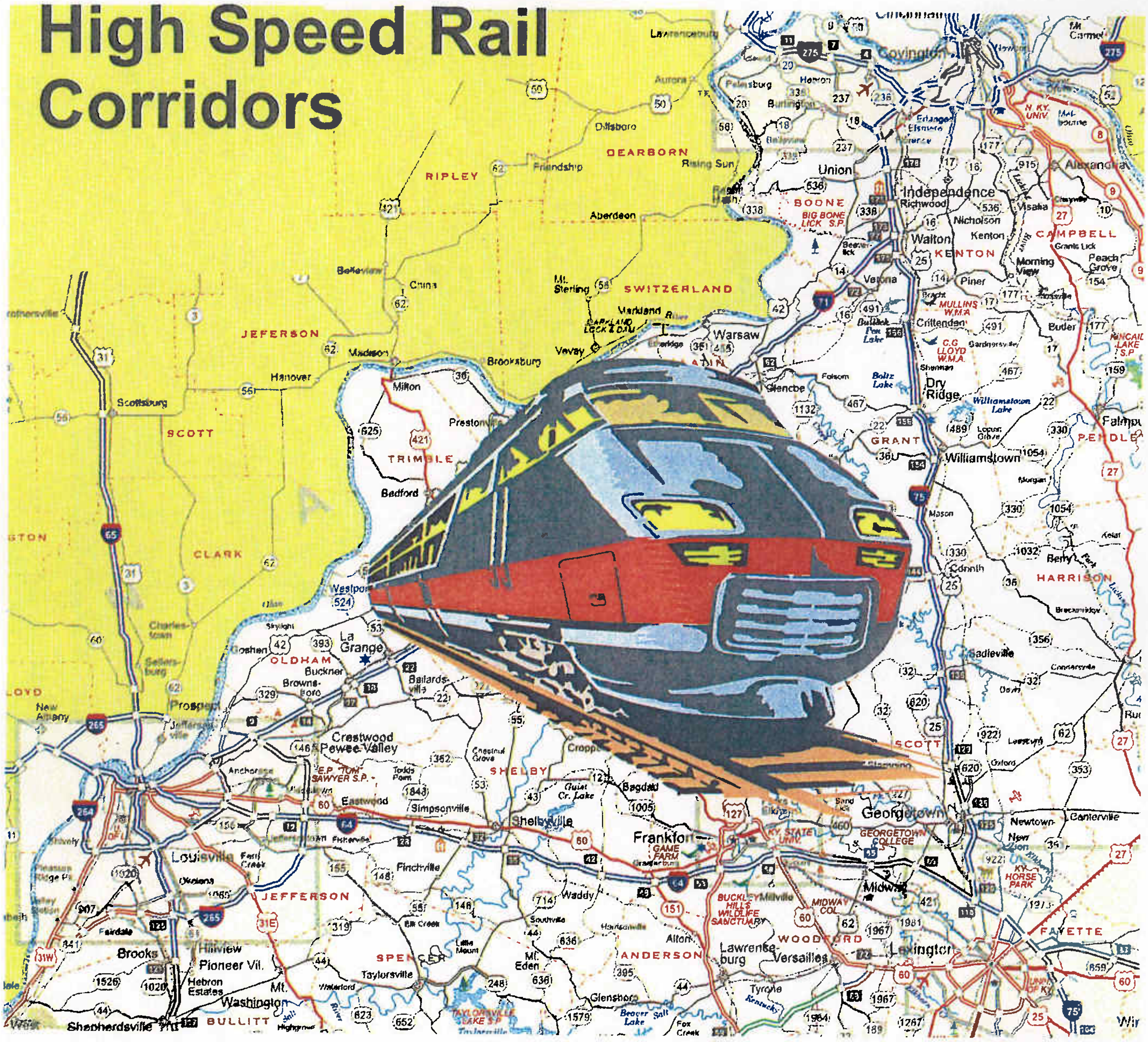
# Examination of I-75, I-64 and I-71 High Speed Rail Corridors




Prepared for

**The Kentucky Transportation Cabinet**

by

**Wilbur Smith Associates**

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# EXHIBITS

## EXECUTIVE SUMMARY

This document contains a review of high-speed rail services, proposals, and a preliminary assessment of the potential for high-speed ground transportation between the Kentucky cities of Lexington, Louisville and Covington. The service would connect the airports in the three locations. The three metropolitan areas in the study area had a combined 1997 population of 3.1 million.

**Infrastructure and Equipment –** True high-speed rail systems are operated with electric-powered trains which draw electricity from overhead wires or catenary, and require alignments appropriate for contemplated speeds (in excess of 125 mph). Extensive safety measures are necessary -- fencing of rights-of-way, grade separating rail-highway crossings and installation of advanced train control systems. Mixed freight trains and high-speed passenger trains raise serious operational and liability concerns.

**Ridership** - The rail ridership forecast shown below was designed to produce an initial "order of magnitude" of potential patronage. It is based on a comparison of the Kentucky corridors with an existing rail corridor currently operating in the U.S. and adjusting for some of the differences between those corridors.

| City 1 | City 2 | Year 2000 Annual Passengers |
|---|---|---|
| Louisville | Lexington/Frankfort CMSA | 22,419 |
| Louisville | Cincinnati | 39,381 |
| Cincinnati | Lexington/Frankfort CMSA | 28,112 |
| Lexington | Frankfort | 3,650 |
| Total | | 93,563 |

Additional ridership could be derived from air connect passengers, those finding it more advantageous to use the rail system directly serving the Cincinnati or Louisville airports instead of a short commuter flight (estimated at 58,000 annually), and from a Cincinnati connection with the Midwest Regional Rail initiative.

**Revenues and Costs** - Revenues in this evaluation are generated solely from patronage using fares competitive with other land transport means. Air fares, due to the short-haul nature, are not competitive. Total revenues attributable to the system from ridership are estimated to total $5.42 and $7.71 million annually, for four and six round trips, respectively.

The costs of developing the infrastructure and acquiring the initial trainsets are included in the capital costs. An order-of-magnitude estimate to construct the 266-route-mile system is $5.48 billion. A similar estimate for the five trainsets needed for six round trips is $100 million, and the three sets needed for four round trips is $60 million. A summary follows.

| Service Frequency (round trips) | Annual Ridership Revenues ($million) | Capital Costs ($million) | Annual Operating and Maintenance Costs ($million) |
|---|---|---|---|
| 4 | $5.4 | $5,539.6 | $38.3 |
| 6 | 7.7 | 5,579.6 | 42.9 |

**Conclusions** - The high-speed rail proposal discussed in this document is estimated to produce only 15 percent of the revenue needed to cover operating costs, and no contribution toward capital costs. Two major factors work against the proposal. First, the system suffers from highway - competitive travel times, a situation due in large part to parallel Interstate Highways. In addition, the trips are not long enough to compete for airline traffic, the target of many HSR proposals. It may be desirable to re-examine the proposal, however, if the Cincinnati-Chicago leg of the Midwest Rail Initiative becomes a reality and proves successful. This connection would extend the effective size of the rail system permitting competitive-length trips, and providing access to a much larger travel market.

