currently provide service to Fort Wayne; instead, the current route serves South Bend, which would not be served under the MWRRI 110 mph emerging HSR proposal.

Chicago to Detroit via Kalamazoo

This 281-mile corridor lies within Illinois, Indiana and Michigan. Major intermediate stops are located at Kalamazoo, Battle Creek and Ann Arbor. The route uses Norfolk Southern tracks between Chicago and Porter, Ind., Amtrak-owned tracks between Porter and Kalamazoo and Norfolk Southern tracks between Kalamazoo and Detroit.

Under the MWRRI plan, nine daily round trips would operate between Chicago and Detroit and five additional daily round trips between Chicago and Kalamazoo as part of services between Chicago and other Michigan destinations not in the Chicago-Detroit corridor. Therefore, the Chicago to Kalamazoo segment would have service approximately every one and one-half hours assuming trains depart from 6:00 AM to 10:00 PM, and the Chicago to Detroit segment would have trains approximately every two hours. Chicago-Detroit travel time would be approximately four hours at an average speed of 70 mph. In January 2010, the states of Illinois, Indiana and Michigan received a combined $244 million in ARRA funding for upgrades to infrastructure, stations and signaling systems between Chicago and Detroit.

Amtrak currently operates Wolverine Service providing three daily round trips between Chicago and Detroit. The trip takes approximately five hours and operates at an average speed of 56 mph. Amtrak's Blue Water train provides one daily round trip in the segment between Chicago and Battle Creek.

1.2.2 Metropolitan Range

In this range, corridor options are focused on serving Chicago's airports and providing alternate routes to and around downtown Chicago.

O'Hare International Airport

From a transportation-access viewpoint, Chicago is a major gateway to the U.S. and the Midwest region. O'Hare is the world's second-busiest airport, with flights to more than 60 foreign destinations. It is also a hub for both United and American Airlines.

Future plans call for a HSR station at O'Hare, providing a more direct link to the airport from downtown, and better opportunities for feeder and distributor services for longer distance air travel. The Midwest High Speed Rail Association (MHSRA) Chicago-St. Louis study envisioned a route from the planned O'Hare Western Terminal to CUS via Metra's Milwaukee West route. In their proposal for HSR in the Midwest, SNCF, the French National Railroad, proposed to serve O'Hare on a bypass route that would send longer-distance trains around downtown Chicago (see next section). With the SNCF proposal, there would be no direct HSR connection between CUS and O'Hare.

Currently, passengers arriving at O'Hare can travel directly to downtown using the CTA Blue Line rapid transit service that departs from Terminal 2 and operates 24 hours a day. The total travel time is 40 minutes and includes 14 intermediate stops. There is also direct service downtown via the Metra North Central commuter rail service, which has a travel time of 27 minutes. However, arriving passengers who wish to access the Metra O'Hare transfer station must first ride the Airport Transit System (a people mover) to Lot E, then transfer to a shuttle bus to reach the Metra station.

Midway Airport and Chicago Bypass

The SNCF proposal's Chicago Bypass includes a station at Midway Airport. At its northern end, the bypass would diverge from the Milwaukee to CUS route near Northbrook. At this location the bypass route would follow the Union Pacific Railroad to Des Plains, where the route would turn onto the Wisconsin Central (the route of Metra's North Central Line). The bypass route continues south on the Wisconsin Central from the O'Hare station until it reaches a rail junction at Franklin Park, where the route turns to follow the Indiana Harbor Belt and then Belt Railroad Company alignments to a Midway Airport station located over the Bedford Park Yard. From the Midway station, the bypass route continues along the Belt Railroad Company alignment and then along the Indiana Harbor Belt alignment to connect with the high-speed route from CUS to Gary.

Currently, passengers arriving at Midway Airport can travel directly to downtown using the CTA Orange Line rapid transit service, with a travel time of 30 - 35 minutes.

1.2.3 Chicago Range

In this range, corridor options are focused on station locations serving downtown Chicago.

Chicago Union Station

Chicago Union Station (CUS) is the only remaining intercity rail station in Chicago and is the preferred central hub for HSR service in the Chicago region. Currently, the station serves seven Amtrak intercity train routes, as well as six Metra commuter rail lines. The Amtrak routes connect to Milwaukee/St. Paul, Denver, San Francisco Bay Area, St. Louis, Dallas, New Orleans, Detroit, New York and Washington, D.C. The Metra services include the North Central, Milwaukee District North Line, Milwaukee District West Line, Burlington Northern Santa Fe (BNSF) Railway Line, Heritage Corridor and SouthWest services. As of 2007, 54,000 passengers use CUS daily, including 6,000 Amtrak passengers. The station features a double stub-end design, which results in all through passengers having to change trains. There is no direct connection to local rapid transit service, but the nearest CTA 'L' line stops one block south at the Blue Line Clinton Station.

CUS is located on the opposite (west) side of the Chicago River from the Loop, the City's central business district. In recent years, office development has progressed into the West Loop, the area along the eastern bank of the Chicago River, and closer to the station. Current plans for the expansion of CUS include the addition of an 18-story tower above the station for retail, office, hotel and condominium use. Plans also call for a transit center to address the congestion caused by the convergence of buses, automobiles, taxis and private shuttles at the station. In addition, a number of "transitways" are proposed to improve connections between CUS and key downtown destinations.

McCormick Place

McCormick Place is the largest convention center in the U.S. and an important downtown Chicago destination. The basement level of the facility incorporates a commuter rail station, which is served daily by the Metra Electric Line (ME) and on the weekends by the South Shore Line (SS). Both lines connect Chicago's southern suburbs to downtown, and the SS operates to Gary and South Bend, Ind.

In addition to CUS, McCormick Place has been identified as a potential HSR station in the downtown Chicago area. It is anticipated that HSR service would increase attendance at events held at the convention center and add convenience for visitors. McCormick Place is not directly served by local rapid transit service, and visitors arriving by HSR at CUS would either have to take a taxi or face an inconvenient trip via transit and walk considerable distances to reach the convention center.

1.2.4 Feeder Service

It is widely recognized that high-speed passenger trains serve an intercity-line haul function, moving people between major metropolitan areas over distances typically in the range of 100 - 500 miles. However, this function works only if there is also a high level of feeder access at each end of the trip. Some HSR customers have ultimate origins and destinations in smaller cities located some distance away from the HSR line. These customers need lower-capacity intercity rail and bus connections to complete their trip. Within the Metropolitan Range, suburban activity centers are served by regional or commuter rail connections or by regional buses. For trips originating or ending near the downtown train hub, feeder access is usually in the form of local transit services.

Intercity Range Feeder Service

In this range, feeder service connects high-speed stations with smaller cities to create a complete transportation network. Feeder trips can be from 20 to as much as 200 miles long. Whether the feeder service is a train or a bus depends on the size of the travel market and the availability of suitable rail infrastructure.

Intercity Feeder Bus

Intercity bus connections would generally connect smaller cities and towns to the HSR system either directly or via an intercity rail connection. Examples of a direct bus connection would be from Kokomo, Ind., to the high-speed station at Lafayette, or from Jacksonville, Ill., to Springfield. An example of a combined intercity bus and rail connection would be a trip via bus from Evansville, Ind., to the rail station at Centralia, Ill., and then via regional rail from Centralia to the HSR station in Champaign. Figure 4 shows the intercity feeder bus routes identified in the MWRRI 110-mph plan.

Intercity Feeder Rail

Intercity rail connections would connect medium-sized cities to the HSR network. The basic intercity rail network would be the lines identified in the MWRRI plan, shown in Figure 4. Examples of intercity rail feeder routes include Green Bay to Milwaukee, Kansas City to St. Louis and Carbondale to Champaign. A subset of intercity rail connections would be local service running parallel to a HSR line. An example would be intercity service between Champaign/Urbana and Chicago that stopped at Homewood, Peotone, Kankakee, Gilman and Rantoul.

Metropolitan Range Feeder Service

In this range, the focus of feeder routes is primarily travel from suburban and other outlying portions of the Chicago metropolitan area to the central HSR hub at CUS. A secondary function is connecting from these outlying areas to any other high-speed stations in the metropolitan area, such as O'Hare or Midway airports. Some travelers would prefer boarding the HSR service at one of these secondary stations to avoid out-of-direction travel and the congestion of CUS.

Regional Bus

Regional bus service in the Chicago area is provided by Pace Suburban Bus, a part of the Regional Transportation Authority (RTA).

Regional Rail

Regional rail service in the Chicago area is provided by Metra, a part of RTA. CUS is served by six Metra commuter rail lines. Nearby are four other major train terminals serving an additional five Metra commuter rail lines. Altogether, the Metra system provides 11 lines that converge downtown from as far as 50 miles away.

Chicago Range Feeder Service – Local Mass Transit

HSR ridership is greatest for cities with extensive local transit systems that provide local connectivity. The five cities with the highest ridership in the Northeast Corridor: New York, Boston, Philadelphia, Washington and Baltimore, all have extensive mass transit. Local transit connections provide a vital feeder and distributor function for intercity-line haul HSR services. Seven CTA rail rapid transit lines meet in downtown Chicago, along with numerous bus lines.

Source: MWRRI , 2004.

Figure 4: MWRRI Intercity Feeder Rail and Bus Routes

CTA

The CTA operates the second-largest transit system in the U.S., serving 1.05 million bus riders and 650,000 rail riders each weekday. Its service area incorporates Chicago and 40 surrounding municipalities. Services are provided on eight rapid transit lines on a 106-mile network, colloquially known as the 'L'. The nickname originates from "elevated," which describes about half of the rail system, another third is at-grade and the remainder is underground.

The 'L' lines radiate north, west and south from downtown Chicago and are referenced by color. Five lines are focused on a central elevated loop, which is bisected by a further two lines that traverse downtown in subway. An additional shuttle line connects a northern suburb to the system. Clinton Station on the Blue Line is situated nearest to CUS (two blocks south) and serves central and northwest Chicago neighborhoods, as well as O'Hare. Quincy Station, on the Loop, is served by four lines and is located four blocks east of CUS. In the central neighborhoods of the City, an 'L' station is generally located within one mile. Some outlying areas, however, do not have 'L' service, especially some northwestern neighborhoods and neighborhoods further south of the City.

In addition to the rapid transit 'L,' the CTA operates more than 154 bus routes, an extensive system covering the entire City. In contrast to the radial rail system, the bus routes follow the overarching grid pattern of the City, with routes generally providing either north-south or east-west service. Ten routes are express services, and one route operates exclusively during late nights and early mornings as a night bus.

New Transitway Proposals

The existence of this vast network of rail rapid transit, commuter rail and intercity rail lines and four separate train terminals, has raised longstanding local discussions regarding the opportunities and challenges for improved connectivity of the various rail lines and services. Separate terminals make it difficult to connect from one service to another, and though the various lines may cross, in many cases there is not a joint transfer station, only individual stations situated some distance away from each other. New transitways are proposed, which would provide connections between the various stations and feed passengers from other stations and modes to the central HSR station hub.

The Clinton Street Transitway (also known as the West Loop Transportation Center) is proposed to be built one block west of CUS to serve as a multi-level, multi-modal facility linking CUS and the Ogilvie Transportation Center (where three other commuter rail lines converge). The City's newly released *Central Area Action Plan (CAAP)* also includes conceptual designs for direct links from CUS to Navy Pier and North Michigan Avenue via a Carroll Transitway, and to Millennium Park and McCormick Place via a Monroe/Lakefront Transitway. There are also proposals for bus rapid transit (BRT) to aid downtown circulation, reduce congestion and bolster bus services to the downtown area.

In addition, the Mid-City Transitway has been proposed as a concept for the use of the right-of-way formerly designated for the Crosstown Expressway for BRT, a truck-only bypass and/or rail rapid transit. The transitway would connect the Kennedy and Dan Ryan Expressways along a 22-mile corridor. Transit services in the corridor would facilitate trips between outlying areas of the City and enable transfers to radial lines to reach downtown or outlying points.

Other System Expansion

Current CTA system expansion efforts include extensions of the outer ends of the Red, Yellow and Orange lines, planning for a Circle Line, and visioning for the modernization of the North Red and Purple Lines. A future Circle Line has the most relevance for HSR, as it is intended to serve an important distribution function, connecting the spokes of the radial rail network.

1.3 Performance Standards for Study Scenarios

1.3.1 Operating Scenarios

79 mph

Existing regional rail and intercity operations are typically limited to a maximum speed of 79 mph. This limit was introduced in a 1951 ruling by the Interstate Commerce Commission, which stipulated that train speeds in excess of 79 mph are permitted only where Automatic Train Stop, Automatic Train Control or cab signals are in use. The expense of installing these systems is justified when conditions otherwise support higher speeds. Additionally, speeds over 79 mph require supportive horizontal alignments and operational scenarios with stations spaced far enough apart to allow intervals of significant length, within which top speeds would be sustained.

110 mph

In addition to the train control systems required for operations at speeds greater than 79 mph, the MWRRI plan identifies several infrastructure improvements necessary to support passenger services operating at speeds up to 110 mph: track replacement and upgrades, additional sidings, signal and communications systems and highway grade-crossing improvements. Highway-railroad grade crossing improvements involve technology improvements, visibility improvements, fencing and some grade-crossing closures. These improvements would increase track capacity and operating safety.

150 mph

The only HSR application currently in operation in the U.S. is Acela, a 150-mph technology operating in the Northeast Corridor. Acela equipment features a tilting mechanism, allowing trains to negotiate curves at higher speed without affecting passenger comfort. This allows higher speeds to be achieved where extensive smoothing of horizontal alignments is impractical or cost-prohibitive, as is the case along much of the Northeast Corridor.

Another aspect of the Northeast Corridor's 150-mph operations is that it is one of the few portions of the Amtrak network where tracks are owned by Amtrak. In most cases, Amtrak operates on tracks owned by freight railroads, resulting in shared operations. Beyond 110 mph, the speed differential between passenger and freight trains becomes greater and shared operations on the same tracks are more difficult to accommodate, though developments in signaling, train control and protection technology are facilitating such operations to a greater degree. Nonetheless, an additional track or set of tracks greatly improves the ability to provide passenger services beyond 110 mph at regular frequency. California experience has demonstrated that it can be problematic for a typical 100'-wide right-of-way to accommodate two sets of double tracks, one for freight and one for passenger operations. In this case, and where rights-of-way are narrower or numerous points of access to freight tracks are needed by adjacent shippers, passenger tracks can be elevated, requiring only right-of-way for the supporting columns.

Acela equipment is compliant with existing FRA buff strength requirements and represents the upper-end of operations using standard, "heavyweight" equipment, as speeds greater than 150 mph become increasingly energy inefficient using such equipment. In the future, it is likely that International Union of Railways (UIC) lightweight equipment like that used in Europe would be accepted for use on U.S. passenger-only tracks, pending FRA rule revisions (see Section 12.6).

Operations at 150 mph may be an end goal for high-speed service, as is the case with Acela, or they may be considered an interim step on the way to speeds above 200 mph. In some cases, the step up to allow for greater speeds may result in only marginal service improvements. For instance, in densely-populated corridors where stations would be spaced rather closely together, the intervals where the top speeds would be reached would be limited. In such cases, 150 mph may be considered the optimum goal for service improvements.

220+ mph

True HSR operates at speeds greater than 150 mph, enabled by exclusive tracks with no shared operations with freight. In addition to supportive infrastructure, lightweight equipment is required to reach speeds of 220 to 250 mph.

Operations beyond 125 mph necessitate the elimination of grade crossings, requiring the construction of overpasses or underpasses for intersecting roadways or aerial alignments or tunneling for the HSR alignment.

As alluded to in the previous section, alignments designed for speeds approaching 250 mph are most appropriate in corridors with large intervals between urban areas, so that top speeds can be sustained for a significant portion of the overall travel distance.

Any guided transportation mode operating at speeds above 150 mph falls under the Rules of Particular Applicability. This means that each particular case and each particular component of the system, such as vehicles, tracks and control systems, are evaluated individually and as a total system.

1.3.2 Criteria and Requirements for Incremental Upgrade of Operating Speeds

The following items are the infrastructure, equipment and systems concerns that will be addressed in the evaluation of facilities necessary to support a true HSR network in the Midwest.

Grade Crossings

The FRA has issued an order limiting train speeds to 87 mph on the Northeast Corridor for at-grade crossings and has set a maximum speed of 95 mph for grade crossings with specialized protection systems. For planning purposes, grade separation should be assumed for operations exceeding 110 mph.

Horizontal Alignment/Curvature

As operating speeds increase, the sharpness of allowable curves needs to decrease. There is no hard and fast rule for minimum allowable curvature, as the location of the curve and the challenges of increasing its radius often result in a series of tradeoffs. For example, a 650’ curve may be acceptable at the throat of a stub-end station, since all trains would be moving slowly anyway, while entering or leaving the station. On the other hand, very large radii may be needed on mainline segments to maintain acceptable average operating speeds. For example, the required radius with desirable superelevation for 220-mph operation is 22,000 to 35,000 ft depending upon whether minimum or desirable superelevation is provided. Although a higher, “exceptional” superelevation can be used to attain slightly higher speeds for a given radius, for planning purposes the study alignments assumed “minimum” or “desirable” superelevation and the corresponding radius of curvature.

Traffic Mix

Generally speaking, as speeds increase, the ability to mix freight and passenger traffic decreases. Above approximately 120 mph, the extent of track authority required for a passenger train (the amount of track the train occupies plus the area ahead and behind to allow safe stopping distances) becomes so long that it is difficult to fit a slow-moving freight train in between two passenger trains. On high-speed, primarily passenger rail lines, occasional freight operations to serve on-line rail shippers may still be possible by limiting freight operations to low-volume passenger periods, such as overnight. Though the regulations have not been finalized, the FRA is anticipating that exclusive tracks for passenger services need to be provided at speeds over 125 mph.

Equipment

Diesel-electric powered locomotives are the common method used to propel conventional passenger rail service at speeds up to 79 mph. While specially-designed diesel locomotives can be used, electric propulsion becomes desirable as speeds exceed 125 mph. Whether locomotive-hauled coaches or multiple-unit trains are used is a function of expected travel demand and the maintenance philosophy of the operating entity. At speeds over 150 mph, purpose-built integrated trainsets are usually the norm.

Signaling

Signaling capabilities must become more complex and robust as speeds increase. At speeds over 79 mph the conventional wayside block signal becomes difficult to read accurately and in-cab signal indications become necessary. The FRA now requires Positive Train Control (PTC) on services operating at speeds greater than 110 mph. At speeds above 150 mph, sophisticated moving-block systems, such as those used in modern rapid transit applications, become necessary.

Overnight Storage Facilities

Often overlooked is the need to provide a large area near the terminal stations for overnight storage of high-speed trainsets. Because of the high frequencies offered on HSR systems, vehicle fleets are fairly large, and it is important to store them as close as possible to the terminal stations to avoid inefficient deadhead movements. This requirement becomes challenging because terminal stations are typically located in dense, urban core areas where a large parcel of sufficient length (upwards of 2,000') is often not available or prohibitively expensive.

1.4 Route and Track Improvements

1.4.1 Shared Track and Corridors

Current practice in the U.S. generally includes four types of shared operation:

- Predominantly freight lines with occasional long-haul passenger trains – the current template for Amtrak passenger service nationwide;
- Predominantly passenger lines with occasional freight trains – similar to the SS regional rail corridor between Chicago and South Bend, Ind., or the Caltrain commuter line between San Francisco and San Jose, Calif.;
- Freight corridors that host varying levels of regional/commuter passenger traffic – such as the UP and BNSF lines radiating from Chicago;
- Corridors that are shared by freight and passenger lines operating on separate sets of tracks – this condition occurs, for example, through the Bridgeport and McKinley Park neighborhoods in Chicago where the CTA Orange Line operates alongside the Canadian National; this was also the case when Illinois Central Gulf operated a four-track electrified passenger service alongside two freight tracks south from downtown Chicago.

Where freight and passenger trains share track, there are numerous operational and legal considerations including:

- Meeting FRA safety requirements, in particular, those dealing with the weight of the passenger equipment;
- The design of the track and alignment to accommodate the different train types – lower maximum grades are desirable for freight operations, whereas higher superelevation (banking) of curves is desired to maintain passenger comfort at higher speeds;
- Having an adequately robust signaling system to efficiently accommodate longer and typically slower freight trains mixed with shorter but faster passenger trains;
- Specifying the density of trains and mix of speeds that can be accommodated within the capacity of the trackage, even if the equipment is compatible and the track and signal infrastructure is adequately robust to accommodate the mix of equipment.

In the event that freight traffic is infrequent (e.g., trains spaced approximately 30 - 60 minutes apart), it is possible to accommodate passenger trains with similar headways in both directions on a double-track network, provided adequate crossovers are provided. However, with higher levels of freight traffic, it is difficult to support regular passenger service without providing a three-track network. As a specific example, the UP Martinez Subdivision in Northern California currently supports 32 Capitol Corridor regional trains between Oakland and Sacramento, eight San Joaquin corridor trains between Oakland and Bakersfield and four Amtrak long-haul trains (the California Zephyr and Coast Starlight) along the heavily-utilized UP transcontinental mainline, which serves as the principal freight route serving the Port of Oakland (32 - 40 UP freights plus six to eight BNSF trackage rights freights). With nearly 100 movements per day, this line is essentially at capacity. The Capitol Corridor long-range development plan aims to eventually construct a three-track mainline to support further expansion of passenger service. Ultimately, there would be two tracks primarily for passenger service and one track primarily for freight service; however, conflicting freight movements would use one of the passenger tracks to meet or pass in windows not occupied by passenger traffic.

The addition of a third track, crossovers and improved signaling to a two-track line would provide enough capacity to support moderate freight traffic mixed with frequent (regional) passenger service. This strategy would not necessarily allow passenger trains to operate faster than the 79-mph speed limit imposed by the FRA for trains without automatic cab signals. The Rail Safety Improvement Act of 2008 (RSIA) mandates the deployment of interoperable Positive Train Control (PTC) systems by December 31, 2015 on mainlines, which include passenger traffic or freight trains carrying poison inhalation or toxic inhalation materials. Implementation of PTC will address the cab signal requirement; however, if passenger train speeds are increased, then the line capacity will be substantially diminished by the need to provide the increased track time occupied by passenger movement. For these reasons, while PTC and the addition of a second track (or even a third track in some cases) would allow for the type of operations envisioned in the MWRRI plan for 110-mph emerging HSR service, this strategy would not be effective at attaining 125-mph service unless very light freight traffic levels are present.

Current FRA regulations do not permit the mixing of "lightweight" (e.g., UIC) equipment with "heavyweight" (e.g., compliant with freight in accordance with FRA buff strength provisions) equipment. Whereas the Acela equipment operated by Amtrak on the Northeast Corridor can attain 150 mph and meet the FRA criteria, world-standard high-speed train equipment (presently operating at 220 mph but expected to attain 250 mph in the future) does not meet current FRA criteria for mixing; however, this situation is beginning to change. With the introduction of the PTC requirement by FRA and with active project development underway in California to electrify the Caltrain corridor (San Francisco to San Jose), the FRA is considering rule modifications that will allow the mixing of equipment at least within the 79-mph limit identified in the current Caltrain application. In the future, should FRA policies change, a possible scenario may emerge allowing lightweight equipment to operate along existing freight lines, albeit at reduced speeds under 125 mph. This strategy could enable U.S. high-speed trains to access densely-developed central areas without needing to provide completely separate trackage.

Developments in signaling, train control and protection technology are facilitating shared operations to a greater degree. While PTC is currently in the design phase in North America, a similar system, the European Train Control System (ETCS) has been implemented in mixed freight/passenger applications in Europe. ETCS has an excellent availability record and is designed for short headways. Special functions accommodate particular operations characteristics, such as axle load supervision for freight and tilting train functions for passenger services. In addition, the interoperability of ETCS equipment from multiple suppliers has been proven. A system that could integrate both PTC and ETCS would be beneficial for the situation in the Midwest, with its high rail traffic densities and mixed freight and passenger operations.

1.4.2 Shared Corridors

For the reasons described above, this study generally considered the need to provide new dedicated passenger tracks outside of the Chicago metropolitan area and, within the Chicago metropolitan area, generally considered following existing Metra corridors with largely new dedicated HSR trackage, or in some limited cases, shared track with Metra operations but not shared track with freight. (One exception is consideration of temporally-separated freight operating at night or in a restricted window when no passenger traffic would be on the line; for example, use of the existing freight tracks paralleling the ME line heading south along the lakefront).

A complicating factor in attaining higher speed levels by following existing rail lines is the curvature of the alignment. Although there are a large number of locations in the Midwest where long stretches of straight, nearly level track are present, when curves occur they rarely meet the radius requirement for high-speed operations. (Whereas a 5,000’ radius curve will support operations at 100 mph, a 7,500’ radius is needed for 120 mph and about 10,000’ for 150 mph operations). Although following interstate highways generally avoids the construction of new routes through populated areas, these facilities often avoid urban areas by use of bypass sections, which include reversing 70 to 90-mph design speed curves. As a result, new HSR lines may only be able to follow bits and pieces of interstate highway.

A final consideration for route planning is the issue of grade crossings. The FRA generally allows at-grade crossings up to speeds of 110 mph, however the FRA is considering enhanced treatments such as four quadrant/full closure crossing systems at speeds above 79 mph. For 110 to 125 mph, the FRA expects that a barrier device of unspecified design will protect crossings and few prototypes exist to address this requirement. Above 125 mph, grade crossings are prohibited. For this analysis of 150 - 220-mph service, it was assumed that there would be no at-grade crossings on higher speed segments.

In applying all of these strategies, the general approach used was to identify locations where new HSR corridors could be developed alongside existing rail and/or highway corridors. There are many locations where the existing rail lines (including abandoned or underutilized lines) are essentially straight for long distances. Where these lines pass through rural areas, it was presumed that highway overcrossings at regular intervals would be provided to preserve most of the existing roadway network and property access. Alternatively, to accommodate agricultural requirements or address environmental needs for wildlife movement, the rail line could be developed on an embankment and low-cost, large-diameter culvert-type underpasses could potentially be provided. Where these lines pass through developed areas with dense roadway networks, a more cost-effective solution is to put the HSR on an aerial structure. In some instances, existing rail corridors pass through built-up areas in an industrial swath of land so that speeds could credibly be maintained. However, opposition to development of new lines to support true high-speed operation adjacent to residential areas, even along existing rail lines, can be anticipated to occur during the environmental review process specified by the National Environmental Policy Act (NEPA). Therefore, at some locations, consideration was given to following interstate highway facilities. Although interstates have sections with tight radius curves, one advantage is that they have widely-spaced roadway crossings. Another condition under which following a highway facility was considered as an alternative was at locations where an existing rail line passes through an environmentally-sensitive area such that park, botanic or wildlife impacts could be anticipated with the expanded footprint of a new HSR alignment.

2.0 Potential Midwest Region 220-mph High-Speed Rail Network

Four corridors centered on Chicago appear appropriate for eventual upgrade to Core Express HSR service (220-mph) like that now operating in Europe and Asia. All six major metropolitan areas previously identified for 110-mph service (Minneapolis/St. Paul, St. Louis, Cincinnati, Cleveland and Detroit/Cleveland) would be served by these four corridors, and these, along with Chicago, represent the six largest metropolitan areas of the Midwest. Detroit and Cleveland would be served by one corridor from Chicago to Toledo, where the corridor would branch. The four corridors and potential stations are shown in Figure 5 (western portion) and Figure 6 (eastern portion).

This study focuses on the Chicago hub, illustrating the considerations involved with implementing HSR in a dense, urban environment and in heavily-trafficked rail corridors. Within this area, and especially at greater distances from Chicago, routing and station locations are provided as examples and do not necessarily reflect specific recommendations. Full environmental review and market analysis will be vital in identifying a range of alternatives for routing and station locations in each corridor. The following sections describe possible alignments and improvements that would be required to realize true 220-mph HSR service. The term 220-mph is used to describe top speeds; because trains would make a number of intermediate stops and top speeds will not be reached on all sections of a corridor. For purposes of estimating actual travel times and ridership, end-to-end speeds approaching 150 mph are used.

2.1 Chicago to Minneapolis/St. Paul

Under the 220-mph network concept that appeared on the Midwest High Speed Rail Association (MHSRA) website as described in the Introduction, this corridor would be routed via O'Hare, Milwaukee, Madison, La Crosse and Rochester. The SNCF-proposed route is via Milwaukee, Madison, Tomah/Oakdale and Eau Claire. SNCF proposed that trains would operate on a clockface schedule every half-hour during peak periods and every hour in the off-peak. Chicago-Milwaukee travel time would be approximately 40 minutes at an average speed of 125 mph, and Chicago to Minneapolis/St. Paul would be approximately three hours at an average speed of about 133 mph. The SNCF proposal also includes a bypass track around CUS serving O'Hare. The bypass track would be used to operate longer-distance trains such as Minneapolis/St. Paul to St. Louis and Minneapolis/St. Paul to Detroit.

Of the four corridors identified for eventual true HSR service, this corridor is the longest, approaching 450 miles. Routings via Eau Claire, Rochester, and the existing river route were considered. Rochester was chosen because the existing route is not suitable for speeds greater than 90 mph and the routing via Eau Claire would require new bridges over the protected St. Croix River and Bruce Vento Park. Alignments supporting 220-mph operations have been defined between Milwaukee and St. Paul, allowing the end-to-end (Chicago to Minneapolis) average speed to exceed 150 mph. If Milwaukee were identified as the end of the high-speed corridor, the incremental benefit of travel time savings along the relatively short distance between Chicago and Milwaukee may not justify implementation of a 220-mph alignment. However, since investment in 220-mph systems and equipment would be required in the overall corridor, the implementation of a 220-mph alignment between Chicago and Milwaukee would be a feasible option, but not essential for true HSR service.

The Chicago to Minneapolis/St. Paul route is shown in Figure 7.

Chicago to Milwaukee

- Chicago Inner Core
  - From an underground West Loop Transportation Center station or reconfigured CUS in downtown Chicago, HSR would be routed north in tunnel and/or aerial structure to follow an alignment along the Milwaukee District North Metra line
  - Merge into METRA/AMTK/CP (MILW)[2] and UP/METRA (CNW) ROW; seven tracks afford capacity for HSR; track upgrade to support speeds up to 80 mph
  - METRA/AMTK/CP (MILW) diverges, aerial flyover of Western Avenue Yard, north of yard the fourth track that has been removed would be replaced, supporting speeds up to 110 mph

[2] A key to railroad abbreviations is provided at the end of the document.

Source: AECOM, 2010; routings are subject to full environmental review and market analysis.

Figure 5: Midwest Region Potential 220-mph High Speed Rail Line (West)

Source: AECOM, 2010; routings are subject to full environmental review and market analysis.

Figure 6: Midwest Region Potential 220-mph High Speed Rail Line (East)

Source: AECOM, 2010; routings are subject to full environmental review and market analysis.

Figure 7: Chicago to Minneapolis/St. Paul Potential 220-mph High-Speed Rail Route

- O'Hare Route between Chicago and Rondout
  - Following METRA/CP (MILW), a fourth track would be replaced between Pacific Junction and Cicero Avenue for HSR and an existing track for passing would be electrified; flyover would allow HSR to cross UP (CNW)
  - West of Cicero Avenue, HSR track would be added and an existing track would be electrified for passing; HSR would be built at the level of the existing tracks (street undercrossings typical) but a flyover of Galewood Yard would likely be necessary
  - HSR would travel on aerial structure west of Galewood Yard, due to the need for grade separations at frequent intervals
  - In Franklin Park, HSR track would be aligned on the north side of Bensenville Yard
  - Approaching UP (CNW), HSR would diverge into a new two-track alignment, roughly parallel with UP (CNW), to a station below the new O'Hare West Terminal and interfacing with a potential CTA Blue Line extension; the 3 to 5 mile segment would be substantially in open cut
  - North of the O'Hare West station, HSR would enter the UP/CP (CNW/MILW) corridor with two new, fully grade-separated tracks; the narrow ROW (100') would require substantial aerial

structure on columns; however, there is a possibility for a short one-mile at-grade segment in the Des Plaines/Glenview area with an underpass at I-294

  - South of Northbrook, the HSR tracks would curve north to join Direct Route on METRA/CP/AMTK/WSOR (MILW) as described below

- Direct Route between Chicago and Rondout
  - North of Pacific Junction concept: one HSR track would be built and an adjacent existing track would be electrified; HSR operations would be confined to the new track, except for passing maneuvers on the newly-electrified existing track. The new track would be built at the level of existing tracks (street undercrossings typical) as far north as Caldwell Avenue; flyovers would be required at Mayfair Crossing and to avoid the Metra stations, allowing speeds up to 150 mph (125 mph average speed)
  - At Caldwell Avenue and north, grade separations would be needed at frequent intervals; the alignment would be built roughly half on embankment, half on aerial structure
  - No Glenview stop would be provided; existing Amtrak ridership would be picked up by Metra
  - North of Northbrook, rejoined lines and more ROW allow for the addition of two HSR tracks; the tracks would be on aerial structure until roads are farther apart (at-grade segments would be implemented where climbing/descending can be accommodated)
  - A north side intermodal station would be located in Deerfield at Lake Cook Metra Station
  - An aerial structure would be built between Lake Forest and Rondout (edge of Metra territory) due to sensitive environment; a flyover of EJE would be built at Rondout

- Rondout to Milwaukee Mitchell Field
  - HSR tracks would remain aerial north of Rondout; an at-grade alignment may start in the vicinity of Belvidere Road between Waukegan and Gurnee
  - HSR would follow CP/AMTK (MILW) through Gurnee and transition to a new 150 to 220-mph alignment in the vicinity of Wadsworth
  - A new 150 to 220-mph alignment would generally parallel I-94 and CP/AMTK (MILW), avoiding multiple curves on CP/AMTK (MILW); an alignment west of I-94 would likely have the least impact on existing development; as noted above, there is an option of building to 150 or 220-mph standards, as 220-mph operations would not be essential to the success of the overall corridor; the actual alignment and design speed would be the subject of an Alternatives Analysis process
  - A new 150 to 220-mph alignment would end in the vicinity of Ryan Road (WI 100) in Oak Creek, transitioning to CP/AMTK (MILW)
  - Two new HSR tracks would be built along CP/AMTK (MILW); they may be substantially at-grade since cross streets are grade-separated; however, aerial structures would be necessary where the ROW is constrained and there are conflicts with spur tracks to adjacent shippers
  - HSR would stop at the existing station at General Mitchell International Airport

- Milwaukee Mitchell Field to Milwaukee Intermodal
  - An aerial structure for the two-track alignment would likely be required between the airport and downtown due to constraints of the CP/AMTK (MILW) ROW; the top speed would be constrained to 80 mph due to curves and the urban context

- HSR would break out of the CP/AMTK (MILW) ROW at approximately Florida Street and continue north two new crossings of the Milwaukee River; the approach into Milwaukee Intermodal Station would require a tight-radius curve across the river
- A high-level aerial structure could allow the HSR platform to be located on the north side of St. Paul Avenue, interfacing with and expanding the existing intermodal terminal
- Alternatively, the post office east of the existing intermodal station would be relocated and the HSR platform located south of the existing station on the post office site

Milwaukee to Minneapolis/St. Paul

- Milwaukee to Madison
  - West of Milwaukee Intermodal Station, the HSR alignment would rejoin CP/AMTK (MILW) to reach a Menomonee River crossing; street overpasses are typical, so the alignment would be at-grade; flyovers would be required over the few grade crossings; where ROW is insufficient, a high aerial structure may be necessary to cross streets on overpasses; between I-94 and downtown a single-track HSR alignment may be sufficient
  - At the Menomonee River crossing, HSR would transition to an I-94 alignment; two HSR tracks would be accommodated on aerial structure along the freeway; the top speed would be limited to 150 mph due to the curving alignment
  - West of Waukesha, the HSR alignment would continue to follow I-94; the rural context would allow greater flexibility of alignment and flatter curves to achieve a 220-mph design speed
  - A Madison station where WSOR (MILW) crosses under I-39/90/94 would minimize route deviation but require transfers to regional rail and/or a potential rail shuttle on WSOR (MILW) to downtown Madison; this is a greenfield location, but near East Towne Mall and surrounding development with possible future densification
  - Various other station locations have been suggested and are subject to further study
- Madison to Minneapolis/St. Paul
  - HSR would generally follow the I-90 corridor west of downtown Milwaukee to Rochester via La Crosse, continuing north in the US 52 corridor to St. Paul; the rural setting along much of the route allows flexibility of alignment and flatter curves to achieve a 220-mph design speed
  - Generally, the HSR alignment would be tied to freeway alignments through cities, resolving tight curves outside of urban areas; however, in some cases, HSR would leave the freeway corridor to bypass cities, such as west of Lake Delton and Wisconsin Dells to avoid a succession of tight curves on I-90/94
  - Between Wisconsin Dells and Camp Douglas, either of the parallel I-90/94 and CP/AMTK (MILW) corridors could support a 220-mph alignment; between Camp Douglas and La Crosse, the alignment would generally follow the I-90 corridor
  - At La Crosse, HSR would continue to follow I-90, stopping at a station near Rose Street (WI 35); though on the edge of town, the station would be situated at the closest I-90 interchange to downtown and four miles from the University of Wisconsin-La Crosse campus
  - West of La Crosse, a 220-mph HSR alignment would cross the Mississippi River and enter new right-of-way, traversing hilly terrain on a series of retained cut and embankment sections, before rejoining the I-90 corridor
  - East of Rochester, the HSR alignment would diverge from the I-90 corridor to follow DME (CNW) to an aerial station in downtown Rochester

- West of downtown Rochester, the HSR alignment would curve north from the DME right-of-way, following the abandoned CGW right-of-way to enter the US 52 corridor
- A 220-mph alignment between Rochester and the Twin Cities would generally follow US 52; once entering the urban area in Inver Grove Heights and South St. Paul, significant sections of aerial structure would be required and curves in the alignment would limit operations to 175 mph

- Minneapolis/St. Paul
  - Entering St. Paul, the HSR would follow existing railroad rights-of-way on a 60-mph alignment approaching a Mississippi River crossing adjoining St. Paul Union Depot
  - HSR would stop at St. Paul Union Depot, eastern terminus of the Central Corridor light rail line, continuing on via an "S" curve entering BN right-of-way; Metro Transit Route 54 provides frequent limited-stop bus service between downtown St. Paul and Minneapolis-St. Paul International Airport
  - HSR on an aerial alignment following BN would connect between St. Paul and Minneapolis due to constraints of the ROW and the urban context; curves would limit the design speed to 80 mph
  - HSR would terminate at Target Field Station in Minneapolis, with direct connections to light rail and Northstar commuter rail

2.2 Chicago to St. Louis

There are two potential routes in this corridor, via Champaign/Urbana and Decatur, as was proposed on the MHSRA website; or via Bloomington/Normal, as proposed by SNCF. SNCF proposed that trains would operate on a clockface schedule every half-hour during peak periods and every hour in the off-peak. The MHSRA concept envisions clockface schedules operating every hour. Under both concepts, the Chicago-St. Louis travel time would be approximately two hours at an average speed of 150 mph.

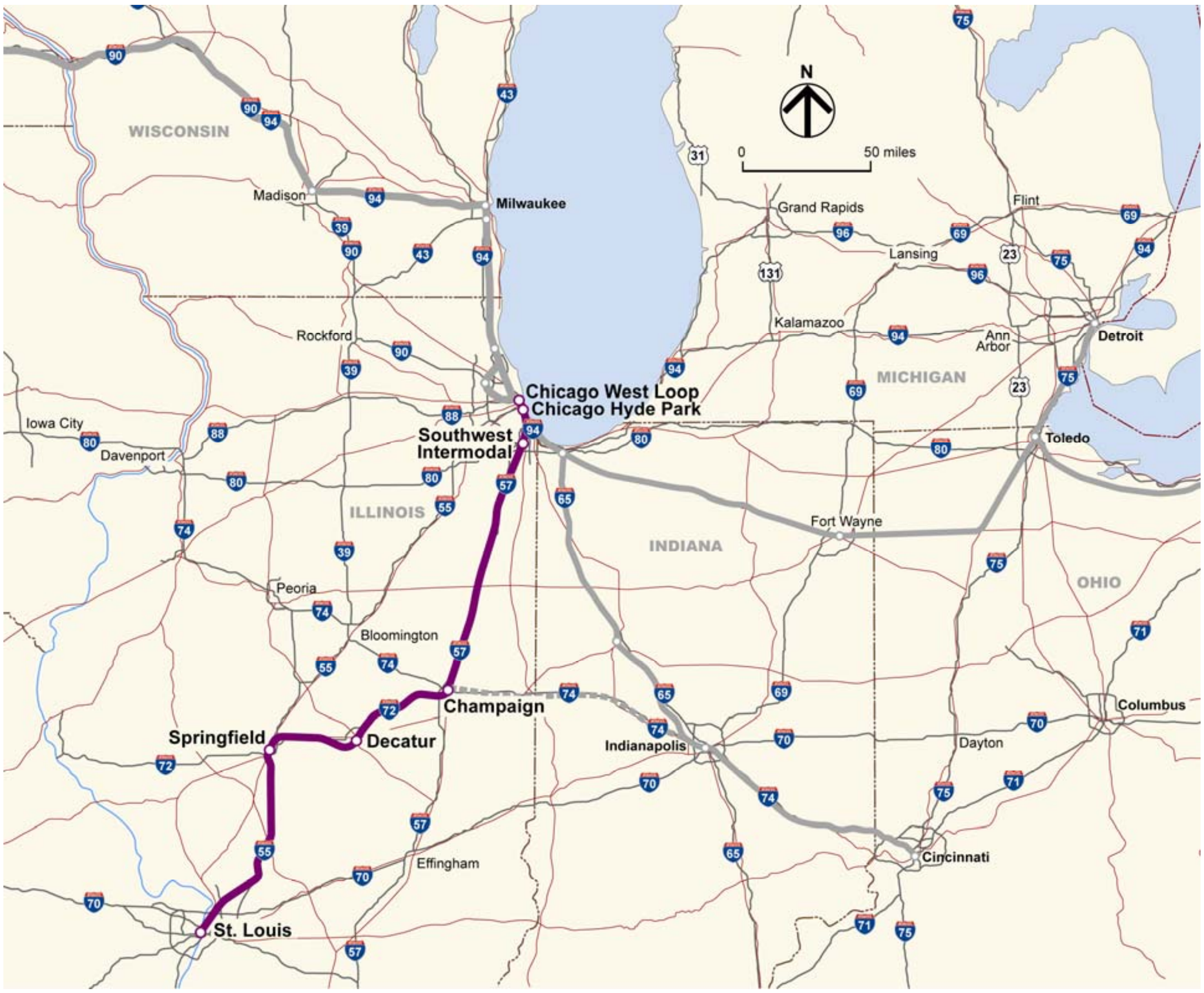
The Champaign route would reach a greater ridership base than the Bloomington route, while still allowing for an end-to-end travel time of approximately two hours. Between Chicago and Springfield, the Champaign route would serve both the Champaign/Urbana metropolitan area (pop. 225,000) and the Decatur metropolitan area (pop. 110,000), while the Bloomington route would serve only the Bloomington/Normal metropolitan area (pop. 170,000), with only about half of the combined population of the other two metropolitan areas. With Champaign/Urbana, Decatur and Springfield situated relatively close to one another, 220-mph alignments would be implemented between Chicago and Champaign/Urbana, and between Springfield and St. Louis to achieve an end-to-end average travel speed of at least 150 mph.

The Chicago to St. Louis route is shown in Figure 8.

