U.S. Department
Of Transportation

**Federal Railroad
Administration**

RAILROAD CORRIDOR TRANSPORTATION PLANS

A GUIDANCE MANUAL

Office of Railroad Development, RDV-10
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Corridor Transportation Plans

I. Introduction

This paper provides guidance to proponents of new or improved high-speed intercity rail services or systems. The Federal Railroad Administration makes this paper available to suggest the level of analysis and planning necessary to progress a program or project of this type. In the past, the Federal Railroad Administration and Amtrak have collaborated on a number of occasions to prepare a long range planning document for various rail corridors that have been called master plans or transportation plans. These studies attempt to take into full account the plans of intercity rail passenger service, local commuter rail services and the rail freight operators over a relatively long period of 20 years. The relatively independent plans of these various operators are synthesized into one long-range plan so that many incremental projects planned by each party over this 20-year period will collectively provide the infrastructure to permit the various services to coexist without degrading the various operations.

An initial reading of this document will quickly reveal that a Corridor Transportation Plan is a very detailed plan that will usually require relatively extensive research and analysis. Many people will ask why such a detailed plan is required at the beginning of a corridor project when there is so much “excess capacity” on the rail line in question. The observation concerning “excess capacity” is usually made by someone standing beside a rail line and observing that “I’ve seen only one train in the last two hours.” While similar observations may be true, most non-railroad people (and many lifelong railroaders) find it difficult to appreciate how train movements or routine maintenance activities many miles away cascade their impact up and down the railroad. Inevitably, a cursory analysis and operating plan for new or significantly upgraded corridor passenger service on an existing freight line (with or without commuter service) will result in undesirable or unacceptable reliability and/or performance levels for all corridor users. There is little question that providing the information and analysis to support a Corridor Transportation Plan may take a period of months, but in the long run its preparation is the quickest way to properly define all the elements that must be addressed in order to provide higher speeds and improved frequencies for intercity passenger service, while maintaining or improving freight and commuter services.

It has usually been found to be relatively easy to take a long range, 20-year plan and determine which pieces need to be done to support the initial service levels and which components can wait for future funding or service level needs. Conversely, without a detailed long-range plan, it is very difficult to know if the short-range plans and projects will address anything other than immediate problems. Sometimes, the apparent short-term solutions only make the long-term problems worse and will ultimately have to be removed and replaced—typically an expensive learning experience.

Proponents of a high-speed rail project also need to consider that any Federal funding or Federal approval of a new or upgraded intercity rail passenger corridor would require preparation of appropriate environmental documentation. Clearances have to be obtained for a project under the requirements of the National Environmental Protection Act (NEPA) and the National Historical Preservation Act, section 4(f) of the DOT Act, the Clean Water Act, and others. All these acts require site-specific information (square footage of wetlands to be filled or detailed modifications to be made to an historic building, for instance) in order to prepare the documents and obtain approvals. A clear and complete understanding of all project elements, reached through sound engineering and railroad planning, is needed to complete these documents.

The Federal Railroad Administration has found that railroad corridor programs or projects lend themselves to tiered environmental documentation. Since funding design and construction of improvements to railroad corridors generally extends over decades, a tiered first level Environmental Impact Statement (EIS) or Programmatic Environmental Impact Statement (PEIS) is usually the appropriate form of documentation. This allows for identification of the full scope of projected improvements or modifications and either full analysis of defined elements or deferral of site-specific clearance of elements to later documentation. Typically, a long-range transportation plan is necessary to identify all project elements and for preparation of the initial environmental document. It is possible that the PEIS or first tier EIS may categorically exclude work that does not impact environmentally or historically sensitive resources (for example: installing welded rail, replacing ties, installing a new signal system, or reinstalling track on an old roadbed) and may also identify other elements for separate environmental documentation (such as: new stations, curve eliminations, new maintenance shops, and so forth). This type of documentation can incorporate by reference many elements of a corridor transportation plan and thus simplify the clearance process.

The balance of this document outlines parameters used and various factors that usually require analysis and study in preparing a corridor transportation plan. The document further discusses in some detail the analysis usually found to be the most critical to a transportation plan, but it should be emphasized that each corridor will most likely have unique conditions or circumstances that will have to be addressed individually. Additional information concerning these studies may be found in Chapter 17 of the American Railway Engineering and Maintenance Association manual of recommended practices.

II. Route Selection - Preliminary Analysis

Potential rail transportation corridors will usually connect at least two and sometimes a series of relatively large population centers. A typical corridor may have one or several rail lines connecting the end points or various intermediate population centers. Where more than one rail line exists (or existed in the past), a determination must be made as to which route or combination of route segments will make up the corridor. Where multiple rail lines exist, it is frequently found that one or more are simply not compatible with being upgraded to corridor status, because of numerous curves, steep grades, routing that avoids population centers, routes that run down city streets at grade or other obvious untenable defects. A preliminary assessment of the options will usually reduce the possibilities to one or perhaps two viable routes that meet basic requirements for speed, multiple tracks, intermodal station sites, ridership potential, estimated cost of improvements, and the like.