# EXAMINATION OF I-75, I-64, AND I-71 HIGH-SPEED RAIL CORRIDORS

## Study Purpose

This document contains an assessment of the potential for high-speed ground transportation between the Kentucky cities of Lexington, Louisville and Covington. The high-speed service is to take the form of a fixed guideway system, more particularly, a rail service. High-speed service is generally considered to be that which operates at or in excess of 125 mph. The service would connect the airports serving the regions surrounding the three locations with selected intermediate stops. Airport terminals were selected as opposed to downtown locations as it would be easier to access them and downtown connections already exist and are proposed to be improved in Northern Kentucky (to Cincinnati) and Louisville with Light Rail Transit connections.

The work performed is preliminary in nature in order that insight may be gained before a decision is made to devote additional resources to the investigation. It is felt that by taking benefit of the work performed previously in other investigations, a fair overview of the potential in Kentucky might be expeditiously and economically obtained.

## Study Area

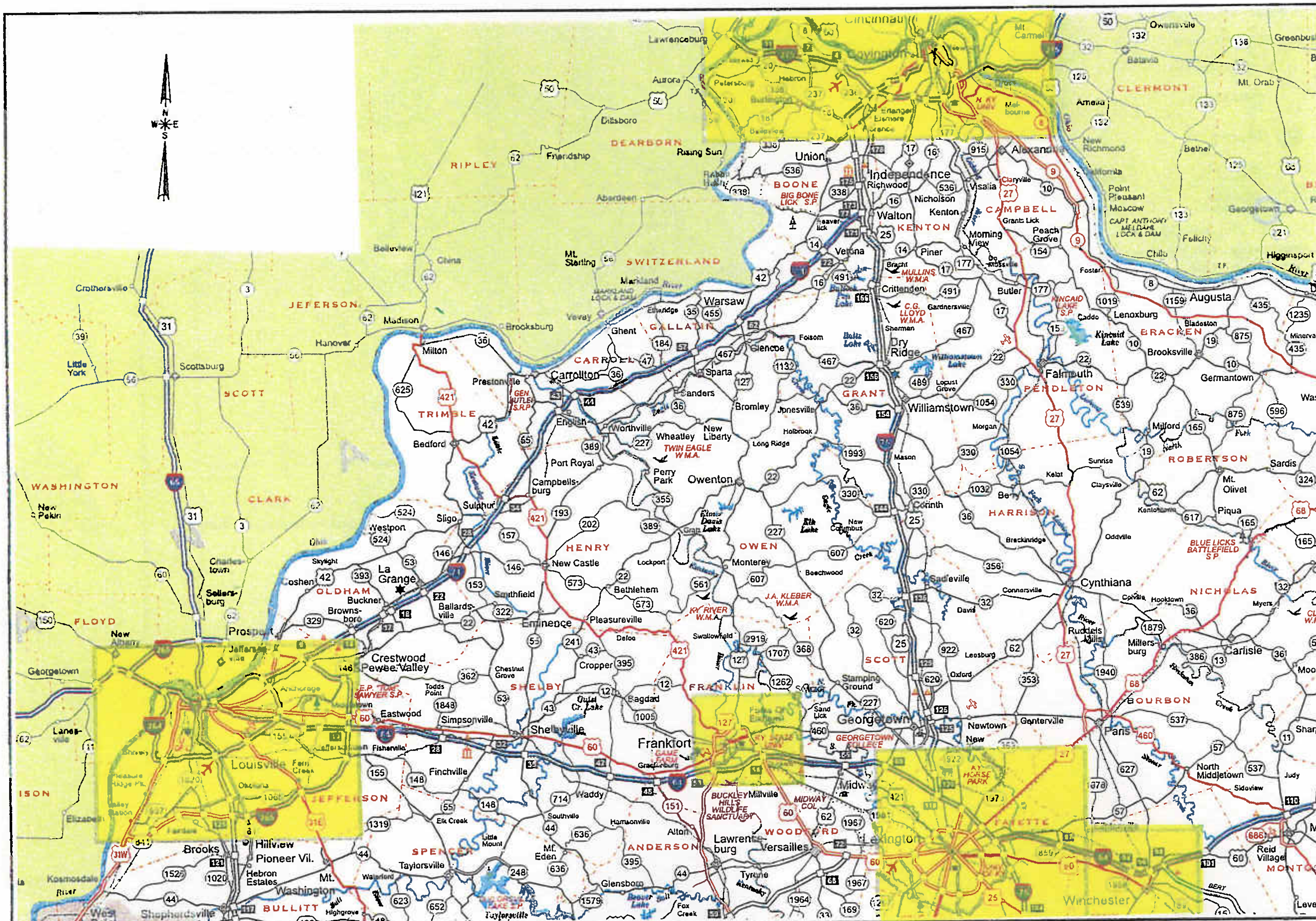
The study area includes the three metropolitan areas mentioned above -- Lexington/Frankfort, Northern Kentucky/Cincinnati and Louisville. The three metropolitan areas had a combined 1997 population of 3.1 million.

The populations centers are connected by existing highways, including Interstates, as evident in Exhibit 1. Interstate 75 connects Lexington with Northern Kentucky and Cincinnati; Interstate 71 connects Northern Kentucky with Louisville; and, Interstate 64 connects Louisville with Lexington.

The study area is also well served with existing rail lines. A principal mainline of the Norfolk Southern Railway (NS) runs between Lexington and Northern Kentucky, and a similar line of CSX Transportation (CSXT) connects Northern Kentucky with Louisville. Other lines of both CSXT and NS lie in the area between Lexington and Louisville, but CSXT has the only line which connects the two.

## High-Speed Rail Services

High-speed rail (HSR) services are currently available in parts of Europe, Asia and the United States. Although many proposals have been advanced in the US, the only high-speed service currently provided is by Amtrak on its Northeast Corridor between Washington, DC and New York City. The Corridor between New York and Boston is now being improved with electrification and new trains for similar operations. The overseas services, although they operate in part over existing rail lines, run primarily over new lines designed and constructed exclusively HSR.




| | | | |
|---|---|---|---|
| 0 | 10 | 20 | 30 |

*APPROXIMATE SCALE*
*In miles*

# STUDY AREA

**Exhibit 1**

**Northeast Corridor** - The Northeast Corridor service is operated over rail lines constructed many years ago (some in the 1830s and 1840s) and operated as conventional, albeit electrified, railroads until the Northeast Corridor Improvement Program was initiated in the 1970s. The Corridor has constantly been improved over the years, a process that continues, with operations currently limited to a top speed of 125 mph by designated trains. The improvements just begun on the New York - Boston segment will permit top speeds of 150 mph using new trains which have the ability to tilt in curves improving passenger comfort when traversing curves at high speeds. Amtrak operates at the pleasure of the US Congress with its budget, both capital and operating, established annually.

**Bullet Trains** - The Japanese Shinkansen or "Bullet" Trains commonly comes to mind whenever HSR services are discussed. The original Bullet Trains began operating at speeds of 131 mph in 1964, but the newer routes are designed for top speeds up to 180 mph. Service is provided or planned throughout the country.