Chicago to Champaign

- Chicago to Grand Crossing
  - From an underground West Loop Transportation Center station or reconfigured CUS, HSR would be routed south in tunnel and/or aerial structure via the St. Charles Air Line to follow an alignment in the Metra Electric District/Canadian National (former Illinois Central) corridor
  - Along the St. Charles Air Line, HSR tracks would be stacked above CN/UP/AMTK (ICRR) and CTA Orange/Green lines due to constraints

- East of the St. Charles Air Line and north of McCormick Place station, a new HSR alignment would join METRA/CSS (ICRR/CSS); to add capacity for HSR, the adjacent CN/AMTK (ICRR) tracks would be electrified; at least 79-mph operations would be possible
- McCormick Place is conceived as an events-only station
- An intermediate station would be located at Hyde Park (55th, 59th or 63rd Street Metra Station)
- Approaching Grand Crossing, a new alignment for Cincinnati, Cleveland and Detroit trains would curve into the NYC (LSMS) ROW



Source: AECOM, 2010; routings are subject to full environmental review and market analysis.

Figure 8: Chicago to St. Louis Potential 220-mph High Speed Rail Route

- Grand Crossing to Champaign
    - Additional tracks would be built in the CN/NS/AMTK (ICRR) corridor south of Grand Crossing; additional capacity would be generated through upgrades and electrification of existing tracks
    - A Southwest Intermodal station would be located at the existing Harvey Metra Station (155th Street) or in Homewood, subject to further study

- South of Homewood, two dedicated HSR tracks would be built in the METRA (ICRR)/CN/NS/AMTK (ICRR) corridor to allow speeds up to 150 mph, transitioning to a 220-mph alignment
- At least as north as Olympia Fields, a dedicated HSR alignment would be implemented with a 200-mph design speed
- Between Olympia Fields and Champaign, the 220-mph HSR alignment would follow CN/NS/AMTK (ICRR) at-grade to the extent possible; as a general rule, grade crossings would be closed on highways that were closed by the adjacent I-57 (i.e., if I-57 provides a crossing, overpasses would be built over HSR alignment as well) – allowing three to four-mile stretches of at-grade trackage
- Grade separations would be implemented in towns, generally requiring an alignment on embankment or aerial structure
- In Kankakee, an aerial structure would be needed to pass over yards north of downtown
- The 220-mph alignment would end on the approach to Champaign
- HSR would stop at Illinois Terminal in Champaign, an existing Amtrak station

Champaign to St. Louis

- Champaign to Decatur
  - South of Champaign station, HSR would continue to follow CN/NS/AMTK (ICRR) to enter a sweeping curve north and west of Savoy into a new cross-country alignment supporting speeds up to 220 mph
  - The new cross-country ROW would be aligned to curve into DT (ICRR) west of Monticello
  - HSR would curve into the former Pennsylvania Railroad (PRR) between Garfield and Grand Avenue, supporting at most 125-mph operations on the approach to Decatur station
  - A new station for HSR would be built east of the downtown core between Prairie and Wood Streets
- Decatur to Springfield
  - HSR would follow CN/DT (ICRR/PRR) south of Decatur station, curving west to enter a new cross-country alignment along Erwin Road supporting speeds up to 220 mph
  - After a short straight section along Erwin Road, the HSR alignment would curve north and then west to enter the I-72 corridor
  - HSR would leave the I-72 corridor just east of the Sangamon River, east of Springfield, transitioning to NS (WAB) along Camp Butler Road; 220-mph operations would end west of the I-55 overcrossing at the edge of the urbanized area
  - HSR would follow NS (WAB) either to a tunnel connecting to the Union Pacific (former Chicago and Alton) corridor to a stop at the Chicago and Alton Station, or to a station along the Norfolk Southern in the 10th Street corridor, which the City has identified for railroad consolidation
- Springfield to St. Louis
  - South of Springfield Station, HSR would continue on aerial structure along UP/KCS/AMTK (C&A) or NS (WAB); at least as far north as the point where the two corridors meet, HSR would descend to grade, as the ROW would no longer be constrained by development

- Southwest of Southern View and approaching I-72, the HSR alignment would curve out of NS/KCS/UP/AMTK (C&A) into a new cross-country alignment to cross Lake Springfield and enter the I-55 corridor
- South of Lake Springfield, HSR would enter a 220-mph alignment along I-55; in the vicinity of Mount Olive, the alignment would transition from the I-55 corridor into UP/BNSF (CCCStL/CEI)
- The 220-mph corridor would continue south along UP/BNSF (CCCStL/CEI) to the Gateway Terminal area in East St. Louis
- The HSR alignment would follow Terminal Railroad Association of St. Louis (TRRA) ROW across a new Mississippi River bridge adjacent to MacArthur Bridge to reach the Gateway Multimodal Transportation Center in St. Louis; curves would limit speeds to under 79 mph

2.3 Chicago to Cincinnati

Both the MHSRA 220-mph network concept and the SNCF proposal routed this corridor through Gary, Lafayette and Indianapolis. The SNCF proposed that trains would operate on a clockface schedule every half-hour during peak periods and every hour in the off-peak. The Chicago to Cincinnati travel time would be approximately two hours at an average speed of 160 mph.

At less than 300 miles, this is the shortest of the four identified high-speed corridors. To achieve an end-to-end travel speed approaching 150 mph and a travel time of two hours, 220-mph alignments would be implemented between Gary through Indianapolis to the vicinity of Greensburg. Because of the hilly topography of southeastern Indiana and the Cincinnati area, alignments supporting more modest speeds would be implemented on the approach to Cincinnati.

The Chicago to Cincinnati route is shown in Figure 9.

Chicago to Indianapolis

- Chicago to Grand Crossing: see discussion under Section 0
- Grand Crossing to Gary
  - At Grand Crossing, a new alignment for Cincinnati, Cleveland and Detroit trains would curve from METRA/CSS (ICRR) / CN/NS/AMTK (ICRR) into NYC (LSMS) ROW
  - Two tracks for HSR would be replaced in NYC (LSMS) ROW from Grand Crossing to at least as far east as the Calumet River; street underpasses are typical, so no grade separations would be needed
  - From the Calumet River east, space would still be available adjacent to NS/CP/AMTK (LSMS), but power lines, yards and other encroachments would make aerial structure necessary
  - The HSR alignment would continue to follow NS/CP/AMTK (LSMS) to Gary, transitioning to NS (PRR)
  - HSR would stop at the existing CSS Gary Metro Center station, providing intermodal connectivity
- Gary to Indianapolis

- o From the station at Gary Metro Center, HSR would curve into the I-65 corridor; the rural context would allow greater flexibility of alignment and flatter curves to achieve a 220-mph design speed
- o Approaching Lafayette, HSR would curve out of the I-65 corridor into the CSXT/AMTK corridor
- o South of Lafayette station, HSR would enter a new alignment along the Wabash River to take an 80-mph curve into the NS (LEW/CCCStL)/CR (CCCStL) corridor, then transition on a new cross-country alignment along the same bearing to re-enter the I-65 corridor
- o HSR would follow an alignment with a design speed of 220 mph in the I-65 corridor; northwest of Lebanon, a sweeping curve would carry HSR around the City and into the CSXT/CIND (PRR) corridor to the western edge of Indianapolis
- o HSR would follow an alignment with 150-mph curves transitioning from the CSXT/CIND (PRR) corridor into the I-74 corridor, and then to the THIE/CR (P&E) corridor, connecting to the CSXT (CCCStL) corridor along the same bearing into Indianapolis Union Station
- o For flatter curves, the HSR platform would be located on the north side of the station

Source: AECOM, 2010; routings are subject to full environmental review and market analysis.

Figure 9: Chicago to Cincinnati Potential 220-mph High-Speed Rail Route

Indianapolis to Cincinnati

- Indianapolis to Harrison
  - o Following CSXT/CIND/AMTK (CCCStL) east of Union Station, HSR would negotiate four 80-mph curves to reach Belt Crossing and transition to a 220-mph alignment in CSXT/CIND (CCCStL)
  - o Northwest of Greensburg, HSR would curve to follow the I-74 corridor east to Harrison; hilly terrain would require curves limiting the alignment to a 150-mph design speed
- Between Harrison and Cincinnati two options are possible: an alignment that continues to follow I-74, and an alignment following the CIND (CCCStL)/CSXT (BO) along the Ohio River
  - Harrison – Cincinnati via I-74
    - o HSR would continue to follow I-74 east from Harrison; curves and gradients would limit the top speed to 80 mph
    - o Crossing Mill Creek, HSR would curve south to thread through the west side of Queensgate Yard on aerial structure, likely requiring straddle bents, into Cincinnati Union Terminal
    - o If service originating in Chicago were to continue to Columbus, trains would have to back track
  - Harrison to Cincinnati via Ohio River
    - o East from Harrison, HSR would curve into a new cross-country alignment in the Great Miami River Valley, roughly parallel to Kilby Road
    - o HSR would enter into the CIND (CCCStL) corridor northwest of Cleves, where curves would limit top speed to 80 mph
    - o Flatter curves would allow for higher speeds along the CIND (CCCStL)/CSXT (BO) along the Ohio River
    - o HSR would curve into Cincinnati Union Terminal from the south, avoiding conflict with Queensgate Yard; service could continue on to Columbus in the same direction of travel

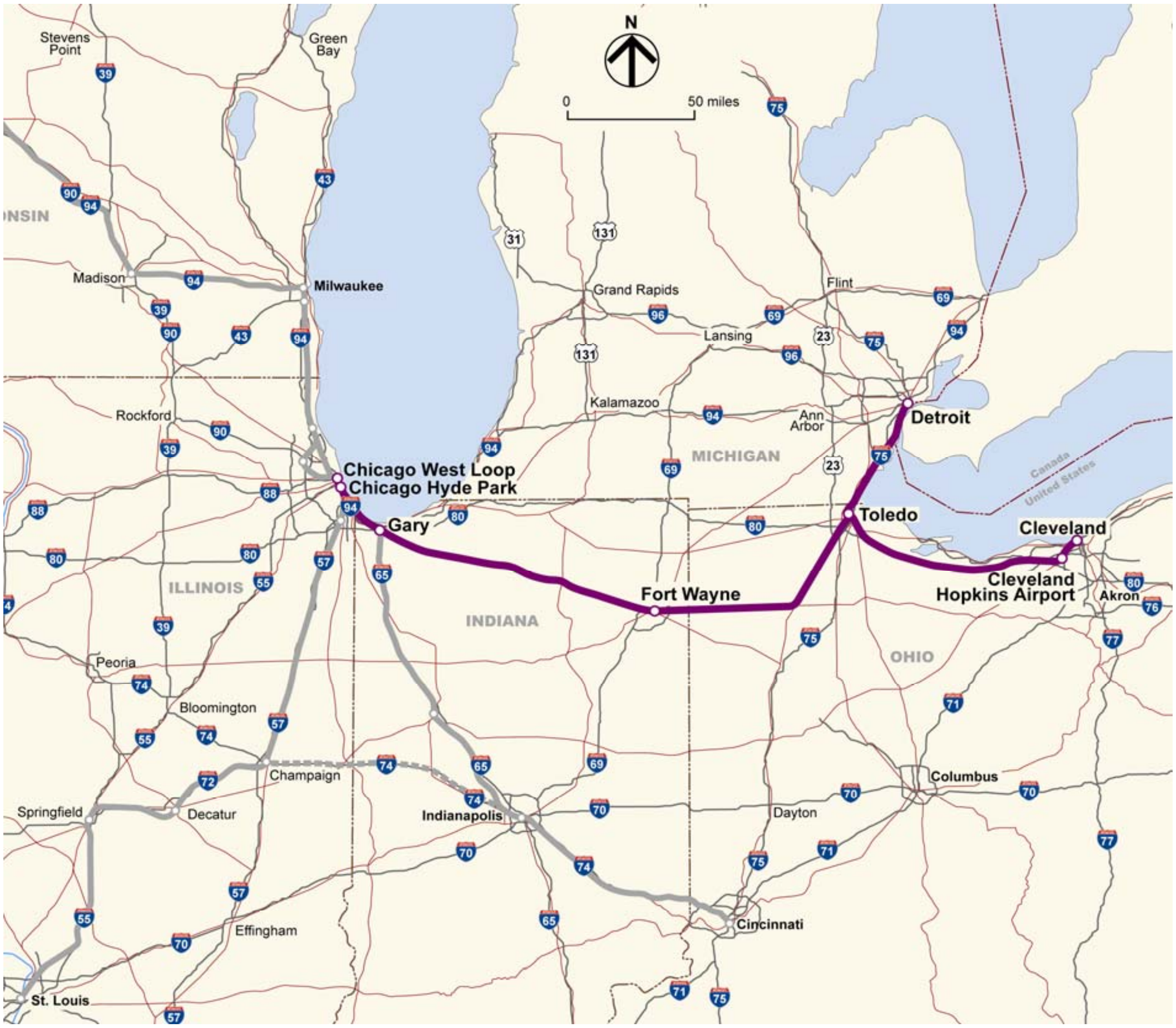
Although not examined in this study, an alternative route via Champaign warrants further study. Combining this portion of the Chicago - Cincinnati route with the Chicago - St. Louis route may reduce the initial costs of construction. It would directly tie Chicago to Indianapolis and Cincinnati via one of the Midwest's major university and research complexes. More importantly, this routing would create the ability to provide direct service between St. Louis and Cincinnati in less than three hours without building a separate line. Under this scenario, it would be critical to fully integrate the schedules of the proposed 110-mph Chicago service via Lafayette and Gary with those for the 220-mph route. As demand for services warrants (including densities along the St. Louis to Chicago route), 220-mph service to Gary and Lafayette could be introduced.

2.4 Chicago to Detroit/Cleveland

Both the MHSRA 220-mph network concept and the SNCF proposal routed this corridor through Gary, Fort Wayne and Toledo. At Toledo, the route would branch, with one line going to Detroit and the other to Cleveland. SNCF proposed that trains would operate on a clockface schedule every half-hour during peak periods, and every hour in the off-peak. The Chicago-Detroit travel time would be about two hours at an average speed of approximately 150 mph. The Chicago-Cleveland travel time would be about two and a half-hours at an average speed of approximately 135 mph.

To support an overall average travel speed of 150 mph in this corridor, 220-mph alignments would be implemented between Gary and Toledo. Given the relatively short distance between Toledo and Detroit, and challenging topography between Toledo and Cleveland, 150-mph alignments would be implemented between these cities, which would still maintain the respective end-to-end travel times.

The Chicago to Detroit/Cleveland route is shown in Figure 10.



Source: AECOM, 2010; routings are subject to full environmental review and market analysis.

Figure 10: Chicago to Detroit/Cleveland Potential 220-mph High-Speed Rail Route

Chicago to Toledo

- Chicago to Gary: See discussion in Section 2.3.
- Gary to Toledo
  - From Gary, HSR would follow the Chicago, Fort Wayne and Eastern (former Pennsylvania Railroad) to Fort Wayne, with a stop at Baker Street Station; a route via South Bend and Elkhart would serve a considerable existing rail passenger market, warranting further study, but would possibly require a new greenfields alignment to the east of Elkhart
  - From the station at Gary Metro Center, HSR would follow a reverse curve to enter a 220-mph alignment along CFER (PRR); impacts to the larger towns of Plymouth and Warsaw would be avoided by constructing bypasses north of each city that would still support speeds up to 175 mph
  - HSR would stop at Baker Street Station in Fort Wayne
  - HSR would continue due east from Fort Wayne, entering a 220-mph alignment along NS (NKP)

- HSR would make a sweeping curve northwest of Leipsic to enter CSXT (CHD)/CLE (IC&E)
- South of Perrysburg, HSR would transition from a 220-mph alignment into the I-75 corridor
- From the I-75 corridor, HSR would curve into CSXT (TT)/CSXT (CHD) and then CSXT (TOC) to cross the Maumee River on a new bridge at a skew angle north of the existing CP bridge to reach Toledo Union Station, where trains would be split into Detroit and Cleveland-bound services

Toledo to Detroit

- Detroit trains would head west from Union Station along NS (LSMS/BO)/NS (MC/BO), limited to 80 mph to negotiate a curve northward at Airline Junction
- Coming out of the Airline Junction curve, trains would enter a 125-mph alignment, reaching a design speed of 150 mph at least as far south as Alexis
- HSR would continue on a 150-mph alignment at least as far north as Trenton, following CRSA (MC/BO)/(LSMS/BO) to reach the existing Amtrak station in the New Center district of Detroit
- The New Center station occupies a central location in the City and a light rail connection to downtown is planned; regional rail services would connect to Ann Arbor, Birmingham and Pontiac

Toledo to Cleveland

- Cleveland trains would return east over the new Maumee River bridge, curving into CSXT (TOC), then continuing southeast along the same bearing along PC (PRR) and then CSXT (PRR) to reach a 150-mph alignment
- A short connection could be built to form a wye, allowing trains to travel directly between Fort Wayne and Cleveland without a Toledo stop
- West of Genoa, the HSR alignment would curve into the I-80/90 corridor, with flattened curves allowing a 150 mph top speed
- Between Amherst and Elyria, HSR would transition to NS/AMTK (LSMS); the HSR alignment would be on aerial structure through Elyria
- The HSR alignment would continue east along NS/AMTK (LSMS) to Cleveland, making a stop at Hopkins International Airport; there, a transfer to the RTA Red Line would provide a connection to western neighborhoods
- HSR would approach an elevated terminus at the existing Amtrak Lakefront Station site on aerial structure along NS/AMTK (LSMS), facilitating connections to rail services operating farther east to Pittsburg and the Northeast Corridor; a transfer to RTA light rail would distribute passengers downtown and provide connections to eastern neighborhoods

3.0 Midwest Regional Rail and Bus Connections

Well-coordinated rail and bus feeder service is an essential component of a HSR system to expand its range and increase its utility beyond walking or driving to the HSR stations. These feeder services would connect to the HSR stations allowing passengers to access the HSR and reach their final destination via local transit with a short walk to the transit stop at each end of the trip. Schedules of feeder services would be aligned to HSR schedules in order to reduce waiting periods and increase customer satisfaction.

Rail and bus feeder service applies to all three geographic ranges identified in Section 1.2. At the Intercity Range, conventional intercity passenger trains and intercity buses provide feeder service. The intercity feeder trains would typically be an evolution of the 79, 90 and 110-mph trains envisioned in the MWRRI plan. Intercity buses would typically run on freeways and major highways and be operated by private bus companies under contract or by arrangement with the rail system. At the Metropolitan Range, current commuter rail and suburban bus transit operators would provide feeder service. The CTA rapid transit network (the subway and "L" lines) and local CTA buses would provide feeder service in downtown Chicago.

Existing transit services in Chicago and other metropolitan areas of the Midwest could be described as a combination of networks of different modes operated by numerous agencies. The ground transportation system of the future would focus on developing trunk lines of HSR services that tie the metropolitan area-networks together, creating connections between regional transit networks. The success of the network inherently depends on reliable connections – not only between the HSR lines themselves, but also between the HSR system and the regional and local transit services of each metropolitan area.

The following discussion outlines the specific connectivity issues that should be considered as the HSR system is planned. The first section develops the criteria contributing to the quality and success of transfer points. The second portion identifies and describes the connectivity points of the future HSR network.

3.1 Quality of Connectivity Points

For the rail passenger, transfers are generally an unwelcome portion of their trip and should be made as seamless as possible. The wide range in the quality of transfers between different transit services can be evaluated with respect to four areas of consideration: cost and payment, travel times and schedule reliability, transfer times and physical connectivity.

3.1.1 Cost and Payment

The implementation of HSR provides added impetus for greater integration of regional and local transit services and provides a framework around which these services can be oriented. The cost and inconvenience of making transfers between different services can thereby be minimized.

Free transfers are generally only available between the lines of a single local operator; generally a second fare must be paid to transfer to the service of another transit provider. Discounts are available in many cases, but are often not widely publicized or especially convenient. The integration of transit services within each metropolitan area, accompanied by a zone-based fare system and/or universal fare structure, would remove fare penalties that riders transferring between local transit providers typically face, and would introduce more transfer-friendly fare policies.

Aside from the cost that might be associated with making a transfer, retaining ticket stubs or remembering to request transfer slips can be inconvenient. Transfer policies can be confusing and inconsistently enforced. Stored-value "smart cards" have been introduced in many metropolitan areas of the U.S., replacing paper transfer media and removing the guesswork from making transfers. The CTA has introduced the *Chicago Card*, a smart card that allows for easy transfers between CTA services and buses operated by Pace Suburban Bus. The utility of such smart cards could be expanded to include additional transit providers within a metropolitan area; in the case of Chicago, Metra commuter rail validity could be added to the *Chicago Card*. The benefit to intercity passengers would be even greater if smart cards were compatible in multiple metropolitan areas (e.g. at either end of a HSR trip).

With greater integration of local transit services, intercity passengers accessing HSR via transit, or using transit from a HSR station to reach their final destination would then minimize the cost and inconvenience of any transfers they would have to make. German Railways has advanced this concept one step further with its *City-Ticket*, which allows passengers on intercity trains to use local transit services (buses, light rail and subway) on either end of their rail trip at no extra charge. To be eligible for a *City-Ticket*, passengers need only hold a *BahnCard* – a loyalty card purchased on an annual basis that already provides a discount on every rail ticket purchase.

3.1.2 Travel Times and Schedule Reliability

Travel time is one of the most important considerations factoring into a decision on whether or not to complete a trip by transit, and transit riders are generally willing to pay a premium fare for higher speed services. The time-savings benefits provided by HSR would be counteracted if the transit trip to and from the HSR station takes a considerable proportion of the HSR trip itself.

Existing rail services often do not operate at their full potential of speed and reliability, largely due to the shared nature of the passenger/freight network. The same elements that allow higher speeds also increase schedule reliability. The following are improvements that can be made to achieve this higher potential, in order of increasing cost and complexity:

- Improved signaling systems, allowing trains to operate at closer spacing and at higher speeds
- Crossovers and sidings to allow faster trains (typically carrying passengers) to pass slower trains (generally freight runs)
- Adding additional track to address capacity shortfalls
- New alignments to allow faster speeds
- Grade separations

The largely independent infrastructure planned for HSR assures maximum speed and reliability, but some portions of the high-speed network would require shared trackage. The improvements presented above would apply to these portions of the system, particularly on the approaches to urban stations. They would also apply to regional rail and commuter rail services, such as Metra, which typically operate almost entirely on tracks shared by passenger and freight services. These improvements would achieve greater reliability and on-time performance, which are essential in establishing schedule coordination and managing transfers more effectively.

3.1.3 Transfer Times

To maximize ridership and convenience, schedules would be coordinated at HSR stations, each of which would be served by local and/or regional transit services. Each transit service operates according to a schedule reflecting travel speed, stops and service frequency, which differ from line to line. Schedule coordination refers to efforts to minimize delay for passengers transferring between transit lines. Schedule coordination is most important when a connection is being made to a less frequent service, during off-peak periods, or to the last trip offered during the service day.[3]

Three schedule coordination strategies can be implemented, depending on the services involved: pulse schedules, directional schedule coordination and dependent linked schedules.

3.1.4 Pulse Schedules

At a station with a pulse schedule, transit lines converge at regular intervals and depart after a short period during which transfers are made. This period would be long enough to include the access time between the bus stop or local/regional rail platform and the HSR platform, as well as the dwell time of the high-speed train at the station. A simultaneous pulse schedule includes all lines serving the station at

[3] MTC Transit Connectivity Plan, San Francisco Bay Area Metropolitan Transportation Commission, 3-10.

each pulse, or high-speed train arrival/departure, while a staggered or alternating pulse schedule includes only certain lines operating in different patterns. For example, less frequent lines would skip every other pulse; thus, only every other pulse would include all lines.

Pulse scheduling facilitates convenient transfers between many origin and destination pairs, in multiple directions of travel. However, the waiting period required lengthens travel times for local area through passengers (i.e. passengers not transferring to or from HSR). For this reason, it is ideal for lines to terminate at the pulsed-schedule station, as the waiting period is simply absorbed into end-of-line layovers.

Where possible, HSR station locations have been selected at existing hubs of local transit services, which are generally in downtown areas or near activity centers. At urban stations, where frequent service is provided on local transit routes, pulse scheduling is not important because local transit lines operate at short headways and waiting times for transferring passengers are minimal.

However, at suburban stations, or in cases where base headways of local transit services are greater than 15-20 minutes, pulse scheduling is desirable. The local transit services would be scheduled to converge at the station at regular intervals, coinciding with train arrivals. Lines would either terminate at these stations, or allow a three to five-minute period to allow transfers to be completed to and from HSR.

The pulse concept could also be applied between HSR services themselves. At stations where the HSR lines come together and branch apart (in Chicago, Gary and Toledo), trains could be scheduled to arrive within short intervals, allowing convenient transfers to take place. This would benefit passengers whose trips begin and end on different corridors (e.g. between Detroit and St. Louis).

Directional Schedule Coordination

At stations where pulse scheduling is implemented for local services, the pulses would be timed to match HSR schedules. Because high-speed trains would generally observe a shorter dwell time than a three to five-minute period to allow transfers to and from local services, trains operating forward in the peak direction of travel could be scheduled to depart after the pulse period. It follows that local transit services operating forward in the peak direction of travel would “pulse” directly following train arrivals.

This is referred to as directional schedule coordination, where service on less frequent lines is coordinated with higher frequency service to assure that connections are made. This type of schedule coordination has the advantage of not requiring the services involved to be held for each other, as in the case of pulse schedules. However, it affords convenient transfers only in one direction of travel – from service A to service B, but not from service B to A. Transferring passengers in the opposite direction of the coordinated schedule would face longer waits. Outside of peak periods, HSR is expected to operate at hourly intervals, so transit schedules serving HSR stations would have to be coordinated to avoid excessive waits for transferring passengers.

At stations served by multiple rail lines, trains operating at less frequent headways would be scheduled to coordinate with higher-frequency lines, and local services would be scheduled to coordinate with high-speed services, as it would be undesirable to hold a through-running train or a HSR train. A train operating in the peak direction of travel on a less-frequent or local route would be scheduled to depart shortly after the arrival of higher-frequency or higher-speed services.

Dependent Linked Schedules

The HSR network would be complemented by a number of feeder services, particularly intercity buses, which would expand the reach of the network beyond the outer HSR termini and to smaller cities between the HSR corridors. These services provide the opportunity for dependent linked schedules, which have the opportunity of reducing transfer times to an absolute minimum. For instance, when a high-speed train arrives, a feeder bus could be waiting at the station and immediately receive transferring passengers. In the opposite direction, feeder buses would be scheduled to arrive just before a HSR train arrival. This of course, would require high reliability on the part of the feeder buses; since high-speed trains would not wait for a feeder bus, the buses would need to be scheduled to build in potential delays.

3.1.5 Physical Connectivity

Particularly where the services of different transportation providers are concerned, the accompanying infrastructure may not have been designed with transferring passengers in mind. Thus, transfers may range from a cross-platform situation to those that require changes in level and a substantial walk between platforms and stops. Passengers with disabilities in particular may face considerable obstacles in transferring from one mode to another. While the HSR stations would be designed and built with connectivity in mind, site constraints may not offer the most convenient connections and will require individual solutions in each case.

The following describes four types of physical connectivity, listed in order of increasing convenience:

- Extended Walk or Shuttle Connection: In this situation, a connection may be located blocks away from the HSR platform. Transferring passengers would typically move from an indoor to an outdoor environment, or vice versa. The transfer may involve crossing streets or taking a short ride on a shuttle bus or people mover in order to get from one to the other. HSR would generally require a greater level of connectivity, but this situation would be acceptable in exceptional circumstances. For instance, HSR passengers transferring at the proposed airport stations (O'Hare, Milwaukee Mitchell Field and Cleveland Hopkins) would require an extended walk and/or shuttle connection to reach their flights.
- Concourse Connection: In this situation, the transfer would take place within an "indoor" environment (though it may be open to the elements) or its immediate surroundings. The paths of transferring passengers would not cross streets, though they may include changing levels (a vertical component) and passage through concourses, halls or other passages (a horizontal component). This level of connectivity would be typical at HSR stations, where transferring passengers would make their way from a stop or platform to a concourse or mezzanine, where they would then access HSR at a platform on a level above or below.
- Direct Vertical Connection: Unlike the concourse connection, this transfer would involve a minimal or no horizontal component, only a change in levels. This greater level of connectivity would be possible where HSR crosses another rail service, with respective platforms positioned above/below one another. The proposed West Loop Transportation Center in Chicago would be an underground station with two levels for a new CTA subway line and HSR, allowing passengers to transfer between the two via a direct vertical connection.
- Cross-platform Transfer: For this transfer, passengers would get off one train and transfer to another on the opposite side of the same platform, or board a train that arrives later on the same side of the platform. This highest level of connectivity would generally be possible only between high-speed trains themselves. However, high-speed trains and a relatively infrequent regional or commuter rail service could share the same platform and allow this type of transfer. For instance, HSR trains could briefly share the tracks of the South Shore Line at the Gary station, and both services could stop at the same platform.

3.2 New Connectivity Points

The future HSR network would be oriented to existing transportation infrastructure, and today's connectivity points would continue in that function in the future. However, the addition of this new mode may require some relocation of connectivity points and reorientation or restructuring of local transit services. Some of the major changes that could be expected are outlined below.

- La Crosse: The proposed HSR station site would be in the I-90 corridor, requiring a transit connection to downtown.
- Madison: Various sites for a HSR station have been proposed, some of which would require a rail or bus shuttle to connect the HSR station to downtown.
- O'Hare West: The implementation of a western terminal at O'Hare would involve a significant expansion and restructuring of local and intra-airport transit services to serve the new facility.
- Detroit: The proposed HSR station at the site of the current Amtrak station at Woodward Avenue in the New Center District is served by local transit services; however, a planned light rail line on Woodward Avenue would strengthen connectivity to downtown.

3.3 Regional Intercity Rail Service

The four proposed HSR corridors, along with feeder services operating at 79, 90, 110-mph, are shown in Figure 11. There are two basic types of rail feeder routes to the HSR network: those that serve CUS directly and those that connect to an outlying HSR station. Table 2 presents the proposed feeder services, organized by corridors serving the Chicago hub. Feeder routes are described in terms of city pairs; the first city listed being the location of the rail station, and the second city listed being the outlying endpoint of the route. The mode and potential headway (time between one-way departures) are given for each feeder route. The middle columns of the table list the connecting route for the feeder service, which is where a transfer would occur. For example, a traveler originating in Manitowoc would ride the feeder bus to Milwaukee and transfer to the Minneapolis to Chicago high-speed train. In some cases, a second transfer is required from the feeder service to access the HSR network, as indicated in the columns on the right side of the table. For example, a traveler originating in Sturgeon Bay, Wis., would ride the feeder bus to Green Bay where a transfer would be made to the Green Bay to Milwaukee train. At Milwaukee, the traveler would transfer again to the Minneapolis/St. Paul to Chicago high-speed train.

Direct Connections to Chicago

Chicago is the hub of the HSR network, and in a very real sense, the HSR corridors would feed passengers to each other. For example, passengers from Milwaukee would ride HSR to Chicago and connect to other trains destined for stops on the St. Louis, Cincinnati and Detroit/Cleveland corridors. In addition, there are six other MWRRI corridors that do not warrant an upgrade to HSR service, but would provide the same connecting function to the Chicago hub.

- Chicago – Omaha (79/90-mph)
- Chicago – Quincy (90-mph)
- Chicago – Springfield (110-mph via Bloomington/Normal)
- Chicago – Kalamazoo – Detroit – Pontiac (110-mph)
- Chicago – Port Huron (79/110-mph)
- Chicago – Grand Rapids – Holland (79/110-mph)

Also, the connection between Rockford and Chicago could be provided by new intercity rail service.

Connections to Outlying High-Speed Rail Stations

This group of rail feeders connects to HSR stations other than CUS, either at the terminal stations of each corridor or at midpoint stations. Routes that are directionally oriented toward Chicago include:

- Milwaukee – Green Bay (110-mph)
- Minneapolis/St. Paul – Duluth
- Champaign – Carbondale (90-mph)
- St. Louis – Kansas City (90-mph)

Routes directionally oriented to terminal or midpoint stations include the route from Pontiac to Detroit (110-mph), and the opposite ends of two routes that primarily serve Chicago:

- The Detroit end of the Chicago – Kalamazoo – Detroit route, which would serve as a feeder to Detroit for passengers originating in Battle Creek or Ann Arbor with eastern destinations such as Toledo or Cleveland
- The Springfield end of the Chicago – Springfield (via Bloomington/Normal) route, which would serve as a feeder for passengers originating in Bloomington/Normal destined for St. Louis

Source: MWRRI, AECOM, 2010; routings are subject to full environmental review and market analysis.

Figure 11: Concept Plan for High-Speed Rail Routing and Connectivity - Midwest Region

Routes with Other Characteristics

The route between Champaign, Danville and Lafayette/Indianapolis connects the Chicago – St. Louis and Chicago – Cincinnati HSR corridors. In this case, it is appropriate to provide connecting service to both HSR corridors, since passengers originating in Danville are likely to have destinations on either corridor. Likewise, the route between Minneapolis, Eau Claire and Madison will serve passengers traveling both east and west from Eau Claire.

Table 2: Feeder Routes and Transfers Serving the Chicago Hub

Corridor to Chicago	Feeder Service			Transfers to:			Secondary Transfer (if necessary)		
	Route (Rail Station Connection – Outlying City)	Mode	Headway (hours)	Connecting Route	Mode	Base Headway (hours)	Connecting Route	Mode	Base Headway (hours)
Chicago – Minneapolis/ St. Paul	Milwaukee - Manitowoc	Bus	8	Chicago - Minneapolis	HSR	1	-	-	-
	Milwaukee - Green Bay	Rail (110-mph)	2	Chicago - Minneapolis	HSR	1	-	-	-
	Green Bay - Sturgeon Bay	Bus	8	Milwaukee - Green Bay	Rail (110-mph)	2	Chicago - Minneapolis	HSR	1
	Green Bay - Marinette	Bus	8	Milwaukee - Green Bay	Rail (110-mph)	2	Chicago - Minneapolis	HSR	1
	Appleton - Wausau	Bus	4	Milwaukee - Green Bay	Rail (110-mph)	2	Chicago - Minneapolis	HSR	1
	Madison - Janesville	Bus	8	Chicago - Minneapolis	HSR	1	-	-	-
	Madison - Eau Claire – St. Paul	Rail	4	Chicago - Minneapolis	HSR	1	-	-	-
	Minneapolis - Duluth	Rail	4	Chicago - Minneapolis	HSR	1	-	-	-
	Minneapolis - St. Cloud - Staples	Bus	4 (to St. Cloud 8 (to Staples)	Chicago - Minneapolis	HSR	1	-	-	-
	Minneapolis - Mankato	Bus	8	Chicago - Minneapolis	HSR	1	-	-	-
Chicago - Rockford	Chicago - Rockford	Rail	4	-	-	-	-	-	-
Chicago - Omaha	Chicago - Omaha	Rail (79/90-mph)	3	-	-	-	-	-	-
	Iowa City - Cedar Falls	Bus	6	Chicago - Omaha	Rail (79/90-mph)	3	-	-	-
	Des Moines - Fort Dodge	Bus	6	Chicago - Omaha	Rail (79/90-mph)	3	-	-	-

Corridor to Chicago	Feeder Service			Transfers to:			Secondary Transfer (if necessary)		
	Route (Rail Station Connection – Outlying City)	Mode	Headway (hours)	Connecting Route	Mode	Base Headway (hours)	Connecting Route	Mode	Base Headway (hours)
	Omaha - Sioux City	Bus	6	Chicago - Omaha	Rail (79/90-mph)	3	-	-	-
	Omaha - Lincoln	Bus	3	Chicago - Omaha	Rail (79/90-mph)	3	-	-	-
Chicago - Quincy	Chicago - Quincy	Rail (90-mph)	4	-	-	-	-	-	-
	Quincy - Kirksville	Bus	8	Chicago - Quincy	Rail (90-mph)	4	-	-	-
Chicago - Springfield	Chicago - Springfield	Rail (110-mph)	4	-	-	-	-	-	-
	Bloomington/Normal - Peoria	Bus	4	Chicago - Springfield	Rail (110-mph)	4	-	-	-
Chicago - St. Louis	Champaign - Danville – Lafayette/Indianapolis	Rail	8	Chicago - St. Louis	HSR	1	-	-	-
	Champaign - Carbondale	Rail (90-mph)	4	Chicago - St. Louis	HSR	1	-	-	-
	Centralia - Evansville	Bus	8	Champaign - Carbondale	Rail (90-mph)	4	Chicago - St. Louis	HSR	1
	Carbondale - Paducah	Bus	8	Champaign - Carbondale	Rail (90-mph)	4	Chicago - St. Louis	HSR	1
	Springfield - Jacksonville - Quincy	Bus	8	Chicago - St. Louis	HSR	1	-	-	-
	St. Louis - Kansas City	Rail (90-mph)	3	Chicago - St. Louis	HSR	1	-	-	-
	Pacific - Joplin	Bus	6	Kansas City - St. Louis	Rail (90-mph)	3	Chicago - St. Louis	HSR	1
	Pacific - Branson	Bus	6	Kansas City - St. Louis	Rail (90-mph)	3	Chicago - St. Louis	HSR	1
	Jefferson City - Columbia	Bus	3	Kansas City - St. Louis	Rail (90-mph)	3	Chicago - St. Louis	HSR	1

Corridor to Chicago	Feeder Service			Transfers to:			Secondary Transfer (if necessary)		
	Route (Rail Station Connection – Outlying City)	**Mode**	**Headway (hours)**	**Connecting Route**	**Mode**	**Base Headway (hours)**	**Connecting Route**	**Mode**	**Base Headway (hours)**
	Kansas City - Omaha	Bus	6	Kansas City - St. Louis	Rail (90-mph)	3	Chicago - St. Louis	HSR	1
	Kansas City - Topeka	Bus	3	Kansas City - St. Louis	Rail (90-mph)	3	Chicago - St. Louis	HSR	1
Chicago - Cincinnati	Lafayette - Kokomo	Bus	8	Chicago - Cincinnati	HSR	1	-	-	-
	Indianapolis - Terre Haute	Bus	8	Chicago - Cincinnati	HSR	1	-	-	-
	Indianapolis - Bloomington, IN	Bus	8	Chicago - Cincinnati	HSR	1	-	-	-
	Indianapolis - Louisville	Bus	4	Chicago - Cincinnati	HSR	1	-	-	-
	Indianapolis - Muncie	Bus	8	Chicago - Cincinnati	HSR	1	-	-	-
	Cincinnati - Lexington	Bus	4	Chicago - Cincinnati	HSR	1	-	-	-
Chicago – Detroit / Cleveland	Fort Wayne - Lima	Bus	8	Chicago - Detroit/Cleveland	HSR	1	-	-	-
	Cleveland - Canton	Bus	8	Chicago - Detroit/Cleveland	HSR	1	-	-	-
	Cleveland - Youngstown	Bus	4	Chicago - Detroit/Cleveland	HSR	1	-	-	-
	Detroit - Anchorville	Bus	8	Chicago - Detroit/Cleveland	HSR	1	-	-	-
	Detroit - Pontiac	Rail (110-mph)	2	Chicago - Detroit/Cleveland	HSR	1	-	-	-
Chicago - Kalamazoo - Detroit	Chicago - Kalamazoo - Detroit	Rail (110-mph)	4	-	-	-	-	-	-
	Niles - South Bend - Elkhart	Bus	4	Chicago - Kalamazoo - Detroit	Rail (110-mph)	4	-	-	-
	Niles - Benton Harbor	Bus	8	Chicago - Kalamazoo - Detroit	Rail (110-mph)	4	-	-	-
	Ann Arbor - Howell	Bus	8	Chicago - Kalamazoo - Detroit	Rail (110-	4	-	-	-

Corridor to Chicago	Feeder Service			Transfers to:			Secondary Transfer (if necessary)		
	Route (Rail Station Connection – Outlying City)	Mode	Headway (hours)	Connecting Route	Mode	Base Headway (hours)	Connecting Route	Mode	Base Headway (hours)
					mph)				
Chicago - Port Huron	Chicago - Port Huron	Rail (79/110-mph)	4	-	-	-	-	-	-
	Lansing - Mt. Pleasant	Bus	8	Chicago - Port Huron	Rail (79/110-mph)	4	-	-	-
	Flint - Midland	Bus	8	Chicago - Port Huron	Rail (79/110-mph)	4	-	-	-
Chicago - Holland	Chicago - Holland	Rail (79/110-mph)	4	-	-	-	-	-	-
	Grand Rapids - Cadillac	Bus	8	Chicago - Holland	Rail (79/110-mph)	4	-	-	-
	Grand Rapids - Ludington	Bus	8	Chicago - Holland	Rail (79/110-mph)	4	-	-	-

Service Frequency and Schedule Coordination

The previous discussion described the general considerations involved in making convenient transfers between feeder and HSR services, such as pulse schedules, directional schedule coordination and dependent linked schedules. Though developing specific schedule recommendations for feeder services is beyond the scope of the current study, it is important to recognize that service frequencies should be established that can be fine-tuned for fast transfers at a later date. Hourly clockface schedules have been recommended as the base schedule for HSR. Headways on the feeder routes that are multiples of these hourly services should be established (i.e., feeder services should operate every two, three or four hours). This allows the feeder service to meet every other high-speed train, or every third or fourth train. High-speed trains would depart their originating stations from approximately 6:00 AM to 10:00 PM daily. Feeder services would also operate within this range, but would be scheduled to meet trains. Therefore a typical feeder route operating every four hours may have departures at 7:00 AM, 11:00 AM, 3:00 PM and 7:00 PM.

Almost by definition, feeder services would not operate as frequently as the HSR trains because the feeder routes serve areas that generate fewer passengers, making very frequent service inefficient. Table 2 lists the recommended headways (in hours) for each of the proposed feeder services. These headways were developed from those identified in the MWRRI plan. Since this study includes a new HSR corridor parallel to the MWRRI Chicago – Kalamazoo – Detroit route, this study recommends longer headways for this route than shown in the MWRRI plan because most passengers will opt for the HSR service. All other routes are at least as frequent as proposed in the MWRRI plan.

3.4 Regional Bus Connections

For cities and towns that are either too small to support rail service, or are difficult to serve via existing rail corridors, dedicated feeder bus service would be provided. These buses would serve both the HSR stations and the other rail stations included in the MWRRI plan. In this concept, buses would be scheduled to meet trains providing a convenient transfer. The buses would travel on freeways or major highways with few intermediate stops. The objective would be to minimize travel time between the rail station and the major population centers along the bus route. The intercity feeder bus routes are shown in Figure 11. Depending on market size, buses would meet every train, or perhaps every second, third or fourth train. Most feeder bus routes would make a direct connection to the closest rail stations. Examples shown in Figure 11 include:

- Kokomo – Lafayette
- Lima – Fort Wayne
- Youngstown – Cleveland

A few routes provide connections between two rail lines to facilitate more direct travel. The routes fall into three categories: those directionally oriented toward Chicago, those that connect to the closest rail station and those that connect to two rail lines. The feeder bus routes are listed in Table 2.

Routes Oriented Toward Chicago

These routes are designed to facilitate trips between an outlying population center and the Chicago hub. They generally follow an alignment that avoids out-of-direction travel for this trip, even if it means that the bus connects to a rail station that may be further away than the closest rail station. Examples include:

- Milwaukee – Manitowoc
- Pacific – Branson
- Indianapolis – Louisville

Routes Oriented to Closest Rail Station

Most feeder bus routes fall into this category. These routes are generally shorter and in locations where passengers originating in the bus terminus are likely to have destinations on either end of the applicable rail corridor. For example, the route from Peoria goes to Bloomington/Normal, where a passenger can transfer to a train bound for Chicago, or one bound for Springfield and by connection to St. Louis. Other examples of this sort include:

- Madison – Janesville
- Jefferson City – Columbia
- Kansas City – Topeka
- Lafayette – Kokomo
- Fort Wayne – Lima
- Detroit – Anchorville
- Flint – Midland

Routes Connecting Two Rail Lines

A few feeder bus routes serve communities that lie between two rail corridors, such as Jacksonville and Nebraska City. In these cases, it is appropriate to provide connecting bus service to both rail corridors, since passengers originating in these communities are likely to have destinations on either corridor. The routes in this category are:

- Springfield – Jacksonville – Quincy
- Kansas City – Nebraska City – Omaha

Service Frequency and Schedule Coordination

As with the feeder rail routes, headways on the feeder bus routes should be set at an hourly multiple, such as every three, four, six or eight hours. The recommended headways shown in Table 2 for the feeder bus routes were developed from those identified in the MWRRI plan, but in many cases the MWRRI plan recommended one round trip per day. This has been increased to two round trips per day (at eight-hour headways) to provide a morning and evening arrival/departure from any point, facilitating day trips and expanding travel options. (One round trip per day forces the traveler to stay overnight at their destination).