The selected route or routes will then need to be subjected to the comprehensive long-range analysis associated with a corridor transportation plan. The two most basic elements of any transportation plan are the selection of station sites and the preparation of passenger train schedules for the 20-year horizon plan.

A. Station Location Fundamentals

Projected ridership along a particular corridor is heavily influenced by accessibility of stations and the proposed train schedules. Station locations are subject to several sometimes conflicting demands, for example:

1. They must be readily accessible to where people live and work.

2. Too many stations will lengthen trip times excessively.

3. Too few stations will make it more difficult for riders to use the rail system.

4. Station sites need to cater to both business and leisure travel.

Building on American experience since the passage of the High-Speed Ground Transportation Act of 1965, as well as on successful examples abroad, the FRA has developed the following general guidelines for locating corridor rail passenger stations:

1. Each city should have a station located in or near the central business district. This is mandatory for larger Metropolitan Statistical Areas (MSAs), with metropolitan populations of 150,000 or more, since to do otherwise would undermine the inherent advantages of rail passenger systems. Central locations are highly desirable, if at all possible, for smaller cities as well. This center city station should have direct access to local transit systems (bus, rail, taxi, etc.) as well as appropriate amounts of parking for private cars.

2. One or more suburban stations need to be provided in the larger metropolitan areas with easy access to the local primary road system in order to accommodate potential riders living outside the city centers. Classic successful examples of suburban or beltway stations are Route 128 outside of Boston, MA and New Carrollton, MD outside of Washington, D.C. These “beltway”-type stations cater to automobile-oriented riders and thus need to have many hundreds, if

not several thousand, parking spaces to fulfill their role in corridor transportation.

3. Every effort should be made to have each corridor station serve as a regional intermodal passenger terminal for all forms of regional and local transportation systems.

Many cities, both large and small, were served at one time by more than one railroad, each with its own station. Some cities ultimately developed union stations, which brought two or more railroads under one roof and efficiently served a multiplicity of passenger train routings. Since the mid-20th century, however, these flexible infrastructures have been slowly vanishing under the pressures of urban development and reductions in the Nation's passenger train route-mileage. Because the restoration of adequate rail access, once lost, would cost the public far more than its preservation, planners need to devote special attention to identifying and protecting essential urban rail facilities. Thus, in addition to the passenger access parameters noted above, the following railroad operating characteristics need to be taken into account when evaluating and designing station sites for corridor applications.

1. Each station track configuration should provide for the through movement of trains along the corridor without having to reverse the train's direction at any time. Through stations are almost always preferable to stub-end terminals, both at the endpoints and intermediate points in a corridor.

2. Where interlockings are located at both ends of the station, the distance between the opposing home signals must be great enough to hold the longest anticipated passenger train (locomotives and cars), including long-distance trains that may operate over the corridor, without fouling either interlocking.

3. Where the normal movement of a corridor train requires a diverging movement through a turnout or crossover to access a platform, the turnout size should be as large as feasible given other local design parameters. Turnouts or crossovers should not be placed adjacent to a platform.

4. The length of a corridor platform should be as long as the longest anticipated passenger train, whether in corridor, long-distance, or commuter service, in order to avoid a very time-consuming double stop at the station and to allow maximum flexibility in train makeup.

5. In order to minimize station dwell time and comply with the Americans With Disabilities Act (ADA), the platform height should be equal to the car floor height. It is recognized that high-level platforms may, on a site-specific basis, entail facilities to protect freight operations (e.g., "gantlet" tracks).

B. Scheduling Fundamentals

Preparing train schedules is unique to each corridor. The basic objective is to provide enough train service to attract sufficient riders to financially support the service without running an uneconomical number of train-miles. The following general train schedule guidelines have been developed from observations of corridor operations in this country and elsewhere:

1. Most riders do not like to take a train that departs before 6:00 a.m. or arrives at a station after midnight. In certain circumstances (e.g. on longer runs), passengers may be willing to arrive at destination somewhat after 12:00 midnight. Therefore, trains should not depart an originating station before 6:00 am or arrive after midnight unless an analysis has shown that it is more economical to deadhead equipment along the corridor to a common layover facility rather than to create another one at an intermediate point. Deadheading equipment (i.e., making a non-revenue move) along a corridor is not only operationally expensive (fuel, crew costs, maintenance costs, etc.), but it may also require additional mainline infrastructure (passing tracks, interlockings, etc.). Serious consideration should be given to establishing a mid-corridor layover facility (middle third of route), when a corridor exceeds 250-300 miles in length or when ridership patterns warrant, in order to provide reasonable early and late service to each end of a corridor.

2. In corridors of sufficient length (about 400 miles or more), a single overnight train in each direction not necessarily operating at high speed may be necessary to provide a complete service. Although such an overnight train may in itself be uneconomic, it will also attract passengers to daylight runs and could contribute to the overall viability of the corridor.

3. By definition, a corridor connects two or more large metropolitan areas. Train schedules should be arranged to maximize the accommodation of riders going to both ends of a corridor as well as

any intermediate points. This usually means that the first and last trains of the day make all stops along the corridor. It has been found that only the most heavily traveled corridors can economically justify express trains during the peak travel hours that skip the smaller intermediate stations. Where local commuter service is provided, intercity trains typically stop only at or near the end of the commuter zone as well as a beltway station.