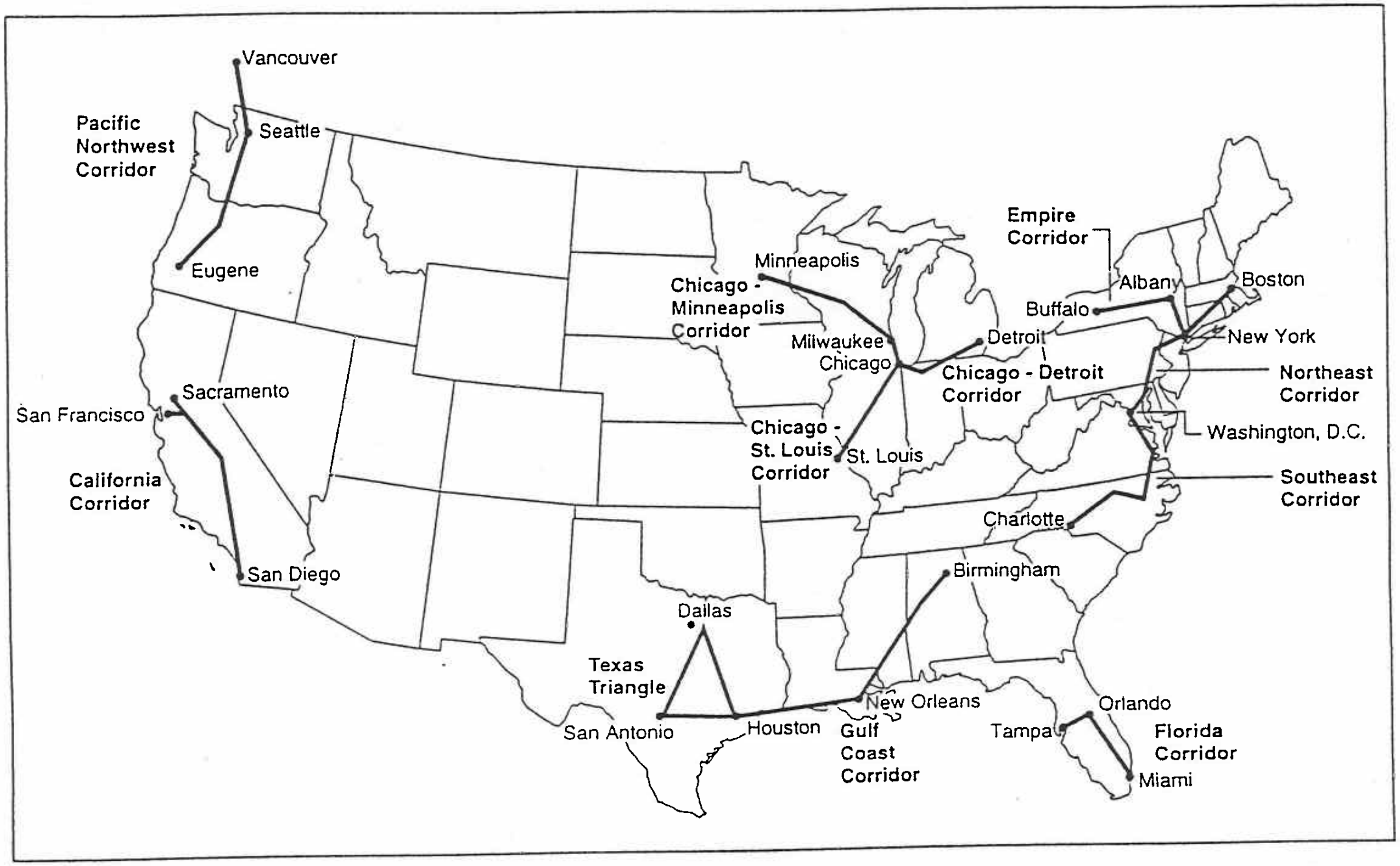
**TGV** - Another easily recognized HSR operation is the French train a' Grande Vitesse (TGV). The first in Europe, it began commercial service between Paris and Lyon in 1981. This train operates at a top speed of 186 mph and with improvements top speeds of 200 mph are expected. An European network of HSR operations are planned connecting with England through the Chunnel and the Eurostar operations which use it now. The TGV operates over lines constructed for its use except in major urban areas where it uses existing rail lines and operates at restricted speeds.

**Other Trains** - A variety of trains are being used/developed in other countries. Two of them, the German Intercity Express (ICE) and the Swedish X-2000 toured this country several years ago. The X-2000 is one of a breed of trains designed to tilt when entering curves to increase passenger comfort at speeds higher than the curves were originally designed to be operated. This feature permits the operation of trains some 30 percent faster through curves than conventional rail equipment. The Spanish Talgo is another such train and is currently being used not only on Spanish railways, but in the Pacific Northwest Corridor in Oregon, Washington State and British Columbia, Canada. The train operates over existing Burlington Northern Santa Fe lines connecting Vancouver, BC with Portland, OR via Seattle, WA.

**Maglev** - No discussion of high speed ground transport is complete without mention of magnetic levitation (maglev) technology being developed in Japan, Germany and the US to operate at speeds in excess of 250 mph. While test systems have been operated for this technology, it is yet to be put into commercial service.

## US High-Speed Rail Proposals

While Amtrak's Northeast Corridor is the only US rail service approaching true HSR operations, several systems have been, and still are, proposed for many parts of the country. Exhibit 2 is a map of many of the proposals, none of which have been




**EXISTING/PROPOSED US HIGH-SPEED RAIL CORRIDORS**

**Exhibit 2**

Source: U.S. General Accounting Office

developed as true HSR. Most of the proposals were to be financed through the private sector and for one reason or the other were never advanced.

**FOX** - A new proposal, the Florida Overland eXpress (FOX) was being progressed in Florida until early this year (1999). This attempt at establishing a Miami-Orlando-Tampa service was being partially funded by the State of Florida which has committed $70 million annually to HSR. A request of $500 million in federal funds was approved in TEA-21, but not authorized. Doubts over ridership and revenue forecasts and the need for a $2 billion loan from the Transportation Investment Finance and Innovation Act (TIFIA) of TEA-21, resulted in new Florida Governor Bush terminating the project in January of 1999.

**Incremental Approaches** - Although true high-speed systems on new alignments are yet to make the American scene, several incremental approaches to HSR are being progressed. These efforts differ from true HSR in that they make use of existing rail lines and obtain the best operating speeds that they can using a combination of selected line improvements such as curve reductions, improved signal systems, added grade crossing warning devices, and equipment technologies, such as tilt trains. In addition to operating on alignments designed for railway operations of 100 years+/- ago, they typically have to contend with freight operations and the many physical and operating restrictions that go along with mixed-service lines.