Where the feeder bus route is connecting to a feeder rail route, the bus needs to be synchronized with the rail headway. For example, the bus feeder from Des Moines to Fort Dodge should operate every six hours since the Chicago – Omaha rail feeder route operates every three hours. The Fort Dodge bus would meet every other train in Des Moines. A typical schedule might have departures from Fort Dodge at 7:00 AM, 1:00 PM and 7:00 PM.

Provision of Feeder Bus Service

Feeder bus service is typically provided on a vehicle-hour cost basis by the service provider, which is most often a private bus company. The service provider is responsible for supplying the bus, and the capital cost is built into the hourly rate. As a result, it is not relevant to estimate capital costs for feeder bus service. As planning for the HSR network progresses and more specifics regarding rail schedules and routes become available, it would be appropriate to begin estimating annual operating costs for the feeder bus network.

In California, where there is a long-established and successful dedicated feeder bus network for the state-supported Amtrak intercity corridor service, the feeder buses are generally owned and operated by private bus companies. The bus companies typically bid on providing the service for a fixed fee, and Amtrak keeps the revenue. The state receives good prices from the bus companies for the service, as the companies find the stable income attractive. Competition concerns from providers of private over-the-road scheduled bus service has been alleviated by legislation that limits riders on the feeder services to passengers who are also using rail to make part of their journey.

3.5 Intermodal Integration with Metropolitan Bus and Rail Services

To fully realize the benefits of HSR service, it is important to maximize the use of transit and other rail services for access to the HSR network. This in turn requires both integration of the HSR service into existing metropolitan services as well as consideration for improvements to the existing local service networks. The discussion below specifically considers the Chicago area; considerations for other metropolitan areas are provided in the guiding principles presented in Section 12.0.

In Chicago, the key service providers include the CTA, Metra and Pace:

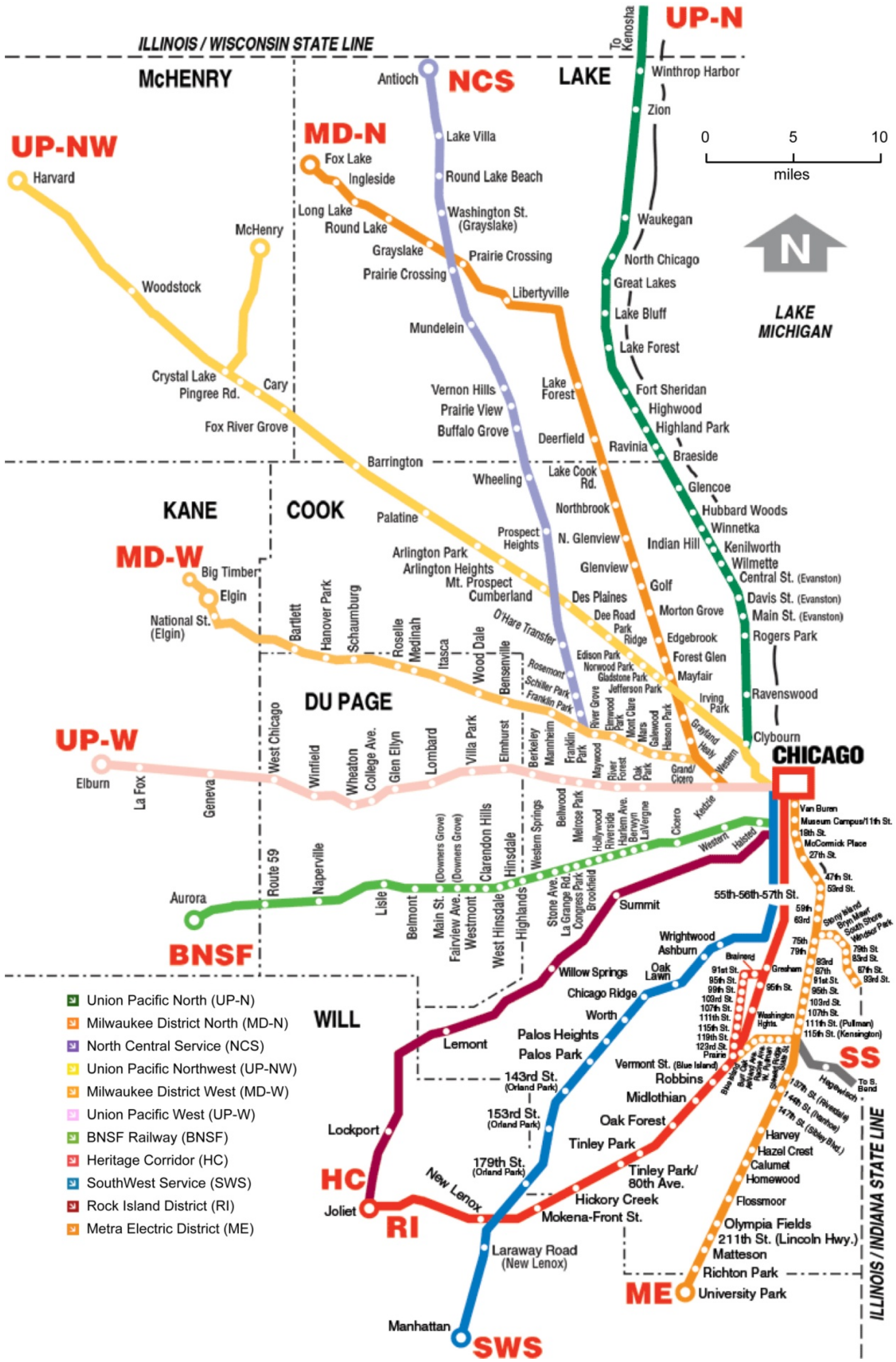
- CTA – Owns and operates the rail rapid transit and bus services serving the City of Chicago, as well as 40 surrounding suburbs. CTA operates nearly 1,800 buses on more than 140 routes, covering 2,230 route miles including more than 11,500 stops. On the rapid transit system, CTA runs nearly 1,200 cars over eight routes and some 220 miles of track. CTA trains make approximately 2,157 trips each day and serve 144 stations. The rail system extends about 10 miles on the south and west sides, and about 15 miles on the north side.

- Metra – Manages 11 regional rail lines serving more than 100 communities, primarily within a 35-mile radius of downtown Chicago The commuter rail agency serves Cook, DuPage, Will, Lake, Kane and McHenry counties in the Chicago area, Metra directly operates seven of the lines and two freight carriers operate four other lines. In addition, Metra has a financial relationship with a twelfth line providing electrified commuter service extending to South Bend, Ind., some 80 miles south and east.

- Pace – Serves six metropolitan counties with suburban transit service reaching approximately 210 communities and more than 215 fixed-route lines complementing the Metra and CTA rail and bus networks.

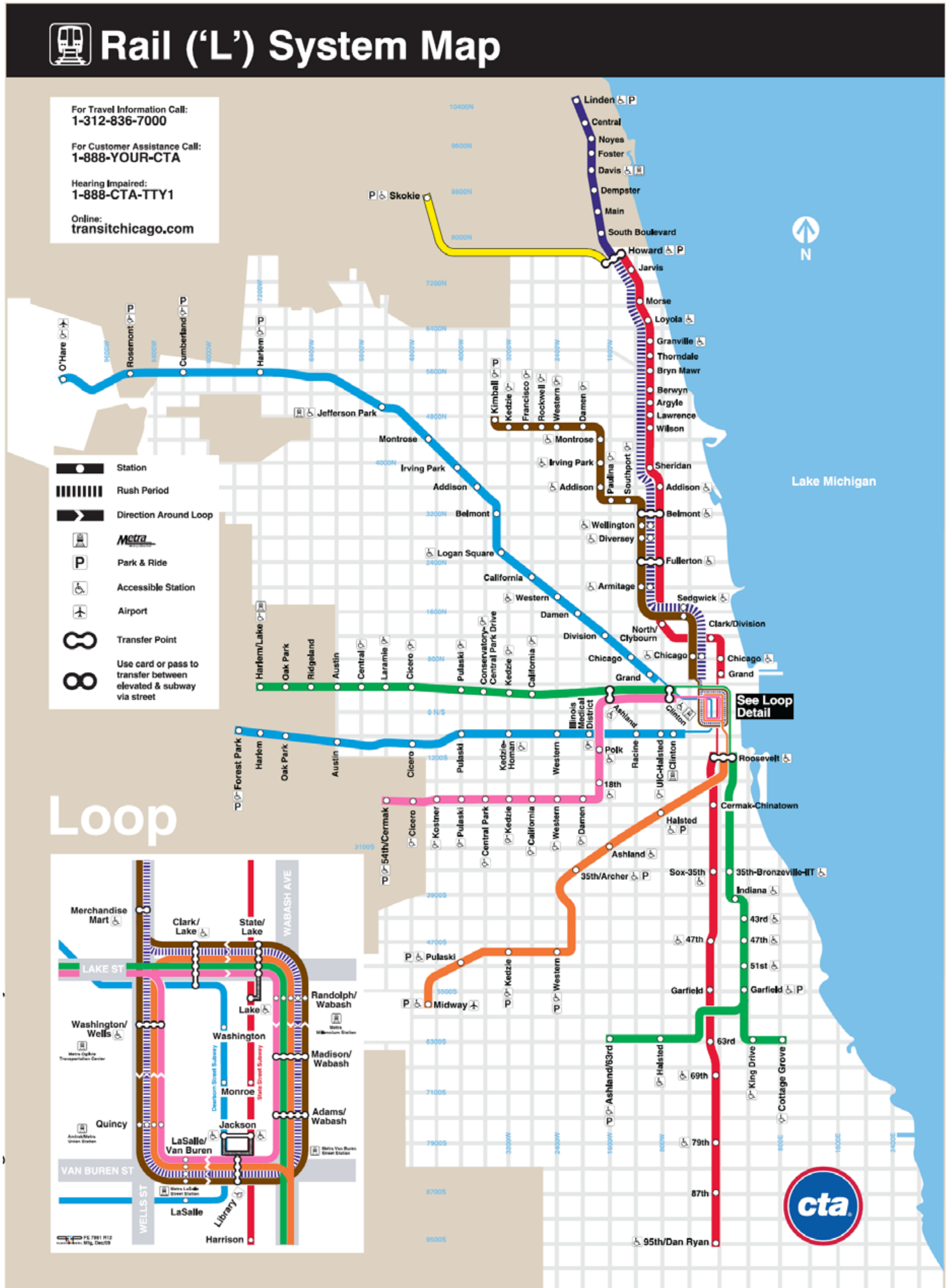
These three service providers operate under the umbrella of the RTA, which provides financial and budget oversight of the service providers, as well as regional transit planning. Figure 12, Figure 13 and Figure 14 show the major transit services within the RTA jurisdiction for the metropolitan region, City of Chicago area and the downtown central area within the City. A predominant feature in the metropolitan region is the Metra commuter rail lines (shown in Figure 12) radiating from downtown Chicago. The City of Chicago area map (Figure 13) shows the CTA rail transit lines in bold colors with the street grid that most bus routes follow shown in grey. The central area map (Figure 14) depicts the convergence of the commuter rail lines to four downtown terminals, and the “loop” elevated rapid transit circulator in the heart of the downtown district, penetrated by the Blue Line (northwest to west) and Red Line (north to south) subways operating along Dearborn and State Streets, respectively. Current long-haul passenger rail service is routed to CUS, which is immediately west of the Loop across the south branch of the Chicago River. The nearest CTA rail stop to CUS is the Clinton Blue Line Station about two blocks to the south; also, the Loop Quincy/Wells stop is about four blocks to the east.

Also shown on Figure 12 is a portion of the South Shore (SS) route connecting from northern Indiana via the Metra Electric District (ME) district trackage extending south along the lakefront. The ME services terminate at the Millennium Station located on the east side of the Loop at Randolph and Michigan. Figure 15 shows the full extent of the SS route, which serves commuters living within an approximate 35 – 40-mile radius of Chicago but extends as an interurban regional rail provider to the South Bend Indiana Airport, nearly 100 miles to the east.



Source: Metra, accessed 2010.

Figure 12: Metra System Map



Source: CTA, accessed 2010.

Figure 13: CTA Rail System Map

Source: Chicago RTA, accessed 2010.

Figure 14: RTA System Map - Central Area

3.5.1 Commuter Rail

The Chicago metropolitan area has a robust commuter rail network that would provide excellent feeder service to the HSR system. The commuter rail system could perform this function at little additional capital cost due to the timing of HSR trips. Unlike commuter service where most passengers travel during the AM and PM peak commuting periods, HSR trips tend to be spread throughout the day. Even the feeder trips for HSR business travel may fall outside the traditional commute period. For example, to arrive in Springfield for a 9:00 AM meeting, a passenger departing suburban Chicago would likely be using the commuter rail system to access CUS earlier than a typical commuter bound for downtown.

Introduction of HSR is likely to increase overall ridership on the commuter lines, mostly occurring outside of the commuting peak periods. Since the commuter system's fleet size is based on the number of vehicles needed during the commute peak, there are typically extra vehicles sitting idle in the off-peak periods. HSR service would provide the opportunity to use this capital investment more efficiently throughout the day. Midday trains would either need to be lengthened or operated more frequently. Operating costs would increase, but there would be little additional capital cost. Depending on fare and transfer arrangements with the HSR service, there is an opportunity for increased revenue for the commuter system.

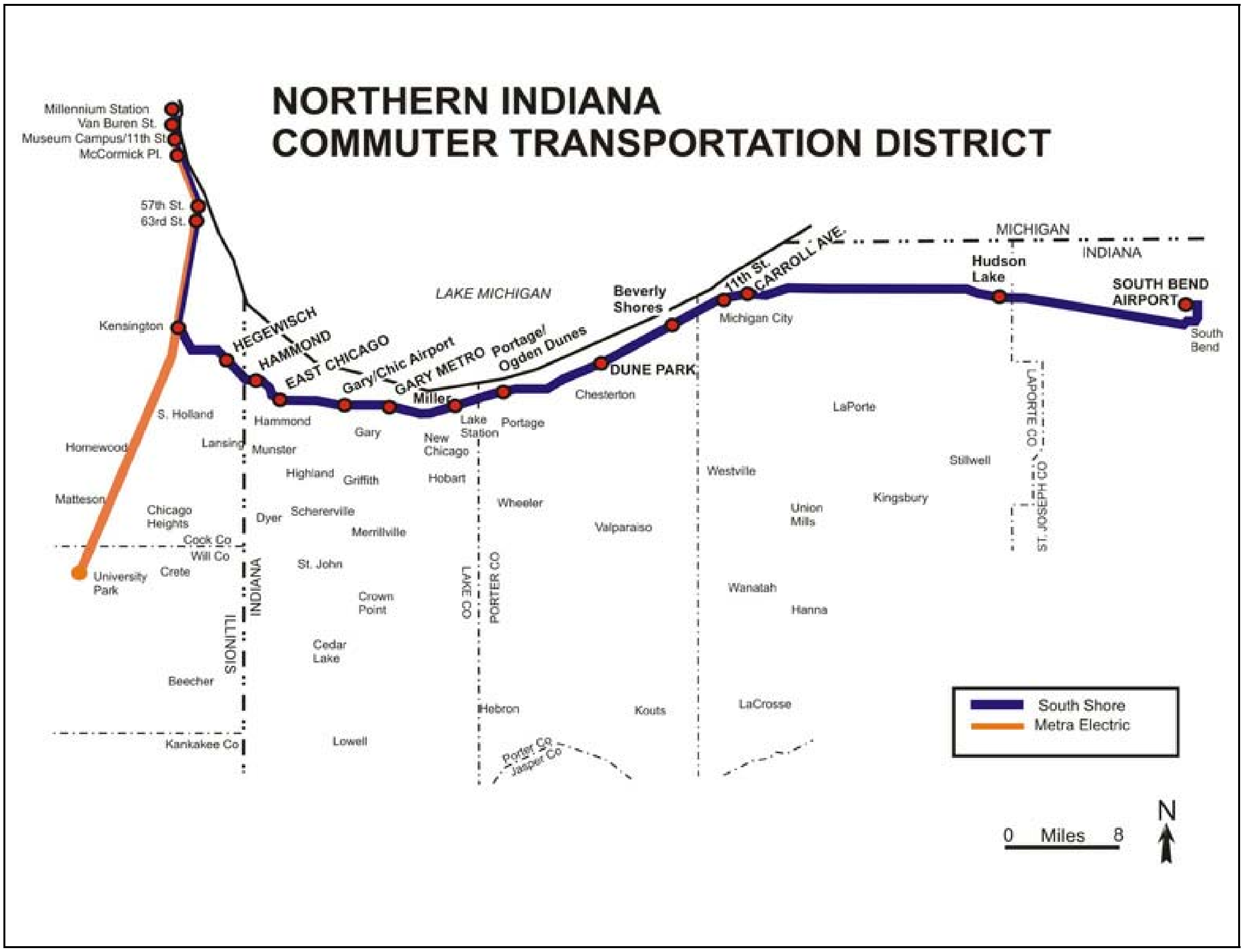
With respect to specific feeder routes and connections, the commuter rail lines fall into categories similar to the intercity feeder services. Most commuter rail lines will serve as feeders to the CUS hub. Many passengers originating in suburban Chicago would ride one of the commuter lines into downtown and connect to a HSR train at CUS. However, passengers that originate along one of the commuter lines that share tracks with the HSR service have other travel options that may not involve CUS. These routes are discussed separately below.

Metra Lines Serving the West Loop Area

Currently, most of the Metra lines serve CUS or Ogilvie Transportation Center, placing passengers within walking distance of the proposed West Loop Transportation Center. These routes include:

- CUS
  - North Central Service (NCS)
  - Milwaukee District West (MD-W)
  - Milwaukee District North (MD-N)
  - BNSF Railway (BNSF)
  - Heritage Corridor (HC)
  - SouthWest Service (SWS)
- Ogilvie Transportation Center
  - Union Pacific North (UP-N)
  - Union Pacific Northwest (UP-NW)
  - Union Pacific West (UP-W)

The Chicago Region Environmental and Transportation Efficiency (CREATE) program proposes to relocate SouthWest Service trains to LaSalle Street Station where Rock Island District (RI) trains currently terminate. This would free up capacity at CUS for growth on the HC and BNSF Railway lines. LaSalle Street Station is one stop away from the Clinton Street stop on the Blue Line subway.



Source: NICTD, accessed 2010.

Figure 15: South Shore Line System Map

The addition of the West Loop Transportation Center may reduce the number of trains using CUS, which suggests consideration of retaining the SouthWest Service at CUS and possibly relocating the Rock Island District trains to CUS as well. This would consolidate all of the commuter lines in the vicinity of the West Loop Transportation Center, with the exception of the ME and SS lines. However, both the ME and SS lines would have other connectivity options at a Hyde Park HSR station, as discussed below.

Milwaukee District North

A HSR station on the Chicago to Minneapolis/St. Paul corridor is proposed for Lake Cook as discussed in Section 3.6.1. This would be a joint station with the Milwaukee District North commuter rail line. HSR passengers originating at stations along the Milwaukee District North Line with destinations north of Lake Cook, such as Milwaukee, could connect to the HSR service at Lake Cook and avoid an out-of-direction trip into downtown Chicago.

Metra Electric and South Shore Lines

A Hyde Park HSR station at either the 55th, 59th or 63rd Street Metra station is proposed on the St. Louis, Cincinnati, and Detroit/Cleveland corridors. This would be a joint station with the ME and SS lines. Like the station at Lake Cook, the Hyde Park station would provide passengers originating on one of these commuter lines, and destined for points south and east, with the opportunity to transfer to HSR service without going into downtown Chicago. This would be especially attractive because the ME and SS trains terminate at Millennium Station on the east side of the Loop. The Millennium Station is not served by the CTA rail system and connections to a HSR station at the West Loop Transportation Center/CUS would be difficult. It would even be possible for passengers originating on the ME or SS with destinations north and west of Chicago to transfer to a HSR train at the Hyde Park station for a direct trip to the West Loop Transportation Center/CUS and their connecting train.

A proposed Southwest Intermodal HSR station would provide a connection for passengers originating on the ME with destinations on the St. Louis corridor. Harvey, an existing Metra station, has been identified as a suitable candidate location. Homewood is a conceivable alternative, but is bordered on one side by a golf course, limiting development opportunities near the station. The Gary HSR station would serve passengers originating on the SS line with destinations on the Cincinnati and Detroit/Cleveland corridors.

3.5.2 Regional Bus

The regional bus network in Chicago does not generally provide direct service into downtown Chicago. Instead, regional bus routes tend to concentrate at Metra and CTA rapid transit (subway and “L”) stations, feeding passengers to the rail mode for the remainder of their trip into downtown. As a result, the regional bus network would directly interface with HSR routes only at the outlying metropolitan area HSR stations. At these locations, regional bus routes provide good connections to major employers.

Lake Cook – The Lake Cook Metra station has a well-developed existing network of bus routes serving residential communities and large employers within a five-mile radius of the station.

Harvey – The Harvey Metra station has a well-developed existing bus network serving residential communities, hospitals and educational institutions within a 10-mile radius of the station. There is potential to add "freeway flyer” service to the west on I-80.

Gary – The Gary Metro Center SS Line station is the hub of the Gary Public Transportation Corporation route system, which serves an area within a 10-mile radius of the station.

3.5.3 Chicago Rail Transit and Fixed Guideway

Section 3 described the physical setting and route opportunities for connecting rail and fixed guideway service at the West Loop Transportation Center/CUS. This section describes how these connections could work together to provide access to the CTA rail network and downtown destinations.

The existing connections to CTA rail service from CUS are as follows:

- Walk east across the river, three and one-half blocks to Quincy/Wells Loop Elevated stop
- Walk south along Clinton Street, two blocks to Clinton Blue Line subway stop
- Walk north along Clinton Street, five blocks to Clinton Green Line “L” stop

Potential new connections from a West Loop HSR station to CTA rail and fixed guideway routes include:

- A vertical transfer to proposed new Red Line north-south subway (the subway stop would be stacked below the HSR platforms at the West Loop Transportation Center);
- A direct connection to the proposed east-west transitway, which would connect to Michigan Avenue and the proposed downtown circulator. These routes are shown as thin blue lines in the CAAP map included as Figure 16;

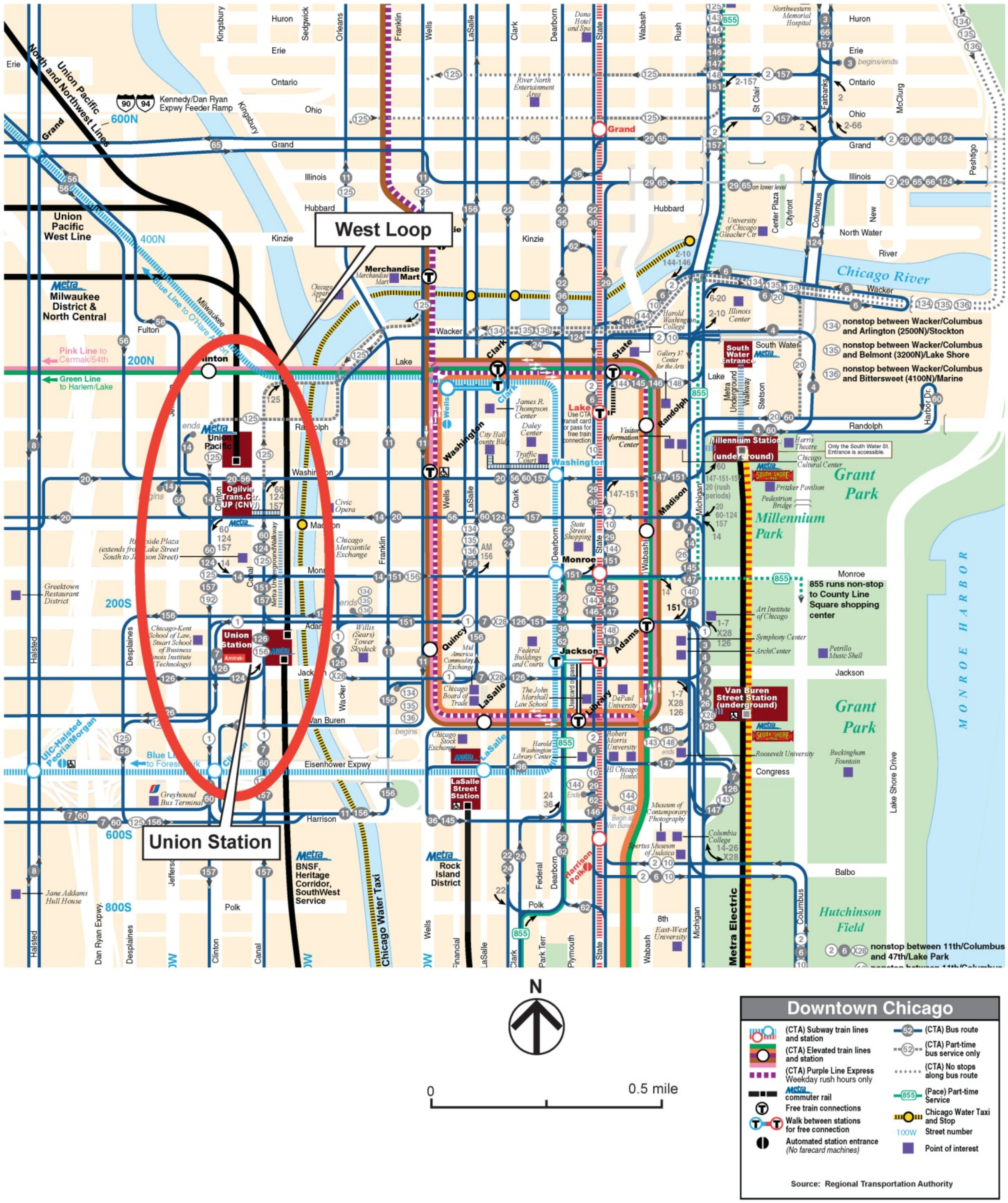
- The downtown circulator also provides a connection to the East Wacker area north of Millennium Park and the River North district across the river north of the loop; both of these areas are relatively underserved by existing rail transit;
- An underground pedestrian concourse extending south from the HSR station along Clinton Street and connecting to the Clinton Blue Line Station. An alternative would be to provide a transfer station at Clinton and Congress Streets on the new Red Line;
- An extension of this underground concourse north to the Ogilvie Transportation Center and the Clinton Green Line "L" station. Again, an alternative would be to provide a transfer station on the new Red Line at Clinton and Lake Streets;
- General expansion of fixed route transit service capacity;
- Expansion of water taxi service to the North Loop and East Wacker areas.

  At the Hyde Park HSR station, consideration could be given to a potential BRT link to Midway Airport via 55th Street and an extension of the 63rd Street Green Line branch to the HSR station.

3.5.4 Chicago Local Bus

Existing bus service in the vicinity of the proposed West Loop Transportation Center/CUS is provided by CTA Routes 1, 7, 14, 20, 56, 60, 124, 125, 126, 151, 156, 157 and 192. Many provide connections to the Loop and East Loop areas. CTA buses also serve the Hyde Park station area, including routes 6, 15, 28, 55, 59 and 63.

A potential improvement to support HSR service would be provision of point-to-point shuttle buses to key destinations such as Loop-area hotels from the West Loop Transportation Center/CUS, or the University of Chicago from the Hyde Park station.



Source: AECOM (base RTA), accessed 2010.

Figure 16: Chicago Union Station and West Loop

3.6 Connectivity Points with Commuter Rail and Local Transit

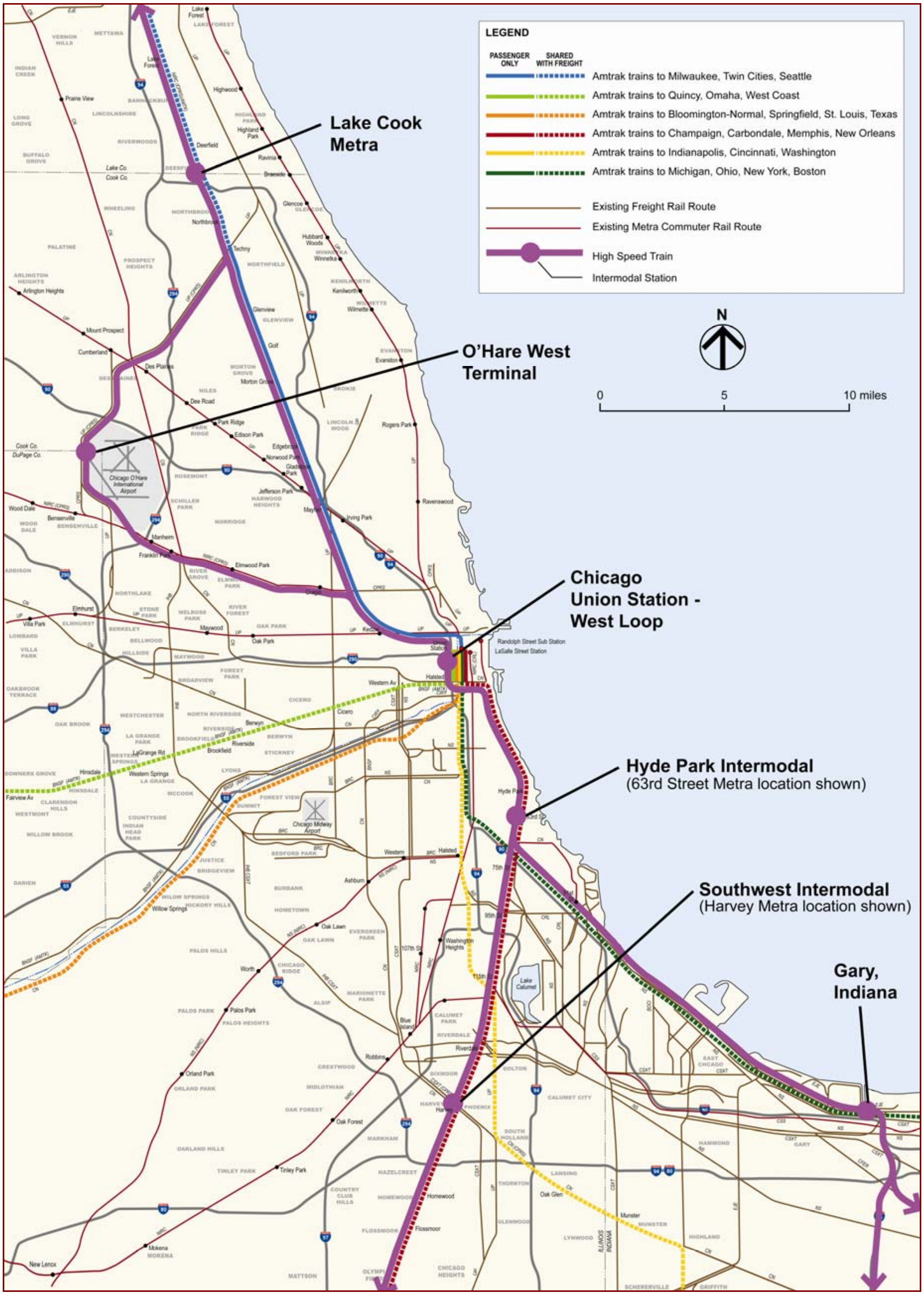
The service concept for integrating HSR with commuter rail and local transit is based upon differentiating HSR service, which would primarily serve intercity travel, and regional and local providers, which would primarily provide regional and local access to the HSR system. Whereas the distinction of service is relatively clear for access trips of less than 10 miles in length, there are circumstances in which regional travel (including long-range commute trips) would be made via HSR, as well as cases in which point-to-point travel will include HSR, a regional provider and a local transit access mode.

For these reasons, this study considers that there would be a benefit to defining regional connectivity points where HSR travelers would interchange with the regional network in addition to the HSR hub in downtown Chicago.

The analysis of the metropolitan district has identified five regional opportunities at:

- Lake Cook Metra Station
- O'Hare International Airport
- Hyde Park (55th, 59th or 63rd Street Metra Station)
- A Southwest Intermodal at Harvey Metra Station or Homewood
- Gary Metro Center South Shore Station

Figure 17 depicts the candidate regional integration points with the potential HSR mainline routing shown in purple. Also shown is the West Loop/CUS downtown hub in the central area, which is discussed in Section 4.0. Additionally, the figure shows a line connecting from Milwaukee in the north-northwest direction with a loop to O'Hare and two lines to the south, branching in a south-southwest direction toward St. Louis and in an easterly direction toward Cincinnati and Toledo. The rationale for the O'Hare option and considerations noted at the regional connectivity sites are discussed further below.



Source: AECOM (Base map IDOT Illinois Railroad Map, 2006).

Figure 17: High-Speed Rail Routing and Connectivity - Metropolitan Area

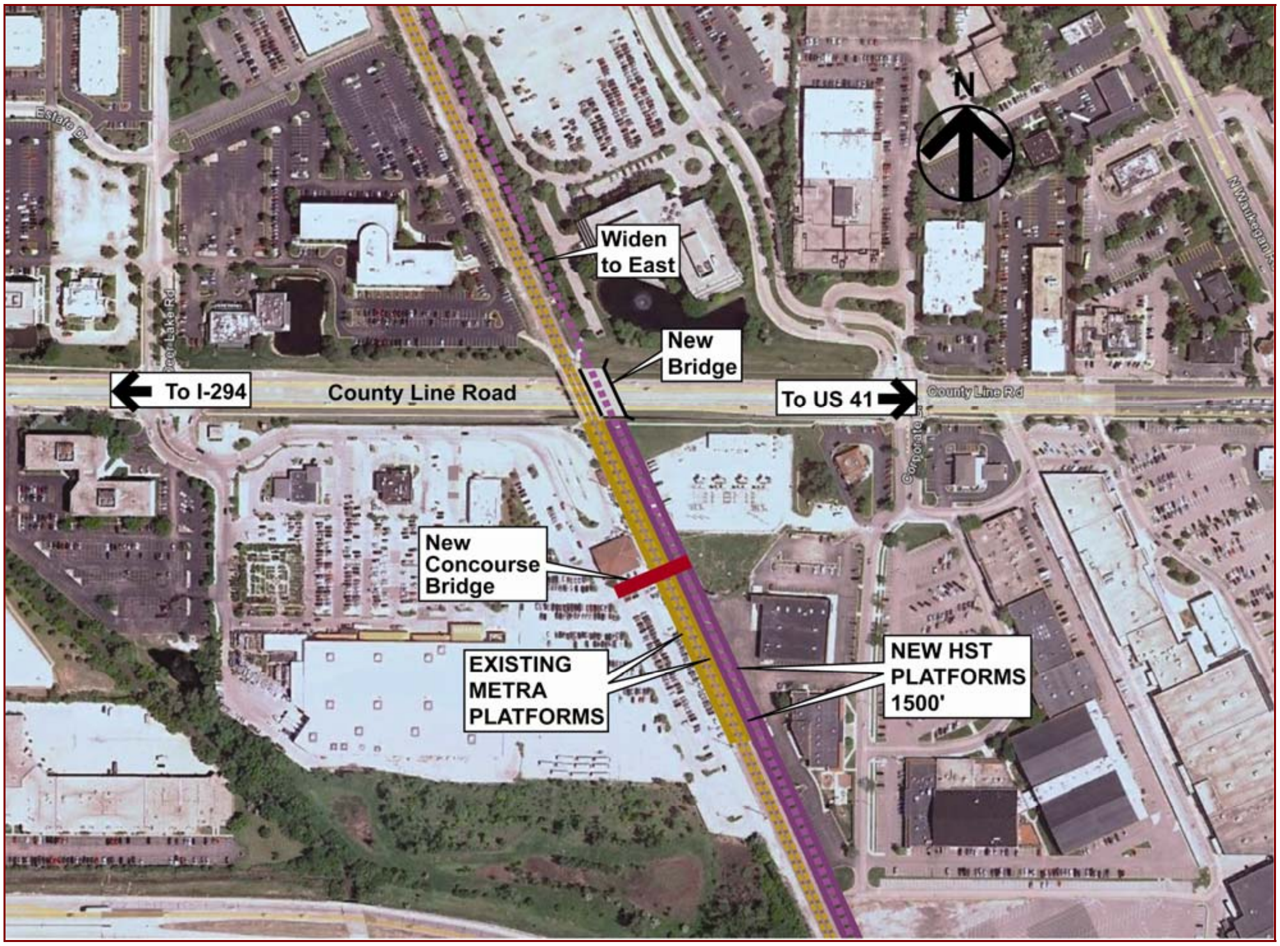
3.6.1 Lake Cook Metra Intermodal

On the north side, the analysis of candidate HSR routes identified two alignments extending toward Milwaukee – a direct line following the Milwaukee District North (MD-N) line with a branch following the Union Pacific West (UP-W) line to O'Hare, which would converge back via the UP Milwaukee Subdivision in the vicinity of Northbrook. Provision of an intermodal with Metra north of Northbrook would therefore serve a dual purpose of allowing HSR patrons a final point to transfer between O'Hare and downtown Chicago direct trains, as well as the opportunity to transfer to Metra trains. Likewise, outbound patrons from points south could potentially transfer between long distance services continuing to Minneapolis/St. Paul and shorter range trains terminating in Madison. Finally, it is reasonable to assume that the ultimate system may also support "regional overlay" services – these trains could potentially serve locations that are too closely spaced to justify true 220-mph HSR service, but which could potentially be served by equipment with a top speed of 150 mph or less, making additional stops (such as the Gurnee/Waukegan area, Kenosha and Racine) that are beyond the range of most services presently provided by Metra.

For the purpose of this study, an intermodal connection was identified at the Lake Cook Road Metra station that straddles the Cook County/Lake County line approximately 25 miles north of downtown Chicago (Figure 18). Positive factors at this location include:

- All HSR trains between Chicago and Milwaukee (regardless whether routed via the MD-N line or via O'Hare) would pass by this station;
- Existing station is located along the MD-N line, a relatively fast commuter line central to the north-northwest area with more than 20 stations;
- The station serves the heart of the highest suburban employment concentration located along the east-west Tri State Tollway (I-94) branch connecting between the Tollway Trunk and the Edens Expressway (SR-41);
- Lake Cook Road provides access across the northern sector between Barrington on the far northwest side to the Glencoe/Highland Park area along Lake Michigan;
- Existing feeder bus service (Pace routes: 473, 626, 627, 631, 632, 633, 634 and 635) connects to numerous large employers, as well as adjacent UP-N and NCS lines serving an additional 45 Metra stops;
- There is an area clear of structures to the east of the existing Metra platforms that would potentially be used to accommodate HSR tracks and platforms – a new HSR bridge would be required across Lake Cook Road, but the HSR tracks would potentially fit beneath the Tri State spur (with appropriate modifications);
- As the existing station is located in a commercial district and there are large surface parking areas, substantial amounts of additional parking and/or mixed-use development would be accommodated at the site (this is not the case for most other north suburban stations).

The plan for the station area should not preclude significant new development of the highest caliber and include a superior public realm (good streets, neighborhood parks and other amenities).



Source: AECOM (base by Google), 2010.

Figure 18: Lake Cook Intermodal Concept Plan

3.6.2 O'Hare Intermodal

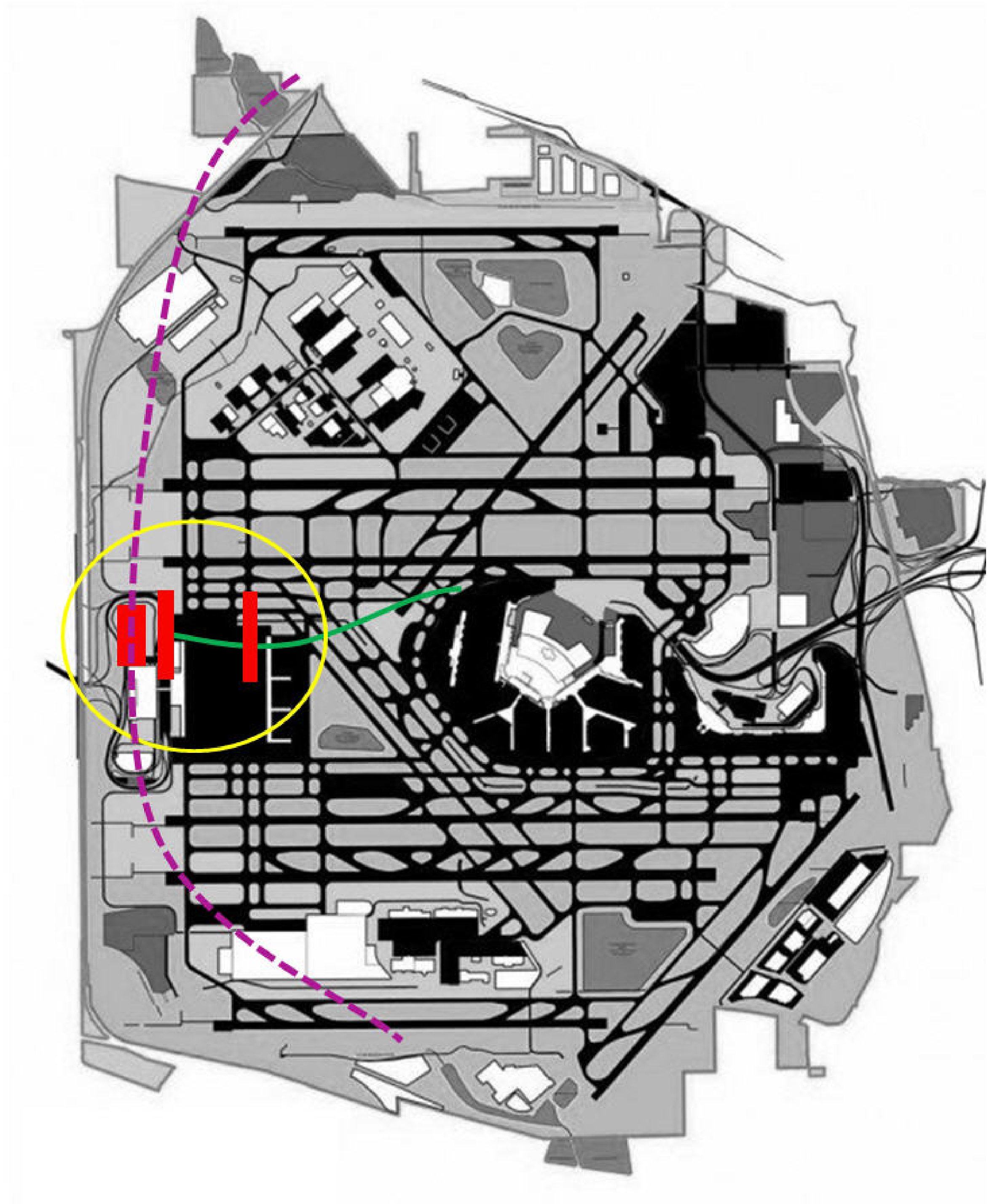
In order to minimize the number of tracks and platforms required to provide an underground HSR station at the West Loop Transportation Center/CUS, trains could be operated through the station to a stop at O'Hare, where it is possible that space would also be identified for maintenance and storage. As indicated previously in the corridor descriptions, a potential alignment to O'Hare would branch from the main north-south HSR line at Pacific Junction Tower, where the MD-W and MD-N lines split. The alignment could follow the MD-W line west to Mannheim Road, and then swing to the north, crossing Irving Park Road to follow the UP line around the west of the airport.