4. It has been shown throughout the world that memory type schedules (trains leave a station at the same time past each hour) aid significantly in attracting and retaining riders. Therefore, whenever feasible, train schedules of all types should be based on the memory schedule principles.

5. Projected schedules for proposed corridor operations are typically prepared from computerized train performance calculators (TPC). These TPC systems simulate perfect train operations that almost never occur in the real world. All trains schedules prepared from TPC runs must have pads added to reflect real world operating conditions as outlined in section V(E) of this document.

6. Corridors usually follow the most direct route between two or more major population centers. Sometimes relatively large cities or a string of smaller cities may be located up to 100 miles to one side of the primary corridor. It may be beneficial to arrange for a spur off the main corridor to tap these markets and at the same time justify more frequent schedules on a portion of the main corridor than would otherwise be economically feasible. The spur(s) can be operated with connecting shuttle service or with a selection of trains from one of the corridor terminals or a combination of both options. As such spurs are complicating factors, the optimal service concept and corridor configuration can only be derived on a site-specific basis.

III. Physical Characteristics of the Rail Line (Existing and Proposed)

The analysis required for a corridor transportation plan will necessitate assembling as much detailed information as possible about the rail line(s). Scaled drawings should be obtained or prepared which contain the following minimum information:

A. Track plans showing

1. Number and location of tracks (existing and previously removed)

2. Curvature

a. Degree of curve

b. Superelevation

c. Spiral length (spirals were not introduced in the U.S. until 1900, so most spirals are retrofitted onto old curves)

3. Track profiles showing all grades and grade change points

4. Interlocking configurations including turnout and crossover sizes and/or diamond crossing with other rail lines

5. Length of passing tracks, if any.

6. Major bridges and tunnels including any weight or clearance restrictions, if any.

7. Highway crossing locations and warning systems (public and private)

8. Location of passenger stations and platforms

9. Location of industrial spurs

10. FRA track classification and construction

a. Rail weight and age, welded or jointed

b. Type of ties

c. Ballast type and section

11. Standard turnout sizes in use

12. Complex terminal and yard sites will typically require larger scales than open running main lines

13. Location of right of way fencing

14. Air rights ownership or utility rights of way

15. Location of freight yards

B. Signal system plans (the FRA regulations that require the enforcement of signal indications, when authorized speeds exceed 79 mph, means that improperly located signal positions or undesirable signal aspects, while overly safe, may significantly add to the trip time of passenger trains under many circumstances).

1. Determine if the system is based on speed signaling or route signaling and obtain the relevant operating rules.

2. Obtain or prepare a set of general signal plans (sometimes known as route and aspect charts) that shows each signal location and aspects that can be displayed (both wayside and cab signals).

3. Determine the type of track circuits (AC, DC, coded, etc.)

4. Determine if pole lines are used for signal lines

5. Determine what the signal design speed is for each corridor segment for each type of train operated

6. Obtain the train braking curves used with the signal design speed (freight and passenger)

7. Highway crossing warning systems

    a. Track circuit based

    b. Overlay circuits

    c. Constant warning time

8. Location and type of hazard detectors (high/wide loads, dragging equipment, hot box, etc.) and their connection to the signal system.

9. Interlocking snow melting systems

    a. Type (electric, gas, hot air, etc.)

    b. Remote or local control

C. Communications systems along the corridor

1. Is it private or leased lines?

2. Is there open line wire?

3. Is the main system microwave, fiber optics, cable, or leased?

4. Where are the radio transmitters for the wayside-to-train radio system?

What systems are used to reach the transmitters?

5. Is there any backup system ?

IV **Operations Support Facilities**

The rail line described in item III carries the trains that move along all or parts of a corridor; however, there are many other supporting facilities that may ultimately have to be modified, expanded, moved or eliminated as the corridor is upgraded to support more services operating at higher speeds. Narrative summaries of the following types of facilities need to be prepared (augmented with plans or drawings as necessary) in order to provide a long-term planning document.

A. Passenger stations are critically important in attracting riders to intercity and commuter trains. The following information needs to be assembled for each existing and proposed station.

1. Location in the community relative to work centers, homes and local highways

2. Platform type (high or low level), length, width, access to station and if it is on tangent or curved track, "train approaching" warning devices, intertrack fences

3. Length of platform canopy, if any

4. Station size and amenities, staffed or unstaffed, primary use (commuter or intercity)

5. Automobile parking capacity

6. Intermodal access (bus, taxi, heavy or light rail transit)

7. Existing physical condition

8. Passenger information systems

9. Compliance with the Americans with Disabilities Act

B. Railway passenger vehicle storage and maintenance facilities will need to be provided at or near the various origination/destination points. The following information will need to be assembled:

1. Site of the facility

2. Function of the facility (daily servicing and storage, light running repairs, medium repairs, etc.)

3. Rail vehicle capacity

4. Special facilities or equipment, if any (a wye or loop for turning trains, etc.)

5. Existing physical condition

C. The corridor rail line will require periodic inspection and repairs. The location of various maintenance-of-way bases, type of staff, required facilities, etc., needs to be documented; so that existing sites can be augmented or new ones selected.