Detroit to Chicago, where an improved train control signal system will permit top speeds of 110 mph, is one example of such a project. The Detroit-Chicago Corridor has become one component of the Midwest Regional Rail Initiative (MRRI), an ongoing effort to develop improved passenger service on a regional basis. It is sponsored by the Federal Railroad Administration (FRA), Amtrak, and the DOTs of nine states. The system is comprised of several existing rail lines comprising eight corridors radiating from a Chicago hub. The terminal points, many of which are the most significant cities in the Midwest, are comprised of the Twin Cities, Omaha, Kansas City via St. Louis, Carbondale, Cincinnati via Indianapolis, Cleveland, Green Bay, Pontiac via Detroit, Port Huron, and Holland via Grand Rapids. The current proposal calls for improvement of existing infrastructure to permit top operating speeds of 79 to 90 mph with subsequent improvements at a later date to 110 mph.

Use of the Spanish Talgo tilting train on BNSF lines in the Pacific Northwest combined with selected improvements, both to increase operating speeds and to increase line capacity to permit freight and passenger operations on the same line, is another. In many eyes, Amtrak's Northeast Corridor is seen as an incremental approach rather than true HSR.

## Infrastructure and Associated Facilities

The principal difference between a true HSR approach and an incremental effort is the design and construction a new line of railroad specifically for high-speed operations. Not only does the alignment have to be appropriate for the contemplated speeds, but extensive safety measures have to be incorporated in the corridor because of the high-speed nature of the operations.

**Alignment and Gradient** - The horizontal geometry for speeds in excess of 125 mph are very restrictive. Curve radii for 186-mph TGV operation, for example, are restricted to 20,000 feet or the equivalent of 17 minutes (about 1/4 of a degree). Interstate highway curvature, for comparative purposes, is around 3 degrees for design speeds of 80 mph. Gradients, however, can reach a maximum of 5 percent, but lesser grades are desirable.

**Safety Features** - A variety of safety precautions have to be taken because of the high speeds. First, the right-of-way has to be fenced. All rail-highway crossings have to be grade separated, and an advanced train control system has to be installed.

**Electrification** - As discussed earlier, the rail line also has been electrified to power the trainsets. Overhead catenary is the prevailing choice, and substations have to be constructed for power supply.

**Stations** - The airport terminals will have to be modified or additions constructed for the high-speed trains. Stations at intermediate stops will have to be built.

**Other Facilities** - A variety of other facilities will have to be built to handle train operations, maintenance of track and structures, and maintenance and servicing of rolling stock and other equipment. Storage yards and layover facilities will also be needed as will crew quarters.

## Equipment

All of the truly HSR systems are operated with electric-powered trains which draw electricity from overhead wires or catenary. Straight electric, as opposed to diesel-electric (diesel engines power electric generators) locomotives, are capable of running at sustained high speeds and have more responsive acceleration and deceleration characteristics. Diesel locomotives, however, are being used in 125-mph service in England and the EMD F59PHI is built with the capability of 110-mph running for use in the USA. A non-electric gas-turbine-powered locomotive is being designed for speeds up to 150 mph.

Many of the high-speed rail proposals in this country have been based on TGV-type trainsets. Amtrak has awarded a contract to a Bombardier-GEC Alsthom consortium for its new 150-mph high-speed trainsets, the *American Flyer*. Bombardier has exclusive rights to the TGV technology in North America, and Alstom is the maker of the French TGV. The power cars are based on the TGV. The passenger cars will have trucks similar to the TGV and will be built with a tilt system to enable them to operate through curves at faster speeds than non-tilit equipment. This design feature is necessary as the Northeast Corridor uses existing rail lines, some dating back to the 1830s and 1840s, rather than operating over new lines built for high-speed operation. Selected characteristics of high-speed trainsets are shown in Exhibit 3.

**Exhibit 3**
**HIGH-SPEED TRAINSETS**

| Country | Train | Operating Speed (mph) | Unit Cost[1] ($ million) | Seats | Cost/seat[1] ($000) |
|---|---|---|---|---|---|
| Japan | Shinkansen | 168 | $32.64 | 1,321 | $24,712 |
| France | TGV-A | 186 | $16.32 | 480 | $33,992 |
| Germany | ICE | 155 | $34.69 | 759 | $45,698 |
| Sweden | X-2000 | 124 | $17.74 | 254 | $69,858 |
| Italy | ETR 500 | 186 | $32.64 | 714 | $45,719 |
| UK | IC225 | 140 | $7.55 | 480 | $15,726 |
| USA | American Flyer | 150 | $33.9[2] | 362 | $93,646[2] |

(1) April 1992 exchange rate factored up to 1998 dollars using the Producer Price Index, except American Flyer, 1998 Amtrak press releases.
(2) Includes part of 3 maintenance facilities.

Source: For European trainset data and 1992 costs, *Europe's High Speed Trains, A Study in Geo-Economics*, Mitchell P. Strohl, 1993, p. 279.

## Estimated Ridership

An investment grade ridership forecast for a potential high speed rail system between Louisville, Frankfort, Lexington and Cincinnati would require developing sophisticated mathematical travel models. Such models first estimate total travel between cities, then estimate the proportion of such travel that may be diverted to a high-speed rail service given its characteristics (stations, travel time, fares, frequency) and those of competing modes of travel (automobile and airplane mostly). Developing such models often requires conducting specialized travel surveys and is both time consuming and expensive. Typically, such investment grade ridership studies are conducted after some initial study has determined that the potential rail system maybe feasible based on realistic but much less detailed analyses.

**Study Approach** - The rail ridership forecast presented here is designed to produce an initial "order of magnitude" of potential ridership. It is not an investment grade ridership forecast. It is based on a comparison of the Kentucky corridors with an existing rail corridor currently operating in the U.S. and adjusting for some of the differences between those corridors.

In selecting an existing U.S. rail corridor for comparison purposes, the following criteria were used:

1. An existing rail corridor for which ridership information is available on a station-to-station basis;
2. An existing rail corridor with a reasonable and long established rail service;
3. An existing rail corridor serving cities whose size is similar to the proposed Kentucky cities;
4. An existing rail corridor whose distance between cities is similar to the Kentucky corridors; and
5. An existing rail corridor with similar institutional environment.

Based on these criteria, the Northeast corridor, Chicago-Milwaukee and the San Diego-Los Angeles corridors, for example, were eliminated primarily because of the size of the cities served, Chicago-St. Louis was eliminated because of the distance between cities. Many of the other corridors served by Amtrak were eliminated because rail service is very limited.