Although there are very few specifics at this point in time, expansion planning for O'Hare is considering a new West Terminal situated between runways 9R/27L and 10L/28R, which would be connected to the existing terminal complex via an underground Airport Transit System and potentially an extension of the CTA Blue Line. Part of the consideration for this new terminal is an in-terminal rail link to downtown and other regional destinations. The in-terminal rail link to downtown would be a clear differentiator for the O'Hare complex and an attraction for passengers and business patrons who use the airport convention facilities as a convenient place to meet. Additionally, the new HSR facility would help cut down on the walking distance between the terminal and the gate, if security and baggage handling could be handled at the point of embarkation for HSR.

Figure 19 indicates the site location and an approximate rail route around the western portion of the airport. As the rail corridor would pass around the end of all of the runways, portions would need to be underground or in a trench to avoid interference with flight operations and ground traffic.

In addition to providing a direct link to the airport, having a location to park, store and maintain equipment outside of downtown would provide many benefits to the HSR network. In particular, the ability to park and turn back trains at this location would address the system capacity imbalance should three routes be developed extending south and east (similar to the existing imbalance to the south in current Amtrak operations, as well as in service projections with the MWRRI plan).

By extending the O'Hare spur further north, routing it parallel to the UP "new line" that crosses from O'Hare back through Techny, the route would connect back to the main line just south of Northbrook. In this manner, various combinations of trains to and from the north (Minneapolis/St. Paul, Madison and Milwaukee) would be routed either to CUS via O'Hare or direct. Likewise, HSR trains to and from the south and east lines (serving St. Louis, Cincinnati, Detroit and Cleveland) would either continue north or would stop and turn back at O'Hare without the need to reverse out of CUS.



Source: AECOM, 2010.

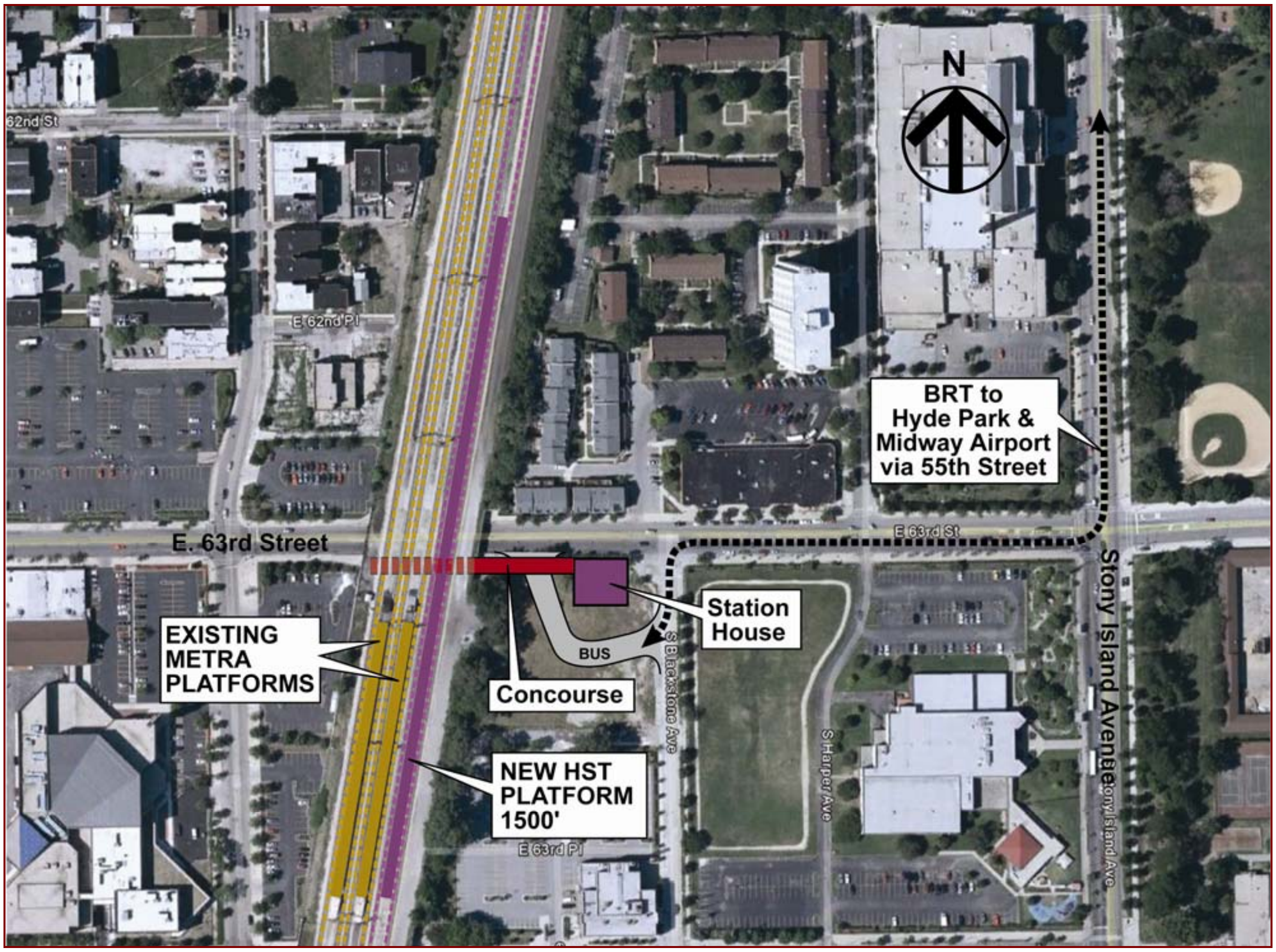
Figure 19: O'Hare West Intermodal Concept Plan

3.6.3 Hyde Park Metra Intermodal

The analysis of the intercity and Midwest HSR network has identified opportunities for routing high-speed lines along a dedicated passenger corridor consisting of the principal line of the ME/former Illinois Central Gulf main line, extending to the south-southeast of downtown, with a branch between services routed to the east (to points in Indiana, Michigan and Ohio) and services routed to the south and west (to downstate Illinois and St. Louis, Mo.) in the "Grand Crossing" vicinity at 75th Street and Chicago Skyway (I-90).

Accordingly, this study identified a south side intermodal station within the inner Metra/CTA rail district located in the Hyde Park area, coinciding with the 55th, 59th or 63rd Street Metra stations. The 55th and 59th Street stations are closer to the heart of the Hyde Park/University of Chicago community and presently offer a greater number of key destinations within walking distance. However, the 63rd Street site is less constrained than the others and could accommodate redevelopment on a greater scale. For purposes of this study, the 63rd Street location was conceptualized as shown in Figure 20. A Hyde Park HSR station would provide connectivity to the rail and bus network on the south side of Chicago and was identified for the following reasons:

- All HSR services routed to the south and east would pass through this station;
- The station would be located on the edge of the University of Chicago, which is a significant point of regional interest and is close to principal civic facilities such as the Museum of Science and Industry located in Jackson Park to the east;
- The station would be located north of where the SS Line branches from the ME line, thereby providing convenient rail access to SS stations between Kensington (Pullman District) and Gary, Ind.;
- The station is north of the ME Blue Island and South Chicago branches providing rail access to 15 additional ME stops;
- The 63rd street location is served by existing CTA routes 6, 15, 28, 55, 59 and 63, which provide access to Hyde Park and Jackson Park, and it is also near the Cottage Grove terminus of the CTA Green Line; other potential station sites have similar local bus service;
- Route 59 also connects to Midway Airport; however, the bus travel time is one hour and fifteen minutes vs. twenty-five minutes by private auto, suggesting the possibility of a new BRT link though the University of Chicago/Hyde Park area and extending via Garfield Boulevard and 55th Street to Midway Airport (this service could originate at the Cottage Grove "L" station);
- The existing embankment appears to be wide enough to accommodate dedicated HSR tracks and platforms east of the existing ME trackage (now that freight traffic on this line has been largely curtailed);
- A station at this location would ideally build on the strengths of the existing uses and differentiators – the University of Chicago and Museum of Science and Industry. Today, portions of the district do not have significant density to promote walking to the station, and would need to attract intensified development as a primary goal.



Source: AECOM (base by Google), 2010.

Figure 20: Hyde Park Intermodal Concept Plan (63rd Street Metra location shown)

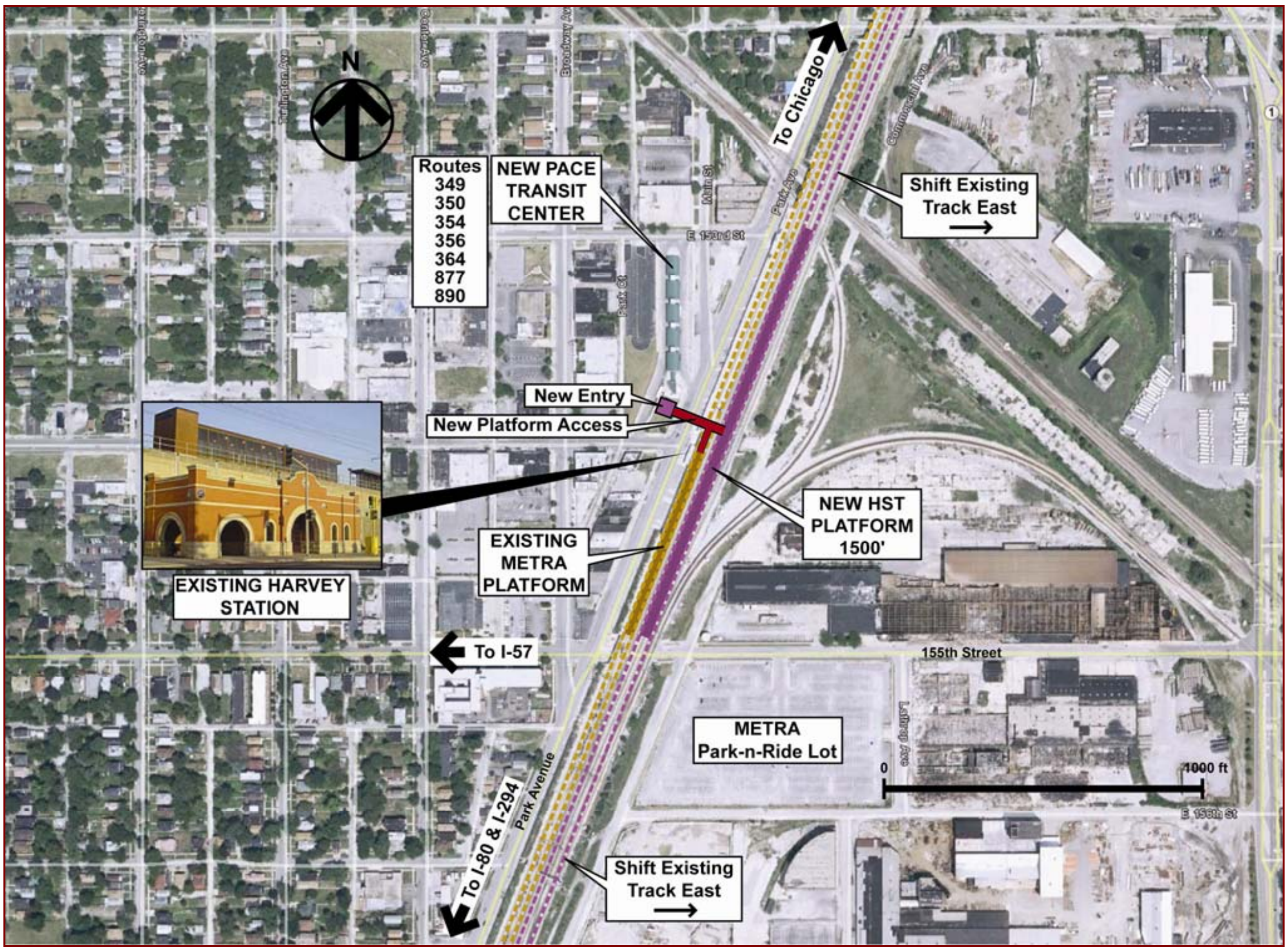
3.6.4 Southwest Intermodal

As the routing for HSR lines serving points east in Indiana, Michigan and Ohio would branch near 75th Street, trains operating further south along the ME main line would be bound for St. Louis. In order to provide connection to the regional network as the HSR trains would enter the metropolitan area, this study identified a south side intermodal at the Harvey Metra station along the ME trunk. Another possible location is further south at Homewood, which would be an effective collection and distribution point for traffic from all of the south suburbs. The Harvey location was conceptualized as shown in Figure 21. Key features of this intermodal include:

- The existing Metra station is located along the ME main line, a relatively fast commuter line with more than 50 stations (including the Blue Island and South Chicago branches);
- The station is located in the heart of contiguous development on the far south-side stretching from Orland Park on the west to Hammond, Ind., which can be accessed via I-80 or 159th Street;
- Existing feeder bus service is extensive (Pace routes: 349, 350, 352, 354, 356, 364, 877 and 890), serving points between Orland Park and Hammond including a connection to the Metra Rock Island line at Midlothian and Robbins;

- As the existing station is located in a commercial district, adding an elevated HSR concourse above the existing station platforms would have less visual impact compared to surrounding stations where land uses are more residential;
- The existing Metra parking lot just east of the rail line on 155th Street and other underutilized land in the vicinity of the station could support new development should economic conditions improve sufficiently with increased rail service.

An opportunity exists at this potential HSR station area to develop a regional anchor (office, residential, retail, sports or corporate campus) due to its high level of accessibility. Large underdeveloped tracts of land are available, with the potential to create a large campus-like district within a five-minute walk of the station. The ability to design and control the density of such a large area suggests that a significant density and vibrant concentration of uses can be accommodated over time, as the market drives the growth.



Source: AECOM (base by Google), 2010.

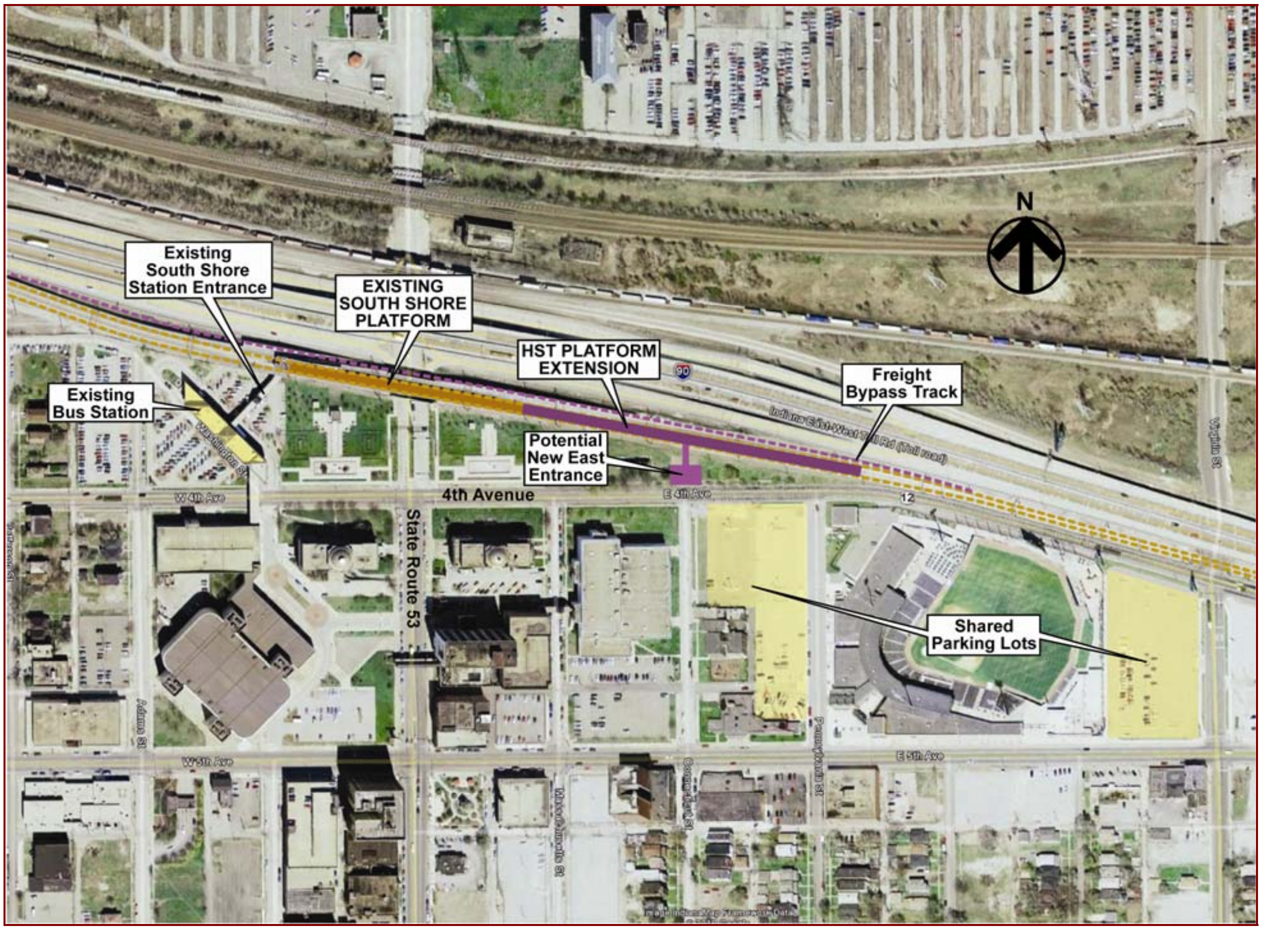
Figure 21: Southwest Intermodal Concept Plan (Harvey Metra location shown)

3.6.5 Gary Metro Center Intermodal

Gary, Indiana is located near the edge of the metropolitan region commute shed and is presently served by the SS electrified rail service, which interlines with the ME division north of Kensington. An intermodal station at this location would perform a similar function for the HSR lines heading east as the Harvey location would for the St. Louis line. The candidate 220-mph routes identified in this study would branch just east of this station into an eastern line continuing to Toledo, Ohio, and a south-southeast line continuing to Indianapolis. Figure 22 shows a conceptual plan of potential improvements to accommodate HSR. Advantages of an intermodal at this location include:

- Connection to the SS Line serving Indiana points along Lake Michigan and South Bend, which are not otherwise served by the proposed MWRRI network;
- Hub of local bus network in Gary and within walking distance of convention center and civic center;
- Potential to route trains onto SS electrified tracks for access to existing platform (with appropriate modifications to traction power systems), which would be extended within an area presently occupied by a pocket track;
- Consideration given to providing a bypass track to the east for routing freight and/or through trains around the station;
- A HSR station at this location could be the only station with a lakefront address. A bold plan to capitalize on the proximity to the lake could be the catalyst for revitalization of this region. Creating a “satellite city” on the lakeshore, and building on the existing historic buildings and uses, the stadium and convention market could be the incubators for a new, revolutionary plan for Gary and the restoration and revitalization of the Indiana Lakefront between Burns Harbor and Buffington Harbor, as well as Gary’s Midtown Central District.

Consideration should be given to providing a new east entrance to the station, which could share parking with the existing SS line, Railcats stadium, Genesis Convention Center, civic buildings and 21st Century Charter School.



Source: AECOM (base by Google), 2010.

Figure 22: Gary Intermodal Concept Plan

3.7 Stations and Transit-Oriented Development

3.7.1 Introduction

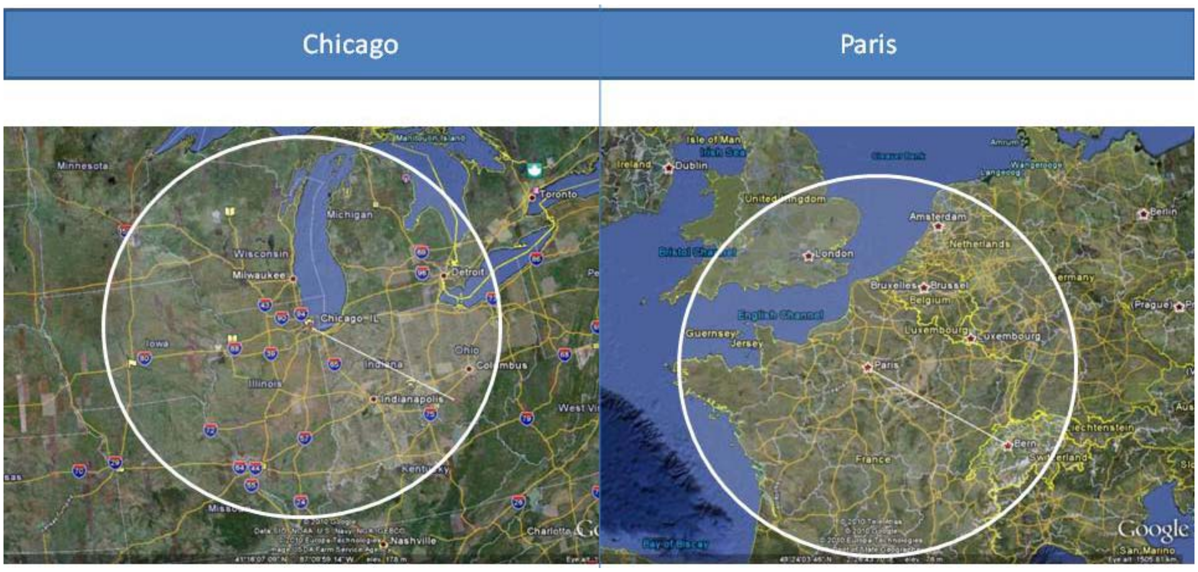
Access to the Midwest HSR network would be enabled via 24 proposed stations conveniently located close to medium and large city populations, central business districts and airports. It is estimated that stations would catalyze the redevelopment of host communities and draw workers from all socio-economic segments. The length of the routes, combined with the populations of the cities served as well as the limited airport and roadway capacity along the corridors, are strong indicators of a successful HSR service.

International Context

Placing the proposed Midwest HSR network in the context of similar systems implemented in other countries reveals relevant lessons. Figure 23 illustrates the areas within a 350-mile radius of both Chicago and Paris. The European context is decidedly more mature and dynamic, and presents a model for Chicago and the region to develop an equally-compelling network of great places to live, work and visit, both inter-state and possibly cross-border with Canada in the future.

Benefits

A key benefit of HSR lies in its ability to divert a significant number of auto trips. Business trips taken by automobile – typically with just one or two occupants per vehicle – represent a significant share of HSR's potential market. Business travelers would be attracted to HSR, given that the full cost of driving exceeds average HSR fares, and that travel times are significantly reduced with HSR. As discussed earlier, door-to-door travel time would be competitive with air travel, and would be significantly shorter than automobile travel. Reducing the need for access trips to and from the station hubs by focusing on creating robust and vibrant activity centers adjacent to HSR stations would promote non-auto dependent travel alternatives.



Sources: Google Maps and AECOM
Figure 23: Chicago vs. Paris

Within the five-minute (approximately 1,500') walk of a station, approximately 163 acres of land are typically considered available for or impacted by redevelopment including streets, parks and buildings. Urban development typically yields a ratio of 40 to 60 percent developable land/coverage and based on other comparable urban locations, a density of 1.0 floor-area ratio (FAR) would be a low-end yield. So, approximately 80 acres at 1 FAR would yield approximately 3,500,000 gross square feet (gsf) of development – an appropriate target for stations in suburban locations or the smaller corridor cities. For an urban area in a key location such as downtown Chicago, where current FARs are much higher, a 4.0 FAR would be easily attainable and should be pursued.

Branding

Taking the train should be as easy as driving; virtual ticketing would bring unprecedented flexibility to travelers: all ticket information would be kept in a central repository, and travelers need only carry a form of identification (i.e. cell phone, drivers license) to collect a ticket. Passengers could modify their ticket at any time, change departure time, add or remove services or even change seats after the train has departed. Many carriers also use web platforms compatible with those used by the travel industry, making their products easy to sell by corporate or online travel agencies. HSR would also present the opportunity to seamlessly combine rail and air segments, for instance, a round-trip ticket from Los Angeles or Tokyo to Milwaukee via O'Hare.

3.7.2 Proposed High-Speed Rail Station Locations and Buildings

Station location proposals for the Midwest HSR network have been based on a four-fold strategic approach:

- Accessibility
- Inter-modality and connectivity issues
- Urban development opportunities
- The existence of historical station buildings

The Midwest HSR network identified in this study would serve 24 stations. HSR service is best located and complemented by the following urban characteristics in and around the station area:

- Highest density of development
- Highest intensity of employment
- Dense urban street grid
- Small block sizes
- Highest access (transit and taxis)
- Parking (structured and shared)
- High pedestrian accessibility
  - Wide sidewalks
  - Pedestrian facilities and bike network

As stations have become magnets and driving forces for urban development, their visual impact, the monumental or symbolic nature of their buildings and their iconic architectural design have grown in importance. Political and business leaders expect stations to be visual "business cards" and join the ranks of the outstanding buildings in their cities, and to fully and seamlessly integrate with the urban fabric.

Particular challenges may exist where historic station buildings may need to be adapted to meet the needs of HSR. Wherever reasonably possible, historic station buildings need to be maintained and restored. Special attention should be given to the use or re-use of historic or existing stations, bringing 21st century train technology to well-positioned icons of America's railroad history: CUS, Indianapolis' Union Station or Cincinnati's Union Terminal can all become revitalized gateways to their respective cities. Marseilles' St. Charles Station provides such an example, where the historic building was extended to integrate an intercity bus station, as well as new shops and services into the HSR terminal. In the Paris-East station renovation, a total overhaul of the historic 1850/1930 station era buildings integrated over 500,000 square feet of new retail shops, cafés and restaurants for the arrival of the TGV East line in 2007. Closer to home, at Los Angeles' historic Union Station a partially-built (previously entitled 8 to 10 million square foot) station redevelopment stands poised to move forward with HSR as the catalyst for change.

3.7.3 Intermodal Travel Connections with Other Transportation Services

One of the main success factors of any new rail service, especially HSR, is its convenience and easy station access for autos, taxis, buses and various public transportation modes, and intercity and regional trains. The entire travel experience must be as carefully designed and operated as a single station. Thus, good cooperation between the HSR operator and its partners will result in convenient, easy-to-access and competitively-priced end-to-end services, and each mode's operations will complement the others' needs.

The Station as an Intermodal Hub

An urgent need exists to reorganize our cities, as inherited from the 20th century with juxtaposed and layered transportation networks that, over the years, have become increasingly segmented, fragmented and confused. The emergence of new transportation projects like HSR should be seen as an opportunity to rethink and rework this legacy. Redesigning the HSR station areas based on general city planning and development goals can be the first step toward transforming the whole urban transportation network into an integrated multi-modal service offering. Therefore, all station projects need to focus first and foremost on optimization of the stations as intermodal transportation hubs between trains, on the one hand, and urban transportation modes such as rapid transit, buses, taxis, autos (rented and private), as well as bicycles and pedestrian walkways, on the other. All of these modes need to be linked in the fastest, safest and most convenient way.

Connecting High-Speed Rail to Existing Rail Network and Local Transportation

Providing convenient connections with the existing rail network is an obvious target to pursue. HSR stations should, wherever possible or realistic, be developed in the vicinity of existing passenger stations served by current services. This will reinforce the development of existing commuter and regional intercity passenger rail services and encourage the creation of new services. Station design must ensure that all transit lines and other modes are brought as close as possible into the station complex in order to rapidly absorb the flow of arriving passengers and minimize walking distances from one mode to the next.

Auto Access and Parking Lots – Previously, it was emphasized that the challenge of a new rail service is to maximize the shift of automobile traffic to HSR services. This would be achieved by correctly planning traffic flows in the station’s neighborhood, adapting the street layout, facilitating taxi access and properly designing pick-up and drop-off areas. Rental car opportunities and adequate parking facilities (with expansion capabilities) would need to be provided, where appropriate.

Catering to Non-motorized Modes and New Mobility Concepts – Catering to the “last mile” of the passenger’s journey is becoming more important, and can be achieved by managing the flow of pedestrian traffic as an integral part of the trip. The aim must be to create a continuum with the urban fabric and ensure the safety of pedestrian areas in and around the station. Space should be allocated close to stations for bicycle paths and bike parking, and services such as bike rental and sharing, secure parking and repairs. Shuttles to hotels and local cultural and recreational attractions can provide connections for passengers for whom walking or biking are not reasonable options. New mobility concepts such as carsharing, which currently represents only a small share of the overall mobility market, are expected to become more relevant in the future. Partnerships with alternative mobility providers would need to be forged.

High-Speed Rail and Air Travel

As previously stated, HSR can complement air travel by providing an alternative for regional air trips. This requires well-designed physical connections similar to those at airports with their own HSR stations such as the HSR station at Paris’ Charles De Gaulle Airport, France’s main air/rail hub. The various air/rail links proposed for the Midwest HSR network would allow for good connectivity through extensions of existing people movers or by creating specific shuttle services.

HSR lies at the intersection between intercontinental/continental and local/regional networks, and can therefore function either as a feeder (generally of a longer air segment) or the main portion of a trip. Travelers will tend to purchase the end-to-end journey from the dominant carrier; airlines could therefore sell the train segment (a concept proven by carriers such as American Airlines or Cathay Pacific that sell rail segments as an extension to an intercontinental journey). By the same token, HSR operators could offer additional services as part of a single transaction (auto rental, local transit, taxi, etc.) Experienced operators who have worked in partnership with auto rental companies, local transit systems or taxi fleets could be beneficial to the HSR project.

Lastly, the impact of strong intermodal ambitions on the design of operations is important. Providing coordinated schedules, traveler information (i.e. displaying real-time departure gates or local transit information on-board trains) and the ability to handle specific cases (i.e. delayed connecting passengers) must be developed to offer an effortless experience for multimodal travelers.

Station Services

Services provided in stations must meet the expectations of a variety of customers, who need to feel as much at ease when in transit as when not. Stations can become meeting places and lifestyle areas, where the operator can offer a wide range of services for various customer segments, providing them with a secure environment, everyday commodities and comprehensive services. In larger stations, full-scale shopping malls could even be developed; Europe's largest rail terminal in Leipzig, Germany, features 140 stores on three levels. For travelers, convenient waiting areas, reliable information, business facilities and recreational opportunities should be provided depending on the specific customer profile. Baggage storage and obstacle-free passages are essential for easy and comfortable movement.

Virtual ticketing, combined with self-service machines for ticket exchanges or multi-operator vending machines, reduces the number of sales staff and size of sales areas in stations, such as that required for ticket counters and back offices. Sales staff redirected to customer service will smooth transfers through the station, offering personalized information and special care for passengers with particular needs.

Stations must offer easy access to all users, including the disabled, by installing necessary facilities (elevators, ramps, escalators, dedicated restrooms, suitably adapted ticket counters, etc.) and having properly trained staff. All these services, combined with reliable, clean installations (lighting, elevators, escalators, restrooms, etc.), must contribute to creating a place where travelers feel safe and at ease, reinforcing the station's appeal not only as a departure point but as one of a city's most lively and compelling venues.

Finally, station design must be conducive to passenger flow and intermodal mobility. The various areas within the passenger building have to receive and orient customers between their points of access/egress, whatever their mode of travel, and the HSR platforms. These areas consist of the main concourse, the various passageways, galleries, underpasses and overpasses that serve to facilitate the flow of arriving and departing foot traffic, and offer waiting areas for those with time to spare. All of these areas should be designed to enable seamless movement and offer convenient signposting and passenger information, while complementing the building's architectural design.

On-Board Services

Time spent on board is a critical part of the overall travel experience, and a key component to win customers' preference. A comprehensive review of the current travel market and its trends, including all elements that could influence decision-making, would identify customers' needs. A "customer experience team" with service specialists from different industries (HSR, airlines, hotels, etc.) would be responsible for designing the overall service architecture, focusing on key selling points (comfort, convenience, human dimension, etc.) and reflecting the brand proposition. The interior design of the trains would also need to comply with the Americans with Disabilities Act (ADA) requirements as mentioned for the stations.

4.0 Chicago Union Station and the Central Area Action Plan (CAAP)

Current planning by the City of Chicago envisions that CUS will continue to be the most heavily-utilized hub for regional rail service, and CUS is also shown as the hub for the MWRRI 110-mph emerging HSR service. This study assumes that 220-mph service would be brought to a candidate location at the proposed West Loop Transportation Center adjacent to CUS or in the existing CUS reconfigured to accommodate HSR.

4.1 Chicago Union Station

The City of Chicago has identified CUS as the transportation hub where both regional and long-distance trains would serve the central area. Six Metra lines currently serve CUS:

- North Central Service (NCS)
- Milwaukee District North (MD-N)
- Milwaukee District West (MD-W)
- BNSF Railway (BNSF)
- Heritage Corridor (HC)
- SouthWest Service (SWS)

In addition, CUS is used by 16 daily Amtrak long-haul trains to and from Milwaukee, Minneapolis/St. Paul and Pacific Northwest, as well as 40 daily Amtrak long-haul trains to and from the west, south and east. The number of intercity trains is expected to climb significantly based upon the development of the 110-mph emerging high-speed corridors delineated by the MWRRI plan.

The combined impact of the MWRRI plan and potential Metra service expansion are expected to exceed the capacity of the existing facility; therefore, improvements would be needed to accommodate all of the identified increases in service, even without inclusion of true HSR.

There are significant physical and geometric challenges in expanding the capacity of the existing terminal. From the air, the station appears to be a through station, however in reality it is a back-to-back stub-end terminal (refer to Figure 24 showing a diagram of the concourse level), with only a single through track to the east along the Chicago River. Amtrak, Metra and the City of Chicago are looking for ways to expand the capacity and/or improve operations and are considering a wide range of approaches including:

- Modifications to the concourse to push through additional through tracks;
- Developing staggered platforms extending to the south;
- Providing additional platforms to the south under the old post office (between Van Buren and Harrison Streets);
- Demolishing the existing office tower between Jackson Boulevard and Adams Street to eliminate structural constraints to re-working the concourse level.

A long-term solution for accommodating true HSR that addresses CUS's capacity constraints would be to implement the West Loop Transportation Center under Clinton Street adjacent to CUS, or reconfigure the existing CUS track, platform and concourse layout to significantly increase capacity. The West Loop Transportation Center/CUS Capacity Expansion is a key project identified in the CAAP adopted by the Chicago Plan Commission on August 20, 2009. This project would also include a new north-south CTA subway alignment under Clinton Street to strengthen intermodal connections and relieve the existing, heavily-used north-south Red Line subway. As illustrated in Figure 25, a new HSR station adjacent to

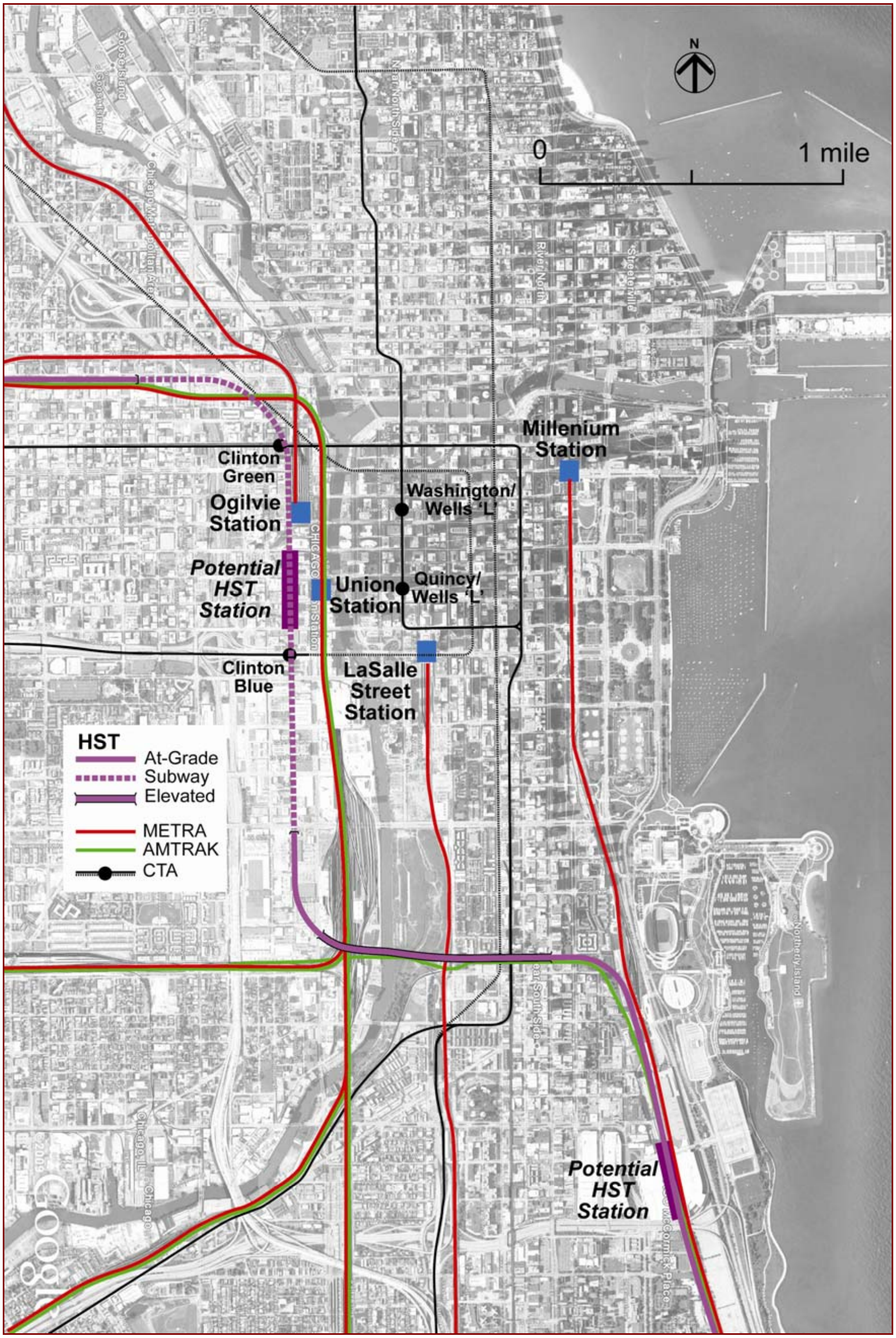
CUS or a reconfigured CUS would have direct access to CTA's rapid transit network via the new north-south subway under Clinton Street.

Source: CUS, accessed 2010.

Figure 24: Chicago Union Station Concourse

Figure 25 shows a potential HSR station located under Clinton Street immediately west of CUS and south of Ogilvie Transportation Center (where three Metra UP lines terminate). Access to this station from the north could be via new tracks paralleling the Milwaukee District Lines (MD-NH and MD-W), transitioning to subway east of Ogden Avenue then swinging south and east to follow Clinton Street in subway. South of the HSR station, the HSR alignment would emerge south of Roosevelt Road within the Clinton Street right-of-way (displacing the existing roadway lanes) and transition to an aerial configuration across the existing railyards and the South Branch of the Chicago River on a new high-level bridge. The HSR line would potentially follow the old St. Charles Air Line rail right-of-way over the leads to the La Salle Street Metra station west of Clark Street, as well as the CTA Orange Line between State Street and Wabash Avenue, dropping to grade and entering the ME corridor at McCormick Place Convention Center, where a special event stop could be provided. At this location riders could also access the East Loop via the Lakeshore Busway, which was developed to provide fast and convenient access to downtown district hotels and restaurants from McCormick Place.

Construction of the West Loop station could potentially be deferred, should the City of Chicago, Metra and Amtrak identify means of addressing the current operational and capacity issues and provided the enhancements can be implemented without serious impact to ongoing operations. A reconfigured CUS would accommodate similar increased capacity track connections.



Source: AECOM (Base provided by Google), 2010.

Figure 25: High-Speed Rail Routing and Connectivity - Central Area

4.2 Central Area Action Plan (CAAP)

The following sections are extracts from the Chicago CAAP with a focus on urban design. A significant amount of planning has already been undertaken for this area and is summarized below.

Major Transportation Improvements

The City of Chicago, as part of its plan to significantly intensify West Loop land use, has identified a number of major transportation improvements, shown in Figure 26, which would address many of the access needs identified above.

Carroll Avenue Transitway – This new transit corridor would connect the West Loop with River North and Streeterville via a dedicated east-west right-of-way at the north edge of the Chicago River. In the West Loop, the service would operate in the dedicated right-of-way north of Lake Street, and use Clinton and Canal Streets to access CUS and Ogilvie Transportation Center.

Clinton Transitway – An extension of the dedicated transit corridor used by the Carroll Avenue Transitway, the Clinton Transitway would create a below-grade transit right-of-way from Lake Street to Jackson Street.

East-West Transitway – An east-west rapid transit route through the Central Loop beneath Monroe Street will connect the West Loop and its commuter rail stations with the Central Loop and lakefront amenities.

West Loop/CUS Area Streetscape – The area around CUS and Ogilvie Transportation Center has heavy foot traffic and demands a pedestrian-friendly environment. A comprehensive streetscape project on adjacent streets, particularly Clinton Street and Canal Street and their intersecting east-west streets from Randolph Street to Jackson Boulevard, would add street plantings, crosswalks, lighting and wayfinding signage.

Bicycle Lanes and Markings – Bicycle lanes are planned for Washington, Madison and Adams Streets, complementing the existing bicycle lanes along Clinton and Canal Streets.

CUS Upgrades – CUS improvement needs include enhanced access points and upgraded passenger amenities and platforms. An intermodal transfer center will move buses and taxis off the street and ease congestion. Amtrak also plans to improve and expand its passenger waiting areas.

West Loop Transportation Center – The creation of a below-grade intermodal center beneath Clinton Street would connect future service corridors such as the Clinton Subway and Transitway with existing assets such as CUS and Ogilvie Transportation Center, and is discussed in Section 4.3.

Clinton Subway – In the West Loop, the Clinton Street Subway will generally be located beneath Clinton Street, with potential stations located at Congress Parkway and Monroe Street. The Monroe Street station would be part of the multi-level West Loop Transportation Center.

South Branch Riverfront – In the West Loop, portions of the continuous Riverwalk exist at street level, but additional sections must be completed.

Kennedy Corridor Enhancements – Multi-phased I-90/94 Kennedy Corridor enhancements are proposed along the east-west corridors that connect the West Loop to the Near West subdistricts. Improvements include pedestrian safety and comfort features on the east/west road segments that cross the Expressway and the addition of trees and landscape features along the ramp infrastructure.

Kennedy Corridor Cap – The creation of a major public park over the Kennedy Expressway is proposed for the area between Monroe and Washington Streets. This cap would provide much-needed green space to serve office and adjacent residential development and would provide improved linkage between the West Loop and Near West subdistricts.

Pedestrian Bridge over River – A dedicated pedestrian bridge connecting the West Loop to the Central Loop (over the Chicago River) would ease pedestrian congestion on the streets.

Expand Water Taxi Service – While the West Loop is currently well served by water taxi service, improvements in coverage and service levels are required to keep pace with employment growth.

Source: City of Chicago, 2009.

Figure 26: Central Area Action Plan

Near West Projects

The Near West subdistrict (immediately west of the West Loop subdistrict) is a high-growth area within the central area. Development has consisted primarily of residential construction in mid-rise buildings and conversion of loft buildings. The Skybridge project is the first high-rise structure west of the Kennedy Expressway. A mix of commercial and residential projects is being proposed for the area close to Halsted Street. It is anticipated that taller buildings will be proposed for the subdistrict along the Kennedy Expressway. Taller buildings may also be appropriate on sites along the Eisenhower Expressway on the southern edge of the district and in the heart of the subdistrict as far west as Morgan Street, where a new CTA Green Line station is proposed. Proposed projects from the CAAP include:

CTA Infill Station (Morgan - Green/Pink Line) – An infill station on the elevated Green/Pink Line along Lake Street would improve transit access to and from the Near West, where stations are currently spaced more than one mile apart.