D. Each corridor will have one or more centers that control the movement of trains and equipment. The location of the traffic control centers needs to be identified, the type of equipment being used, and the capability of the systems to accept new track configurations and increased numbers of trains on the corridor.

V. Proposed Operating Plan for All Corridor Services on a Date 20 Years in the Future

It is essential for each organization intending to operate rail service of any kind over a corridor or portions of a corridor to analyze their long-term objectives and prepare a realistic assessment of the service levels that can be anticipated. Although each corridor will have unique projections, several general comments need to be made.

Copies of all operating agreements between the rail corridor owner and tenant operators with operating rights need to be obtained and appropriate summaries prepared so that everyone will know all of the various rights and conditions. Likewise, if the corridor contains moveable bridges over public navigable waterways, Coast Guard regulations covering those specific bridges should be obtained and summarized.

Very high annual growth rates (6 - 10%) are usually not sustained in a mature economy like that found in the United States, unless the particular corridor is shown to be experiencing large population and industrial growth or any proposed new services would tend to relieve existing overcrowding on alternative modes of travel. One might observe a relatively high growth rate for intermodal freight service, but when the diversion from more conventional carload freight is taken into account the overall growth is reduced rather significantly. Similarly, existing mature rail commuter systems around major cities like New York or Chicago might average 2% growth per year over 20 years, which in absolute terms would still require more and longer trains due to the high base ridership of existing service levels.

Conversely, a start-up commuter service in a relatively large metropolitan region might experience very high percentage growth rates, but still require only 30 minutes peak headways after 20 years. All projections need to be carefully scrutinized in order to avoid constructing infrastructure that may never be required.

Proposed schedules may be based on existing timetables if similar service now exists. However, most corridors will be projecting service of a kind not now in existence, which will require the use of computerized train performance calculators (TPCs) working on the data base developed in section III.

The following information needs to be developed for each service using the corridor:

A. Intercity corridor passenger service

   1. Location of station stops

   2. Train schedules (include dwell time)

   3. Train size and type of equipment (coaches, tilt cars, food service, etc.), train weight and locomotive horsepower

B. Local commuter services

   1. Location of station stops (existing and proposed)

   2. Train schedules (local, express, zone express, deadhead moves, etc.)

   3. Train consists (locomotives and cars), train weight and locomotive horsepower

   4. Branch line junction points

C. Freight services

   1. Local freight schedules (note places where the train clears the corridor for extended periods of time)

   2. Manifest freight schedules (include all points where stops are made to pick-up or set-off cars and typical horsepower and tonnage)

   3. Intermodal freight schedules (include all stops, tonnage and typical horsepower/ton ratio)

   4. Mineral and extra train schedules (include all stops, tonnage and horsepower)

5. All yards or work sites should be defined

D. Long distance passenger services

1. Location of station stops

2. Train schedules (arrival and departure times at all stations)

3. Train size, locomotive horsepower (minus hotel power requirements), type of cars (coach, sleeper, diner, mail, express, etc.)

E. Schedule pad

Whenever passenger schedules are produced by various TPC runs, a pad <u>must</u> be added to the TPC schedule to account for a number of factors. The following describes various factors that need to be included for calculating a single-track schedule pad. A double-track schedule pad is the first term only (1.07T).

$$Schedule\ with\ pad = 1.07T + M\left(\frac{\frac{1}{2}L}{S} + W + \frac{D}{S}\right)$$

Where

T = Train performance calculator (TPC) run time

1.07 = 7% added for:

a. Human operation instead of perfect TPC operation
b. Some TPC assumptions will prove not feasible to achieve
c. Extra station dwell for mail, baggage, wheelchairs, etc
d. Temporary slow orders
e. Low diesel power output or extra cars
f. Congestion or other off-schedule trains
g. Signal imposed delays
h. Weather conditions
i. Miscellaneous delays

M = Number of meets with other passenger trains (freight trains are assumed to wait longer for meets, and not cause delays to passenger trains)

L = Distance between passing tracks in miles (average with deviation not greater than 25%)

D = Distance in miles from home signal at passing track to distant signal at passing track.

S = Average speed in miles per minute

W = Interlocking operating time, use 1 minute

a. 5 second loss of shunt protection
b. 2 second CTC polling time for transmit/receive
c. 8 second switch movement time for small interlocking (15 to 30 seconds for large interlocking)
d. 30 second human response time
e. 10 second train brake release time

Assumption: Passing tracks are at least 4 miles long with at least one intermediate block signal and turnouts are either equilateral #20 or lateral #20.

If freight traffic is particularly heavy on a single track railroad a further adjustment may be necessary to account for the occasion when a passing track between two passenger trains is occupied by a freight train, thus more than doubling the distance between passing tracks available for passenger trains. In order to keep the pad within reason, it may be necessary to provide a universal crossover in the middle of selected passing tracks so that a meet and overtake can occur at the same time. Alternatively, two passing tracks can be provided at the same location.