**Corridor Comparison** - Exhibit 4 describes the Detroit-to-Chicago corridor in terms of rail ridership, population and employment of the cities served and distance between cities. It, and more specifically Detroit to intermediary stations, did appear the most suited in addressing the various criteria. While Detroit is a larger city than any of the cities under study here, it isn't a megalopolis either. Some of the distances between

**Exhibit 4**
**DETROIT-CHICAGO RAIL CORRIDOR**

| City 1 | City 2 | 1985 Annual Passengers | Highway Distance | 1985 Population (000) City 1 | 1985 Population (000) City 2 | 1985 Employment (000) City 1 | 1985 Employment (000) City 2 |
|---|---|---|---|---|---|---|---|
| Detroit | Ann Arbor | 33,201 | 38 | 4,225 | 452 | 2,038 | 248 |
| | Jackson | 3,844 | 73 | 4,225 | 145 | 2,038 | 60 |
| | Battle Creek | 7,339 | 116 | 4,225 | 162 | 2,038 | 78 |
| | Kalamazoo | 19,920 | 139 | 4,225 | 253 | 2,038 | 122 |
| | Chicago | 93,661 | 279 | 4,225 | 7,301 | 2,038 | 3,913 |
| Ann Arbor | Jackson | 2,796 | 35 | 452 | 145 | 248 | 60 |
| | Battle Creek | 4,543 | 78 | 452 | 162 | 248 | 78 |
| | Kalamazoo | 11,882 | 101 | 452 | 253 | 248 | 122 |
| | Chicago | 51,374 | 241 | 452 | 7,301 | 248 | 3,913 |
| Jackson | Battle Creek | 3,145 | 43 | 145 | 162 | 60 | 78 |
| | Kalamazoo | 1,747 | 66 | 145 | 253 | 60 | 122 |
| | Chicago | 14,329 | 206 | 145 | 7,301 | 60 | 3,913 |
| Battle Creek | Kalamazoo | 5,941 | 23 | 162 | 253 | 78 | 122 |
| | Chicago | 15,727 | 163 | 162 | 7,301 | 78 | 3,913 |
| Kalamazo | Chicago | 32,152 | 140 | 253 | 7,301 | 122 | 3,913 |
| Total Without Chicago | | 94,360 | | 5,237 | | 2,546 | |

cities are similar to the Kentucky corridors and the competitive environment can be considered similar as interstate highways connect the various cities in both corridors. In addition, Wilbur Smith Associates possessed some detailed ridership data having previously conducted a study of this corridor.

The first comparison between the Detroit-Chicago corridor and the Kentucky corridors was based on population and distance between cities. Exhibit 5 shows the same characteristics of the Kentucky corridors. While there is no perfect match between the city pairs in the Kentucky corridor and the Detroit-to-Chicago corridor, a portion of it, Detroit to Battle Creek/Kalamazoo, appeared a good starting point for Louisville to Lexington/Frankfort and Cincinnati to Lexington/Frankfort. In the same fashion, Lexington to Frankfort may be best compared to Battle Creek to Kalamazoo in terms of distance and overall population.

**Exhibit 5**
**PROPOSED KENTUCKY HSR CORRIDORS**

| City 1 | City 2 | Highway Distance | 2000 Population (000) | | 2000 Employment (000) | |
|---|---|---|---|---|---|---|
| | | | City 1 | City 2 | City 1 | City 2 |
| Louisville | Lexington/Frankfort CMSA | 83 | 1,009 | 505 | 659 | 352 |
| | Cincinnati | 105 | 1,009 | 1,596 | 659 | 1,019 |
| Cincinnati | Lexington/Frankfort CMSA | 88 | 1,596 | 505 | 1,019 | 352 |
| Lexington | Frankfort | 29 | 252 | 47 | 201 | 38 |
| **Total** | | | **3,110** | | **2,029** | |

Note: See Exhibit 11 for schematic diagram of routes.

**Estimated Ridership** - After adjustment for population and employment, annual potential ridership for a rail service between Louisville, Cincinnati and Lexington similar to the Detroit-Chicago service was estimated as shown in Exhibit 6 for the Year 2000.

**Exhibit 6**
**POTENTIAL CORRIDOR RIDERSHIP**
**Amtrak-Type Service**

| City 1 | City 2 | Year 2000 Annual Passengers |
|---|---|---|
| Louisville | Lexington/Frankfort CMSA | 22,419 |
| Louisville | Cincinnati | 39,381 |
| Cincinnati | Lexington/Frankfort CMSA | 28,112 |
| Lexington | Frankfort | 3,650 |
| Total | | 93,563 |

The rail service in the Detroit-Chicago corridor is a conventional type of service with three round trips a day, an average running speed of 50 MPH, and relatively low fares. The proposed service for the Kentucky corridors is a high-speed type of service. Using typical elasticity for time, frequency and fares, the ridership above was adjusted to reflect a higher level of service (6 round trips a day, 120 MPH average running speed, more comfortable trains, and 50% higher fares). The results are presented in Exhibit 7.

**Exhibit 7**
**POTENTIAL CORRIDOR RIDERSHIP**
**High-Speed Rail Service**

| City 1 | City 2 | Year 2000 Annual Passengers |
|---|---|---|
| Louisville | Lexington/Frankfort CMSA | 40,912 |
| Louisville | Cincinnati | 71,867 |
| Cincinnati | Lexington/Frankfort CMSA | 51,303 |
| Lexington | Frankfort | 6,661 |
| Total | | 170,743 |

**Potential Diversion to Rail from Connect Air Traffic** - Another significant difference between the Detroit-Chicago corridor and the potential Kentucky service is that the former does not serve any airports while the latter would serve the three principal airports in the region. There are two types of potential ridership for rail services serving airports:

1. Access ridership – If the rail system links downtown to the airport, air travelers can access the airport by rail. However, to attract ridership the rail service needs to be more transit oriented i.e. frequent service and several stations. This is unlikely to be the case for the proposed Kentucky rail service as frequent stops work against high-speed service.

2. Air Connect Ridership – Blue Grass Airport is a smaller airport than the Louisville airport, or the one in Northern Kentucky. Many air travelers to/from Blue Grass Airport are flying out and connecting in another airport for the main portion of their air trip. Rather than flying from Blue Grass Airport to the Cincinnati airport to connect to their flight, travelers could be using the proposed rail system to access the Northern Kentucky (or Louisville) airport. This could reduce air congestion at these airports by reducing the number of short commuter flights.

The potential rail diversion from air travelers, if the rail system serves a major airport, depends on a number of factors related to the competitive position of the rail system versus the air service. It also depends on the competition between airports and the airlines serving these airports. Potential travelers would be looking at the overall cost of their trip not simply at the first leg. For example, a traveler planning an air trip from Lexington to New York may now have the following choices:

1. Fly from Lexington to Cincinnati and connect there to New York.
2. Fly from Lexington to another major airport and connect to a New York flight.
3. Drive to either Cincinnati or Louisville airport and fly to New York.
4. Take a bus to either Cincinnati or Louisville airport and fly to New York.

If train service between Lexington, Frankfort, Louisville and Cincinnati were available, and that train service served the various airports directly with stations at the airports, the air traveler described above would have two more choices:

5. Take the train from Lexington to the Louisville airport and fly to New York
6. Take the train from Lexington to the Cincinnati airport and fly to New York.

The choice is likely to depend on the airfare offered by the various airlines from the Lexington, Louisville, or Cincinnati airport and the additional cost of a train ticket. The air market at the Blue Grass Airport and Louisville International appears fairly competitive already with several airlines serving each of them. The Cincinnati airport being a hub for Delta may be less competitive except for the proximity to other airports (Columbus, Louisville, and Indianapolis). Currently, however, it appears, based on a few spot checks, that area airfares are constructed so as to favor connecting flights.

Because it depends on the airlines' pricing, which can change very quickly in response to competition, it is very difficult to estimate what proportion of air travel to/from Blue Grass Airport might be diverted to a train serving the various airports. The following exhibit (Exhibit 8) shows the forecasted air carrier/ commuter enplanments and deplanments at the three airports in Year 2001.