Bicycle Lanes and Markings – A new bicycle lane is planned for Halsted Street and will complement the existing bicycle lanes along Washington Street and Jackson Boulevard.

Kennedy Corridor – The area along the Kennedy Expressway from Van Buren Street to Lake Street was studied in order to identify opportunities for pedestrian and vehicular mobility improvements, development considerations for expressway-adjacent parcels and potentials for park development. Urban design recommendations for this corridor include the following:

- Pedestrian safety and comfort enhancements are recommended for the sidewalks along the bridges that span the expressway. Sidewalk widths can be expanded utilizing a cantilever system on existing piers. An expanded sidewalk would provide space for planters with trees or other landscape material to serve as a buffer between pedestrians and automobiles;
- Pedestrian crossing of ramp intersections is a key safety concern. Improvements in crosswalk striping and utilization of an audible warning system are potential features warranting further study;
- Landscape enhancements have been installed in several areas along the expressway, particularly at access ramp locations. This program should be continued and expanded;
- Regarding development, a rational massing strategy is identified that would provide visual continuity to expressway-adjacent parcels. Recommendations include utilization of parking decks to establish regulating lines along the corridor and step-backs in building mass to frame the corridor.

Central Loop Projects

The Central Loop is the heart of downtown Chicago and the engine that drives development in the adjacent subdistricts. By virtue of its location immediately east of the West Loop area, it is a key component to development around the proposed HSR station. Proposed projects in the Central Loop identified in the CAAP include:

CTA Station Modernization – The station modernization program has improved numerous aged stations in the Central Loop. Additional subway and elevated stations in the Central Loop are planned for improvements under this program:

- Madison/Monroe (Red)
- Washington/Dearborn (Blue)
- Washington/Wabash (Loop “L”)
- State/Lake (Loop “L”)
- Monroe/Dearborn (Blue)
- LaSalle/Congress (Blue)

- A new Washington/Wabash station is envisioned to replace the two existing elevated Loop stations at Randolph Street and Madison Street. If possible, funding for both elevated and subway station upgrades should be accelerated.

East Randolph Streetscape – A comprehensive streetscape program is needed to enhance the visual character of Randolph Street east of Michigan Avenue. Enhancement recommendations include establishment of wider sidewalks, new street lighting, landscape and wayfinding signage (particularly connecting the Loop to Millennium and Grant Parks).

Congress Parkway Streetscape – The streetscape project on Congress Parkway (currently being designed) will improve the pedestrian environment in the important east-west thoroughfare along the south edge of the Central Loop. Congress Parkway connects Grant Park, a concentration of universities, new residential developments in the vicinity and Metra's LaSalle Street Station. Streetscape elements include trees, planted medians, new lighting fixtures, improved crosswalks and specialized light displays.

Wacker Drive Reconstruction – The reconstruction of the north-south segment of Wacker Drive south of Lake Street would improve traffic operations, pedestrian amenities and aesthetics in an active office development corridor. This project would continue the work completed along the east-west section of Wacker Drive, which added amenities along the Chicago Riverfront.

Bicycle Lanes and Markings – New bicycle lanes are planned for Washington and Madison Streets to complement the existing bicycle lane along Upper Randolph Street near Millennium Park.

Lighting Enhancements – Michigan Avenue should receive top priority for streetscape and lighting enhancement funds and serve as the location for a pilot lighting enhancement project. Additional lighting enhancement projects should follow for key Central Loop corridors including Randolph Street, Congress Parkway, Wacker Drive and LaSalle Street.

Main Branch and South Branch Riverfront – Riverwalk improvements are envisioned to include a permanent public market, under-bridge connections at Michigan Avenue and Lake Shore Drive, several on-street connections, a dock-level riverwalk, green space and a vertical connection near Van Buren Street.

Grant Park and Central Station Railscape – Railscape improvements from Grant Park south to Museum Park would enhance the visual character of the area and create new park space near Roosevelt Road.

Lakefront Transitway – The Lakefront Transitway would use an existing, improved right-of-way traveling north-south through Grant Park. This transit service would provide a connection to McCormick Place on the south and the Carroll Avenue Transitway on the north. In the Central Loop, the service would provide stops at major streets and connect with the East-West Transitway at Monroe Street.

Pedestrian Connection at Queen's Landing – Pedestrian mobility between Buckingham Fountain and the Lake will be restored. An at-grade street crossing is preferred, although a more expensive alternative could be the construction of a grade-separated underpass at this location.

Grant Park Improvements N**orth** – While the exact scope of this project has not yet been determined, the project will generally include reconstruction of the obsolete Monroe Street Garage and other public amenities associated with the garage structure. Open spaces and park facilities potentially affected by this project include Daley Bicentennial Plaza/Fieldhouse, Cancer Survivors Garden and "Peanut Park."

Central Loop Development

The CAAP includes the following discussion of past and future development in the Central Loop:

Trends, 2000-2007

- The Central Loop added 7.2 million square feet to its office inventory between 2000 and 2007, with an additional 3 million square feet under construction and planned. Wacker Drive solidified its position as a premier office address, with additions including the Hyatt Center, UBS Tower, 151 North Wacker, 191 North Wacker and 111 South Wacker.
- Millennium Park was completed in 2004 and has had a stimulating impact on the residential and hotel development sectors. While the Central Loop contained about 6.7 percent of central area

households in 2000, virtually all resided in the portion of the Central Loop east of Michigan Avenue. The number of households doubled from 4,455 in 2000 to 9,091 in 2007. The Heritage and Legacy developments (356 and 355 units, respectively) led the new construction growth sparked by Millennium Park.

- With Millennium Park drawing over 3.5 million visitors annually, the Central Loop captured roughly 3 percent of new hotel development activity in the central area between 2000 and 2007, including two major adaptive-use projects: the 385-room Hard Rock Hotel and the 128-room Hampton Inn at the renovated Bank of America Theater.
- Development on North State Street included student housing for the School of the Art Institute of Chicago, new retail space and the Gene Siskel Film Center. The Theater District expanded with the addition of the new Goodman Theater, the Joffrey Center at State and Randolph and the renovation of the former Schubert Theater, now the Bank of America Theater. The State Street Corridor attracted new retailers and saw the return of the Sears department store at State and Madison Streets.

Forecast, 2008-2020

- Ten Central Loop sites identified as vacant or underutilized would support nearly 9 million square feet of new office space. With the expansion of the Federal Campus onto State Street, another 1.5 million square feet will be added and both public and private-sector employment will increase.
- The upcoming completion of 108 North State (Block 37) with 400,000 square feet of retail, restaurant and entertainment, along with the re-tenanting of the historic Carson Pirie Scott building, will boost State Street retail.
- The Wit Hotel at State and Lake Streets is currently under construction, and several other hotel projects are planned or proposed for the Central Loop, including adaptive re-use projects in vintage properties on South LaSalle Street. The Children’s Museum proposes to relocate from Navy Pier to a site at the north end of Grant Park and the Art Institute is expanding with a new 265,000 square-foot wing, adding attractions adjacent to Millennium Park.
- Several new residential towers were completed or are in development in the 28-acre, 4,950-unit Lakeshore East planned development. A new public park, public school and on-site retail center are also among the existing and planned amenities.
- While new residential buildings are under construction or planned, additions to the supply will slow until economic recovery occurs.

2020 Vision/Goals

- The Central Loop is the economic center of the central area, the City and the entire metropolitan region. To continue to thrive, it requires a dense, walkable office core that is well served by a reliable, high-capacity transit system that prioritizes use of public transportation.
- Newer office development would be concentrated along Wacker Drive with most of the competitive inventory located west of Dearborn Street.
- LaSalle Street will continue to function as a prime corridor for financial services, and its vintage buildings would provide opportunities for renovation and adaptive-reuse developments.
- A merged Chicago Board of Trade (CBOT) and Chicago Mercantile Exchange (CME) would be headquartered at LaSalle Street and Jackson Boulevard and would encourage reinvestment along Jackson Boulevard and Van Buren Street in the southern portion of the Central Loop.
- Residential development would continue, as older buildings are recycled, infill sites are identified and Lakeshore East completes its build out. Access to and views of Millennium and Grant Parks would be amenities drawing developers and residents.

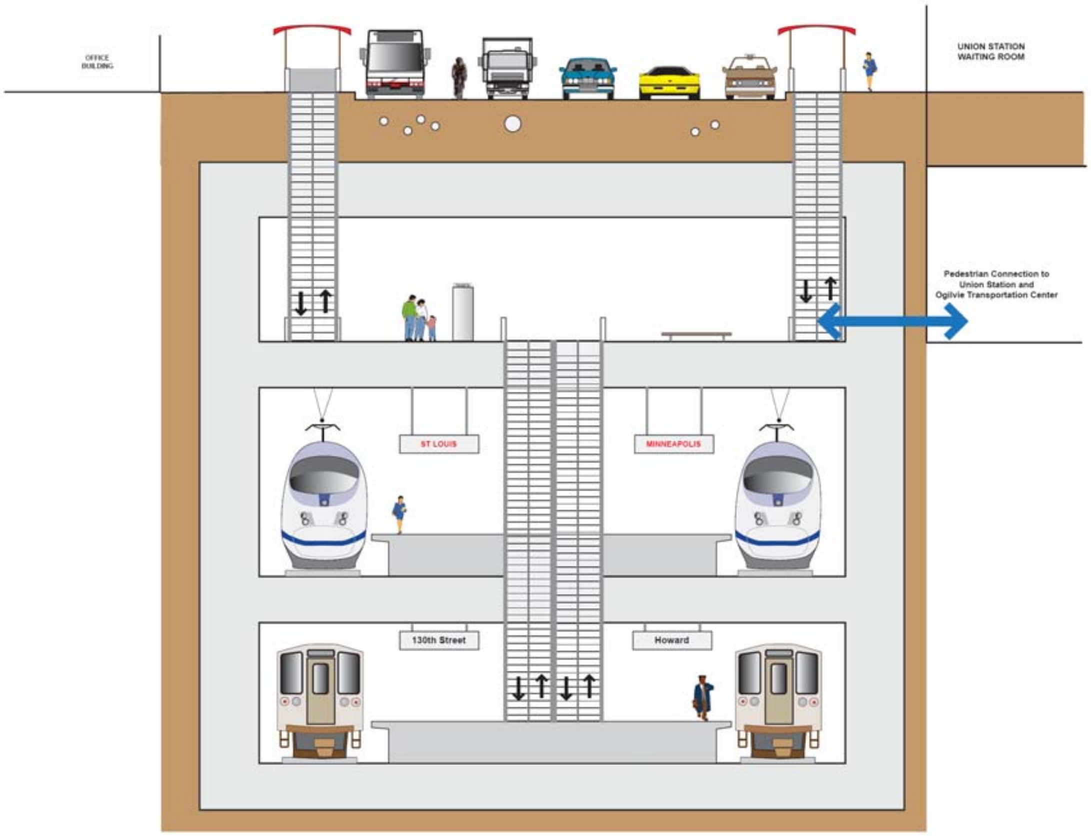
- Higher-education institutions would continue to add students, facilities and programs that build upon an already strong presence in the Central Loop.
- The three-block section of Michigan Avenue from Randolph Street to the Chicago River has little identity, despite its important role as a connection between the vibrant Magnificent Mile and Millennium Park. The City should give further considerations to recent recommendations for invigorating this vital link from a technical assistance panel of the Urban Land Institute.

Even with the multitude of projects identified above in and around the study area of the proposed downtown Chicago HSR station, it is recommended that more redevelopment would be achieved with a singular big idea. The interventions described in the current plan can be considered business as usual, and should be accomplished regardless of HSR. As in the case of Los Angeles, this area should be developed as the next great place, a postcard image for a new generation, as significant as that of the Burnham Plan and the recent expansion of the City at the southern end of Grant Park and the convention center.

4.3 West Loop Transportation Center

Locating the long-term hub for HSR at a new station adjacent to CUS or reconfiguring CUS itself will address the capacity issues present at the existing terminal while taking advantage of all of the West Loop planned improvements described above. Currently, no detailed planning or design has been accomplished for the West Loop Transportation Center. A rendering is presented in the CAAP, which shows the facility as a multi-level, underground station along Clinton Street. For this study, a conceptual cross-sectional diagram was developed, shown in Figure 27.

The CAAP rendering had HSR at the lowest level of the transportation center, but Figure 27 shows the HSR platform above the subway. This arrangement is recommended because the proposed Red Line subway branch would need to pass beneath the river both to the north and south of the Clinton Street subway alignment and HSR trackage would essentially be built alongside the Milwaukee District trackage to the north and as a new level over the St. Charles Air Line branch to the south. Therefore, it would make sense for the HSR trackage to be built above the subway line. Though the CAAP rendering showed an underground level for buses, the City is also reconsidering whether it would be worth the expense of moving buses below grade for more flexibility in route planning. It would be desirable to provide an all-weather underground pedestrian connection north-south along Clinton Street to allow access to Ogilvie, CUS, the future HSR and the Red Line branch. If developed, potential additional platforms south of CUS could serve expanded Metra and Midwest regional rail services.



Source: AECOM, 2011.

Figure 27: West Loop Transportation Center

5.0 System Facilities

The HSR network would require central support facilities. A central control center would typically be developed near the heart of the system where connections to communication links for all elements would be provided and where trained staff would be available to monitor and manage operations.

Maintenance functions would most likely be divided between a Heavy Maintenance Facility (HMF) capable of performing the most demanding, time-consuming and costly repairs and refurbishment, and overnight vehicle storage areas where light maintenance could be performed. In general, it would be desirable to have the HMF situated near the heart of the system to minimize average access distance and time. On the other hand, overnight storage and light maintenance would be desirably located at/or within a few miles of terminal stations. With Chicago as the central point in the Midwest network, it is likely that a site for the HMF would be located within the metropolitan area, potentially on the south or southwest side where large industrial tracts are found. Land use constraints near the downtown hub would mean that overnight storage and light maintenance would be provided within the metropolitan area as well, either near the O'Hare West Terminal station (if sufficient land could be identified) or on the south or southwest side. By way of comparison, the HMF for the proposed California HSR system is anticipated to require a site of approximately 150 acres, which would support maintenance for a fleet of several hundred cars. California is also identifying overnight storage and light maintenance sites of approximately

75 acres, located within three miles of terminal stations to minimize deadheading. While the selection of sites for system facilities will take reduction of non-revenue operations into consideration, this is ultimately a land use decision.

5.1 Heavy Maintenance Facility (HMF)

The HMF would include a vehicle storage area to accommodate trainsets coming in for maintenance, as well as parking serviced units. Additionally, if the HMF is located near a terminal station it could also support overnight storage and routine servicing, as well as putting out equipment for daily use (refer to Section 5.2 for a description of overnight storage and light maintenance). The principal elements in the HMF would include:

- Storage tracks
- Enclosed inspection tracks
- Exterior train washing machines
- Automated wheel inspection machine
- Wheel truing/re-profiling machine(s)
- Heavy duty interior cleaning platform(s)
- Toilet servicing system
- Inspection "pit" tracks
- Traction power inspection
- Sanding system replenishment
- Inspection/maintenance crew support facilities
- Operation crew support facilities
- Yard traffic control tower
- Layup/storage tracks
- Detailed bogie inspection/maintenance facility
- Train exterior workshop facility
- Electric components inspection/maintenance facility
- Heavy machinery
- Machining tool facility

The HMF requires specialty shops for specific equipment components, and inspection and maintenance activities, including:

- Bogey Shop – Disassembly and assembly of bogies to provide detailed inspections and rehabilitation of components, including wheel sets and bogey frames;
- Vehicle Assembly Shop – Disassembly and assembly of the major mechanical and electrical components of the trainsets, where a full range of tests and diagnostics after re-assembly are performed. This shop includes overhead cranes and heavy lifting equipment to facilitate vehicle disassembly and assembly;
- Body Shop – Maintenance and treatment of car bodies, including exterior painting and extensive cleaning and maintenance on certain large components that are attached to the vehicle body;
- Electrical Shop – Detailed maintenance and reconditioning for electrical and computer components, such as transformers, motors, compressors and diagnostic hardware;
- Pneumatic/Brake Shop – Maintenance and tests on the braking and shock-absorbing components on the vehicles;
- Comfort Shop – Maintenance of sanitary, comfort and interior components of the vehicles, such as seats, restrooms and HVAC units;

- Warehouse – Efficient organization, storage and distribution of parts, modules and components of trainsets and heavy machinery used for specialized tasks.

Specific site-selection criteria for the HMF would include:

- Centrally located to the overall system;
- Property configuration that allows access to the mainline from both ends of the maintenance yard;
- Access to major utilities, including ~34.5kV electrical service;
- Roadway access for movement of goods by truck and for employees and visitors;
- Presence of suitable labor market to support functions based at that location.

The HMF would not necessarily be publicly-owned, but could be outsourced and operated by private rail service suppliers/manufacturers.

5.2 Overnight Storage and Light Maintenance

The configuration, capacity and length of the tracks in the layup/storage area of the facility are based primarily on the number of trainsets identified in the operating plan that are required for morning start-up of daily service at each terminal. Minimum length of tracks are assumed to conform with a "standard" trainset (400 meters) plus seven to eight percent (an additional 15 meters for 200-meter and 30 meters for 400-meter trainsets, respectively) to provide a safety "buffer" on either end of a parked train, and to accommodate access between the trains for maintenance personnel. A walkway between yard tracks is necessary to provide access to trains for operating crews, and cleaning, inspection and maintenance personnel. The walkways should be three to four meters wide, sufficient to:

- Allow crews to access trains safely;
- Allow maintenance employees to efficiently transport tools and maintenance and repair materials;
- Allow cleaning, inspection and maintenance employees to work safely on the trains;
- Provide access to trains for commissary servicing (restocking food and beverages, etc.)
- Allow clearance for an electric cart-type vehicle to use the toilet servicing system.

5.3 Midwest High-Speed Rail Storage and Maintenance Options

For a Midwest HSR network centered around Chicago, one option would be to provide an overnight storage and light maintenance facility (approximately 75 acres in size), ideally within three miles of the terminal station, with an outlying HMF of 100 acres or more in size located further out along one of the two lines radiating to the south and east. Alternatively, a site of 150 acres or more could be provided for a large, consolidated maintenance facility, with smaller satellite yards for overnight storage closer to the terminal station(s).

Within a three-mile radius of the Loop there are few large parcels that are undeveloped or currently in marginal use, especially along the candidate HSR routes. (There is one potential site of about 20 acres located adjacent to the Metra Western Avenue Yard near West Chicago Avenue and North Sacramento Boulevard, which is within three miles of downtown). However, in the event most trains are terminated at O'Hare West, it is possible that land for train storage could be found in the O'Hare vicinity. There are more opportunities for assembling large sites on the south side in the industrial lands between Calumet Park and East Chicago/Gary. Another alternative would be to provide a non-revenue connection to a storage yard elsewhere in the West side.

5.4 Fleet Size

A preliminary estimate was made of the required number of HSR vehicles. The estimate is shown in Table 3 and is based on the following assumptions:

- Departures from terminal stations would occur daily between 4:00 AM and 10:00 PM;
- Trains would run every half hour in peak periods (6 to 9 AM and 4 to 7 PM), and every hour at other times, on all routes throughout the day;
- Each end-to-end trip includes a 30-minute recovery and servicing period;
- At least 10 percent added to fleet requirement for spares;
- Corridor seat capacity is based on the Viaggio SpeedComfort USA Premium Train for 150-mph service, and the Velaro Train for 220-mph service:
  - For an eight-car train, seat capacity of 534 (Viaggio) and 510 (Velaro);
  - For a 10-car train, seat capacity of 702 (Viaggio) and 670 (Velaro);
- Trains would split/join in Toledo, serving Toledo-Detroit and Toledo-Cleveland with four or five-car trains, respectively.

Table 3: Fleet Size Estimate

Corridor	**Trainsets Required** By Speed Regime		**Cars Required** By Trainset Length And Speed Regime				**Maximum Corridor Seat Capacity** By Trainset Length And Speed Regime			
			8	**10**	**8**	**10**	**8**	**10**	**8**	**10**
	150-mph	**220-mph**	**150-mph**		**220-mph**		**150-mph**		**220-mph**	
CHICAGO – MINNEAPOLIS/ST. PAUL	19	15	152	190	120	150	10,100	13,300	7,600	10,000
CHICAGO – ST. LOUIS	15	11	120	150	88	110	8,000	10,500	5,600	7,400
CHICAGO – CINCINNATI	14	11	112	140	88	110	7,500	9.800	5,600	7,400
CHICAGO – DETROIT/CLEVELAND	15	13	120	150	104	130	8,000	10,500	6,600	8,700

Source: AECOM, 2010.

6.0 Operations and Travel Time

The implementation of HSR would represent a dramatic improvement over travel on existing rail service, and under various scenarios rail travel would become increasingly reasonable alternative to driving and highly complementary to long-haul and international air service by providing a feeder service for the O'Hare airport. Table 4 presents principal cities in each of the four corridors, along with the distance and station-to-station travel times from Chicago under four speed regimes:

- Current scheduled Amtrak service, which typically has delays built into the schedule
- Improvements proposed by the MWRRI, enabling 110-mph top speeds
- 150-mph maximum speed – comparable to the fastest U.S. rail service currently in operation
- 220-mph maximum speed – true HSR, as implemented in Europe and Asia

While Table 4 presents station-to-station travel times, the door-to-door travel times in Table 5 are more appropriate for comparing rail travel times to other modes. Reviewing door-to-door times facilitates comparisons with the auto mode, which typically does not have a time component for accessing the rail station or airport, or for processing time at the rail station or airport.

The door-to-door travel times shown in Table 5 were estimated based on a typical trip from a location within the Central Business District (CBD) of the originating city to a location within the CBD of the destination city. Since airports are outside the CBD, the time to travel between trip origin and the airport was assumed to be 30 minutes. One hour was assumed to be the typical time spent in the airport prior to departure, allowing for security screening and boarding the airplane. Time in the airport on arrival was assumed to be 30 minutes, which included time to disembark from the airplane, walk through the terminal and obtain ground transportation. Travel time from the airport to the final destination was assumed to be 30 minutes. In all, for the air mode, the travel time while not on-board the airplane totals 2 hours and 30 minutes.

For the rail mode, the time to travel between the origin and the train stations was assumed to be 15 minutes, since train stations are typically located in the CBD. The time in the rail station prior to departure was assumed to be 10 minutes, which allowed for reaching the platform and boarding the train. Time in the station on arrival was assumed to be 5 minutes for disembarking the train and walking through the station. Travel time from the train station to the final destination was assumed to be 15 minutes. In all, for the rail mode, the travel time while not on-board the train totals 45 minutes.

The door-to-door travel time comparison produces fairly consistent results for all city pairs. Usually, the auto mode is faster than the current Amtrak schedule, however, by upgrading rail service to top speeds of 110-mph rail becomes equivalent. Rail operating at top speeds of 150-mph achieves parity to air, and is sometimes a little faster. Rail with top speeds of 220-mph is consistently faster than the air mode, typically by 30 to 60 minutes.

HSR service must match the frequency of hourly air shuttles and approach the on-demand convenience of auto travel to provide an effective alternative to both short-haul Midwest regional air flight and auto travel. Hourly service throughout the day with half-hourly service during peak periods (roughly 6:00 to 9:00 A.M. and 4:00 to 7:00 P.M.) is recommended, for a total of 25 daily departures on each major route. This service frequency is necessary to meet the needs of business and connecting air travel; for example, if a meeting goes longer than expected, the average wait time for a return train during peak periods would be only fifteen minutes. The frequent schedule would provide the utmost flexibility and minimized waiting times, allowing travelers to “show up and go,” provided unreserved seats are available on the next train.

The potential for HSR to reduce travel times and “shrink” the distances between cities is illustrated in Figure 28. The travel time by automobile (based on Google Maps) is shown in the left diagram and by HSR (with a top speed of 220-mph) in the right diagram, holding the travel time scale constant. The resulting comparison shows that the Midwest’s largest metropolitan areas – now separated by a drive of several hours – would all lie within a few hours of Chicago via HSR.

Table 4: Rail Travel Times Under Four Speed Regimes

Corridor[1]	Miles from Chicago[2]	Travel time from Chicago[3] (hours:minutes)			
		Amtrak Schedule	110-mph[4]	150-mph	220-mph
CHICAGO – MINNEAPOLIS / ST. PAUL					
Milwaukee	85	1:29	1:08	0:50	0:40
Madison	156	3:20	2:28	1:20	1:05
La Crosse	291	4:59	4:18	2:25	1:45
Rochester	358	—	—	2:55	2:05
St. Paul	430	8:05	6:29	3:30	2:30
Minneapolis	442	8:05	—	3:45	2:45
CHICAGO – ST. LOUIS					
Champaign	128	2:10	1:58	1:05	0:45
Decatur	176	—	—	1:30	1:00
Springfield	214	3:24	2:44	1:55	1:20
St. Louis	311	5:20	4:10	2:40	1:55
CHICAGO – CINCINNATI					
Lafayette	115	3:13	1:46	1:00	0:45
Indianapolis	178	4:10	2:55	1:30	1:10
Cincinnati	284	8:10	4:27	2:30	1:55
CHICAGO – DETROIT / CLEVELAND					
Fort Wayne	149	—	1:53	1:05	0:55
Toledo	253	3:59	3:18	1:55	1:25
Detroit	312	5:36	4:24	2:25	1:55
Cleveland	361	6:24	4:48	2:50	2:15

Notes: [1] Secondary HSR stations within each metropolitan area are not listed (e.g. O'Hare West)
[2] Mileage based on 150-mph / 220-mph corridor routing
[3] Reflecting typical rail operations, under which top speeds are reached along only portions of the route
[4] Based on non-express service and greatest level of improvement documented in *Midwest Regional Rail Initiative Project Notebook*, June 2004

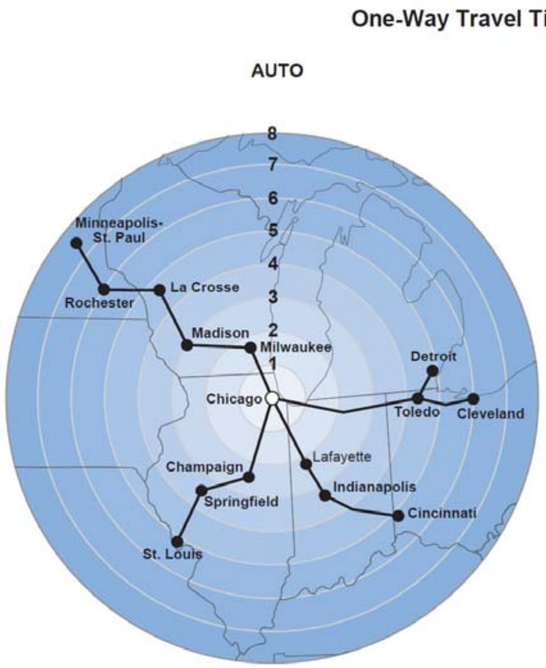
Sources: Amtrak schedule effective May 10, 2010; AECOM 2011.

Table 5: Total Door-to-Door Trip Travel Times by Mode (hours:minutes)

Corridor	Air	Auto	Rail			
			Current Service	110-mph	150-mph	220-mph
CHICAGO - MINNEAPOLIS/ST. PAUL						
St. Paul	3:55	7:27	8:50	7:14	4:15	3:15
Minneapolis	3:55	7:39	8:50	—	4:30	3:30
CHICAGO – ST. LOUIS	3:40	5:09	6:05	4:55	3:25	2:40
CHICAGO – CINCINNATI	3:44	5:10	8:55	5:12	3:15	2:40
CHICAGO – DETROIT	3:46	4:50	6:21	5:09	3:10	2:40
CHICAGO – CLEVELAND	3:47	6:03	7:09	5:33	3:35	3:00

Sources: US Airways website accessed 8/11/10, Google Maps accessed 8/11/10, Amtrak schedule effective May 10, 2010; AECOM 2011.

Note: For rail mode, total additional time not on-board train is assumed to be 45 minutes



Source: Google Maps, AECOM, 2010.

Figure 28: Midwest Region Major Destinations - Automobile/High-Speed Rail Travel Times
(Hours from Chicago)

7.0 Ridership

Ridership estimates for proposed HSR service in the four corridors were developed using a high-level sketch planning approach based on existing data. The sketch-level tools developed for this analysis were based on travel demand models applied by AECOM for high-speed and intercity rail studies in a number of states including Ohio, North Carolina and Virginia.

The major analysis data inputs and assumptions include:

- Current Travel Volumes
  - Existing auto trips in the corridors were estimated using the Inter-Regional Trip Model and developed by The Volpe Center
  - Existing air trips in the corridors were estimated using the U.S. DOT/Bureau of Transportation Statistics (BTS) 10-percent sample of tickets sold by U.S. carriers DB1B database
  - Existing Amtrak rail ridership in the corridors is available through Amtrak's website, at the corridor-level only
  - Only travel between metropolitan areas was considered, intra-metropolitan area travel was not incorporated
- Estimate of Future Travel Volumes
  - Future travel volumes were estimated based on current travel volumes and the forecasted growth of population, employment and income as provided by Moody's Economy.com

- Current Travel Service Characteristics
    - Highway travel times, distances and costs per mile were estimated using the Oak Ridge Network national GIS database and standard transportation planning software
    - Air travel times, fares and frequency were estimated from the U.S. DOT/BTS T-100 database
    - Amtrak rail times, frequencies and fares were obtained from the Amtrak website
- Calibration and Analysis Framework
    - The sketch planning tool was calibrated to reflect current air and Amtrak rail activity in the four corridors, and incorporates all aspects of intercity travel, by mode, including: on-board time, access/egress time, frequency and cost/fare
    - Since the approach is applied at the metropolitan area level, service characteristics are generalized to represent the population of the entire metropolitan area; a more sophisticated approach would allow the model to be applied at a finer geographic detail
    - Traveler sensitivities to travel time (on-board and access), cost/fare and frequency, are based on travel demand models developed for nationwide high-speed and intercity rail studies, including recently for Ohio, North Carolina and Virginia
- Proposed HSR Operating Plan Assumptions
    - 2030 Forecast Year
    - In each corridor, trains were assumed to depart from each end of the corridor every half hour during peak periods, and hourly at other times, for a total of 25 daily round trips
    - All corridors include a stop at O'Hare; which means that trains from St. Louis, Cincinnati, Detroit and Cleveland would stop in Downtown Chicago and continue to O'Hare before ending their run
    - The analysis does not include any trains through-routed through Chicago (such as a Minneapolis/St. Paul to St. Louis train)
    - Travelers making connections between corridors in Chicago are not accounted for in the forecasts (such as a traveler from Milwaukee to Cincinnati changing trains in Chicago)
    - The analysis assumes Coach Class only
    - HSR fares are 75 to 100 percent higher than the existing Amtrak fares in the corridors, consistent with prior HSR studies conducted in the Midwest
- Intra-Metropolitan Trips
    - Since the sketch-planning framework is applied at the metropolitan area to/from metropolitan area level, trips beginning and ending within one metropolitan area are not estimated or included in the results
    - Metropolitan areas with multiple proposed high-speed stations and the potential for intra-metropolitan trips include: Chicago, Milwaukee, Minneapolis/St. Paul and Cleveland
    - Typically intercity and HSR services are not priced to encourage local trips; especially in Chicago, the local transit network may be a more attractive alternative for most local travelers
    - HSR service would be expected to serve some local Chicago (and other local metropolitan area) travelers, especially to/from O'Hare; an estimate of the magnitude of this impact would require an analysis of detailed local O-D travel and commuting patterns

- Intercity Bus
    - Since existing intercity bus travel volume data and service data is difficult to obtain, intercity bus travelers were not included in the analysis framework
    - Intercity bus travelers generally have low sensitivity to travel time and high sensitivity to cost, two characteristics that make current intercity bus travelers less likely to divert to HSR
    - A small portion of intercity bus travelers would likely divert to the proposed HSR service, though the magnitude would be expected to represent a small percentage (less than two percent) of the total HSR ridership
- Air Connect Market
    - A number of Midwest air passengers connect through O'Hare or Midway en route to final destinations; these travelers were not represented in the analysis, but they represent another potential HSR market
    - According to the DOT/BTS T-100 and DB1B databases, in 2009 about 7 million air travelers in the study area connected through Chicago en route to their ultimate destination
    - Potential coordination between airlines and rail operators could facilitate efficiencies in the transportation system by substituting short-haul flights to airport hubs with HSR service. Airlines and passenger rail operators in Europe currently apply this strategy. Increasing ridership on the HSR network provides airlines with additional capacity for more efficient and profitable long-haul flights.
- Summary of Results and Comparison to MWRRI Plan
    - Table 6 summarizes the ridership and revenue forecasts by each corridor in comparison with the forecasts presented in the 2004 MWRRI Plan
    - MWRRI revenues are in 2002 dollars (vs. 2010 dollars in current study), and the MWRRI Minneapolis/St. Paul corridor also includes service to Green Bay
    - In general, the 150-mph ridership forecasts are more than twice the MWRRI forecasts, as a result of 35 to 50 percent travel time improvements and adding 3-5 times more daily frequencies than the proposed MWRRI service.

Table 6: Ridership Forecast Summary

	Annual Riders	Annual Revenue	Travel Time	Daily Roundtrips
CHICAGO – MINNEAPOLIS / ST. PAUL				
110 mph (MWRRI)	4,362,404	$158,030,000	6:29	6
150 mph	12,537,000	$634,220,000	3:30	25
220 mph	15,884,000	$842,150,000	2:30	25
CHICAGO – ST. LOUIS				
110 mph (MWRRI)	1,757,123	$65,760,000	4:27	8
150 mph	5,999,000	$249,090,000	2:40	25
220 mph	7,904,000	$336,750,000	1:55	25
CHICAGO – CINCINNATI				
110 mph (MWRRI)	894,669	$55,420,000	4:08	5
150 mph	5,877,000	$285,660,000	2:30	25
220 mph	7,226,000	$374,280,000	1:55	25
CHICAGO – DETROIT / CLEVELAND				
110 mph (MWRRI)	4,795,048	$179,360,000	4:24 / 4:48	9
150 mph	10,661,000	$561,770,000	2:25 / 2:50	25
220 mph	12,650,000	$685,190,000	1:55 / 2:15	25
TOTALS				
110 mph (MWRRI)	11,809,244	$458,570,000	–	28
150 mph	35,074,000	$1,730,740,000	–	100
220 mph	43,664,000	$2,238,370,000	–	100

Notes: Current project forecast year: 2030; revenue in 2010 dollars
MWRRI forecast year: 2025; revenue in 2002 dollars
MWRRI reported Michigan and Cleveland corridors separately; results combined above
MWRRI Minneapolis / St. Paul corridor also includes Green Bay
MWRRI total only represents ridership forecast in the four corridors
Sources: *Midwest Regional Rail Initiative Project Notebook*, June 2004; AECOM 2011.

A 220-mph HSR network in the Midwest has the potential to attract over 43 million annual riders, generating more than $2.2 billion in revenue. By comparison, the 110-mph MWRRI network was estimated to attract nearly 12 million passengers in the four study corridors. A 150-mph network would attract 35 million riders.

Table 6 summarizes the 2025 ridership forecasted by the MWRRI for each of the four candidate corridors, as well as new estimates for 150-mph and 220-mph services in 2030. The expected annual revenue for each corridor, and under each scenario, is also presented. With implementation of 220-mph service, the Chicago to Minneapolis/St. Paul corridor would be expected to have the greatest ridership at nearly 16 million; followed by the Detroit/Cleveland corridor with over 12 million and the St. Louis and Cincinnati corridors would each attract between 7 and 8 million riders annually. The same order would be expected given 150-mph service. The MWRRI forecasts proportionately higher ridership in the Detroit / Cleveland and St. Louis corridors, but this reflects an expanded level of service to these cities.

8.0 Economic Impacts and Other Benefits

8.1 Economic Impacts

8.1.1 Types of Economic Impact

Economic impacts associated with development of the HSR system and supporting infrastructure are attributable to the expected ridership shown in Table 6 for the four line HSR system serving the Chicago metropolitan area. For 220-mph service, approximately 21.2 million out of the 43.7 million total (one-way) riders are involved in a trip to or from Chicago. For 150-mph service, 16.7 million of the 35.0 annual (one-way) estimated riders are Chicago-based. These Chicago-based estimates are shown in Table 7, as are the diversions from automobile, existing Amtrak and intercity air travel. New trips – those that are made because the HSR services have been introduced, but were not made before – are also included.

Table 7: 2030 Ridership Estimates for Chicago-Based High-Speed Rail Travel

Chicago-Based Trips	150-mph Service			220-mph Service		
		Percentage			Percentage	
		Trip Type	*Of Total*		*Trip Type*	*Of Total*
Diverted from Auto						
Business	3,182,000	81.7%	19.1%	4,220,000	81.1%	19.9%
Non-Business	10,746,000	84.1%	64.5%	13,539,000	84.4%	63.7%
Total	13,928,000		**83.6%**	17,759,000		**83.6%**
Diverted from Existing Amtrak						
Business	85,000	2.2%	0.5%	69,000	1.3%	0.3%
Non-Business	993,000	7.8%	6.0%	943,000	5.9%	4.4%
Total	1,078,000		**6.5%**	1,012,000		**4.8%**
Diverted from Air						
Business	331,000	8.5%	2.0%	445,000	8.5%	2.1%
Non-Business	148,000	1.2%	0.9%	184,000	1.1%	0.9%
Total	479,000		**2.9%**	629,000		**3.0%**
New/Induced						
Business	296,000	7.6%	1.8%	471,000	9.0%	2.2%
Non-Business	889,000	7.0%	5.3%	1,370,000	8.5%	6.4%
Total	1,185,000		**7.1%**	1,841,000		**8.7%**
Total						
Business	3,894,000		23.4%	5,205,000		24.5%
Non-Business	12,776,000		76.6%	16,036,000		75.5%
Total	16,670,000		**100.0%**	21,241,000		**100.0%**

Source: AECOM HSR Ridership Projections, 2011.

Economic impact analysis accounts for the ways that travel time savings for both diverted and new/induced trips affect both travel costs and decisions associated with the purchase of goods and services. These decisions affect overall regional spending and business sales (output). The additional spending (by both businesses and households) attributable to this increased output and the income and jobs generated by this spending all contribute to the economic impact of HSR on the Chicago regional economy.

The approach to estimating economic impacts accounts for the dynamic effects generated through household and business responses to transportation cost and market size changes, indirect effects due to inter-industry supplier-buyer linkages, and induced effects generated by the recirculation of wages and secondary purchases by businesses that supply goods and services to shippers into the local economy. Table 8 presents the total economic impacts for the Chicago metropolitan area, which includes the economic multiplier effects, as well as direct effects.

Table 8: Estimated Annual High-Speed Rail Economic Impacts for 2030 Chicago Metropolitan Area

		Scenario	
Impact Category	**Units**	**150-mph Service**	**220-mph Service**
Employment	*jobs*	58,050	103,610
Output	*$ (millions)*	$ 7,590	$ 13,770
Value Added	*$ (millions)*	$ 4,290	$ 7,820
Income	*$ (millions)*	$ 2,990	$ 5,480

Source: EDR Group, Inc. TREDIS model analysis, 2011.

Depending on the scenario, the estimated economic impact potential as of 2030 ranges from $7.6 to $13.8 billion/year of additional business sales for the 150-mph service and the 220-mph service, respectively. These values include $4.3 to $7.8 billion/year of value added (as measured using the regional equivalent of GDP). Of that value added, roughly $3.0 to $5.5 billion/year is worker wages, associated with 58,050 to 103,610 jobs. The impact will grow over time, so it is expected to be less than these levels in years before 2030, and potentially more than these levels in later years. It is also important to note that these different impact measures cannot be added because they are all alternative ways of measuring the same effects of economic growth.

The calculation of long-term economic impact from multi-modal transportation improvements was analyzed using a package called TREDIS® (Transportation Economic Development Impact System) for the entire eight-county Chicago metropolitan area economy. This economic impact modeling system is designed specifically for multi-modal transportation scenarios. The system is comprised of a set of modules. One module translates changes in travel times, costs, reliability and safety into household income and business productivity changes. A second module translates changes in labor market access and intermodal connectivity into business productivity and growth changes. A third module applies a time series, multi-regional economic model to calculate longer-term impacts on growth of jobs, income and business activity. While this analysis system has been applied in numerous states across the country, the version applied for this study was built upon a model of the Chicago metropolitan area economy, its specific economic characteristics and ways in which different Chicago metropolitan area industries depend on transportation for workers, materials and product deliveries.

Introduction of HSR service will significantly improve the competitiveness of Chicago and the entire metropolitan region – improvements attributable primarily to the reduced time needed to travel between the Chicago metropolitan area and major metropolitan areas throughout the Midwest (see Table 5). These services will expand visitor and tourism markets, provide greater business access to labor markets and induce travel by visitors who would not normally travel to the region in general and the downtown/suburban station areas in particular. These economic impacts result from traveler time/cost savings over prior mode choices, labor market access benefits to Chicago's employers including future business clusters and development areas, and visitor (spending) activity related to both induced riders, as well as diverted riders into downtown from airport arrivals or auto arrivals – each of which are described in Table 7.

The ability of HSR services to expand labor markets and business travel opportunities also enables it to support the local growth of the financial services, insurance, technical services and technology industry firms in downtown business districts and other office centers served either directly or indirectly by the proposed METRA connections. As shown in Table 7, it is expected that nearly 90 percent of the HSR trips on these new systems will be switching from automobile or air travel (putting more travelers downtown) while around 7.6 to 9.0 percent will be entirely new trips that would not otherwise be made to the Chicago region. TREDIS provides the detail to assess the impacts on each of these sectors, and they are accounted for in the detailed breakdown of the sources of economic impacts shown in Table 9.

Table 9: Sources of Economic Impact (by 2030)

		Scenario					
		150-mph Service			220-mph Service		
Impact Category	**Units**	**Travel Time Savings**	**New Visitors**	**Improved Market Access**	**Travel Time Savings**	**New Visitors**	**Improved Market Access**
Employment	*jobs*	20,990	7,530	29,530	27,040	11,410	65,160
percent of total employment		*36.2%*	*13.0%*	*50.9%*	*26.1%*	*11.0%*	*62.9%*
Output	*($ millions)*	$ 2,640	$ 750	$ 4,200	$ 3,390	$ 1,130	$ 9,240
percent of total output		*34.8%*	*9.9%*	*55.3%*	*24.6%*	*8.2%*	*67.1%*
Value Added	*($ millions)*	$ 1,460	$ 410	$ 2,420	$ 1,880	$ 620	$ 5,320
percent of total value added		*34.0%*	*9.6%*	*56.4%*	*24.0%*	*7.9%*	*68.0%*
Income	*($ millions)*	$ 990	$ 270	$ 1,730	$ 1,270	$ 420	$ 3,800
percent of total income		*33.1%*	*9.0%*	*57.9%*	*23.2%*	*7.7%*	*69.3%*

Source: EDR Group, Inc. TREDIS model analysis, 2011.

8.1.2 Travel Time Savings

HSR service will have broad regional impacts on travel time/cost savings for train riders, as well as time/cost savings due to congestion reduction for those still flying, riding buses or driving cars and trucks. The full range of economic impacts associated with these effects is shown in Table 9 as travel time savings. The effects of travel time savings on employment, output, value added and income are shown for both 150-mph service and 220-mph service. Percentages are shown relative to the total for each category provided in Table 8. Thus, the increase in employment (27,040 new jobs) attributable to the effects of travel time savings for the 220-mph service represents 26.1 percent of the total 103,610 jobs generated by implementing this service.