Railroads have historically placed most of the needed schedule pad near the end of the trip, in order to influence the on-time performance that is typically calculated from end point to end point. On long corridors with relatively large pads, this technique can result in relatively large deviations from published schedules near the end of a run. These large schedule deviations may be totally unacceptable to a high-density commuter operation, where certain schedule slots at junctions or major stations are reserved for the intercity corridor trains. Where high-density commuter or freight operations are encountered on a corridor, the intercity schedule pad must be spread out over the whole route at appropriate locations so that the intercity trains will have small schedule deviations at critical operating locations and not negatively impact the performance of other corridor users.

F. Trip time feasibility analysis

Analyzing a particular corridor to assess ways to increase average overall speeds will involve many TPC runs that individually determine the effects of changing one parameter at a time. All of the speed restrictions contained in the employees' timetable special instructions should first be carefully reviewed to make sure everyone understands why they exist; sometimes their reason for existence is obsolete or is no longer valid. Most of the effort usually involves increasing speeds through curves, raising maximum speeds or increasing horsepower-per-ton ratios.

1. Increasing speeds through curves can be accomplished by increasing the actual superelevation up to a maximum of 6 inches, increasing the unbalance of passenger cars to approximately 5 inches for non-tilting vehicles, or by using tilt-body trains that can operate at an effective unbalance up to 9 inches as permitted by FRA regulations. Any increase in curve speeds must address the spiral curve which connects tangent track to a constant radius curve. Since spirals were not introduced to American railroads until 1900, the retrofitted spiral must be carefully checked to see if higher speeds can be accommodated with comfort and safety. Higher curve speeds will usually require rather significant changes to spirals, some of which will not prove feasible and will ultimately limit the maximum speed through a curve.

2. Maximum speeds on tangent track can typically be increased after the track structure has been improved and the track geometry (alignment, cross-level, profile, etc.) tightened up to meet FRA standards for the desired speed. Higher speeds may require respacing signals and installing cab signals for speeds above 79 mph. It should be noted that, when cab signals are installed, FRA regulations require <u>all</u> trains (freight, commuter, etc.) operating over those tracks to have fully functioning cab signals. Enforcement of all speed restrictions may be required where speeds exceed 110 mph. Highway grade crossings are prohibited where train speeds exceed 125 mph.

3. Increasing the horsepower-per-ton ratio by adding a locomotive on a typical corridor passenger train has been shown to improve low-speed acceleration and grade climbing speeds in addition to attaining higher maximum speeds. The improved lower-speed performance and grade climbing ability may eliminate the need for higher maximum speeds in order to attain a certain overall schedule.

VI. Proposed Railroad Operations Analysis

Most railroad corridors being proposed for higher-speed, more frequent intercity passenger services will typically already have significant freight service over at least a significant portion of the route. Additionally, there is likely to be existing or proposed local commuter service in the larger metropolitan areas. Creating an infrastructure that will allow these three services to coexist on the same tracks is usually the biggest challenge in preparing a corridor transportation plan. Unless the corridor is short (100 miles or so) and service is made up of only commuter, intercity corridor, and local freight trains, it will be necessary to employ a relatively sophisticated train operating model simulator that is smart enough to do its own train dispatching via alternative paths over the corridor's track configuration. At a minimum, these systems will need to be able to plot train movement stringlines at a useable scale (typically 10 minutes per inch), be able to randomly input delays by type of train (freight, commuter, intercity), and tabulate delays associated with each train operated during the 24 hour day. The plot should locate each interlocking or station and identify which track a train took as it moved over the corridor.

A typical corridor will probably require the model to be run a number of times, with track and interlocking changes being made after each run, before all services are able to operate at an acceptable level of 90% on-time performance. The initial schedules (developed under Section V) will have to be altered or additional infrastructure provided as conflict points are identified along the corridor. Conflicts will occur when a faster train has to pass a slower train (e.g., a non-stop intermodal freight overtaking a local commuter train) or opposing trains try to pass each other on a single track. It should be noted that schedule variability of freight trains is generally greater than that of passenger trains, because freight train tonnage and the resulting horsepower-per-ton ratios will vary rather significantly by day of week and through the various seasons of the year. After the modeling simulations and various revisions to track and schedules have produced what appears to be a viable operation for all services, it is desirable to run a 7-day simulation with only the random train performance changing daily to confirm that most normal operations can be handled.

CAUTION: FLEXIBILITY MUST BE MAINTAINED!

The detailed railroad operations analysis described in these sections will provide useful, indeed indispensable, input to the design process. However, such an analysis can also instill, in those who perform it, an unjustified level of confidence in the infallibility and durability of the underlying assumptions and results. This overconfidence may, in turn, lead to the adoption of a facility design that will **only** function properly if all the study assumptions are fully realized.