**Exhibit 8**
**STUDY AREA AIRPORT PATRONAGE**

| | Enplaned/Deplaned Passengers | |
|---|---|---|
| **Airport Name** | **1996** | **2001** |
| | | |
| Cincinnati/Northern KY Intl. | 14,459,130 (4) | 18,242,400 (1) |
| Blue Grass Field | 977,052 (4) | 1,163,780 (1) |
| Louisville Intl. | 3,547,668 (4) | 5,414,000 (3) |

Sources:
(1) Cincinnati/Northern Kentucky International Master Plan
(2) Blue Grass Airport Master Plan Update
(3) Louisville International Master Plan
(4) FAA Enplanment Activity Report – CY96

Assuming fare relationships change, in our professional judgement, five percent of the future air passengers from/to Blue Grass Field may find it more advantageous to use the rail system directly serving the Cincinnati or Louisville airports instead of a short commuter flight. This consideration could add another 58,000 rail passengers annually.

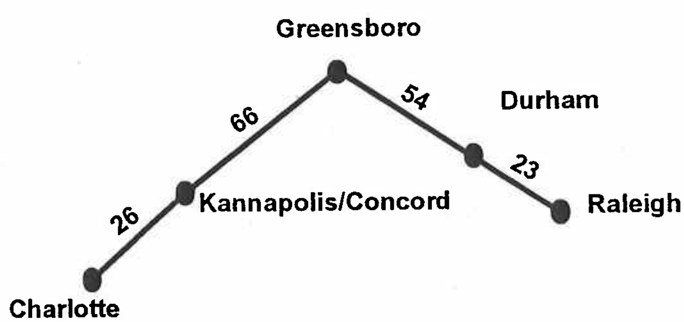
**Four Round Trips** – Given that the forecasted ridership, in reality, could be transported in only a couple of trains, an alternate service frequency was considered, and a reduced train service of four round trips per day was examined. This frequency is considered to be a bare minimum level of service. The results of the ridership estimate for this level of service is shown in more detail later in Exhibit 13. In summary, however, the reduction in service results in a decrease in the corridor ridership forecast from 228,743 to 148,851, or 35 percent. Average passengers per round trip change very little although, from 38,124 to 37,213 for the six and four round trips, respectively.

## Piedmont Corridor

Most of the corridors which have been subjects of HSR proposals are much longer and/or connect larger population centers than this one. One corridor which is comparable in population, although somewhat shorter in overall length, is North Carolina's Piedmont Corridor which is discussed here for comparative purposes.

**Length and Population** - As shown in Exhibit 9, the Piedmont Corridor connects Raleigh with Charlotte, a distance of 169 miles. Although the route mileage is less than the 266 connecting Northern Kentucky-Cincinnati, Lexington-Frankfort, and Louisville, it is a linear corridor with longer average trip lengths. The population projected for the corridor in 2015 is the same as that forecast for the Kentucky Corridor in 2000, 3.1 million.

**Exhibit 9**
**NORTH CAROLINA'S PIEDMONT CORRIDOR**




Note: Distances are highway miles.

**Ridership Forecasts** - The ridership forecast for the year 2015 under several different scenarios is contained in Exhibit 10. Note that with four round trips, the ridership for intra-corridor trips is less than that projected for Kentucky, and exceeds it for six round trips, but the forecast is still within the same order-of-magnitude. The principal difference in the two corridors is the top operating speed, only 100 mph in North Carolina, and the connection the Piedmont Corridor has with the Northeast Corridor. Note how much that corridor extension adds to total ridership forecasts.

## Midwest Regional Rail Initiative

One ongoing rail passenger plan which could influence the Kentucky proposal contained in this document is the previously mentioned Midwest Regional Rail Initiative, more specifically, the Chicago-Cincinnati route.

**High-Speed Corridor Designation** - Three of the routes -- Chicago to Milwaukee, to St. Louis and to Detroit -- had been previously designated as federal high-speed rail corridors under Section 1010 of ISTEA. The designation permitted federal funds to be used for grade crossing improvements in the corridors. The recently enacted successor to ISTEA, TEA-21, permitted the designation and funding of additional high-speed corridors for which $5.25 million has been authorized for six years. The Chicago-Cincinnati segment was so designated in January, 1999.

**Significance of the Designation** – Although the current proposal limits top speeds to 79 – 90 mph initially and 110 mph later, and mixes passenger and freight operations, neither of which are characteristic of true high-speed operations, it does provide a connection in Cincinnati to Chicago and other major markets throughout the Midwest. The patronage for an intrastate system projected elsewhere in this document is extremely low. A connection to major markets, as shown in several studies elsewhere (North Carolina's Piedmont Corridor connecting with the Northeast Corridor, for example), could be of significant benefit in boosting ridership.

**Direct Connection** - While the Cincinnati terminal in this study lies at the airport in Northern Kentucky, consideration should be given long range to a direct connection to the rail terminal in Cincinnati. Although it will probably be possible to connect the two services with a transfer, such as using the proposed Light Rail System, a direct connection will have a more positive impact on ridership and should be studied if the MRRI is successful in improving rail passenger service to Cincinnati.

## Operating Plan

The operating plan is based on the system to be operated, the equipment to be used, and the ridership forecast, including the service characteristics required to attract the patrons.

## Exhibit10
## NORTH CAROLINA PIEDMONT CORRIDOR PATRONAGE FORECASTS
## Year 2015

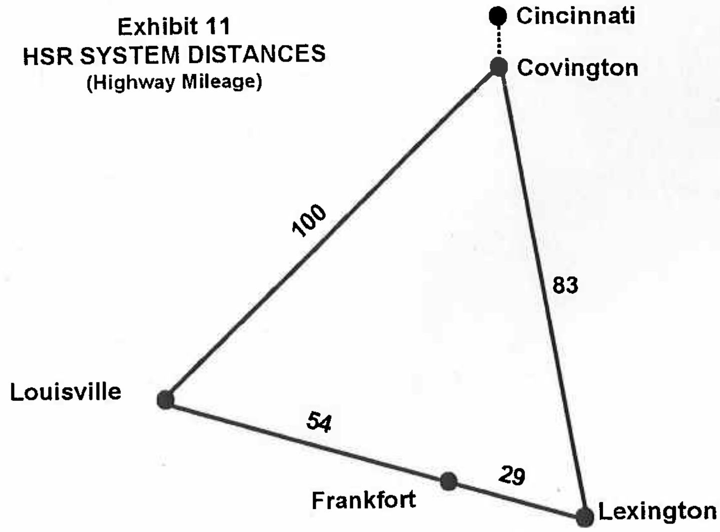
| Scenarios | Base Scenario | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 | Scenario 5 | Scenario 6 |
|---|---|---|---|---|---|---|---|
| | Existing Speed<br>Existing Frequency[a]<br>Existing Fares | 79 mph<br>Existing Frequency<br>Existing Fares | 100 mph<br>4 RT Frequency<br>Existing Fares | 100 mph<br>6 RT Frequency<br>Existing Fares | 100 mph<br>6 RT Frequency<br>Enhanced Fares | 100 mph<br>8 RT Frequency<br>Existing Fares | 100 mph<br>8 RT Frequency<br>Enhanced Fares |
| **Ridership** | | | | | | | |
| NC Corridor[b] | 134,500 | 164,600 | 189,000 | 429,500 | 399,600 | 475,800 | 430,000 |
| NC-NEC/VA[c] | 176,600 | 320,800 | 367,700 | 742,800 | 639,500 | 849,700 | 749,500 |
| TOTAL | 311,100 | 485,400 | 556,700 | 1,172,300 | 1,039,100 | 1,325,500 | 1,179,500 |