8.1.3 Improved Market Access

The ability of HSR services to expand labor markets and business travel opportunities also enables it to support the growth of key professional service, finance and insurance industries in downtown Chicago and to link each of the major Midwestern metropolitan areas in the HSR network to important research, development and technology service industries in other office centers throughout the metropolitan region. These impacts also lead to further indirect growth at suppliers to the growth businesses and induced growth supported by the additional consumer spending of worker wages. The increase in employment (65,160 new jobs) attributable to the effects of improved market access for the 220-mph service represents 62.9 percent of the total 103,610 jobs generated.

High-speed trains can extend the effective labor market for the Chicago region by enabling more daily travel from distant cities in Indiana, Wisconsin and central Illinois. One of the important aspects of these linkages is that the centers of innovative research and development for high-technology, medical, bio-technical and power/energy technology innovation – including linkages to operations and management of major existing and evolving centers of manufacturing – will be served by the proposed HSR system. The ability to be within three hours of downtown Chicago, or one of several metropolitan centers linked by

HSR and transit systems, from as far away as Minneapolis, Detroit or Cincinnati produces significant competitive advantages for both the Chicago metropolitan area and those metropolitan areas that are linked to it by the HSR system.

Reverse travel (from the Chicago metropolitan area to other major Midwestern metropolitan areas) would also be enabled, so the net effect would be a productivity improvement for businesses that can better tap into specialized worker skills and a wider pool of contractors and vendors. Chicago-area industries involved in medical technologies, food packaging and computer and control equipment all stand to gain from the wider market access for specialized workers and consultants. The proposed HSR network can also support establishment of new connections and strengthening of existing connections between universities and R&D centers in the Chicago area and those located in outlying metropolitan areas including Champaign/Urbana, Ill., and Madison, Wis. The network will also serve student travel markets, depending on how prices are set.

Considering the structure of key sectors in the Chicago metropolitan area's economy that depend on and are most likely to capitalize on labor market access improvements, office business attraction enabled by HSR is estimated between 8,925 and 18,530 net additional jobs in downtown and areas surrounding the three anticipated Metra station areas (see Table 10). As shown in Table 10, by 2030 between 30 percent and 28 percent of all market access effects will have located in the downtown and Metra station areas (under the 150 mph and 220 mph scenarios, respectively).

Experience in other regions of the U.S. and in Europe has shown that as downtown and more densely developed areas reach capacity, a greater proportion of future employment growth is likely to be absorbed at the outlying areas. This effect is shown in the scenarios evaluated for this study, in that as design speeds increase from 150 mph to 220 mph, a slightly lower percentage (1.8 percent) of market access-driven development will be attracted to the downtown and suburban METRA stations under the 220-mph service. Given the land availability and development densities likely to be supported by the three suburban METRA stations evaluated for this study, a higher share of employment-oriented development is likely to locate in these areas given their potential capacity to absorb this increased demand. Clearly, a host of land use, development and connectivity issues will have to be considered. One of the major factors will likely be related to both the HSR and other connections provided between downtown Chicago and O'Hare airport. A number of these design factors, including experience on other countries, is discussed below (see Section 12).

Table 10: Station Area Development Employment Effects

	Scenario	
	150-mph Service	**220-mph Service**
Market Access - Total	**29,530**	**65,160**
Station Area Development	**8,925**	**18,530**
percent of total employment	*30.22%*	*28.44%*
Downtown Chicago Development	**4,725**	**10,730**
percent of Station Area Development	*52.94%*	*57.91%*
percent of market access effect	*16.00%*	*16.47%*
Suburban METRA Development	**4,200**	**7,800**
percent of Station Area Development	*47.06%*	*42.09%*
percent of market access effect	*14.22%*	*11.97%*

Source: EDR Group, Inc. TREDIS model analysis, 2011.

8.1.4 Visitor Travel Market

According to the Chicago Convention and Visitor's Bureau, 44 million visitors come to the Chicago area each year. This includes 12 million who come for convention and business purposes, and 35 million who come for tourism and cultural attractions. International visitors account for over 13 percent of all visitor spending in the region4. Table 9 demonstrates the expected impacts of both the 150 and 220-mph service on new visitors to the region. This includes new visitors attracted for both business conventions and visitor/leisure travel (both recreational and cultural). As with travel time and market access effects, visitor spending leads to further indirect growth at suppliers to the growth businesses and induced growth supported by the additional consumer spending of worker wages. The visitor base generates opportunities for economic growth associated with three distinct travel markets:

- Intercity Travel Market - One factor that will be especially important for broadening the base for HSR in Chicago is the potential for high-speed train services to integrate regional travel with national and international travel at O'Hare This direct connection would enable HSR trains to become regional feeder and distributor services for longer distance air travel.
- Tourism Market - It is expected that over 75 percent of the added HSR trips would be leisure trips (see Table 7). Since 2004 when Chicago unveiled its most recent tourism venue, Millennium Park, the City and its downtown area have experienced an increase in tourism in a city replete with cultural and professional sports offerings. Day-trip shopping excursions within a two-hour perimeter would also be facilitated (particularly for visitors from Wisconsin, Iowa and Indiana). Surveys indicate that leisure travelers spend an average of $139 per day in the Chicago area (including both overnight and day trips).
- Business Travel Market - The business segment travel growth (assumed to be between 23 - 25 percent of the induced trips) focuses on connecting to the City/region's concentrations in financial services, professional business services, manufacturing and medical research. In addition, Chicago's role as a regional trade center will be reinforced. Proposals for high-speed trains also call for supplemental transit services connecting O'Hare to both CUS and McCormick Place. These services can potentially improve the access attraction for convention booking. Surveys indicate that business visitors spend an average of $489 per trip in the Chicago area.

These trips include the following market segments:

- Day Trips – Residents of outlying cities and smaller communities who travel to Chicago for business meetings or for sports and cultural attractions and events in Chicago
- Airport Connecting Trips – Visitors who fly into O'Hare and Midway from around the nation and the world and then ride HSR to their regional destinations; these may include both business and leisure trips
- Overnight Trips Via Rail – Visitors ride the high-speed train into Chicago from out-of-state areas for business or leisure trips

For the 150 to 220-mph services envisioned in this study, visitor spending enabled by HSR will directly support between 4,410 and 5,990 additional jobs region-wide (see Table 11). The expanded new/induced travel is estimated to generate roughly $107.3 to 157.8 million/year of entirely new spending in the region (created by trips that would otherwise not occur)[5], and another $122.5 to $156.3 million/year will be redirected into downtown Chicago and the areas served by the connecting Metra station areas. This

[4] Chicago Visitor Profile, Shifflet & Associates for the Chicago Convention & Tourism Bureau, 2009.
[5] These figures are consistent with the most recent St. Louis to Chicago study that assumed up to six and one-half percent of all forecast ridership is induced new travel.

diverted spending would have occurred elsewhere in the region if the travelers had driven or flown into the Chicago region and avoided downtown or the Metra station areas. Based on the proposed HSR service levels, overall visitor-related spending is expected to range between $229.8 and $314.1 million by 2030.

Table 11: Visitor Spending Effects by 2030 (in millions)

	Scenario	
	150-mph Service	**220-mph Service**
Direct Employment	4,410	5,990
percent of New Visitor Jobs	*58.57%*	*52.50%*
New Visitor Spending	$107.3	$157.8
percent of Total Visitor Spending	*44.50%*	*47.00%*
Diverted/Rerouted Visitor Spending	$122.5	$156.3
percent of Total Visitor Spending	*55.50%*	*53.00%*
Total Visitor Spending	$229.8	$314.1

Source: EDR Group, Inc. TREDIS model analysis, 2011.

8.2 Other Benefits

Aside from speed, HSR service has a number of other attributes that make it attractive to the traveling public and a strong contributor to the overall transportation system. HSR systems are exceptionally reliable. Trains run when scheduled and delays are unusual. Unlike air and auto modes that can be subject to weather delays, high-speed trains operate reliably in all weather conditions. Congestion is not a problem, since the trains run on their own tracks. This means that travel times are predictable via rail, where auto or air travel is frequently subject to unexpected delays. As a result, rail travelers can plan their trips by the schedule, confident that they do not need to include extra time.

The short-term economic impacts of construction and the region-wide economic consequences of supplying materials, equipment and labor to operate, maintain and supply equipment (rail cars, signalization, and long-term maintenance of the tracks and right-of-way) have not been included in this analysis. Phasing of construction, the amount of materials, labor and equipment to be supplied over time, and the specific operating requirements of each HSR corridor need to be better determined before these kinds of assessments can be completed. However, each of these effects and the benefits that they will bring to households (through increased employment opportunities) and businesses (through increased sales) will add significantly to the overall economic benefits provided by constructing the proposed HSR systems.

Once the rail system is installed, capacity can be increased by adding cars to specific trains or by adding more frequent train departures. Though this study has assumed half-hourly headways during peak periods, high-speed trains can operate at closer intervals to provide additional capacity or to accommodate long-term ridership growth. Of course, to maintain higher capacities over a longer period, vehicles will need to be added to the fleet, but expansion would not necessarily require any change to the tracks or stations.

Passengers are able to walk around at any time and have room to work on board the train. This is a significant benefit for business travelers, and changes their perception on the time spent traveling as well as their productivity while traveling. Instead of being wasted time, travel can be a productive part of the business traveler’s day.

HSR benefits non-users as well. Since it is electrically powered, it has the potential to be carbon neutral, depending on the ultimate electricity source. Compared to freeways and airports, HSR fits into a relatively small footprint, and can be integrated into dense urban areas without disrupting walkability. HSR stations are nodes that encourage compact, high-density development, which make more efficient use of infrastructure and energy.

9.0 Preliminary Planning Level Capital Cost Estimate

A preliminary, planning-level capital cost estimate has been assembled to suggest an order-of-magnitude capital cost for a 220-mph HSR system. This estimate was then used to derive an order-of-magnitude cost estimate for a 150-mph HSR system. The route descriptions provided in this study are highly conceptual in nature; should a formal planning and project development process be initiated, the NEPA process will require preparation of an Alternatives Analysis evaluating a wide range of options for modes, routes, stations and configuration. Therefore, the scope of the project is subject to change. Additionally, as Advanced Conceptual Engineering and Preliminary Engineering studies are prepared, more substantial detail and more comprehensive descriptions of the project elements would be established along with a commensurate capital cost estimate suitable for system programming and implementation.

9.1 Typical Unit Costs

The corridor-level cost estimates developed in this study incorporate unit costs for typical major elements as summarized in Table 12. Various sources were used, including prior U.S. HSR and electrified rail planning studies prepared by AECOM, the Chicago-St. Louis study prepared by the MHSRA (October 2009), the San Francisco Bay Area Regional Rail Plan by the Metropolitan Transportation Commission (September, 2007) and recent cost studies by the California High-Speed Rail Authority, which incorporate the most current domestic pricing for HSR.

Not included in the unit costs or summary cost are a HMF or light maintenance/storage facilities proximate to terminal locations, as the size of such facilities would be dependent upon the vehicle fleet and service plan and the locations would be subject to the actual system configuration. Likewise, a specific figure for a central control center has not been provided, although the cost of signaling is included in the system cost.

The system-wide cost includes a very preliminary number for the HSR element of a West Loop Transportation Center (based upon recent estimates for underground central district stations in San Francisco).

9.2 Summary of Planning Level Cost Estimates

Table 13 through Table 17 present the system-wide cost summary and corridor-by-corridor breakouts of cost. The system-wide cost is lower than the sum of the individual corridor costs due to shared track sections approaching downtown Chicago.

As shown, the approximate total cost of the entire system (excepting system facilities noted in Section 5.0) is estimated at $83.6 billion, in 2010 dollars. The corridor costs are largely driven by the lengths of the corridors; however, on a per-mile basis, the routes from Chicago to the Twin Cities and to Detroit/Cleveland would have the highest per-mile cost, and the routes from Chicago to St. Louis and Chicago to Cincinnati are tied with the lowest per-mile cost.

Table 12: Typical Unit Costs

Item	Unit Cost ($ Million 2010)	Units
Civil Construction - Trackway		
At Grade Trackbed (low fill)	$2.80	Route Mi
At Grade Trackbed (high fill)	$3.30	Route Mi
Retained Fill	$16.00	Route Mi
Low-Aerial Structure	$46.00	Route Mi
High-Aerial Structure	$68.00	Route Mi
Retained Cut	$85.00	Route Mi
Cut and Cover Subway	$190.00	Route Mi
Subway	$250.00	Route Mi
Structures		
Medium Span HSR Bridge	$25.00	Ea
Long Span HSR Bridge	$40.00	Ea
Highway Overpass (short)	$3.50	Ea
Highway Overpass (long)	$6.00	Ea
Highway Underpass	$12.00	Ea
Utilities	$1.25	Route Mi
Stations		
At-Grade	$15.00	Ea
Aerial	$40.00	Ea
Below Grade	$60.00	Ea
Subway Box	$300.00	Ea
Trackwork		
New Trackwork	$4.00	Route Mi
Single Track	$2.00	Route Mi
Replace/Upgrade Existing	$2.00	Route Mi
Systems	$7.50	Route Mi
Right of Way		
Urban or Parallel to Existing	$6.00	Route Mi
Purchased Railroad	$4.00	Route Mi
Rural or unencumbered suburban	$1.25	Route Mi

Source: Prior studies by AECOM, CHSRA and Transystems, 2010.

Table 13: Systemwide Cost Summary (220-mph)

	Miles	Project Cost ($ Million 2010)
Chicago to Minneapolis/St. Paul	455	$28,643
Chicago to St. Louis [1)]	311	$15,861
Chicago to Cincinnati [2)]	284	$14,182
Chicago to Detroit/Cleveland [2)]	420	$26,488
Chicago West Loop HSR Station	n/a	$466
SYSTEM COST [3)]	1,457	$83,572

Notes:

1) Includes route overlap from West Loop to Grand Crossing

2) Includes route overlap from West Loop to Gary

3) Excludes route overlap

Source: AECOM, 2010.

Table 14: Corridor Cost - Chicago to Minneapolis/St. Paul (220-mph)

455 Route Miles Item	Unit Cost ($ Million 2010)
Civil and Structures	
Embankment	$41
At-Grade	$1,651
Retained Fill	$56
Structures	$411
Aerial	$7,986
Tunnel	$1,067
Stations (9)	$280
Trackwork	$1,790
Systems [1]	$4,001
Subtotal: Infrastructure	$17,283
Right-of-Way Allowance	$1,167
Subtotal: Preliminary Estimated Construction Cost	$18,450
Project Development Soft Cost (15%) [2]	$2,767
Planning Level Contingency (35%)	$7,426
Preliminary Planning Level Total Cost	$28,643

Notes:
1) Includes overhead catenary, traction power, signaling and communications and miscellaneous systems
2) Allowance for planning and environmental, preliminary and final design, construction management and program/agency cost

Source: AECOM, 2010.

Table 15: Corridor Cost - Chicago to St. Louis (220-mph)

311 Route Miles **Item**	**Unit Cost** ($ Million 2010)
Civil and Structures	
Embankment	$132
At-Grade	$1,074
Retained Fill	$56
Structures	$240
Aerial	$3,521
Tunnel	$480
Stations (7)	$205
Trackwork	$1,213
Systems [1]	$2,761
Subtotal: Infrastructure	$9,681
Right-of-Way Allowance	$535
Subtotal: Preliminary Estimated Construction Cost	$10,217
Project Development Soft Cost (15%) [2]	$1,532
Planning Level Contingency (35%)	$4,112
Preliminary Planning Level Total Cost	$15,861

Notes:
1) Includes overhead catenary, traction power, signaling and communications and miscellaneous systems
2) Allowance for planning and environmental, preliminary and final design, construction management and program/agency cost

Source: AECOM, 2010.

Table 16: Corridor Cost - Chicago to Cincinnati (220-mph)

284 Route Miles Item	Unit Cost ($ Million 2010)
Civil and Structures	
Embankment	$52
At-Grade	$1,164
Retained Fill	$0
Structures	$292
Aerial	$3,115
Tunnel	$165
Stations (6)	$165
Trackwork	$1,116
Systems [1]	$2,492
Subtotal: Infrastructure	$8,560
Right-of-Way Allowance	$575
Subtotal: Preliminary Estimated Construction Cost	$9,135
Project Development Soft Cost (15%) [2]	$1,370
Planning Level Contingency (35%)	$3,677
Preliminary Planning Level Total Cost	$14,182

Notes:
1) Includes overhead catenary, traction power, signaling and communications and miscellaneous systems
2) Allowance for planning and environmental, preliminary and final design, construction management and program/agency cost

Source: AECOM, 2010.

Table 17: Corridor Cost - Chicago to Detroit/Cleveland (220-mph)

Item (420 Route Miles)	Unit Cost ($ Million 2010)
Civil and Structures	
Embankment	$28
At-Grade	$2,206
Retained Fill	$83
Structures	$552
Aerial	$7,746
Tunnel	$165
Stations (7)	$170
Trackwork	$1,659
Systems [1]	$3,686
Subtotal: Infrastructure	$16,296
Right-of-Way Allowance	$766
Subtotal: Preliminary Estimated Construction Cost	$17,062
Project Development Soft Cost (15%) [2]	$2,559
Planning Level Contingency (35%)	$6,867
Preliminary Planning Level Total Cost	$26,488

Notes:
1) Includes overhead catenary, traction power, signaling and communications and miscellaneous systems
2) Allowance for planning and environmental, preliminary and final design, construction management and program/agency cost

Source: AECOM, 2010.

9.3 Cost for 150-mph System

Compared to a HSR network accommodating 220-mph service, a system supporting services only to a level of 150-mph would require an investment similar in magnitude. New trackway and structures along nearly the entire network would still be required to support 150-mph speeds, but specific reductions in cost which may be achievable for a lower-speed HSR network could be potentially realized in the following areas:

- Less stringent alignment criteria, especially for curves may allow lower-cost routings to be achieved in selected sections (especially at constrained locations);
- Although the Overhead Catenary System (OCS) cost would be similar, some savings could be achieved in the Traction Power Substation (TPSS) network due to substantially lower current draw requirements;
- Although the weight and general design of the track/fastener/tie/ballast system would be similar, some savings could be achieved due to the need for somewhat reduced requirements for maintaining track tolerance between maintenance operations.

With these discounts considered, $75 billion (2010 dollars) in capital costs are estimated for a 150-mph network, amounting to a 10 percent decrease from a 220-mph system. Costs by corridor are included in Table 18.

On the other hand, the Operations and Maintenance (O&M) cost for a 150-mph network would be substantially lower than the O&M cost for a 220-mph network. Therefore on an annualized cost basis, a 150-mph system may provide a more cost-effective solution depending upon other factors. It is suggested that the following discriminators be considered in deciding between 150-mph and 220-mph:

- Travel Time Savings – 220-mph network or segment may not result in substantial reductions in travel time (in absolute time or percentage);
- Desired Station Spacing – If stations are spaced closer than 50 miles apart, 220-mph service would operate at the maximum effective operating speed for limited periods of time between stops;
- Alignment Constraints – 220-mph curves are approximately five miles in radius vs. two miles in radius for 150-mph. In the event tight curves are required, the segment may not effectively support 220-mph operation;
- O&M Cost – As noted previously, track maintenance, energy consumption, and servicing vehicle costs may be compelling factors if travel time and ridership are not substantially higher with 220-mph operation.

Constructing a 150 mph system would cost nearly as much as a 220 mph system. New trackway and structures along nearly the entire network would be required to support either 220- or 150-mph speeds, but less stringent alignment criteria, lower traction power demand and reduced track design requirements would allow some cost reductions to be realized for the 150-mph system. With these discounts considered, $75 billion (2010 dollars) in capital costs are estimated for a 150-mph network. The marginally higher costs for a 220 mph network (11.9%) would be offset by significantly higher ridership (24.5%) and even greater annual revenues (29.3%).

It should be reiterated that development of a HSR network will produce significant new revenues and jobs – each of which will permanently contribute to the tax base of communities in which they live and work.

The proposed 220-mph HSR system will produce $13.8 billion in new business sales every year and 104,000 permanent new jobs when it is in full operation. Over the 30-year operating life of the initial system investments, the total value of business sales and wages derived from the new jobs will be the equivalent of $295.9 billion in sales and $117.9 billion in wages. These new jobs and business opportunities will support and enhance the Chicago metropolitan area's global competitiveness and help Chicagoland maintain its preeminence as a global center of business, finance, technology and education.

Table 18: Capital Cost Comparison Summary

Corridor	HSR – 150 / 220-mph		
	Miles	Project Cost $-Billions (2010)	
		150-mph	220-mph
CHICAGO – MINNEAPOLIS / ST. PAUL	442	25.7	28.6
CHICAGO – ST. LOUIS[1]	311	14.1	15.9
CHICAGO – CINCINNATI[2]	284	12.6	14.2
CHICAGO – DETROIT CHICAGO – CLEVELAND	420	23.8	26.5
CHICAGO TERMINAL STATION	–	0.450	0.475
SYSTEM TOTALS[3]	1,430	74.7	83.6

Notes:
1 Figures include route overlap from West Loop to Grand Crossing
2 Figures include route overlap from West Loop to Gary
3 Totals exclude route overlap
Source: AECOM 2011.

10.0 Phasing

The MWRRI plan to develop a system of 110-mph emerging HSR corridors radiating from Chicago throughout the Midwest region would be developed by making strategic improvements to selected corridors, which have the capacity to absorb passenger traffic at speeds above the current 79 mph limit established by the FRA and freight operators.

This system would result in substantial increases in passenger service levels – more than 300 percent at CUS – and would make intercity rail competitive with the automobile for numerous trips between Midwest city centers. However, it may be difficult to support passenger operations at higher frequencies than envisioned by the MWRRI plan using trackage shared with freight due to the larger schedule windows required for passenger service, which operates at nearly twice the speed of fast freights. Beyond 110 mph, the speed differential between passenger and freight trains becomes greater and shared operations on the same tracks are more difficult to accommodate, though developments in signaling, train control and protection technology are facilitating such operations to a greater degree. Therefore, dedicated passenger tracks may be required to serve, for example, hourly passenger service even at 110 mph.

Increasing the speed of passenger operation to 150 mph would require elimination of all grade crossings, as well as modifications to current FRA safety regulations if freight traffic were to remain on these lines. In addition, the FRA now requires PTC on services operating at speeds greater than 110 mph. Even if regulations were changed and freight trains were equipped with PTC safely accommodating mixed traffic, the large difference in speed between passenger and freight trains would make it difficult to share track. At best, shared operations would be used near terminals where passenger traffic would be operating at reduced speeds and where freight traffic levels would be relatively low. Accordingly, implementation of dedicated passenger trackage along selected segments would be an integral part of a strategy to provide an intercity passenger rail network with higher speeds.

Developments in signaling, train control and protection technology are facilitating shared operations to a greater degree. In North America, PTC is currently in the design phase and will incorporate automatic cab signaling and other systems to monitor and control train movements. A similar system, the ETCS has been implemented in mixed freight/passenger applications in Europe and is designed for short headways. A system that could integrate both PTC and ETCS would be beneficial for the situation in the Midwest, with its high rail traffic densities and mixed freight and passenger operations.

Much of the cost of a higher speed network (especially the high price items such as civil and structural improvements) would be similar regardless of 150 or 220-mph maximum speed. (Of course much larger curves would be required for 220-mph and there may be locations where such curves could not be provided). For these reasons, investments in new passenger track capable of (or upgradable to) 150 or 220-mph operation should be considered for principal intercity corridors outside of urban areas. Within urban areas, new passenger track should be capable of 125-mph operation.

In summary, from the perspective of this study, these would be the key steps to incrementally developing a Midwest HSR system:

Near Term

- Implement improvements to resolve rail/rail bottlenecks within the Chicago metropolitan area
- Implement 79/90/110-mph services identified in the MWRRI
- Resolve track capacity issues affecting access to Chicago Union Station (CUS) and address capacity needs at CUS to accommodate MWRRI traffic levels with anticipated growth in Metra traffic

Intermediate Term

- Determine and plan for additional dedicated HSR trackage capable of up to 125-mph service along identified access routes paralleling Metra lines in the Chicago metropolitan area
- Expand and improve CUS; confirm site location and alignment needed to serve the West Loop Transportation Center along with supportive transportation improvements in the Central Area Plan
- Confirm site location and alignments needed to provide overnight storage and train turnback for Chicago terminating services (such as an O'Hare West station and new storage yard near downtown)
- Identify candidate sites for a central HMF within the Chicago metropolitan area
- Develop dedicated HSR corridors to support 150 to 220-mph service connecting metropolitan areas; prioritize factors such as cost, potential ridership and travel time savings/modal substitution
- Introduce 220-mph equipment along a demonstration corridor

Long Term

- Build out the system by implementing other HSR segments not included in the Intermediate Term Plan
- Upgrade service with the introduction of 220-mph service along other corridors where attainable given alignment constraints and warranted by travel time benefits and modal substitution.

It should be noted that this study draws its findings from a Chicago perspective; commensurate considerations would need to be developed for other principal terminals and metropolitan areas served to deliver a comprehensive Midwest Vision HSR System.

11.0 High-Speed Rail Development Checklist

The findings of this study of a Midwest HSR system centered on Chicago have been the summarized in the following checklist of key considerations to be addressed at the outset of the project development and planning process.

11.1 Which Outlying Metropolitan Areas Will be the Endpoints of HSR Corridors?

The MWRRI plan identified an emerging HSR network, which would connect to the following principal terminals:

- Minneapolis/St. Paul, Minnesota
- St. Louis, Missouri
- Cincinnati, Ohio
- Cleveland, Ohio
- Detroit, Michigan

This network would include other lines operating at 79/90/110-mph, which would add service to other major destinations including Omaha, Kansas City and other points in Wisconsin, Illinois and Michigan. The MWRRI proposal has wide acceptance and many of the states have initiated project development on this network under HSR funding provided by the FRA.

Experience and the results of this study have demonstrated that true HSR (operating at 220-mph) can be competitive “door-to-door” with regional airline service and automobile travel at distances where the travel time is about three to four hours (door-to-door) by train, which for Chicago would provide access to the principal metropolitan areas within an approximate 350-mile radius.

Four corridors centered on Chicago appear appropriate for eventual upgrade to true HSR operating at speeds comparable to existing and proposed services in Europe and Asia. Accordingly, this study has identified a 220-mph “Midwest Vision Network” (as shown in Figure 29) which would connect Chicago to the same principal terminals identified above that would be served in the MWRRI plan. This Midwest Vision Network could be developed by incrementally upgrading selected segments, using the 79/90/110-mph network identified in the MWRRI plan as a service base. Segments of the MWRRI network would be progressively upgraded to 125-mph in urban areas and to 150 to 220-mph between cities. With 79 to 110-mph rail corridors and intercity buses feeding the primary network and serving additional cities outside the four 220-mph corridors, coverage of the Midwest’s urban population would be comprehensive.

Source: AECOM, 2010.

Figure 29: Midwest Region Potential 220-mph High-Speed Rail Lines

The 220-mph Midwest Vision Network would serve the six largest metropolitan areas of the Midwest (Chicago, Detroit, Minneapolis/St. Paul, St. Louis, Cincinnati and Cleveland), providing end-to-end service of less than three hours in each corridor. These metropolitan areas rank among the 26 largest metropolitan areas of the U.S., and a number of large urban areas are also situated at intermediate locations along the four corridors. The primary network of HSR would serve 11 of the 20 largest metropolitan areas within a 350-mile downtown-to-downtown radius of Chicago. Since the corridor endpoints represent the Midwest's largest cities, 80 percent of the combined population of the top 20 metropolitan areas would be served by at least one HSR station. The 220-mph trunk network would reach 15 of the 50 largest metropolitan areas within the 350-mile radius; however, nearly 70 percent of the combined population of these 50 areas would still reside in an urban area served by the network.

11.2 Where Will the Downtown HSR Station be Located?

As stations have become magnets and even driving forces for urban development, their visual impact, the monumental or symbolic nature of their buildings and their iconic architectural design have grown in importance. Political and business leaders expect stations to be visual business cards and join the ranks of the outstanding buildings in their cities, and also to fully and seamlessly integrate with the urban fabric.

The City of Chicago has identified CUS as the transportation hub where both regional and long-distance trains would serve the central area. CUS is located on the opposite (west) side of the Chicago River from the Loop, the City's central business district (see Figure 16). In recent years, office development has progressed west into the West Loop, the area along the eastern bank of the Chicago River, and closer to the station. CUS is the major hub for existing commuter services and the City is planning major new development in the vicinity of the station along with significant improvements to connectivity and access. As noted, a new West Loop HSR station adjacent to CUS may be required, or substantial improvements yet to be identified would need to be provided to CUS. This study focuses on the Chicago hub, illustrating the considerations involved with a downtown HSR station. Locations of HSR stations in other cities have been identified but require further study and analysis.

11.3 How Should Chicago's Existing Rail Terminal be Upgraded to Accommodate HSR?

Though CUS appears from the air to be a through station, it is in reality a back-to-back stub-end terminal with only a single through track. Six Metra lines, three lines entering from the north and three from the south, currently serve CUS. In addition, 16 daily Amtrak long-haul trains to the north and 40 to the west, south and east use CUS. The number of intercity trains is expected to climb significantly based upon the development of the 110-mph emerging high-speed corridors delineated in the MWRRI plan. The combined impact of the MWRRI service expansion along with potential Metra service increases are expected to exceed the capacity of the existing facility; therefore improvements would be needed to accommodate all of the identified increases in service, even without inclusion of true (e.g., 150 - 220-mph) HSR.

There are significant physical and geometric challenges to expanding the capacity of the existing terminal. Amtrak, Metra and the City of Chicago are looking for ways to expand CUS's capacity and/or improve operations. Though HSR requires high-throughput modern loading areas and efficient train operations, which would require new construction; ticketing and waiting functions can be accommodated by adapting and upgrading the existing historic station building.

A promising long-term solution for true HSR would be to implement the West Loop Transportation Center, which was a key project identified in the CAAP adopted by the Chicago Plan Commission on August 20, 2009. Alternatively, the existing CUS complex could be significantly reconfigured to expand track and passenger capacity.

11.4 How Would the Potential for Through Trains be Accommodated in Chicago?

First, it should be noted that a station with platforms along through tracks has a higher capacity than a stub-end terminal, provided trains are turned back from a remote location. Given the high cost of real estate in the central area of Chicago along with significant physical constraints, a through station would minimize the footprint and allow much of the station box to be constructed beneath Clinton Street alongside the existing CUS and Ogilvie Transportation Center. In order to function as the center of a Midwest network, this station would need to be complemented by an overnight storage/light maintenance yard near downtown or at an outlying location such as near O'Hare where trains could be turned back.

Chicago has been the rail crossroads of the U.S. for more than a century. With Chicago positioned strategically near the southern end of Lake Michigan, many of the lines from the east funnel through the metropolitan area and lines to the north, west and south converge here as well. As Chicago is also the largest metropolitan area in the region, it is unlikely that through trains would bypass the central area.

A four-spoke HSR network identified in this study, which would have three lines branching to the south and east and one line heading north to O'Hare and points beyond, would allow for interlining of various trains from the south and east with service to the north stopping at O'Hare, and/or other northern terminals including Milwaukee or Madison, as well as St. Paul and Minneapolis. Detailed ridership forecasting would need to be accomplished to refine the specific lines and frequencies and would be a prerequisite to further development of a 220-mph network.

11.5 What Access Improvements Should be Provided at the HSR Hub?

The CAAP outlines a number of pedestrian, rail transit and fixed guideway improvements to connect the West Loop Transportation Center/CUS with other destinations in downtown Chicago. Starting with these improvements as a guide, the following access improvements have been identified, as shown in Figure 30:

- A vertical transfer to a proposed new north-south CTA subway line under Clinton Street adjacent to CUS; the subway stop would be stacked below the HSR platforms in the West Loop Transportation Center;
- A direct connection to the proposed east-west Transitway, which would connect to Michigan Avenue and a proposed downtown circulator transit system. The circulator would provide a connection to the new East Wacker area north of Millennium Park and the River North district just across the river north of the loop; both of these areas are relatively underserved by existing rail transit;
- An underground pedestrian concourse extending south from the HSR station along Clinton Street that would provide HSR passengers a sheltered walk to the existing CTA rail stations at Congress Parkway and at Lake Street; alternatively, if the new Red Line subway had a transfer station at Clinton Street and Congress Parkway, HSR passengers could make a one-stop subway ride from the West Loop Transportation Center to the Clinton Blue Line station;
- An extension of the underground concourse north to the Ogilvie Transportation Center and the Clinton Green Line “L” station at Lake Street; if the new Red Line had a transfer station at Clinton and Lake Streets, a one-stop subway ride would be an alternative for HSR passengers connecting to the “L”;
- General expansion of fixed route transit service capacity;
- Expansion of water taxi service to the North Loop and East Wacker areas;
- New pedestrian bridges across the Chicago River providing walking access to the loop.

S

ource: City of Chicago, 2009.

Figure 30: Central Area Action Plan

11.6 What Connectivity Should be Provided for HSR Service in the Metropolitan Area?

Well-coordinated intercity feeder service is an essential component of a HSR system to expand its range. The MWRRI plan identified rail services in six corridors, operating at speeds up to 110-mph, which could provide connections to the HSR network at the Chicago hub:

- Chicago – Omaha (79/90-mph)
- Chicago – Quincy (90-mph)
- Chicago – Bloomington/Normal – Springfield (110-mph)
- Chicago – Kalamazoo – Detroit – Pontiac (110-mph)
- Chicago – Port Huron (79/110-mph)
- Chicago – Grand Rapids – Holland (79/110-mph)

A successful HSR network also requires excellent connectivity to the rest of the metropolitan area via the local public transportation system. Fortunately, the Chicago metropolitan area has a robust commuter rail network that would provide feeder service to the HSR system. Connectivity points for HSR were identified to meet the following objectives:

- Connections to Metra at the outer ends of radial routes to minimize out-of-direction travel for access to HSR;
- Connections between Metra and HSR to provide access to key Chicago destinations such as the lakefront and O'Hare;
- HSR stops at locations where transfers between various HSR lines could be accomplished outside of downtown;
- HSR stops at locations where rubber-tired services or other rail transit networks are robust.

The following metropolitan-area HSR stations were identified to meet these objectives, as shown in Figure 31:

West Loop Transportation Center/CUS – Most Metra lines currently serve CUS or the Ogilvie Transportation Center, which place them within walking distance of the proposed West Loop Transportation Center. The addition of the West Loop Transportation Center may reduce the number of trains using CUS, which suggests consideration of relocating the Rock Island District trains to CUS from LaSalle Street Station where they currently terminate. This would consolidate all of the commuter lines in the vicinity of the West Loop Transportation Center, with the exception of the ME and SS lines, which would have other connectivity options at a Hyde Park HSR station described below.

Lake Cook Metra – This would be a joint station with the Milwaukee District North commuter rail line on the Chicago to Minneapolis/St. Paul HSR corridor. HSR passengers originating at stations along the Milwaukee District North Line with destinations north of Lake Cook, such as Milwaukee or Madison, could connect to the HSR service at Lake Cook and avoid an out-of-direction trip into downtown Chicago. The Lake Cook station has a well-developed existing network of bus routes serving residential communities and large employers within about a five-mile radius of the station.

O'Hare – Besides the advantages of linking HSR to international and national air service, a station at O'Hare also provides operational advantages to the rail system. In order to minimize the number of tracks and platforms required to provide an underground HSR station at CUS, trains could be operated through the station to a stop at O'Hare. Although there are very few specifics at this point in time, expansion planning for O'Hare is considering a new West Terminal, which would be linked to the existing terminal complex via an underground connection. Part of the consideration for this new terminal is an in-terminal rail link to downtown and other regional destinations. In addition to providing a direct link to the airport, having a location to park, store and maintain equipment outside of downtown would provide many HSR system benefits. In particular, the ability to park and turn back trains at this location could address the system capacity imbalance created by having one HSR corridor to the north and three corridors extending to the south and east.

Hyde Park (55th, 59th or 63rd Street Metra) – This would be a joint station with the ME and SS lines on the St. Louis, Cincinnati and Detroit/Cleveland HSR corridors. A station at 55th, 59th or 63rd Street would provide passengers originating on one of these commuter lines and destined for points south and east with the opportunity to transfer to HSR service without going into downtown Chicago. This would be especially attractive because the ME and SS trains terminate at Millennium Station on the east side of the Loop. Millennium Station is not served by the CTA rail system and it would be difficult to make connections to a HSR station at the West Loop Transportation Center/CUS. The Hyde Park station would also provide passengers originating on the ME or SS with destinations north and west of Chicago to transfer to a HSR train for a direct trip to the West Loop Transportation Center/CUS and their connecting train. HSR passengers making connections between the St. Louis and Cincinnati corridors and between the St. Louis and Detroit/Cleveland corridors could do so at the Hyde Park station instead of downtown.

Southwest Intermodal – This could be a joint station at Harvey with the ME on the St. Louis HSR corridor, or potentially further south at Homewood. This station would allow passengers originating on the ME with destinations on the St. Louis corridor to avoid out-of-direction travel. The Harvey station has a well-developed existing bus network serving residential communities, hospitals and educational institutions within a 10-mile radius of the station. There is also potential to add "freeway flyer" service to the west on I-80.

Gary Metro Center – This would be a joint station with the SS line on the Cincinnati and Detroit/Cleveland HSR corridors. The Gary HSR station would allow passengers originating on the SS line with destinations on the Cincinnati and Detroit/Cleveland corridors to avoid out-of-direction travel and make their connections outside of downtown Chicago. The Gary Metro Center station is the hub of the Gary Public Transportation Corporation route system, which serves an area within a 10-mile radius of the station.

Source: AECOM (Base map IDOT Illinois Railroad Map, 2006).

Figure 31: High-Speed Rail Routing and Connectivity - Metropolitan Area

11.7 How Can We Make Short-Term Changes to Accommodate HSR?

As previously noted, numerous rail lines converge in Chicago. There are a significant number of locations where at-grade rail/rail crossings result in rail traffic bottlenecks within the metropolitan area. The City of Chicago, working in conjunction with U.S. DOT, the State of Illinois, Metra, Amtrak, and freight railroads is pursuing the CREATE Program, which includes a number of strategic rail/rail grade separations intended to significantly reduce rail conflicts.

At the same time, development of the MWRRI plan for emerging HSR service is expected to increase long distance passenger traffic entering CUS from the south from 40 to 112 trains per day, as well as service from the north from 16 to 34 trains per day. This traffic will compete with future freight and Metra commuter rail traffic with a concentration of increased passenger traffic entering CUS from the south.

As illustrated in Figure 32, one possible solution for southern access to CUS would be to shift passenger traffic converging from the south and east (i.e., lines south to New Orleans via Champaign, southeast to Washington, D.C., via Indianapolis, and lines east to Michigan, Ohio and points beyond) over to the two lakefront tracks paralleling the ME, with a new connection at the Grand Crossing location on the near south side (at East 75th Street/Chicago Skyway). Passenger traffic could potentially be routed to CUS via the east-west St. Charles Air Line segment located between 15th and 16th Streets immediately north of McCormick Place. This shift would essentially result in a passenger-only railroad section (excepting possible nighttime freights for any remaining customers) between CUS and Grand Crossing, which could be upgraded to provide service at speeds of up to 125 mph approaching the downtown hub from the south.

Where the strategy of physical separation of passenger and freight services and consolidation of operations in separate corridors may not be possible, temporal separation of passenger and freight services may still remain an option. Under such schemes, daytime capacity would be reserved for passenger trains, leaving nighttime hours exclusively for freight use.

The MWRRI plan presumes that since the various proposed 110-mph lines radiate from Chicago, with 10 – 20 trains per day on most corridors (excepting 52 trains on the Norfolk Southern lines heading east), additional rail consolidation and reorganization would not be required.

Source: AECOM, 2011.

Figure 32: Integration of 220-mph with 110-mph Service for Chicago Union Station Passenger Traffic Access

11.8 How Will HSR Access to the Downtown Terminal be Accommodated?

Current Amtrak intercity service to Chicago operates over lines shared with varying levels of freight as do some of the Metra commuter services. However, the approach to CUS (especially from the south) includes three Metra lines (BNSF Railway, Heritage Corridor and SouthWest Service) along with Amtrak trains bound for points to the south and east. Under the MWRRI plan, 110-mph emerging HSR service would increase the intercity train count south of CUS from 40 to 112 trains per day, challenging both the capacity of the existing terminal, as well as the approach trackage.

As noted above, creating dedicated passenger trackage along the lakefront could help resolve conflicts with freight service. This strategy could be expanded to include a new dedicated HSR approach (separate from Metra lines), connecting to a future dedicated HSR hub at the West Loop Transportation Center or expanded CUS. The dedicated HSR line would be designed to support 125-mph (express) operation parallel to the ME trunk line to University Park. A dedicated HSR track would also solve the need to bypass more than two dozen Metra stops along the ME corridor. With separate HSR trackage connecting to the West Loop Transportation Center/CUS, the existing at-grade crossing of the St. Charles Air Line trackage and Metra Rock Island tracks east of the Chicago River would be eliminated as well.

12.0 Guidance for Other Cities

Based on this study of Chicago and Midwest HSR, the following guiding principles have been identified for other regions wishing to develop a HSR system. These guiding principles address a range of topics including:

- System planning
- Suitability of existing/abandoned railroad corridors
- Connectivity
- Stations and land use
- Maintenance and storage facilities
- Incremental upgrade strategy for HSR corridors

12.1 System Planning

One of the first choices to be made in establishing a HSR system is determining the desired routes for services. Issues which were identified and considered in this study include:

- **Identification of Terminals and Intermediate Stops** – Linking the largest urban areas with service to the city centers where good connections to transit feeder services can be provided and where some principal destinations are within walking distance is one consideration. Selecting intermediate stations requires balancing the choice to serve additional communities with the need to minimize the number of stops and to keep the stops adequately spaced so trains can operate at the maximum effective operating speed for much of the trip. (However, if a robust service plan is implemented, a mix of express and local trains can be provided). Keeping routes as straight as possible results in faster overall travel times; however in some circumstances, the speed of the service allows for route deviations to serve major intermediate points without unacceptable impact to travel times between terminal locations (e.g., routing from Chicago to Detroit via Fort Wayne to allow access to Toledo and to facilitate service to Cleveland).
- **Determining Speed of Service** – The speed of service should be fast enough to provide competitive travel times with auto and/or air depending upon the market objectives of the system. For example, on the approximate 90-mile reach between Chicago and Milwaukee, 220-mph

service is not required to be competitive; the 110-mph service proposed in the MWRRI plan with a travel time of one hour and eight minutes easily exceeds typical auto travel times of one hour and forty-five minutes to two hours, even without peak period highway congestion. On the other hand, between Chicago and St. Paul, the 110-mph service proposed in the MWRRI plan requires a travel time of six hours and twenty-nine minutes; although this is about an hour faster than driving, it does not offer a reasonable opportunity to provide feeder service for air travel. However, the service identified in this study, which attains 220-mph outside of the Chicago metropolitan area, provides a door-to-door travel time of three hours and thirty minutes, which beats a typical air door-to-door travel time of three hours and fifty-five minutes. The European experience has been that HSR is competitive when rail travel times are four hours or less.