In reality, actual operations almost **never** correspond with study assumptions:

- Because of the long gestation period for most transportation projects, many years may elapse between the projections and the real-world operations;
- Stations are added or deleted;
- Schedules are changed, and often augmented, to meet changes in public demand. For example, trains may be added over time, or memory schedules may be altered from hourly on the hour to hourly on the half-hour;
- Some improvements are never built, while other unforeseen project elements may be added;
- Structural changes in rail transportation may significantly alter the nature of one or more types of service over the territory in question (for example, new freight flows due to a merger of Class I railroads; or institution of a new commuter service).

Accordingly, no matter how careful and detailed is the operations analysis, **a proper design process will proactively and continually assure that the improved infrastructure is flexible enough to <u>reliably</u> accommodate a full spectrum of the potential changes—including but not limited to those exemplified above—that may affect all service types: intercity passenger, commuter and freight.**

The track configuration produced by the simulations should be reviewed to see if additional facilities should be added to handle routine contingencies such as; track maintenance, locomotive or other train failure, etc. Complex terminal areas (passenger and freight) usually need detailed human analysis to insure that interlocking configurations provide for not only the routine revenue moves, but also the various switching and yard moves. After these adjustments are made, a scaled track plan of the entire corridor should be prepared and checked to insure that the proposed facilities can be built without undue expense. Some locations may require more detailed verification analysis using large-scale mapping (at 40 feet per inch) to confirm that the desired track layout will fit.

VII. Highway Crossings

The typical corridor has a relatively large number of public and private highway-rail and pedestrian crossings at grade. A corridor transportation plan should identify each of these grade crossings, the relationship of the highway to the rail line at each site (sight lines, grades, pavement type, etc.), type of warning system, type and density of highway traffic, history of accidents, proximity of nearby crossings or grade separated bridges, etc. Special pre-emptive circuits should be considered for nearby highway traffic signals in order to clear highway traffic that might have stopped on a railroad grade crossing.

Every effort should be made to simply close as many highway grade crossings as possible, especially where there is a series of closely-spaced crossings or where nearby bridges can carry the traffic over or under the railroad. If closing a crossing is not readily feasible and train speeds will not exceed 110 mph, then each crossing should be provided with gates, flashing lights, and bells activated by a constant warning time system that adjusts for different train speeds. Four-quadrant crossing gates, lane barriers and other devices to preclude vehicles from driving around gates should be installed as deemed appropriate.

Every effort should be made to provide grade separation for high-density crossings or those with a history of accidents. Each of these sites usually requires a separate study to assess options.

VIII. Environmental/Historic Impacts

A corridor transportation plan is not intended to be an environmental or historic assessment of any of the many proposed actions. However, there should be a general awareness of environmental or historic properties that could eventually pose major obstacles to proposed changes. A proposal to relocate a corridor on a causeway through a Federal or state waterfowl preserve for several miles might never see the light of day. Likewise, a proposal to demolish a station on the National Register of Historic Places would probably have extremely rough going. On the other hand, old signal towers have been relocated or demolished after preparing an Historic American Engineering Report to document the structure.

IX. Cost Estimates

Conceptual level cost estimates should be prepared for each item listed as a corridor requirement. All parties should be aware that conceptual level cost estimates will carry a large contingency factor (typically 30 - 35 percent), because average unit costs are usually used and detailed design analysis has not been done. Review of the various cost estimates will typically result in some projects being deemed too expensive for the benefits produced, and requests to look at other alternatives will be made. It can be expected that a typical transportation plan will involve a number of options being costed before all parties can agree on some of the most cost-effective solutions.

A corridor transportation plan would typically summarize the various project costs into four basic categories:

A. Recapitalization: This category would include repairs or replacement of life-expired capital assets that would be necessary under any circumstance to simply continue existing levels of service and operations. Typical elements might include:

1. Bridge replacements (undergrade and overhead)
2. Replacement of signal and communications cable
3. Replacement of right-of-way fencing
4. Replacement of station roofs, platforms, etc.

B. Trip time improvements: This category would include items that are solely intended to reduce trip times for corridor passenger train service. Typical elements might include:

1. Curve realignments
2. Concrete ties and welded rail installation
3. Grade crossing removal or improvements
4. Install a new cab signal system in order to operate at more than 79 mph
5. Reconfigure a junction or station for higher speeds
6. Purchase higher-speed rolling stock

7. Install an electric traction system

C. Capacity-related improvements: This category would include items that are required to increase the capacity of the corridor in order to allow increases in traffic by all users of the corridor. Typical elements might include:

1. New passing tracks
2. Additional main tracks
3. Interlocking reconfigurations
4. Additional station platforms
5. New or expanded maintenance facilities
6. Install high-level ADA-compliant passenger platforms
7. Revise signal locations and aspects

D. Other projects: This category would include other corridor related projects that do not fall within any of the other three categories. Typical projects might include:

1. Purchasing new commuter rolling stock
2. Building new commuter stations
3. Constructing multi-modal terminals
4. Constructing additional parking facilities
5. Improving freight clearances

X. Prioritization of Projects

A long-range plan that projects requirements over a period of two decades can only provide general guidance on construction priorities. The studies that make up a corridor transportation plan will usually be able to identify those projects that would be of significant benefit to existing operations or some projects that should have been built years ago. The studies will also identify projects that all parties agree will not be required until traffic levels have reached those projected near the end of the 20 year planning period. The remaining projects will fall into a rather broad category of being needed sometime in the next 5 to 15 years. Three priority categories are usually sufficient:

A. Immediate requirement

B. Mid-term requirement

C. Long-term requirement

Many transportation executives will request a ranking of schedule improvement projects based on cost per minute saved. Comparison of several TPC runs would determine trip time savings achieved by curve alignment changes, higher maximum speeds, improved acceleration, higher-speed turnouts, etc., which can then be compared to the cost. Likewise, more frequent passing tracks on a single track railroad might be shown by the train modeling system to be able to reduce the schedule pad and thus the schedule at a certain cost per minute of eliminated pad.