Notes:
(a) Existing Frequency is one round-trip train between Raleigh and Charlotte and one round-trip train from Charlotte to New York. In scenarios 2 through 6, half of all round trips continue beyond NC to New York.
(b) Trips within North Carolina only, including trips on Amtrak's *Crescent* between Charlotte and Greensboro.
(c) Trips between North Carolina and Virginia and between North Carolina and the Northeast Corridor, including *Crescent* Trips between NC and the NEC/VA and Silver Star trips between Raleigh and the NEC/VA.

Source: NCDOT, Rail Division

**The Rail System** - The system, comprised of new construction designed exclusively for HSR, is shown schematically in Exhibit 11. It is basically a triangle with sides of almost equal length (83-100 miles). The whole system is 267 miles long. The segment lengths were taken from the 1998 Kentucky Official Highway Map. Highway distances were used as the actual HSR routes are unknown but should more closely approximate highway alignments as opposed to the more circuitous existing rail routes. As stated earlier, the airports at the cities comprising the points of the triangle are the station sites.

**Exhibit 11**
**HSR SYSTEM DISTANCES**
**(Highway Mileage)**

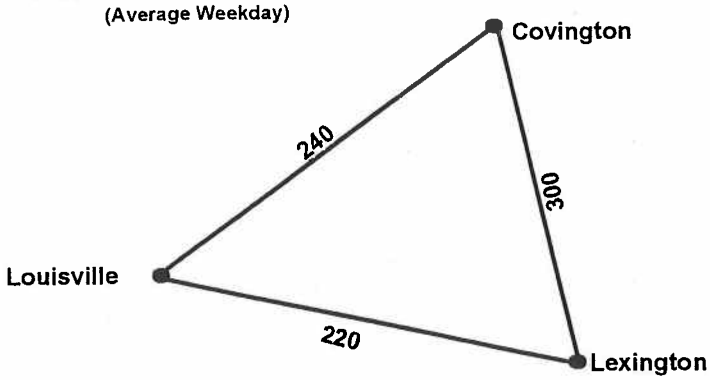



Source: Mileage Chart, Kentucky Official Highway Map, 1998.

**Trainsets** - An electrified TGV-type trainset, maybe similar to the *American Flyer*, capable of operating at 186 mph would comprise the rolling stock. Due to low ridership projected, trainsets of 1-6-1 configuration (power unit on each end and six passenger cars) capable of transporting some 280-300 people would provide more than ample capacity.

**Passengers To Be Transported** - The annual ridership projected earlier, including the air connect component, is adopted for the purposes of framing the operating plan. The annual ridership is converted to daily demand by system link by dividing annual totals by 300. This factor considers that ridership on a business day will be greater than that on a weekend day. The resulting demand is the subject of Exhibit 12.

**Exhibit 12**
**FORECAST YEAR 2000 RIDERSHIP**
**(Average Weekday)**




Source: Wilbur Smith Associates

While there will be some overlap in passengers over route segments, e.g., Frankfort-Lexington-Cincinnati, without other intermediate stations, the ridership per link is comprised essentially of those passengers traveling between the city pairs per link. It is unlikely, for example that a Louisville-Covington passenger would take a train that would go through Lexington if direct Louisville-Covington service were available.

**Proposed Operating Scheme** - The triangular rail system presents some operating choices not available in a more typical point-to-point system. It could be operated like multiple point-to-point systems with separate trains operating back and forth on each leg of the triangle, especially since there will not be a lot of passengers needing to connect with other trains. It could also be operated as a continuous loop with trains running in one direction or in both (clockwise and counter-clockwise).

For purposes of this evaluation, it is assumed that the trains operate in a circular fashion and in both directions. This scheme appears to present the most flexible service with minimum equipment requirements. Theoretically, the total daily demand could be accommodated with one trip using the selected trainset. In reality, this does not work because the one train would not operate when all of the passengers would want to travel, and thus the patronage would be much lower. As stated earlier, ridership is forecast for both four and six round trips per day.

**Trainset Requirements** – Assuming that service is provided between the hours of 6:00 AM and 10:00 PM, and that a round trip takes approximately three hours with station stops and some home terminal layover time, it would be possible to make five round trips in an operating day, one less than required. Therefore, four trainsets would be required to protect the schedule. A fifth set will be needed as a spare for use when one of the other sets is out-of-service for repairs or maintenance. A service frequency of four round trips per day reduces equipment needs to three trainsets.

## Revenues

Revenues attributable to the HSR service for the purposes of this study are considered to be derived solely from ridership. While additional revenue sources are possible, such as the use of the right-of-way for fiber optic cable or other communication or utility uses, they are not considered.

**Fares** - The fare basis adopted, $34.50 for the three long legs, is based on what a comparable Amtrak ticket would cost plus 50 percent because, in comparison, it is an enhanced service. Also included is a 15-percent recovery additive. This fare compares favorably, on the same basis, with existing intercity bus fares, $20 one way for the longer legs, and far less than on-call taxi/limo services, approximately $100. Discounted air fares, which have comprised the basis of a lot of HSR revenue estimates, are not applicable to this system. Point-to-point fares between any two of the three principal cities are highly variable, but appear to average $400-500, and as such do not represent a competitive mode of transportation for HSR.

The private automobile, given the relatively short distances, the nature of the highway system connecting the principal origins and destinations, and low vehicle operating costs, $30+/- on an incremental basis for the long legs, is probably the most competitive means of travel. Parking would also be considered, especially at an airport for a week-long business trip.

**Ridership Revenue** - Total revenues attributable to the system from ridership are estimated to total $5,417,842 and $7,705,092 annually, for four and six round trips, respectively, as shown in Exhibit 13.

**Exhibit 13**
**ESTIMATED ANNUAL PASSENGER REVENUES**

| | | 6 Round Trips | | 4 Round Trips | |
|---|---|---|---|---|---|
| **Route Segments** | **Fare** | **Passengers** | **Revenue** | **Passengers** | **Revenue** |
| Louisville–Lexington/Frankfort | $34.50 | 40,912 | $1,411,464 | 33,118 | $1,142,571 |
| Cincinnati | 34.50 | 71,867 | 2,479,412 | 58,176 | 2,007,072 |
| Lexington/Frankfort – Cincinnati | 34.50 | 51,302 | 1,769,919 | 41,529 | 1,432,751 |
| Lexington to Frankfort | 6.50 | 6,661 | 43,297 | 5,392 | 35,048 |
| Air Connect (1) | 34.50 | 58,000 | 2,001,000 | 23,200 | 800,400 |
| **TOTALS** | | 228,742 | $7,705,092 | 161,415 | $5,417,842 |

(1) See discussion pp. 10-12.
Source: Wilbur Smith Associates

## Development, Operating and Maintenance Costs

As a new high-speed rail system has yet to be developed in this country, estimates of development and operating costs are just that, estimates. These estimates are based on international experiences and typical costs of construction, materials and labor in the US.