- **Identification of Alignments** – Three distinct alignment types were evaluated in this study: 1) 110-mph emerging HSR on lines shared with freight traffic, 2) 150-mph HSR similar in top speed to the Northeast Corridor service and 3) 220+ (up to 250-mph) true HSR, as developed in Europe and Asia and under development in California.
    - 110-mph Emerging HSR - Where stations are closely spaced, 110-mph service using corridors shared with freight may provide a highly cost-effective solution especially if the cost of track and signal upgrades is moderate. However, unless freight traffic is very limited or can be reduced by shifting some freight trains to alternative routes, it will be difficult to accommodate robust passenger schedules. (extensive Metra commuter rail service using conventional equipment likewise limits the ability to operate 110-mph services on existing commuter lines during peak periods).
    - 150-mph HSR - Operation at this speed requires elimination of all grade crossings, which in turn may require a new rail alignment especially in dense areas where it may not be possible to fully grade separate and/or close all existing road crossings. Therefore, the alignment strategy may be to look for fitting dedicated HSR tracks within a “shared” rail corridor, using an abandoned railroad corridor, following a freeway or developing a new corridor. California experience has shown that providing a double-track at-grade HSR section within an existing typical 100-foot wide railroad corridor is problematic once the required setbacks, maintenance access and physical barriers have been provided. Since full grade separation is required at 150 mph, new HSR tracks can be provided on an elevated structure developed partly within an existing railroad corridor, thereby addressing both the space considerations, as well as separation of HSR from highway and rail traffic. The approximate 10,000-foot radius required to maintain top speed may require the HSR tracks to follow a separate route at locations where an existing alignment is not straight.
    - 220+ --mph HSR - At speeds of 220 mph and higher, very long radius curves are required (e.g., more than a five-mile radius at 250 mph). With such radius requirements it is impractical to closely follow, let alone stay within most existing railroad or freeway corridors. As a result, following an existing transportation corridor necessarily involves following straight sections where available and providing sweeping bends to re-orient back to a tangent section further along. The candidate routings identified in this study therefore follow existing or abandoned railroad corridors only where they are very straight. In practice it was not possible to identify sections between stations that met the curve criteria end-to-end, and some speed-restricted curves were assumed. As a general design principle, every effort was made to maintain a 150-mph minimum speed, which was feasible except where the alignment was constrained by urban development (generally within existing metropolitan areas). At these locations, trains would not necessarily be expected to operate at top speed due to other factors such as noise and vibration.

- Frequency of Service/Clockface Scheduling - A minimum of hourly service all day long with 30-minute headways during peak periods is recommended in each corridor to provide door-to-door travel times that are reasonable substitutes for air service (flights are available at this level of frequency between Chicago and the endpoint cities) and with auto (which is available on demand). A train each hour is necessary to meet the needs of the business traveler; for example, if a meeting goes longer than expected, the average wait time for a return train would be one half hour, given hourly service. Such a system will also support the possibility of combining HSR service with scheduled international/long-haul air service by providing feeder services, thereby simultaneously serving the short-haul air markets and freeing gate capacity at O'Hare. If train schedules are less frequent or irregular, passengers are tied to the schedule, limiting travel flexibility and introducing inordinate waiting times. Where feasible, schedules should incorporate "clockface" departures (e.g., on the hour, half hour, or 15 / 45 minutes after the hour) from key destinations to maximize passenger convenience.

12.2 Suitability of Existing/Abandoned Railroad Corridors

Existing and/or abandoned railroad corridors may or may not be suitable for HSR, and land acquisition and/or easement costs would typically be involved. As described previously, shared track/110-mph corridors where freight traffic levels are low (e.g., less than a dozen trains per day) may support moderate levels of emerging HSR service with relatively low investment. As previously noted, ETCS or a similar system may be beneficial by allowing HSR to be implemented on shared corridors with low traffic levels. For true HSR operating at 150 to 220+-mph, full grade separation is required so the benefit of existing corridors is primarily use of the right-of-way. HSR on an elevated structure can fit within a typical 100-foot wide active rail right-of-way provided the alignment is straight. Even if there are no active standard rail tracks (or if the right-of-way is surplus or abandoned) the requirement for full grade separation means that the HSR alignment will generally be on an embankment or aerial structure; outside of urban areas, a low embankment in conjunction with frontage roads and simple highway overpasses can be used to develop an at-grade HSR section. Conversely, in urban areas with frequent required road crossings, a higher retained earth embankment or aerial structure is usually required. A key issue regarding suitability of existing corridors is the nature of the adjacent land uses. In the event the existing rail right-of-way passes through cities within an industrial zone, HSR could potentially operate close to the maximum effective operating speed. The presence of adjacent residential uses or other uses sensitive to noise and vibration may result in operation at reduced speeds or providing an alternative route or bypass around such areas.

In this study, consideration was given to following interstate highways where existing rail corridors and abandoned rail corridors were found to have incompatible adjacent land use. At some candidate locations, abandoned rail corridors have been redeveloped for recreational use and also pass through residential zones, making the right-of-way generally unsuitable for HSR.

12.3 Regional Connectivity

Well-coordinated regional rail and bus feeder service is an essential component of a HSR system to expand its range. Feeder service allows passengers to access HSR and reach their final destination via public transportation. The following six MWRRI corridors would provide connections to the HSR network at the Chicago hub, as shown in Figure 33:

- Chicago – Omaha (79/90-mph)
- Chicago – Quincy (90-mph)
- Chicago – Springfield (110-mph via Bloomington/Normal)
- Chicago – Kalamazoo – Detroit – Pontiac (110-mph)

- Chicago – Port Huron (79/110-mph)
- Chicago – Grand Rapids – Holland (79/110-mph)

Four other MWRRI corridors would provide connections to HSR at stations outside Chicago:

- Milwaukee – Green Bay (110-mph)
- Madison –- Eau Claire – St. Paul
- Champaign – Carbondale (90-mph)
- St. Louis – Kansas City (90-mph)

For cities that are either too small to support rail service or difficult to serve via existing rail corridors, dedicated feeder bus service would be provided. These buses would serve both the HSR stations and the other rail stations included in the MWRRI plan. Buses would be scheduled to meet trains providing a convenient transfer. The buses would travel on freeways or major highways with few intermediate stops to minimize travel time between the rail station and the major population centers along the bus route. Depending on market size, buses could meet every train, or perhaps every second, third or fourth train.

Where connections are convenient, HSR has the potential to substitute for other modes providing access to airports in its service area. This ability raises the question of whether the HSR service should include a station at the major airport in each metropolitan area that it serves. The answer is usually yes, if the following conditions apply:

- The airport has flights that serve national and international destinations beyond the range of HSR; O'Hare is in this category.
- It is possible to serve the airport without a major deviation in the HSR route alignment; Milwaukee's General Mitchell International Airport and Cleveland's Hopkins International Airport are in this category, where the recommended HSR route goes directly by these airports;
- The existing airport-area land use is compatible with the HSR customer base; many airports have adjacent higher-density office districts that support logistics and warehouse functions, or cater to businesses that require frequent travel or "fly-in" meetings; these types of businesses can also benefit from convenient HSR service.

12.4 Stations and Land Use

Stations should be optimized as intermodal transportation hubs between HSR and urban transportation modes including subways, light rail, buses, taxis and auto. Outside the station, urban design should cater to the "last mile" of the passenger's journey by managing the flow of pedestrian traffic and creating a continuum with the urban fabric. Inside the station, the main concourse, passageways, galleries, underpasses and overpasses should be designed for a seamless flow of foot traffic. When considering station locations, it should be remembered that HSR services require long platforms and long "throat" areas for switching trains between platforms, which are difficult to fit within the highest density areas of the urban core. As a result, the more feasible station location is often adjacent to, but not directly within, the center of the downtown area. This is precisely why the West Loop Transportation Center/CUS is a suitable location for the downtown Chicago HSR station.

Areas adjacent to HSR stations have strong potential for high-density development and high-intensity employment. In the area within a five-minute walk station, there is potential for 3.5 million square feet of development at a 1.0 FAR. In dense urban areas such as around the downtown Chicago station, a FAR of 4.0 or more is attainable. To support this level of activity, walkable urban design strategies such as a dense urban street grid, small block sizes and wide sidewalks are important.

Often, rail stations and adjacent railyards may appear to be attractive air-rights development opportunities. To avoid constraining future expansion of rail facilities, it is important to verify the ultimate rail system requirements before proceeding with air-rights development over stations and yards. Existing development over the CUS platforms is one of the constraints to expanding and upgrading its capacity to serve HSR.

Source: MWRRI, AECOM; routings are subject to full environmental review and market analysis, 2010.

Figure 33: High-Speed Rail Routing and Connectivity - Midwest Region

12.5 Maintenance and Storage Facilities

The HSR network would require central and support facilities. A central control center would typically be developed near the heart of the system where connections to communication links for all elements could be provided and where trained staff would be available to monitor and manage operations.

Maintenance functions would most likely be divided between a Heavy Maintenance Facility (HMF) capable of performing the most demanding, time-consuming and costly repairs and refurbishment, and overnight vehicle storage areas where light maintenance could be performed. In general, it would be desirable to have the HMF situated near the heart of the system in order to minimize average access distance and time. On the other hand, overnight storage and light maintenance would be desirably located at or within a few miles of terminal stations. With Chicago as the central point in the Midwest network, it is likely that a site for the HMF would be located within the metropolitan area, potentially on the south or southwest side where large industrial tracts are found. Land use constraints near the downtown hub would mean that overnight storage and light maintenance would be provided within the metropolitan area, either near the O'Hare West Terminal station (if sufficient land could be identified) or again on the south or southwest side.

Within a three-mile radius of the Loop there are few large parcels that are undeveloped or in current marginal use, especially along the candidate HSR routes. However, in the event most trains are terminated at O'Hare West, it is possible that land for train storage could be found in the O'Hare vicinity. There are more opportunities for assembling large sites on the south side in the industrial lands between Calumet Park and East Chicago/Gary. Another alternative would be to provide a non-revenue connection to a storage yard elsewhere on the west side.

12.6 Incremental Upgrade Strategy for High-Speed Rail Corridors

The MWRRI plan proposes increasing the frequency and speed of existing Amtrak routes running on existing freight tracks. While the higher speed envisioned in the MWRRI plan could make intercity rail competitive with the automobile for trips between select Midwest city centers, it may be difficult to support more frequent passenger operations using trackage shared with freight trains. Passenger trains would operate at nearly twice the speed of fast freight trains, and they would be more frequent than current service. This would create a number of challenges, chief among them the larger "schedule windows" required for passenger service that would reduce the amount of "track time" available for freight service. The operation of freight and passenger trains at substantially different speeds on the same line results in trade-offs between capacity and schedule reliability. Dedicated passenger tracks may therefore be required to serve, for example, hourly passenger service – even at 110-mph.

Developments in signaling, train control and protection technology have the potential to facilitate shared operations in the future. In North America, Positive Train Control (PTC) is currently in the design phase and will incorporate automatic cab signaling and other systems to monitor and control train movements. A similar system, the European Train Control System (ETCS) has been implemented in mixed freight/passenger applications in Europe and is designed to support short headways. A system that could integrate both PTC and ETCS would be beneficial for the situation in the Midwest, with its high-rail traffic densities and mixed freight and passenger operations.

Given the high capital cost of implementing a 150 to 220+ --mph system, and given that many routes in the Midwest will be improved to provide 110-mph service under the MWRRI plan, a strategy for incrementally developing a higher-speed network would be desirable. Such a system could potentially be phased in over time with the "building blocks" consisting not only of specific segments from point-to-point, but also progressive upgrades to specific segments so that investments over many years could be used to develop a comprehensive network.

It was beyond the scope of this study to suggest a specific phasing plan for the Midwest HSR system; however, there are a number of strategies which can be utilized depending upon the configuration of the network.

Given the need to build or improve most routes from end-to-end, there are two alternative approaches: 1) Similar to the European model, develop long intercity links in the early phases, or, 2) develop shorter links providing access to the central city core areas first. Whereas rural segments can be built with more at-grade sections resulting in lower costs per mile and fewer alignment constraints, and can be operated at higher speeds thereby yielding large time savings, some means to access metropolitan areas and central business districts still needs to be provided to have a complete system. On the other hand, construction of new electrified passenger links within metro areas can be accomplished not only to provide access to downtown locations but such trackage can also support "regional overlay" services (e.g., trains with lower top speeds stopping at additional stops between the principal HSR stations serving a combination of commuters and intercity travelers) provided the financial resources are available to develop these routes which may have very high per-mile costs as well as costly terminals.

For the basic reason that few US cities have a well developed passenger network serving the core and there are few existing electrified lines, implementation of HSR in the US will need to depart from the European model and include construction of new lines to penetrate metro areas and access urban cores while at the same time still providing high speed intercity sections.

Strategies which can be used to phase HSR investments:

- Prioritize Short Intercity "Minimum Operating Segments" – Although short intercity segments will not yield as high time savings as long rural links, such segments can be put into service with a lower total investment and if market conditions are positive can potentially generate substantial ridership.

  Example: Chicago – Milwaukee is an example of a short interstate HSR link which could be developed to 250-mph standards in anticipation of ultimate Twin Cities service.

- Prioritize Routes Providing Core Access for Multiple Lines – Where the network is dense and multiple lines can be operated over common trackage, early construction of routes which can be shared will increase the cost-effectiveness of the investment. Also, as noted previously, "overlay services" providing access to additional more closely-spaced regional stops can be operated in conjunction with new HSR intercity routes over new metro-area trackage.

  Example: Chicago – Champaign segment would support traffic bound for Toledo, Detroit and Cleveland in the Chicago Metro area and could also potentially branch west towards St. Louis as well as east towards Indianapolis and Cincinnati.

- Convert Low Traffic Freight Lines to Passenger Service – Provided the alignment is suitable for passenger service, and where freight traffic is low enough to be shifted to other lines or operated at night, existing lines can be upgraded by providing grade separations and electrification to support HSR services.

  Example: Chicago's lakefront route has two freight tracks which used to terminate at the former Illinois Central railyards at the current Millennium Park site in downtown; these could be converted to provide HSR access to downtown Chicago.

- Add Capacity to Existing Passenger Lines – If the right-of-way is adequate, HSR tracks can be added to existing passenger lines. In some cases, it may be possible to convert a two-track passenger operation to support HSR by providing a new third "express" track and by electrifying and upgrading signal systems to operate HSR trains in conjunction with commuter or regional passenger trains.

  Example: HSR could be phased in to the Chicago Milwaukee District North line by building a single grade-separated express track and electrifying the existing line to support HSR overtakes of commuter trains and to allow HSR trains to pass.

- Consider "Stopping Short" – Although provision of a "one seat ride" to the central city is a key goal of a successful system, where existing metro services can provide frequent service and timely access to final destinations, and where the construction of the full route may require a very large investment to reach the core, or where the full route includes a "back leg" which extends beyond the first principal HSR stop, phased construction can be used to reduce the cost of the first phase.

Examples: Chicago to St. Louis could have interim terminal in East St. Louis to avoid costly new river crossing; or Chicago to Minneapolis could have interim terminal in St. Paul.

- Consider Interim or Alternative CBD Station – Rather than constructing an entire new downtown terminal for HST, it may be possible to add capacity to an existing station; or it may be possible to provide a new platform and tracks adjacent to an existing depot allowing sharing of waiting rooms and intermodal connections. In some cases, it may be possible to construct a lower-cost interim end of line station at an alternative site before the system is built out and the cost of a new terminal at the preferred location can be funded.

  Example: An interim HSR terminal could be constructed in Chicago south of Union Station near the old post office.

In addition to phasing in various sections and stations as noted above, it also may be possible to phase successive improvements into a corridor over time such that an existing passenger service operating on a line shared with freight traffic can be upgraded first to higher-speed regional service and ultimately to true HSR. It is useful to refer to three distinct classifications for passenger rail corridor services recently developed by the FRA which generally refer to increasing levels of investment:

- Emerging Corridor – State- or regionally designated passenger rail corridor that offers service operating on shared use track at peak speeds of up to 90 miles per hour and that connects large, mid-sized, and small urban areas generally less than 750 miles apart
- Regional Corridor – Passenger rail corridor that offers service operating on a mix of dedicated and shared use track at peak speeds of 90 to 125 miles per hour, and that primarily connects mid-size urban areas to larger and smaller communities that are generally up to 500 miles apart
- Core Express Corridor – The term 'Core Express Corridor' means a passenger rail corridor that offers electric-powered service operating primarily on dedicated track at peak speeds of 125 miles per hour or greater, and that primarily connects major metropolitan centers in the United States that are generally up to 500 miles apart within a three-hour travel time

Table 19 synthesizes these corridor descriptions and characteristics with other guidance under consideration by FRA including grade crossing treatments and passenger equipment type using FRA's classification into "Tiers" of progressive safety requirements. In this regard, Tier I refers to standards applicable to equipment for Amtrak intercity service and commuter rail operations, Tier II refers to legacy equipment such as the current heavyweight "Acela" consists used in Northeast Corridor service, and Tier III refers to proposed standards for HST equipment. Tier III equipment would be lightweight and would be similar to equipment developed under the EN 15227 (European) standard modified to meet additional safety criteria for US service as specified by FRA.

As shown in the table, grade crossings utilizing conventional safety treatments would be allowable up to 79 mph and no grade crossings would be allowed above 125 mph. Above 79 mph, "sealed corridor" treatments consisting of enhanced safety devices such as four-quadrant gates and long medians would be required, and above 110 mph additional provisions such as "barrier gates" and presence detection tied to the train signal system (PTC) would be required. Above 125 mph, there would be no grade crossings, passenger service would be on dedicated tracks, and electrification would be required as a practical matter to attain the allowable maximum operating speed.

Table 19: FRA Passenger Service Classifications and Related Requirements

	Speed Range	Grade Crossings	Traffic Mix	Minimum Passenger Equipment Type (see note)
Emerging Passenger Corridor	0 – 79	• Conventional Warning Devices & Traffic Control	• Shared Track	• Tier I
	80 – 90	• Sealed Corridor		
Regional Passenger Corridor	90 – 110	• Sealed Corridor	• Shared Track or • Dedicated Track	• Tier I
	110 – 125	• Sealed Corridor • Barriers • Presence Detection tied to Positive Train Control		
Core Express Passenger Corridor	125 – 250	• Not Allowed	• Dedicated Track	• Tier II • Tier III

Note: Tier II equipment can be operated on dedicated track up to 150 mph; with Positive Train Control, Tier II or Tier III equipment can be operated on shared track mixed with freight at speeds below 125 mph

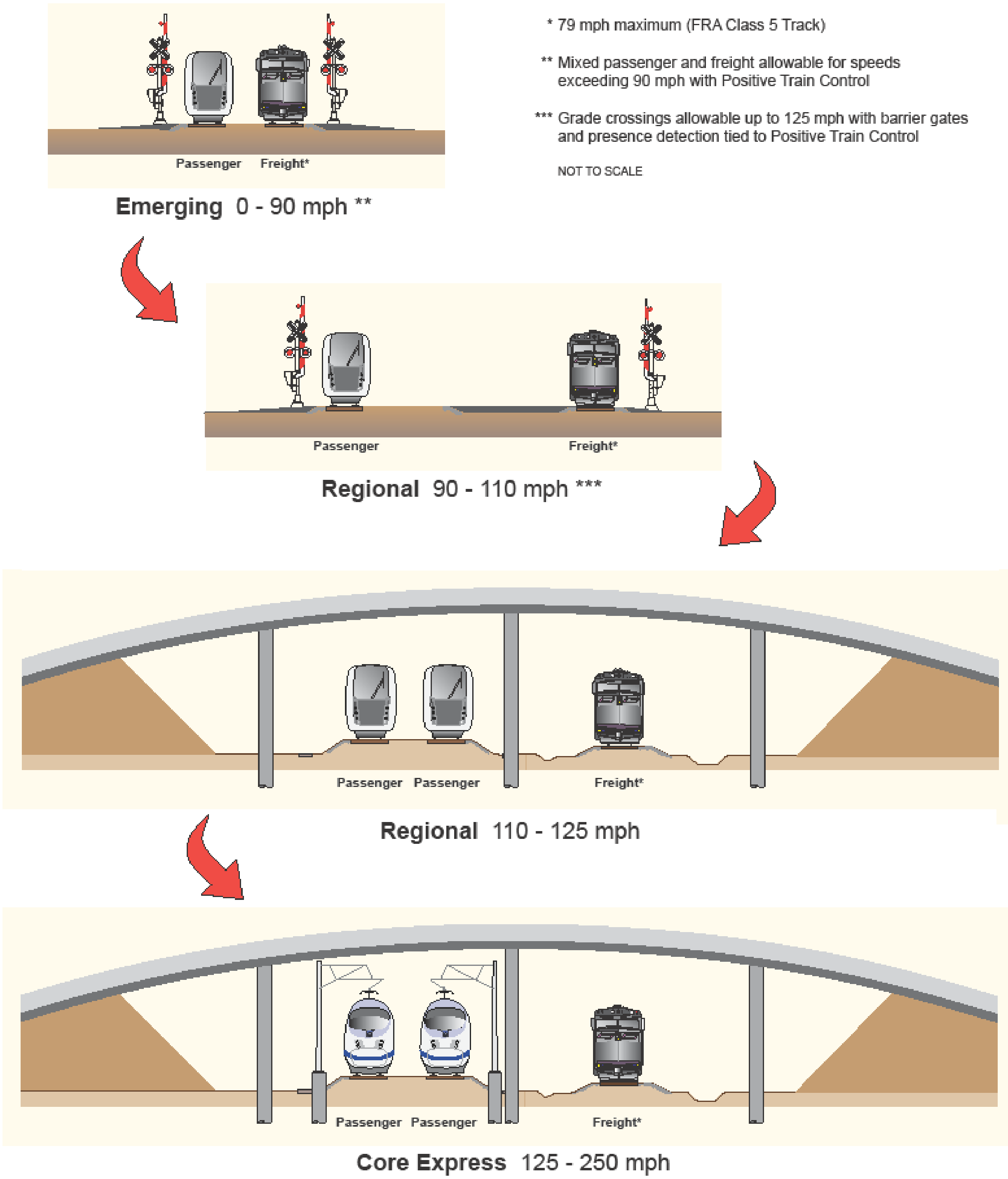
With such provisions, it may be possible to incrementally develop a corridor to support progressively higher top passenger speeds with four distinct phases of improvements, as shown in Figure 34:

- Phase 1: Emerging Corridor – This shows a typical existing condition with standard passenger service sharing a freight track. Although 79 mph is the typical maximum speed supported by most existing freight corridors, FRA identifies "Class 5" track with a maximum permissible speed of 80 mph for freight and 90 mph for passenger operations.
- Phase 2: Regional Corridor – By providing a separate passenger track within a shared corridor, it would be possible to support passenger speeds up to 110 mph while retaining grade crossings provided the safety treatments are upgraded to "sealed corridor" as previously noted.

- Phase 3: Regional Corridor – With higher speeds between 110 and 125 mph it would be desirable to eliminate grade crossings and provide separate tracks for each direction of travel. If the grade separations are provided by modifying the roadway network, it would be possible to eliminate safety concerns, operational conflicts and noise impacts associated with use of horns and bells which occurs at the existing freight grade crossings as well.
- Phase 4: Core Express Corridor – Electrification of the passenger tracks would allow true HST speeds to be attained where the track alignment and station spacing permits.

In conjunction with the incremental improvement of track and systems from conventional service to Core Express HSR, the vehicle fleet could be upgraded over time in a parallel fashion in a series of steps to 110, 125 and true HSR (150 – 250mph):

- 110 – 125 mph – A good candidate for operating under these conditions would be a lightweight diesel multiple-unit train – self-propelled equipment has a high power-to-weight ratio and would also be fuel efficient. In a push-pull configuration, the lightweight Siemens “Viaggio” consist can be equipped with diesel traction for this speed range, or an electric power unit can be substituted for quicker acceleration and higher top speeds.
- 125 – 150 mph – Grade separation is mandatory and electrification is required to effectively exceed speeds of 125 mph. Legacy Tier II (heavyweight) equipment can be operated on lines shared with freight. With no freight traffic or temporal separation, fuel-efficient lightweight equipment could be based on the EN-15227 European crashworthiness standard, “Americanized” to comply with US-specific Tier III requirements. Train consists could either be locomotive-hauled or multiple-unit.
- 150 – 250 mph – For speeds in excess of 150 mph operating on alignments designed to support maximum speeds of 220+ mph, “true” lightweight HST equipment would be required. Such equipment includes “distributed power” with many powered axles throughout the trainset even if some of the coaches may be unpowered “trailer” cars. Equipment of this nature is included in the European EN 15227 standard and would also comply with the US modifications required by FRA. Examples of such equipment in use in Europe would include the Siemens “Velaro” train. It should be noted that Tier III equipment can operate on lines shared with freight at speeds below 125 mph where Positive Train Control is implemented.



Source: AECOM, 2011.

Figure 34: Potential Incremental Upgrade Strategy

Table 20: Key to Railroad Abbreviations

References to railroads in the corridor descriptions of Section 2.0 are presented thus:
Current Owner / Trackage Rights (Previous Owner)

AMTK	Amtrak
BNSF	Burlington Northern Santa Fe Railway
BO	Baltimore & Ohio Railroad
C&A	Chicago & Alton Railroad
CCCStL	Cleveland Cincinnati Chicago & St. Louis Railway
CEI	Chicago & Eastern Illinois Railroad
CFER	Chicago Fort Wayne & Eastern Railroad
CGW	Chicago Great Western Railway
CHD	Cincinnati Hamilton & Dayton Railway
CIND	Central Railroad of Indiana
CLE	Cincinnati & Lake Erie Railroad
CMO	Chicago St. Paul Minneapolis & Omaha Railway
CN	Canadian National Railways
CNW	Chicago & North Western Transportation Company
CP	Canadian Pacific Railway
CR	Conrail
CRSA	Conrail Shared Assets Operation
CTA	Chicago Transit Authority
CSS	Chicago Southshore & South Bend Railroad
CSXT	CSX Transportation
DME	Dakota Minnesota & Eastern Railroad
DT	Decatur Junction Railway
EJE	Elgin Joliet & Eastern Railway
IC&E	Iowa Chicago & Eastern Railroad
ICRR	Illinois Central Railroad
KCS	Kansas City Southern Railway
LEW	Lake Erie & Western Railroad
LSMS	Lake Shore & Michigan Southern
MC	Michigan Central Railroad
METRA	Metra
MILW	Chicago Milwaukee St. Paul & Pacific Railroad
NKP	New York Chicago & St. Louis Railroad
NS	Norfolk Southern Corporation
NYC	New York Central System
PC	Penn Central Transportation Company
P&E	Peoria & Eastern Railway
PRR	Pennsylvania Railroad
RTA	Regional Transportation Authority (Illinois)
RTA	Greater Cleveland Regional Transit Authority
THIE	Terre Haute Indianapolis & Eastern Traction
TRRA	Terminal Railroad Association of St. Louis
TOC	Toledo & Ohio Central Railway
TT	Toledo Terminal Railroad
UP	Union Pacific Railroad
WAB	Wabash Railroad
WSOR	Wisconsin & Southern Railroad

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Appendix A: Economic Impact Methodology

A-1. Economic Impacts of Chicago High Speed Rail

The proposed high speed rail system is estimated to have three primary impacts on the economy of the Chicago metropolitan area. The first is *traveler time and expense savings*, which arise where high speed rail provides a cheaper, faster mode of travel, and also because fewer cars on Chicago highway system means less congestion. The second is from additional *visitor spending*, which flow from the greater pool of travelers that can make Chicago a destination for same-day business and recreation trips. Finally, high speed rail will improve the Chicago's regional *access to markets*, thereby improving businesses' ability to find workers, consumers, suppliers, and collaborators – in turn improving competitiveness and productivity. Theses three categories of impact are carefully designed to encompass the full range of potential economic impacts while avoiding "double counting".

The purpose of this Appendix is to provide an overview of the methodology used to estimate the economic impacts from the three sources described above. In all cases, the Transportation Economic Development Impact System (TREDIS) was used to calculate the total economic impacts of investing in high speed rail (vs. not investing). Therefore, as shown in Figure A-1, the methodology falls into the two main steps of (1) estimating inputs to TREDIS (shown in blue), and (2) using TREDIS to estimate total impacts (shown in orange).

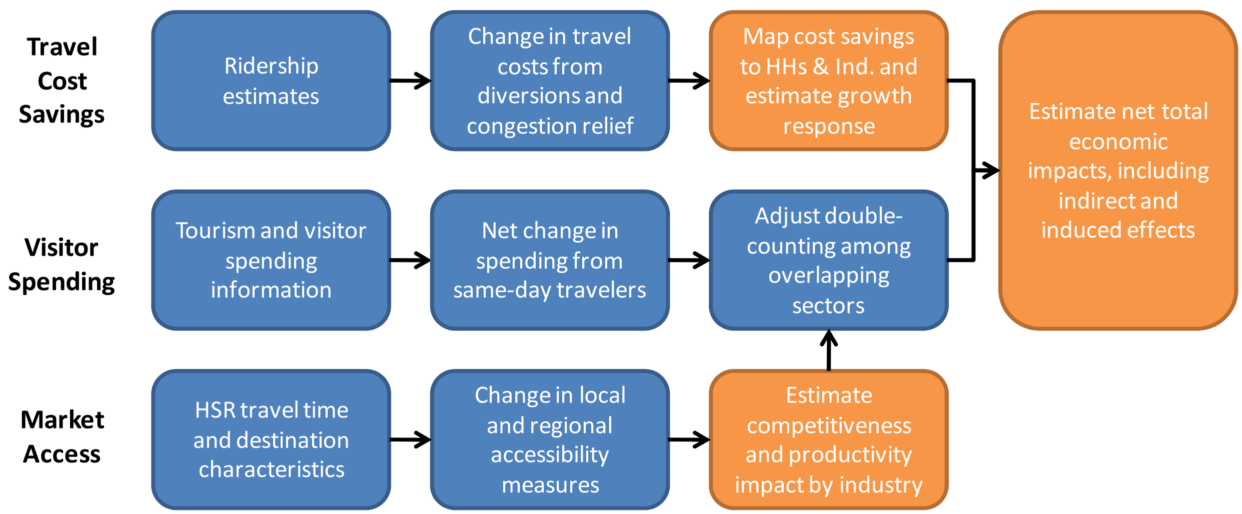

Figure A-1: Overview of economic impact methodology (TREDIS steps in orange)

A-2. Travel Time and Expense Savings

When introduced, high speed rail will provide a faster and/or lower cost alternative for existing classes of travelers now traveling via automobiles, airplanes, and regular Amtrak trains. This will attract ridership to high speed rail from those other modes, and these diversions will reduce travel time and out-of-pocket costs for those opting for the HSR mode. Further, they will reduce highway congestion due to fewer cars on the roadway system. To estimate the economic impacts from these savings, we followed the steps shown in Figure A-2. For both sources of traveler savings, the starting point of the analysis was modeling of trip generation and mode split to generate high speed rail ridership estimates shown in Table A-1.

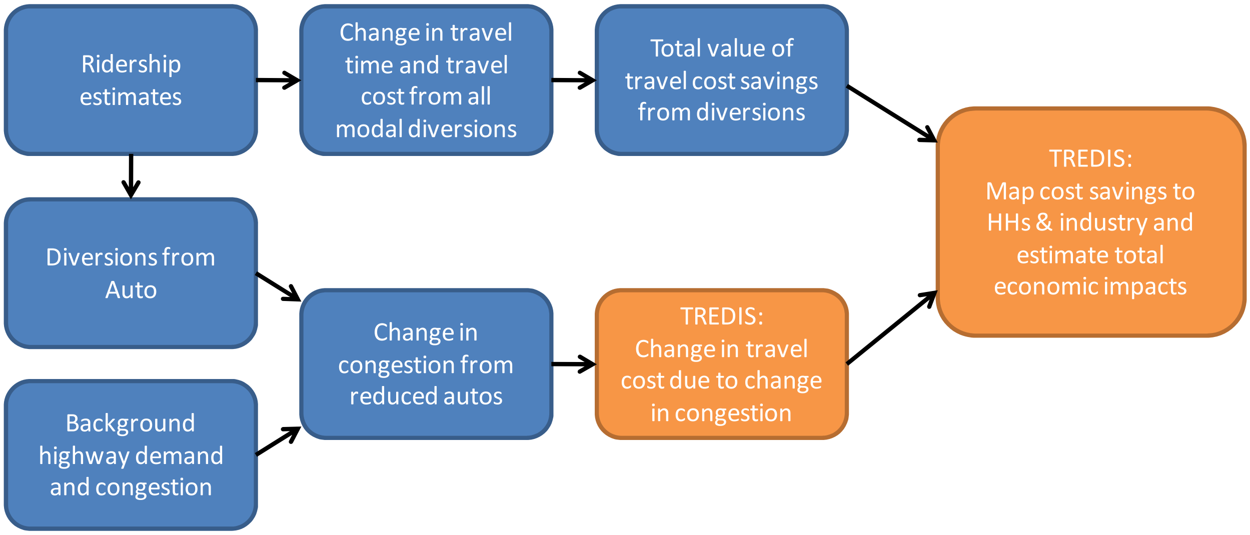

Figure A-2: Steps to estimate economic impacts from traveler cost savings

Table A-1: Estimated 2030 HSR Annual Ridership by Source

	Corridor	Estimated Ridership	Diversions From: Auto	Diversions From: Amtrak	Diversions From: Air	Total Diversions	Induced
150 MPH	Chicago - Minneapolis	12,537,000	10,589,000	777,000	258,000	11,624,000	913,000
	Chicago - St. Louis	5,999,000	5,196,000	358,000	75,000	5,629,000	370,000
	Chicago – Cincinnati	5,877,000	5,411,000	11,000	95,000	5,517,000	360,000
	Chicago - Detroit / Cleveland	10,661,000	9,584,000	177,000	149,000	9,910,000	751,000
	System Totals	35,074,000	30,780,000	1,323,000	577,000	32,680,000	2,394,000
	Riders to/from Chicago	16,670,000	13,928,000	1,078,000	479,000	15,485,000	1,185,000
220 MPH	Chicago - Minneapolis	15,884,000	13,388,000	779,000	351,000	14,518,000	1,366,000
	Chicago - St. Louis	7,904,000	6,884,000	287,000	109,000	7,280,000	624,000
	Chicago – Cincinnati	7,226,000	6,544,000	10,000	120,000	6,674,000	552,000
	Chicago - Detroit / Cleveland	12,650,000	11,258,000	160,000	185,000	11,603,000	1,047,000
	System Totals	43,664,000	38,074,000	1,236,000	765,000	40,075,000	3,589,000
	Riders to/from Chicago	21,241,000	17,759,000	1,012,000	629,000	19,400,000	1,841,000

Source: AECOM, 2011

Ultimately, HSR ridership is either induced (new trips), or diverted from another mode. In the latter case, the diversion estimates were based on reduced travel time and out-of-pocket expenses for HSR versus the other three competing modes (auto, air, and conventional rail). For HSR, air and conventional rail, out of pocket expenses include the total ticket price; for automobile, costs include fuel, maintenance, oil, and other per-mile operating costs. Table A-2 shows estimated travel cost information for 150 and 220 MPH high speed rail options compared to alternative modes for station pairs considered in study.

Each of these types of cost savings was provided through the ridership estimation process (Section 7), and was reported separately for business and non-business travel. Distinguishing between these trip purposes is important because of the way these translate to industry versus household activities that lead to total economic impacts. Business trips were all treated as “on-the-clock”, where the out-of-pocket costs are expensed by firms, and the traveler’s time is valued at the wage rate. In contrast, “non-business” trips were treated as personal/leisure. As such, while the out-of-pocket cost enable more local discretionary consumer spending, travel time savings does not create any new economic activity.

For diversions, time and cost savings were used to estimate the total net cost change from using high speed rail versus the previous mode. This step required “monetization” of travel time savings – in this case, an assigned value of $25 per hour for business travelers and $15 per hour for non-business travelers[1]. This step yielded total travel cost savings (in $ terms) by origin/destination pair, and for business vs. personal trips.

Next, because the geographic scope of economic impacts was the Chicago metropolitan area, ridership origin/destination patterns were used to isolate only those travel cost savings where either the origin or destination is Chicago. The resulting travel cost savings were those accruing to Chicago businesses and residents.

[1] The $15 per hour value for personal time is a valuation of personal welfare , reflecting personal travelers’ preferences and perceived value of time – although personal travel time is valued, changes in personal time do not affect economic outcomes, and therefore do not trigger any economic impacts.

Table A-2: Travel Times and Costs for High Speed Rail and Competing Modes

			Auto		Air		Existing Amtrak		150 mph Option		220 mph Option	
	City 1	City 2	Travel Time (min)	Travel Cost ($)	Travel Time (min)	Travel Cost ($)	Travel Time (min)	Travel Cost ($)	Travel Time (min)	Travel Cost ($)	Travel Time (min)	Travel Cost ($)
Chicago - Minneapolis	Chicago, IL	La Crosse, WI	287	109.29	189	182.42	348	44.01	188	56.77	148	56.77
	Chicago, IL	Madison, WI	169	60.53	184	122.57	279	34.12	124	30.92	107	30.92
	Chicago, IL	Milwaukee, WI	101	35.61	173	67.19	123	15.13	99	20.92	94	20.92
	Chicago, IL	Minneapolis-St. Paul, WI	418	158.29	198	102.83	525	54.45	255	80.00	195	80.00
	La Crosse, WI	Madison, WI	196	70.12	0	0.00	0	0.00	112	29.25	89	29.25
	La Crosse, WI	Milwaukee, WI	235	85.97	227	186.35	253	36.09	145	51.36	112	51.36
	La Crosse, WI	Minneapolis-St. Paul, WI	192	58.95	159	166.66	227	21.47	120	35.94	100	35.94
	Madison, WI	Milwaukee, WI	120	39.34	175	68.89	184	25.23	80	20.22	71	20.22
	Madison, WI	Minneapolis-St. Paul, WI	274	101.62	188	202.35	341	35.11	182	54.26	139	54.26
	Milwaukee, WI	Minneapolis-St. Paul, WI	366	134.98	197	92.99	430	52.34	210	69.01	158	69.01
	Chicago, IL	Rochester, MN	343	143.33	220	120.44	604	60.41	217	65.78	167	65.78
	La Crosse, WI	Rochester, MN	78	36.80	256	173.54	0	0.00	79	18.94	69	18.94
	Milwaukee, WI	Rochester, MN	272	119.58	296	99.84	531	61.22	160	51.90	118	51.90
	Madison, WI	Rochester, MN	200	86.62	285	209.23	473	52.19	142	39.79	109	39.79
	Minneapolis-St. Paul, WI	Rochester, MN	103	50.19	157	70.17	0	0.00	89	19.56	79	19.56
Chicago - St. Louis	Champaign, IL	Chicago, IL	147	56.67	194	155.41	183	19.01	113	29.86	96	29.86
	Champaign, IL	Decatur, IL	47	18.57	0	0.00	0	0.00	58	13.10	48	13.10
	Champaign, IL	Gary, IN	136	46.89	0	0.00	0	0.00	130	28.04	111	28.04
	Champaign, IL	Springfield, IL	88	35.18	0	0.00	0	0.00	80	20.30	64	20.30
	Champaign, IL	St. Louis, MO	184	75.49	0	0.00	0	0.00	127	36.94	99	36.94
	Chicago, IL	Decatur, IL	183	69.81	213	164.45	230	22.65	139	35.24	110	35.24
	Chicago, IL	Springfield, IL	198	78.60	182	160.09	223	18.84	169	36.55	136	36.55
	Chicago, IL	St. Louis, MO	302	121.22	185	93.80	329	27.51	224	48.70	180	48.70
	Decatur, IL	Gary, IN	179	63.99	0	0.00	0	0.00	159	35.91	130	35.91
	Decatur, IL	Springfield, IL	47	16.89	0	0.00	0	0.00	51	11.55	45	11.55
	Decatur, IL	St. Louis, MO	148	57.99	0	0.00	190	16.56	98	28.19	80	28.19
	Gary, IN	Springfield, IL	220	80.60	0	0.00	0	0.00	181	43.12	146	43.12
	Gary, IN	St. Louis, MO	317	120.91	234	99.29	0	0.00	228	59.76	181	59.76
	Springfield, IL	St. Louis, MO	117	45.11	0	0.00	153	12.66	85	20.82	75	20.82
Chicago - Cincinnati	Chicago, IL	Cincinnati, OH	322	124.09	215	145.40	559	35.31	204	59.00	170	59.00
	Chicago, IL	Indianapolis, IN	205	79.78	179	87.85	361	18.46	151	31.40	128	31.40
	Chicago, IL	Lafayette, IN	133	52.18	236	95.25	264	19.34	123	29.87	109	29.87
	Cincinnati, OH	Gary, IN	246	94.27	335	99.15	474	28.09	201	51.71	167	51.71
	Cincinnati, OH	Indianapolis, IN	122	47.18	162	107.71	241	18.24	92	30.77	81	30.77
	Cincinnati, OH	Lafayette, IN	188	71.91	219	115.11	391	22.01	132	37.18	112	37.18
	Gary, IN	Indianapolis, IN	130	49.97	225	86.18	230	18.42	149	34.66	126	34.66
	Indianapolis, IN	Lafayette, IN	72	27.60	0	0.00	147	14.60	79	23.90	71	23.90
Chicago - Detroit / Cleveland	Ann Arbor, MI	Chicago, IL	281	101.11	206	96.88	329	31.65	255	57.07	226	57.07
	Ann Arbor, MI	Cleveland, OH	176	65.89	179	206.34	218	25.13	147	38.54	143	38.54
	Ann Arbor, MI	Fort Wayne, IN	175	61.04	276	190.68	210	20.40	160	36.83	142	36.83
	Ann Arbor, MI	Gary, IN	234	81.64	232	146.45	261	30.18	252	45.58	237	45.58
	Battle Creek, MI	Cleveland, OH	217	86.37	0	0.00	267	31.76	222	49.56	200	49.56
	Chicago, IL	Cleveland, OH	361	143.37	196	93.56	454	44.45	223	73.93	189	73.93
	Chicago, IL	Detroit, MI	348	122.14	227	98.52	399	33.13	213	55.46	185	55.46
	Chicago, IL	Fort Wayne, IN	234	80.46	186	157.69	267	28.25	121	31.77	109	31.77
	Chicago, IL	Jackson, MI	248	89.51	241	100.44	288	29.48	286	53.80	278	53.80
	Chicago, IL	Sandusky, OH	308	123.21	228	97.12	388	32.85	221	57.18	191	57.18
	Chicago, IL	Toledo, OH	252	100.41	192	116.86	312	31.85	172	52.00	142	52.00
	Cleveland, OH	Detroit, MI	204	78.73	199	207.98	247	28.87	176	42.29	172	42.29
	Cleveland, OH	Fort Wayne, IN	239	91.29	169	236.58	296	29.59	138	41.01	116	41.01
	Cleveland, OH	Gary, IN	309	121.63	228	135.63	374	40.47	225	65.35	191	65.35
	Cleveland, OH	Jackson, MI	211	78.79	214	209.90	253	28.69	182	42.10	178	42.10
	Cleveland, OH	Kalamazoo, MI	270	104.50	251	181.94	0	0.00	296	72.71	262	72.71
	Cleveland, OH	South Bend, IN	251	99.69	204	177.34	317	31.54	241	61.72	211	61.72
	Cleveland, OH	Toledo, OH	113	44.54	209	209.90	160	20.22	89	33.63	84	33.63
	Detroit, MI	Fort Wayne, IN	236	87.34	296	192.32	239	24.14	119	35.23	101	35.23
	Detroit, MI	Gary, IN	301	102.80	253	148.09	329	31.62	206	59.57	176	59.57
	Detroit, MI	Sandusky, OH	151	58.57	231	211.54	184	20.70	119	23.71	118	23.71
	Detroit, MI	South Bend, IN	231	76.68	224	194.74	273	31.01	247	46.55	241	46.55
	Detroit, MI	Toledo, OH	110	40.59	245	89.81	159	16.22	69	18.53	69	18.53
	Fort Wayne, IN	Gary, IN	178	47.10	0	0.00	183	19.07	126	29.74	114	29.74
	Fort Wayne, IN	Sandusky, OH	186	71.12	200	240.14	227	23.39	138	28.45	120	28.45
	Fort Wayne, IN	Toledo, OH	130	48.33	306	194.24	152	15.49	89	23.27	71	23.27
	Gary, IN	Sandusky, OH	256	101.47	260	139.19	303	33.45	225	52.80	195	52.80
	Gary, IN	Toledo, OH	200	78.67	263	150.01	228	27.09	176	47.62	146	47.62
	South Bend, IN	Toledo, OH	142	56.74	233	196.67	234	27.84	189	44.17	179	44.17

Source: AECOM, 2011

In addition to savings from diversions, we estimated travel cost savings from congestion relief to the Chicago road and highway system. As with the cost savings described above, the starting point of this analysis was ridership estimates. As shown in Table A-1, the introduction of 220 MPH high speed rail service is expected to remove about 17.8 million auto trips per year from regional roads. This reduction in network vehicles has the effect of reducing congestion to the remaining network travelers, including both cars and trucks.