XI. The Corridor Transportation Plan Report

A formal report needs to be prepared that outlines and summarizes the analysis and findings of the various studies undertaken for the transportation plan. This typically results in a simple two volume report: Volume One summarizes the findings and projected costs of the various improvements; Volume Two contains the detailed analysis and justification of all the improvements contained in Volume One. Usage of past transportation plans has shown that Volume Two, with its detailed analyses and other technical components, is the more important from a substantive viewpoint. However, Volume One requires careful attention because it is directed toward policy-makers, who set priorities, control budgets, and need to understand the rationale for the proposals.

Volume One should contain information such as that described below. Since each corridor is unique, the topics, order, and emphasis will necessarily vary. The following arrangement has worked well in recent reports in which the FRA staff has participated.

A. Executive Summary (extracted from the sections that follow)

B. Chapter 1—Introduction
   1. Rationale for the study
   2. Purpose and approach

C. Chapter 2—The Corridor Today
   1. Fixed Plant
      a. Location (include map)
      b. Background and ownership
      c. Data sources for the condition descriptions that follow
      d. Trackage and track conditions
         (1) Rail
         (2) Ties and timbers

(3) Turnouts, crossovers, double-slip switches
(4) Ballast and subgrade
(5) Geometry of the permanent way; discuss line and surface; curves, spirals, and superelevation

e. Bridges, culverts, and other structures
f. Highway/railroad grade crossings
g. Electrification (if any)
h. Signals, train control, communications
    (1) Signals and train control
    (2) Operational control and dispatching
i. Support facilities (yards and shops; maintenance-of-way bases)
j. Stations and parking

2. Users and services
    a. Entities
    b. Services
        (1) Intercity passenger
            (a) Corridor
            (b) Other
        (2) Commuter (there may be more than one type)
        (3) Freight (Through and local; there may be multiple types)
        (4) Summary description of existing service quality

D. Chapter 3—Service Goals (i.e. what each service expects or intends by the planning “horizon year,” which should be identified early in this chapter.)
    1. Intercity passenger
        (a) Corridor
        (b) Other
    2. Commuter (there may be more than one type)
    3. Freight (Through and local; there may be multiple types)

E. Chapter 4—Methodologies (i.e., how the work was done; the chapter should largely track this guidance manual. Topics for additional study can be listed here as well.)

F. Chapter 5—Analytical results (Generalized descriptions; site-specific projects go in Chapter 8)
    1. Travel time analyses (train performance calculator results and discussion)
    2. Capacity analyses (manual and computerized train interaction simulations)

G. Chapter 6—Environmental/historic factors. Summarize any items that have surfaced in the study that appear to warrant any environmental/historic reviews.

H. Chapter 7—Corridor-wide investments. (i.e., investments in subsystems. For each of the components, exemplified by the following, "the need" (based on foregoing chapters) should be summarized and "the program" should be described.)

1. Track geometry (curves, spirals, superelevation)
2. Track structure (ordinary track components and special trackwork)
3. Bridges, culverts, and other structures
4. Highway-railroad crossings (general treatments; specific major projects go in Chapter 8)
5. Electrification (if applicable)
6. Signals and train control
7. Support facilities
8. Stations and parking

I. Chapter 8—Site-Specific Investments. (This key chapter should describe, both in words and in very clear before-and-after schematics, all important site-specific improvements and rationalizations.)

J. Chapter 9—Program summary and conclusions. This chapter should recapitulate the potential improvements, summarize the study's conclusions, and provide a table of corridor-wide and site-specific investment proposals, with their estimated costs.

The detailed appendices in Volume Two should contain the following minimum information:

A. The final proposed operating schedules of all trains (including deadheads) of all users of the corridor (intercity passenger, commuter, freight, and long-distance passenger services), including the ultimate destination or origination of each train.

B. The final track configuration of the entire corridor drawn to scale (sample attached as Exhibit 1) and containing the following basic information:

1. All main tracks, passing tracks, industrial spurs, station tracks, etc.

2. All interlockings and junctions with other lines showing turnout sizes and track configuration

3. The location of all passenger platforms

4. The location of all pedestrian and highway grade crossings:

    a. To be removed

    b. To be grade separated

    c. To remain in use

5. All maintenance facilities and yards

6. All curves, major bridges and tunnels

7. All industrial freight spurs

C. Cost estimates of distinguishable segments such as a passing track (turnouts, signals, track components, bridges, retaining walls, earthworks, etc.). Listings of unit cost figures used in the estimates should be included.