**Capital Costs** - The costs of developing the infrastructure and acquiring the initial trainsets are included in the capital costs. Since the budget for this study effort does not allow for route-specific engineering; therefore, the estimate is based on a unit-cost basis. Two basic references exist. One work by the National Research Council[1], operating through the Transportation Research Board, developed costs for generic corridors. The other, sponsored by the Federal Railroad Administration of the US Department of Transportation[2] commonly referenced as the Commercial Feasibility Study (CFS), examined a number of specific corridors throughout the US.

Based on the costs developed in the first, and factoring the cost up for the intervening period between its development, 1991, and today using the Producers Price

[1] *In Pursuit of Speed, New Options for Intercity Passenger Transport*, Transportation Research Board, National Research Council, Washington, DC, 1991.
[2] *High-Speed Ground Transportation for America*, U.S. Department of Transportation, Federal Railroad Administration, September 1997.

Index, the per mile cost for roadbed, track, signals, electrification, fencing, etc., is $19.4 million. Using an average of the five corridors most similar to those in Kentucky from the second study, $21.75 million per mile would be an appropriate unit cost. The unit costs per mile in this study varied over a range of $10 million to $ 45 million depending on topography, waterways and wetlands encountered, anticipated aerial structure and so forth. An average of the two unit costs cited earlier, $20.6 million per mile, appears to represent an appropriate order-of-magnitude estimate for this effort. Thus, the 266-route-mile system would cost $5.48 billion to construct.

An estimated cost for TGV-type trainsets configured 1-6-1, or 6 passenger cars with a power unit on each end, of $20,000 million is also contained in the second work. This unit cost is adopted for use in this assessment. The five trainsets needed for six round trips would cost $100 million, and the three sets needed for four round trips would cost $60 million.

**Maintenance and Operating Costs** - Both of the previously cited works contain estimates of maintenance, right-of-way and equipment, and operating costs. In addition, a methodology of generalized mathematical relationships to estimate the corridor-specific costs contained in the CFS was developed by Ducan Allen and published by the Transport Research Board of the National Research Council[3].

The results from applying the two methods for six round trips provide estimates of $31.7 million and $54.1 million annually after updating the costs to 1998 dollars. For the purpose of this evaluation, an average of the two, $42.9 million per year is adopted. For four round trips, the cost estimates are $26.95 million and $49.7 million, an average of $38.3 million.

**Cost Per Segment** – Exhibit 14 is a summary of the costs associated with each route segment. The total equipment costs are slightly higher as two sets per segment are included rather than the total of five for six round trips. Only the estimates for six round trips are shown for simplicity.

**Exhibit 14**
**ESTIMATED COSTS PER ROUTE SEGMENT**

| ($millions) Route Segment | Infrastructure | Equipment | Total Capital | Annual Operations |
|---|---|---|---|---|
| | | | | |
| Lexington-Cincinnati | $1,710 | $40 | $1,750 | $13.5 |
| Cincinnati-Louisville | 2,060 | 40 | 2,100 | 16.1 |
| Louisville-Lexington | 1,710 | 40 | 1,750 | 13.3 |
| Totals | $5,480 | $120 | $5,600 | $42.9 |

Note: Exhibit values are for six round trips.

3 "*Cross-Corridor Comparison of Operating Costs for High-Speed Ground Transportation*," Duncan W. Allen, Transportation Research Record No. 1584, Transportation Research Board, National Research Council, National Academy Press, Washington, DC, 1997, pp. 8-16.

## Revenue-Cost Summary

Annual costs exceed revenues in both service frequency cases shown in Exhibit 15. The four daily round trips result in a $4.6 million reduction in annual operating and maintenance costs with only a $2.3 million per year reduction in revenues. Capital costs are reduced $40 million. The revenue – cost relationship is not attractive in either case, however, and a very significant increase in ridership and revenues would be required for the proposal to even approach a viable project.

**Exhibit 15**
**REVENUE-COST SUMMARY**

| Service Frequency (round trips) | Annual Ridership Revenues ($million) | Capital Costs ($million) | Annual Operating and Maintenance Costs ($million) |
|---|---|---|---|
| | | | |
| 4 | $5.4 | $5,539.6 | $38.3 |
| 6 | 7.7 | 5,579.6 | 42.9 |

Exhibit 16 depicts revenues and costs on an annual basis for each line segment as well as the deficit on operations. While the annual revenue from projected patronage averages about 15 percent of operating and maintenance costs per year, it is barely over one percent when both annualized capital and operating costs are considered.

**Exhibit 16**
**ANNUAL REVENUE-COST COMPARISON**
**(by Route Segment)**

| Line Segment | Ridership Revenue ($millions) | Capital(1) Costs ($millions) | Operating Costs ($millions) | Net(2) ($millions) |
|---|---|---|---|---|
| | | | | |
| Lexington-Cincinnati | $2.0 | $125.8 | $12.0 | $[135.8] |
| Cincinnati-Louisville | 1.8 | 151.6 | 14.4 | [164.2] |
| Louisville-Lexington | 1.6 | 125.8 | 11.9 | [136.1] |
| Totals | $5.4 | $403.2 | $38.3 | $[436.1] |

Note: for four round trips.

(1) Annualized over 20 years at 4 percent interest.
(2) [ ] indicates deficit.

Source: Wilbur Smith Associates

## Conclusions

The high-speed rail proposal discussed in this document is estimated to produce only 15 percent of the revenue needed to cover operating costs. Thus, there would not be any ridership revenue to contribute toward capital expenditures. In fact, fares would have to increase to $190 per passenger for any one leg of the triangle with six round trips per day and to $245 at four round trips per day. These fares are competitive only with air travel between the same points. If capital (annual) and operating costs are considered, the fares have to increase to $2,000 and $2,800, respectively. There are two major reasons for this analysis result. First, the system suffers from highway - competitive travel times, a situation due in large part to parallel Interstate Highways. In addition, the trips are not long enough to compete for airline traffic, the target of many HSR proposals.

The primary market for high-speed rail is considered to lie between 150 and 500 miles[4]. Trips less than 150 miles are considered to be the domain of the private automobile. While it does not travel as fast as a high-speed train, it becomes competitive when overall travel times including HSR station access and waiting times are considered. Trips over 500 miles, even considering airport access, waiting for flight departures, and picking up baggage, etc., are faster by air.

It may be desirable to re-examine the proposal, however, if the Cincinnati-Chicago leg of the Midwest Regional Rail Initiative becomes a reality and proves to be successful. As stated previously, this connection would extend the size of the system thus permitting competitive-length trips, and provide access to a much larger travel market.

[4] *In Pursuit of Speed*, p. 6.