To estimate the effect of congestion relief, we used information describing existing and forecasted congestion levels[2], and then approximated how reduced highway demand would reduce the system-wide congestion in the year 2030. Fundamentally, removing cars from the road benefits all remaining drivers, including both cars and trucks. However, because the time-of-day of HSR trips is not well defined at this stage in the planning process, reduced congestion was estimated as an average across peak and off-peak periods. The result of this process was an estimated change in average network speed and congestion[3] for both cars and trucks for average daily travel. TREDIS then used this information to estimate the value of savings for travel time, reliability, and vehicle operating costs.

Finally, the combined travel cost savings from diversions and background highway congestion relief were entered into TREDIS, which estimated how households and businesses change their investment and consumption behavior as a result. As a result of the out-of-pocket savings, households spend less money on automotive consumption (fuel and maintenance), and more on discretionary items (such as retail, restaurant, and services). For industries, the cost savings can be used to grow their sales, either by (1) passing savings onto their customers, thereby increasing market share, or (2) investing savings into new capital or workers, thereby increasing new sales opportunities and productivity. As a last step, TREDIS estimates the total economic impacts of the combined industry and household effects by calculating the indirect and induced impacts to the Chicago metro area.

A-3. Visitor Spending

Besides diverting some existing trips, high speed rail will also induce additional trips to Chicago because it will expand the market for same-day travel to (or from) Chicago. Expanding the market for same day travel is important because it reduces the cost-threshold for travel (by not requiring lodging), and therefore enables more trip-making to conventions, for business, and for tourism/personal activities. Alternatively, high speed rail can be seen as expanding the boundaries of the area from which same-day travel is possible on a reliable basis. To estimate the economic impact of high speed rail on visitor spending, a four step process shown in Figure A-3 was used. The first step was to calculate baseline trends for same-day trip making activities, including origin/destination patterns and average traveler spending for different trip purpose types. This information was drawn from Convention and Visitor Bureau data.

[2] Information on demand and congestion was gathered from Chicago Metropolis 2020 Report *Time is Money: The Economic Benefits of Transit Investment*, available online (http://www.chicagometropolis2020.org/PDFs/TimeisMoney.pdf)
[3] For this purpose, “congestion” is measured as the fraction of daily VMT subject to a volume/capacity ratio greater than 0.9.

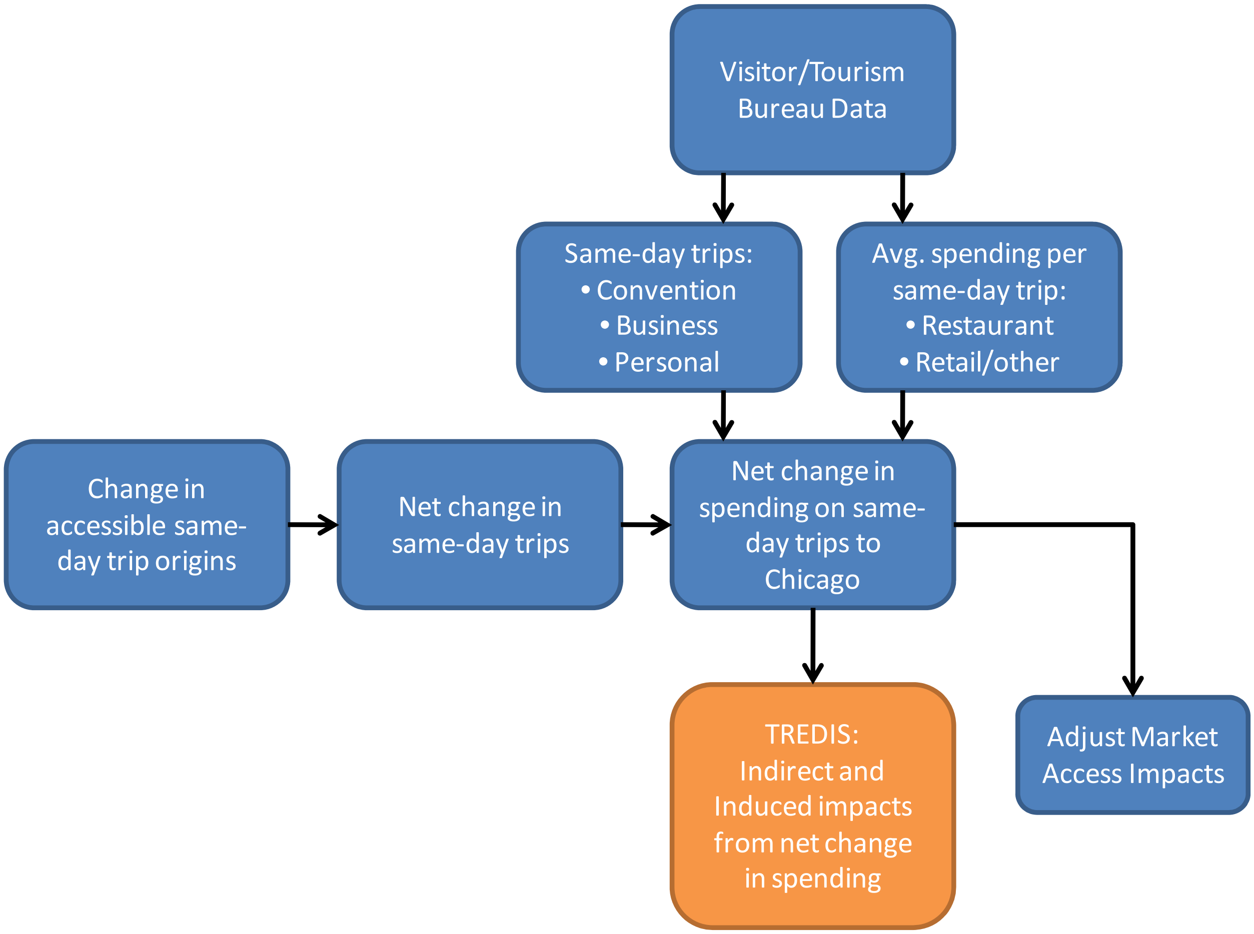

Figure A-3: Steps to estimate visitor spending impacts of HSR service

The second step was to calculate the change in same-day market size (spatial geography) by assessing the extent to which high speed rail can enable same-day trips within a larger market area. A rule of thumb adopted for this study was that occasional day trips should typically allow for at least 4 hours of activity time at the destination and include round-trip travel completed in a period typically no longer than ten-hours. This implies travel time constrained to around three hours each way. Accordingly, origin/destination travel times from the proposed HSR service were used to determine which station stops fall within three hours of Chicago, but are beyond a typical three hour drive. This analysis yielded the incremental change in market potential for same-day travel to Chicago.

The third step was to calculate the net change in number of visitor trips enabled by market area expansion. This was done by calculating the increased population and employment able to access the Chicago metropolitan area by high speed rail and assuming proportionate growth in same day travel. (Adjustment was made for enabling trips both into and out of Chicago, though it was also estimated that net trip generation would increase.) The calculation distinguished the mix of same-day trips among the three classes of business trips, convention trips, and tourism/personal travel.

The fourth step was to calculate net change in visitor spending flowing to Chicago, based on the estimated enlargement of visitor trips and average per traveler spending patterns for each of the three classes of trips. The calculation incorporated the following visitor spending statistics for induced trips:

- Conference & Business-related day trips 27%
- Leisure & personal visitor trips – 73%
- Average day trip spending $59 per day
- Business receipts from additional visitor spending to assigned to sectors of the economy

Table A-3: Direct visitor spending impacts from high speed rail service

		Additional Sales ($m)	
NAICS	Industry Description	220 MPH	150 MPH
441-454	Retail Trade	56.2	41.4
481-487	Transportation	112.3	82.8
711-713	Amusement & Recreation	112.3	82.8
721-722	Accommodations, Eating & Drinking	280.9	206.7
	Total	561.7	413.8

Source: EDR Group estimates

These increased sales were input into TREDIS to determine the total economic impact (including multiplier effects.

A-4. Market Access

Besides expanding the market for visitor spending, high speed rail will affect productivity for businesses that can gain from having broader access to workers and resources with specialized skills and expertise, as well as worker access to a broader array of markets for specialized products, services, customers and R&D opportunities. From the viewpoint of businesses, "Market Access" refers to the effect of enlarging: (a) the scale of the labor market (number of workers and mix of specialized skills) that businesses can utilize, (b) the scale of specialized materials, services or other inputs that a business can acquire for production, *or* (c) the scale of customers with specialized needs that a business can serve. From the viewpoint of households, market access can also be viewed as enlarging (d) the scale of employment opportunities with specialized needs that may be desirable match to worker skills, and (e) the scale and diversity of goods and amenities available for consumption activities.

From both perspectives, an important characteristic of "access" is that it is inherently multimodal. The pool of workers accessible from a central business district is affected by both the highway and available transit modes. Furthermore, improvement in one mode can have spillover effects in accessibility for other modes. For example, a local transit link can affect inter-regional access if it provides better connectivity to the airport. As noted in the Technical Report, this intermodal connectivity was one of the primary concerns in locating stations in the Chicago metropolitan area.

All of these concepts are important to understanding how high speed rail affects accessibility and ensuing economic activity. This section describes how HSR travel times and other data were used to estimate the change in market access for two important thresholds for businesses, as well as how TREDIS translates changes in accessibility to economic growth. The basic steps of this process are shown in Figure A-4.

The TREDIS Market Access Module is built on a long line of research showing that businesses can gain productivity (i.e., increase the output/cost ratio) when the scale of access to inputs or scale of customers is enlarged. It follows the work of Krugman (1991)[4] who showed that, with imperfect competition, regions

[4] Krugman, P. (1991), "Increasing Returns and Economic Geography", *Journal of Political Economy*, 99, 483-499.

develop differentiated industry mixes that reflect "agglomeration economies." The agglomeration is reflected in a disproportionately large concentration (or cluster) of some activities. It is typically enabled by access to larger markets, which in turn brings demand for greater product variety, and enables firms to realize increasing returns to scale (i.e., lower cost).

This effect can reflect not only production scale economies (spreading fixed cost of products or services over a wider customer base to reduce unit cost), but also economies associated with greater access to differentiated inputs (i.e., cost and quality benefits associated with greater ability to acquire specialized labor & materials). The effect is driven by inter-industry linkages (which create demand for specialized suppliers that varies by industry) – a concept further developed by Krugman and Venables (1995)[5] and modeled via the inter-industry trade flow element of TREDIS. While high speed rail transportation focuses on passenger (rather than freight) travel, these same inter-industry linkages apply for classes of business that depend on investment and financial services, expertise from skilled professional services, and the "knowledge spillovers" gained from access to broader research and development activities.

Before proceeding, it should be noted that the visitor spending effect described above is also the result of expanded market access for a specific class of trips. Therefore, for the four sectors affected by visitor spending, Market Access impacts (as estimated below) were reduced by the visitor spending effect – thereby eliminating any double-counting between concepts.

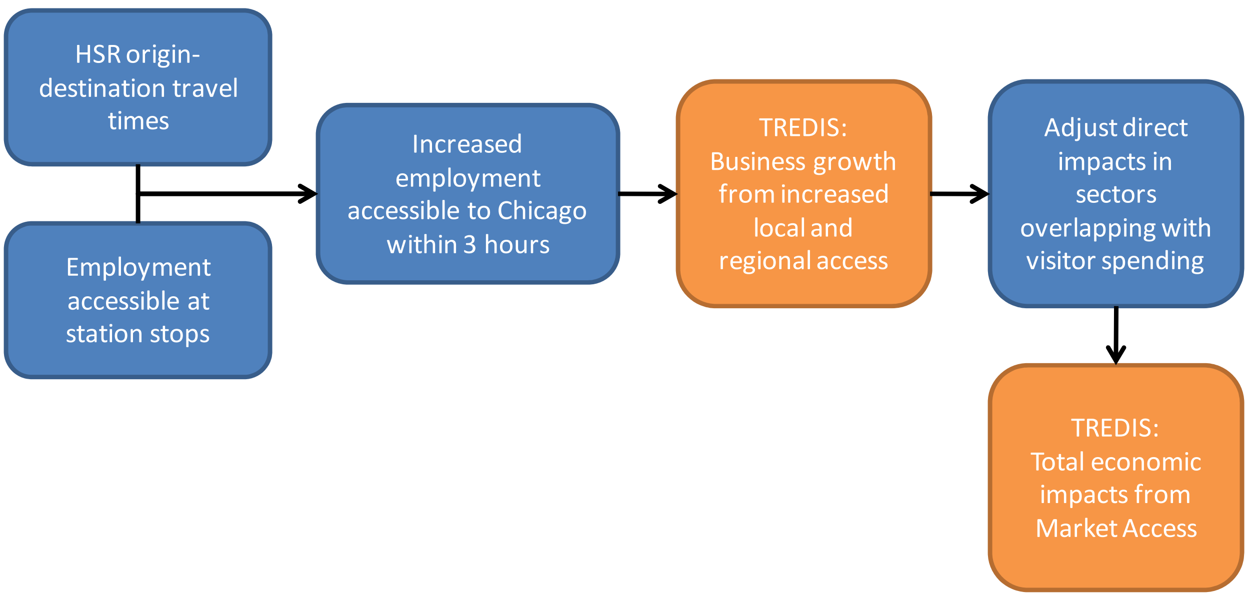

Figure A-4: Steps to estimating economic impacts from improved market access

Estimating Access Changes

In order to estimate market access impacts, TREDIS requires estimates of how accessibility will change from an investment. For high speed rail, the critical accessibility measure is regional business access – measured as the employment accessible within a 3 hour travel time. TREDIS provides baseline estimates for each of this measure; therefore, to determine HSR impacts, the required input was the

[5] Krugman, P. and A. Venables (1995), Globalization and the Inequality of Nations, *Quarterly Journal of Economics*, 110, 857-880.

incremental change in accessibility offered by the introduction of service versus the existing modal options. The HSR origin/destination travel times shown in Table A-2 were used to determine which station stops would fall within the 3 hour threshold for each of the 150 and 220 MPH service options. Table A-4 summarizes these stations and the comparable drive time.

Table A-4: Change in regional accessibility measure due to HSR service

Station	Travel Time (minutes) Auto	HSR-220	HSR-150	Jobs Accessible at Station
La Crosse, WI	287	148	-	2,512
Rochester, MN	343	167	-	16,612
Decatur, IL	183	110	139	8,665
Springfield, IL	198	136	169	36,575
St. Louis, MO	302	180	-	51,417
Cincinnati, OH	322	170	-	86,692
Indianapolis, IN	205	128	151	77,509
Fort Wayne, IN	234	109	121	20,881
Toledo, OH	252	142	172	2,879
Total - 220 MPH				303,742
Total - 150 MPH				146,509

Sources: AECOM,2011; ESRI

Table A-4 also shows the employment accessible at the station. This was estimated by first identifying the station location. For those cities with an existing Amtrak station, this was chosen as the HSR station location. For those cities without an existing Amtrak station, the HSR station was estimated to be the closest possible location on an existing rail right of way to the central business district. For each station, ESRI GIS data was used to calculate the number of jobs accessible within a 2.5 minute drive time, thereby capturing business activity within walking distance or a short cab ride from the station.

TREDIS Method for Estimating Market Access Impacts

The TREDIS analysis system used for this study incorporates an array of detailed metrics on different forms of market access impact caused by transportation changes, and their statistical relationships to broader economic change.[6] As discussed above, the critical measure in this study is access to population and employment within 3 hours, which captures the effects of input matching, input and resource sharing, and knowledge spillovers. The 3-hour threshold reflects the outer-limit within which a person can make a same-day trip, which has been shown to be an important part of participating in research and development networks, utilizing specialized suppliers or vendors, and generally maintaining business relationships.

[6] The statistical relationships were estimated via a two-stage least squares (2SLS) simultaneous regression of eight access measures on employment density, labor productivity, and international export for 54 industry sectors. The access measures included access to domestic airport, international airport, same-day highway market access, same-day rail market access, labor market access and connectivity to intermodal rail facility, seaport, international land gateway. The system was estimated using 2007 data for all 3100+ U.S. counties. See TREDIS v3.6.4 Technical Document: Market Access Module for further explanation.

The TREDIS market access calculations estimate two effects related to access. The first is the propensity of an industry to locate in regions with good accessibility, reflecting the fact that good access can serve as a competitive advantage for industry location. Second, through the mechanisms of agglomeration discussed by Krugman and others, better access leads to greater industry productivity. Both mechanisms are facilitated by high speed rail access, and therefore lead to business expansion and economic growth for the Chicago metropolitan area.

Business attraction and productivity sensitivity to market access differs substantially depending on the specific industry and form of market access. While the actual calculation of market access impacts utilized detailed regression estimates, the general relationships are illustrated in Table A-5. That table ranks industry sensitivity for relevant Chicago area industries to four selected access measures on a scale of 1 to 10 (where 10 indicates highest benefit from increased market access). The table shows that enhanced labor market access particularly benefits productivity for technology-oriented service industries. However, highway market access yields strongest productivity gains for manufacturing industries that depend on just-in-time supply chains, though some industries such as financial services are also attracted to areas where there is a greater market scale. Both same day rail market access and airport market access tend to provide particularly notable benefits for professional, scientific, technical, internet, recreation, and publishing services.

Table A-5: Sensitivity to Access Measures (Scale of 1-10)

NAICS	Sector Description	40-min Population	3-hr Employment by Road	3-Hr Employment by HSR	Domestic Airport
111	Crop Production	3	5	0	0
112	Animal Production	0	5	0	0
113	Forestry & Logging	5	0	0	2
114	Fishing, Hunting & Trapping	3	3	0	0
115	Support for Agriculture & Forestry	3	0	2	0
211	Oil & Gas Extraction	0	0	0	2
212-213	Mining & Support Activities	3	0	3	4
221	Utilities	5	0	2	3
230	Construction	8	5	4	7
311	Food Products	3	0	3	2
312	Beverage & Tobacco Products	10	0	4	0
313	Textile Mills	5	5	3	2
314	Textile Product Mills	5	10	3	0
315	Apparel Manufacturing	5	5	4	0
316	Leather & Allied Products	5	3	1	2
321	Wood Products	0	5	0	0
322	Paper Manufacturing	0	5	0	0
323	Printing & Related Support Activities	10	10	5	7
324	Petroleum & Coal Products	6	0	3	0
325	Chemical Manufacturing	5	3	5	4
326	Plastics & Rubber Products	8	10	5	2
327	Nonmetallic Mineral Products	5	5	4	4
331	Primary Metal Manufacturing	3	5	5	4
332	Fabricated Metal Products	10	8	7	2
333	Machinery Manufacturing	6	5	6	2
334	Computer & Electronic Products	3	8	7	2
335	Electric Equipment, Appliances, etc.	0	10	6	3
336	Transportation Equipment	5	5	5	3
337	Furniture & Related Products	5	10	4	3
339	Miscellaneous Manufacturing	5	5	7	5
420	Wholesale Trade	10	0	6	3
441-454	Retail Trade	8	3	8	3
481-487	Transportation	5	0	5	3
491-493	Mail, package delivery & warehousing	10	0	7	2
511	Publishing Industries (except Internet)	10	0	10	10
512	Motion Picture & Sound Recording	10	3	9	9
513	Broadcasting	10	0	7	5
514	Internet & data process svcs	8	3	7	7
521-523	Monetary, Financial, & Credit Activity	10	0	8	3
524	Insurance Carriers & Related Activities	10	3	9	5
525	Funds, Trusts, & Other Financial Vehicles	5	5	7	5
531	Real Estate	10	3	9	9
532	Rental & Leasing Services	10	0	9	5
533	Lessors of Nonfinancial Intangible Assets	6	5	6	5
541-551	Professional Scientific, Technical, Services	10	3	10	10
561	Administrative & Support Services	5	0	10	10
562	Waste Management & Remediation	3	5	4	3
611	Educational Services	10	5	8	3
621-624	Health Care & Social Services	8	0	4	0
711-713	Amusement & Recreation	5	0	8	10
721-722	Accommodations, Eating & Drinking	8	0	8	9
811-812	Repair, Maintenance, & Personal Services	5	0	5	7
813	Religious, Civic, Professional, Organizations	8	0	7	7
920	Government & non NAICs	8	5	2	7

To further illustrate these relationships, Figure A-5 on the next page shows how details of the market access impacts for one single line in Table A-1 – (#541-651) Professional, Scientific and Technical Services. It shows the "elasticity" (degree of response) for business productivity associated with changes in expanding labor markets , same day road (drive) markets, same day rail access markets and airport access. It shows that as there is a positive relationship is all four forms of access, but that same-day high speed rail market area and same-day road access market area have increasing returns to scale that are particularly notable for counties having population above 100,000 persons. Similar curves exist for the other industry sectors, and were applied to calculate the economic growth implications of alternative high speed rail scenarios

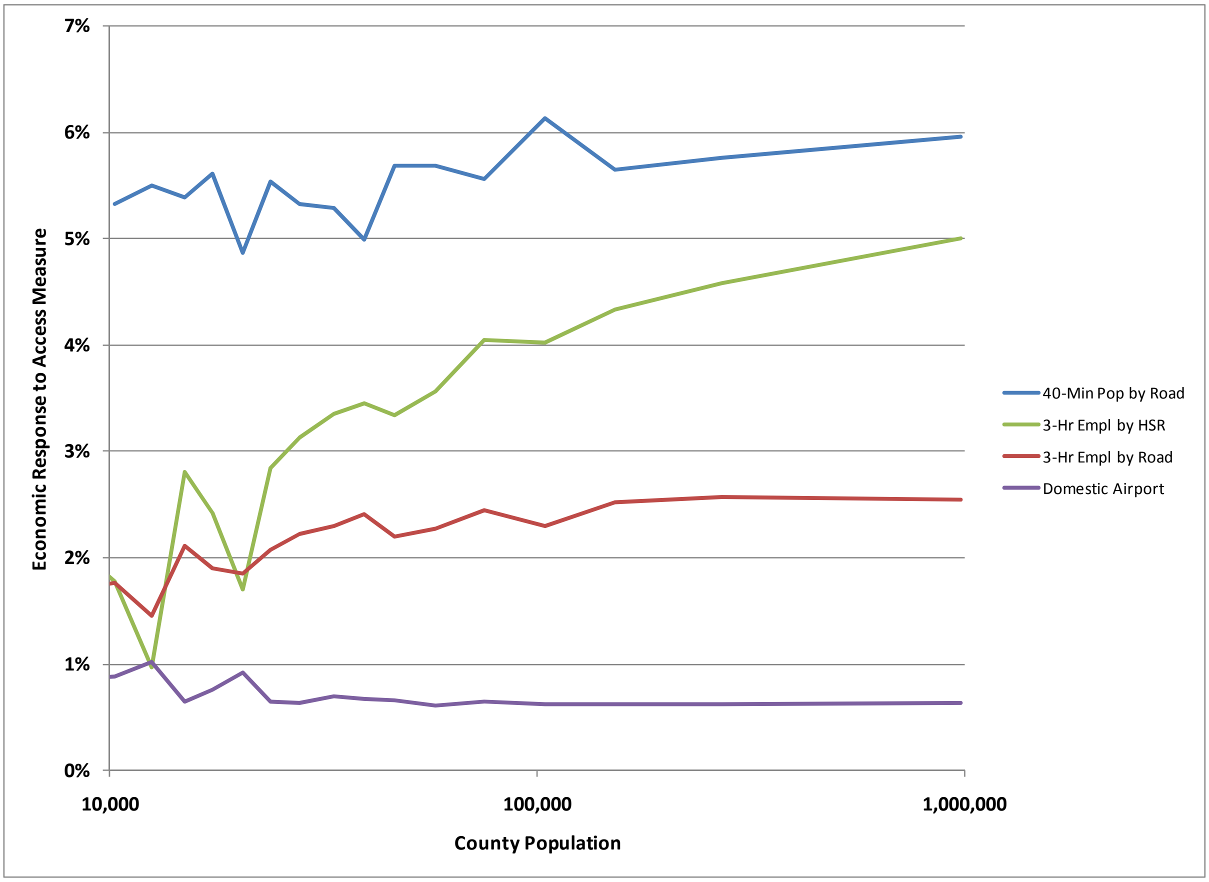

Figure A-5: Sensitivity to Market Access for Professional, Scientific, Technical Services Sector

HSR Impacts

The impacts from introducing 150 and 220 mph high speed rail service in Chicago are therefore the outcome of the applied statistical model described above. In order to generate total economic impacts, each industry was run through the market access model. The specific industry outcome is a function of (1) the strength of that industry within the Chicago region, (2) that industry's sensitivity to the regional access measure being changed, and (3) a range of other transportation factors and control variables (such as worker skill) that help explain how accessibility translates to industry performance.

To prevent double-counting, the "raw" market access results were reduced by the direct visitor spending impacts shown in Table A-3. Therefore, the resulting market impacts for sectors related to visitor spending are interpreted as impacts over and above those impacts. The net effect of those sectors, and total direct impacts for all other sectors are shown in Table A-6, listed in descending order by sector.

Table A-6 indicates that from a market access perspective, Professional, Scientific, Technical Services is the single biggest beneficiary of high speed rail investment, followed by Computer and Electronic Products. What these sectors have in common is that they are both high-skilled industries that rely heavily on communication for research and development and other business activities. More generally, Table A-6 shows that service sectors are more strongly affected than manufacturing sectors, and the latter are effected to the extent that they are high skill and information-based in nature.

Table A-6: Direct impact of market access improvements after controlling for visitor spending impacts

NAICS	Industry Description	Additional Direct Business Output from Market Access Improvement ($m) 220 MPH	150 MPH
541-551	Professional Scientific, Technical, Services	1,393	675
334	Computer & Electronic Products	460	223
441-454	Retail Trade	337	149
491-493	Mail, package delivery & warehousing	324	157
561	Administrative & Support Services	295	143
521-523	Monetary, Financial, & Credit Activity	198	96
621-624	Health Care & Social Services	169	82
513	Broadcasting	162	79
524	Insurance Carriers & Related Activities	153	74
611	Educational Services	82	40
531	Real Estate	66	32
532	Rental & Leasing Services	64	31
811-812	Repair, Maintenance, & Personal Services	60	29
533	Lessors of Nonfinancial Intangible Assets	56	27
511	Publishing Industries (except Internet)	44	21
323	Printing & Related Support Activities	29	14
333	Machinery Manufacturing	22	10
514	Internet & data process svcs	18	9
332	Fabricated Metal Products	17	8
311	Food Products	15	7
339	Miscellaneous Manufacturing	10	5
512	Motion Picture & Sound Recording	9	4
312	Beverage & Tobacco Products	9	4
336	Transportation Equipment	7	3
525	Funds, Trusts, & Other Financial Vehicles	7	3
813	Religious, Civic, Professional, Organizations	6	3
337	Furniture & Related Products	6	3
327	Nonmetallic Mineral Products	3	1
562	Waste Management & Remediation	2	1
326	Plastics & Rubber Products	1	1
313	Textile Mills	1	1
315	Apparel Manufacturing	1	0
325	Chemical Manufacturing	1	0
314	Textile Product Mills	1	0
	Total – All Sectors	4,028	1,935

A-5. Total Impacts

Finally, the direct economic impacts from travel time and cost, visitor spending, and market access were used to calculate total economic impacts. This step was performed in TREDIS to yield the impacts shown in Tables 6 and 7.

Table A-6: Total economic impacts from 150 service (2030)

		COST SAVINGS - 150 MPH				VISITOR SPENDING - 150 MPH*				MARKET ACCESS - 150 MPH			
NAICS	Industry	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wages ($ mil.)	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wages ($ mil.)	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wages ($ mil.)
111	Crop Production	6.4	2.596	68	0.763	0.190	0.077	2	0.023	0.661	0.268	7	0.079
112	Animal Production	2.356	0.805	25	0.276	0.292	0.100	3	0.034	0.769	0.263	8	0.09
113	Forestry & Logging	0.134	0.068	1	0.019	0.014	0.008	0	0.002	0.054	0.027	0	0.008
114	Fishing, Hunting & Trapping	0.315	0.204	2	0.032	0.052	0.034	0	0.006	0.075	0.048	1	0.007
115	Support for Agriculture & Forestry	0.098	0.08	3	0.1	0.001	0.001	0	0.001	0.006	0.005	0	0.007
211	Oil & Gas Extraction	14.946	8.977	10	3.832	4.700	2.823	3	1.205	15.199	9.129	10	3.897
212-213	Mining & Support Activities	0.088	0.051	0	0.028	0.007	0.004	0	0.002	0.032	0.018	0	0.01
221	Utilities	54.411	31.386	53	9.619	11.203	6.463	11	1.980	45.452	26.218	44	8.035
230	Construction	33.338	15.523	196	12.908	4.955	2.307	29	1.918	21.39	9.959	125	8.282
311	Food Products	97.136	20.477	234	15.68	23.639	4.983	57	3.816	60.438	12.741	146	9.756
312	Beverage & Tobacco Products	25.533	5.418	33	2.97	3.646	0.774	5	0.424	17.329	3.677	22	2.015
313	Textile Mills	0.859	0.209	3	0.202	0.016	0.004	0	0.004	1.101	0.268	4	0.259
314	Textile Product Mills	3.106	0.606	13	0.507	0.032	0.007	0	0.006	0.159	0.031	1	0.026
315	Apparel Manufacturing	6.266	1.551	39	1.49	0.269	0.067	2	0.064	2.7	0.668	17	0.642
316	Leather & Allied Products	0.812	0.185	4	0.176	0.040	0.009	0	0.008	0.248	0.056	1	0.054
321	Wood Products	2.323	0.832	14	0.596	0.388	0.139	2	0.100	1.33	0.476	8	0.341
322	Paper Manufacturing	5.821	1.364	15	1.22	0.056	0.013	0	0.012	0.294	0.069	1	0.062
323	Printing & Related Support Activities	5.159	3.092	41	2.663	0.753	0.451	6	0.388	21.587	12.94	171	11.143
324	Petroleum & Coal Products	51.937	11.051	9	4.29	17.451	3.713	3	1.441	54.795	11.659	10	4.526
325	Chemical Manufacturing	65.243	22.063	71	10.934	5.893	1.992	7	0.987	42.833	14.484	47	7.179
326	Plastics & Rubber Products	26.026	9.139	87	5.829	4.034	1.416	13	0.904	21.353	7.499	71	4.782
327	Nonmetallic Mineral Products	0.799	0.334	2	0.196	0.030	0.013	0	0.008	2.13	0.891	6	0.522
331	Primary Metal Manufacturing	4.758	1.16	5	0.618	0.193	0.047	0	0.025	2.562	0.624	3	0.333
332	Fabricated Metal Products	21.059	8.147	81	5.599	0.410	0.159	2	0.109	12.354	4.779	48	3.284
333	Machinery Manufacturing	21.741	7.779	68	5.645	1.721	0.616	6	0.447	23.468	8.397	73	6.093
334	Computer & Electronic Products	26.339	6.777	78	6.387	2.142	0.551	7	0.519	306.414	78.837	908	74.302
335	Electric Equipment, Appliances, etc.	10.392	3.338	30	2.306	0.323	0.103	1	0.071	2.699	0.867	8	0.599
336	Transportation Equipment	41.882	13.037	103	9.953	1.663	0.518	4	0.395	12.584	3.917	31	2.99
337	Furniture & Related Products	9.052	3.171	52	2.876	0.871	0.306	5	0.276	7.901	2.768	45	2.51
339	Miscellaneous Manufacturing	22.095	11.584	76	8.976	1.903	0.998	7	0.773	18.083	9.481	62	7.346
420	Wholesale Trade	137.662	90.698	597	53.572	21.688	14.289	94	8.440	124.263	81.871	539	48.358
441-454	Retail Trade	270.843	189.233	3,743	117.687	60.807	42.485	841	26.422	315.074	220.137	4,355	136.906
481-487	Transportation	70.487	32.086	370	23.193	91.927	41.845	483	30.248	56.101	25.537	295	18.459
491-493	Mail, package delivery & warehousing	29.628	21.063	371	16.589	10.432	7.416	131	5.841	31.722	22.551	398	17.761
511	Publishing Industries (except Internet)	17.549	8.301	61	5.076	2.242	1.061	8	0.649	39.886	18.866	138	11.537
512	Motion Picture & Sound Recording	11.627	2.935	51	1.971	1.489	0.376	7	0.252	22.85	5.767	100	3.873
513	Broadcasting	32.785	17.419	67	7.134	1.535	0.816	3	0.334	111.387	59.181	227	24.238
514	Internet & data process svcs	23.483	12.086	98	7.522	5.263	2.709	22	1.686	48.492	24.956	201	15.533
521-523	Monetary, Financial, & Credit Activity	128.228	77.397	504	46.902	18.869	11.389	74	6.902	255.465	154.197	1,003	93.441
524	Insurance Carriers & Related Activities	79.14	36.151	314	26.279	13.447	6.143	54	4.465	172.68	78.879	684	57.341
525	Funds, Trusts, & Other Financial Vehicles	14.17	3.537	37	2.923	1.781	0.445	5	0.368	16.514	4.122	43	3.407
531	Real Estate	117.963	88.174	344	10.304	23.154	17.307	68	2.023	162.439	121.419	474	14.189
532	Rental & Leasing Services	15.062	6.586	72	4.216	2.835	1.239	13	0.794	51.579	22.554	245	14.436
533	Lessors of Nonfinancial Intangible Assets	3.803	2.444	4	0.28	1.247	0.801	1	0.092	39.309	25.26	40	2.893
541-551	Professional Scientific, Technical, Services	234.394	151.708	1,280	125.944	43.892	28.409	240	23.584	1,072.72	694.305	5,859	576.391
561	Administrative & Support Services	105.627	66.572	1,672	54.548	15.163	9.557	240	7.831	260.435	164.14	4,123	134.494
562	Waste Management & Remediation	6.172	3.254	26	2.028	1.634	0.861	7	0.537	7.045	3.714	29	2.315
611	Educational Services	44.068	26.021	621	23.998	3.440	2.032	49	1.874	68.427	40.405	965	37.264
621-624	Health Care & Social Services	338.872	207.753	3,789	182.183	27.267	16.717	305	14.659	270.531	165.855	3,024	145.442
711-713	Amusement & Recreation	42.019	26.059	642	17.685	84.564	52.445	1293	35.591	30.63	18.996	468	12.891
721-722	Accommodations, Eating & Drinking	232.35	122.293	3,559	83.37	209.377	110.201	3207	75.127	94.481	49.728	1,447	33.901
811-812	Repair, Maintenance, & Personal Services	74.927	40.954	756	24.785	8.972	4.905	90	2.968	83.822	45.816	845	27.728
813	Religious, Civic, Professional, Organizations	25.995	14.994	332	16.261	3.342	1.928	42	2.090	25.622	14.779	327	16.028
920	Government & non NAICs	21.057	19.431	264	17.185	6.651	6.137	84	5.427	144.787	133.607	1,819	118.162
	Total	2,638.34	1,458.15	20,991	988.322	747.906	410.208	7,530	274.150	4,202.27	2,417.71	29,528	1,726.17

Table A-7: Total economic impacts from 220 service (2030)

		COST SAVINGS - 220 MPH				VISITOR SPENDING - 220 MPH				MARKET ACCESS - 220 MPH			
NAICS	Industry	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wages ($ mil.)	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wages ($ mil.)	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wages ($ mil.)
111	Crop Production	8.166	3.312	87	0.973	0.287	0.116	3	0.035	1.456	0.59	16	0.173
112	Animal Production	3.013	1.029	32	0.353	0.44376	0.151067	4	0.051405	1.696	0.579	18	0.199
113	Forestry & Logging	0.172	0.087	1	0.024	0.022031	0.01154	0	0.003147	0.118	0.06	1	0.017
114	Fishing, Hunting & Trapping	0.402	0.26	3	0.04	0.078681	0.051405	1	0.007344	0.164	0.106	1	0.016
115	Support for Agriculture & Forestry	0.124	0.102	4	0.127	0.002098	0.001049	0	0.002098	0.014	0.012	0	0.015
211	Oil & Gas Extraction	19.159	11.508	13	4.913	7.115893	4.273942	5	1.824346	33.474	20.106	23	8.583
212-213	Mining & Support Activities	0.112	0.065	0	0.036	0.010491	0.006294	0	0.003147	0.07	0.04	0	0.022
221	Utilities	69.67	40.187	68	12.316	16.97303	9.789992	17	3.000362	100.036	57.703	97	17.684
230	Construction	43.24	20.134	254	16.742	7.505101	3.494477	44	2.905945	47.066	21.915	276	18.223
311	Food Products	124.402	26.224	300	20.081	35.82075	7.55126	86	5.782515	133.306	28.101	322	21.519
312	Beverage & Tobacco Products	32.599	6.917	42	3.792	5.525491	1.172869	7	0.643085	38.103	8.085	49	4.432
313	Textile Mills	1.098	0.267	4	0.258	0.024129	0.005245	0	0.005245	1.218	0.297	5	0.286
314	Textile Product Mills	3.962	0.773	17	0.646	0.049307	0.009442	0	0.008393	1.35	0.263	6	0.22
315	Apparel Manufacturing	7.989	1.978	50	1.9	0.408091	0.100711	2	0.096515	4.728	1.17	30	1.125
316	Leather & Allied Products	1.037	0.236	6	0.224	0.060846	0.013638	0	0.013638	0.547	0.125	3	0.119
321	Wood Products	2.994	1.072	18	0.768	0.588533	0.210865	3	0.151067	2.938	1.052	17	0.754
322	Paper Manufacturing	7.476	1.752	19	1.567	0.084975	0.019932	0	0.017834	0.646	0.151	2	0.135
323	Printing & Related Support Activities	6.63	3.974	53	3.422	1.140347	0.683999	9	0.588533	47.26	28.329	375	24.395
324	Petroleum & Coal Products	66.593	14.17	12	5.5	26.42207	5.622007	4	2.182081	120.699	25.682	21	9.969
325	Chemical Manufacturing	83.608	28.273	91	14.012	8.926601	3.018196	9	1.495985	95.079	32.152	104	15.935
326	Plastics & Rubber Products	33.485	11.759	112	7.499	6.110877	2.145364	20	1.369046	46.774	16.426	156	10.476
327	Nonmetallic Mineral Products	1.016	0.425	3	0.249	0.046159	0.018883	0	0.01154	4.285	1.792	13	1.049
331	Primary Metal Manufacturing	6.151	1.499	7	0.799	0.291644	0.071337	0	0.037767	5.601	1.365	6	0.727
332	Fabricated Metal Products	27.242	10.539	105	7.243	0.621054	0.240239	2	0.164705	26.164	10.122	101	6.956
333	Machinery Manufacturing	28.03	10.029	87	7.278	2.605909	0.93263	8	0.676655	52.22	18.684	163	13.559
334	Computer & Electronic Products	33.799	8.696	100	8.196	3.244797	0.835066	9	0.786808	669.594	172.278	1,984	162.369
335	Electric Equipment, Appliances, etc.	13.396	4.303	39	2.973	0.48887	0.157362	1	0.108055	5.922	1.902	17	1.314
336	Transportation Equipment	53.399	16.622	131	12.69	2.518835	0.783661	6	0.599023	27.911	8.688	68	6.633
337	Furniture & Related Products	11.61	4.068	66	3.688	1.31974	0.462643	7	0.419631	17.783	6.231	102	5.649
339	Miscellaneous Manufacturing	28.348	14.862	98	11.516	2.882865	1.511721	9	1.170771	38.502	20.186	133	15.641
420	Wholesale Trade	176.42	116.234	765	68.655	32.85396	21.64562	143	12.78511	273.061	179.905	1,184	106.263
441-454	Retail Trade	348.761	243.673	4,820	151.544	92.06705	64.32524	1273	40.00552	724.838	506.432	10,018	314.957
481-487	Transportation	90.335	41.121	475	29.724	139.1454	63.33911	731	45.78489	125.471	57.115	659	41.285
491-493	Mail, package delivery & warehousing	38.135	27.11	478	21.352	15.79911	11.23142	198	8.845822	70.277	49.959	881	39.349
511	Publishing Industries (except Internet)	22.47	10.628	78	6.5	3.394815	1.606138	12	0.981937	86.695	41.007	300	25.077
512	Motion Picture & Sound Recording	14.9	3.761	65	2.526	2.255517	0.569649	9	0.382913	50.044	12.63	219	8.482
513	Broadcasting	41.764	22.189	85	9.088	2.325805	1.235813	5	0.505655	242.342	128.758	494	52.735
514	Internet & data process svcs	30.268	15.577	126	9.696	7.97194	4.102942	34	2.553455	106.53	54.826	442	34.125
521-523	Monetary, Financial, & Credit Activity	163.951	98.96	644	59.968	28.57582	17.24893	112	10.45196	559.793	337.887	2,199	204.755
524	Insurance Carriers & Related Activities	101.182	46.219	401	33.599	20.36679	9.30322	81	6.763403	379.696	173.442	1,505	126.083
525	Funds, Trusts, & Other Financial Vehicles	18.1	4.518	47	3.734	2.697178	0.673508	7	0.556011	35.503	8.861	93	7.324
531	Real Estate	151.183	113.006	441	13.205	35.07276	26.21645	103	3.063306	356.145	266.209	1,039	31.108
532	Rental & Leasing Services	19.269	8.426	92	5.393	4.292825	1.8768	20	1.201194	113.231	49.513	538	31.692
533	Lessors of Nonfinancial Intangible Assets	4.894	3.145	5	0.36	1.88834	1.213783	2	0.138478	85.062	54.66	87	6.26
541-551	Professional Scientific, Technical, Services	302.851	196.016	1,654	162.727	66.48214	43.03001	363	35.72214	2,348.30	1,519.91	12,825	1,261.78
561	Administrative & Support Services	137.02	86.357	2,169	70.76	22.96326	14.47307	364	11.85877	570.328	359.451	9,030	294.528
562	Waste Management & Remediation	7.911	4.171	33	2.6	2.474774	1.305052	10	0.813035	15.281	8.056	64	5.021
611	Educational Services	56.844	33.566	801	30.956	5.210768	3.076944	73	2.837755	149.15	88.072	2,103	81.224
621-624	Health Care & Social Services	435.384	266.922	4,868	234.07	41.30008	25.31949	462	22.20373	592.679	363.355	6,626	318.634
711-713	Amusement & Recreation	54.021	33.503	826	22.736	127.9948	79.3795	1957	53.86908	67.191	41.671	1,027	28.279
721-722	Accommodations, Eating & Drinking	301.132	158.495	4,613	108.049	317.3481	167.0289	4861	113.8679	207.536	109.232	3,179	74.466
811-812	Repair, Maintenance, & Personal Services	96.139	52.548	969	31.802	13.5908	7.428518	137	4.495297	184.525	100.859	1,861	61.04
813	Religious, Civic, Professional, Organizations	33.209	19.156	424	20.774	5.061799	2.919583	65	3.166116	55.519	32.025	708	34.73
920	Government & non NAICs	27.076	24.985	340	22.097	10.07324	9.294827	127	8.220572	316.278	291.856	3,973	258.117
	Total	3,392.14	1,875.41	27,040	1,271.74	1,132.83	621.308	11,410	415.235	9,240.21	5,319.88	65,160	3,795.51

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