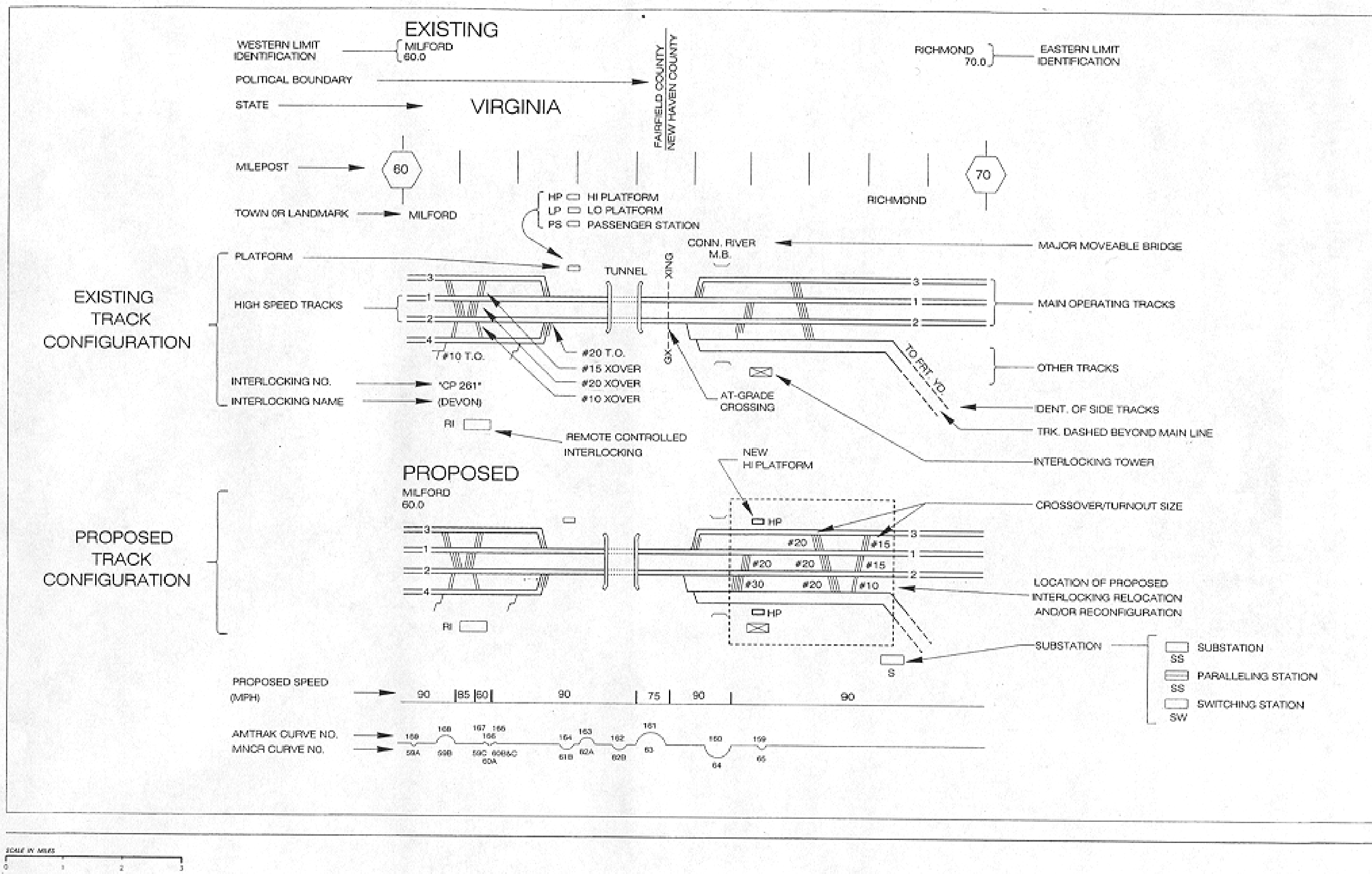
D. The detailed analysis of each curve on the corridor showing elements such as: degree of curve, superelevation, spiral length, maximum speed if limited by jerk rate (the rate of change of superelevation), etc.

E. A detailed description explaining the train operating modeling work that describes the justification for each of the changes recommended for the corridor track configuration.

F. The final proposed speed-versus- distance plot for the proposed intercity corridor passenger service and a brief description of the proposed passenger trains (horsepower, tonnage, seats, maximum speed, tilt or non-tilt, etc.)

G. A discussion of interactions between various individual projects that may dictate the construction sequence or cause significant disruption to train operations. Some projects, such as replacing a major bridge or interlocking, may require suspending all rail service for a period of time (several days to a week or two) during which other work can be accomplished without additional disruption.

H. A detailed description of proposed signal system changes such as; installing cab signals, respacing signal locations for higher speeds, adding signal aspects to increase capacity, installing a new centralized traffic control system, etc. This section should contain a description of any vehicle modifications required to permit operations on a new cab signal or speed enforcement system.



De LEUW, CATHER

EXHIBIT 1
TRACK CONFIGURATION LEGEND

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