Appendix C  Alternatives Development and Screening Report
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1. Initial Alternatives Development and Screening

1.1. Overview

The High Speed Rail Empire Corridor Program initially considered six passenger rail service alternatives, defined by their “maximum authorized speed” (MAS) ratings along the Empire Corridor West segment of the Corridor that runs between Albany/Schenectady and Buffalo-Depew/Niagara Falls, in addition to a Base Alternative (No Action). Three of the six proposed MAS services were: 79 mph (the current passenger MAS west of Hoffmans MP169.9), 90 mph and 110 mph. Each of these speeds has specific regulatory requirements associated with track geometry and topography and, together, they were deemed to represent a reasonable range of alternatives. Subsequently, as a result of input from Public Scoping meetings held in the fall of 2010, “very high speed” (VHS) alternatives of 125 mph, 160 mph and 220 mph MAS were added to the alternatives development and screening process.

1.2. Base Alternative (No Action)

All alternatives include the improvements made under the Base Alternative (No Action). The Base Alternative consists of eight capital improvement projects that have been funded under TIGER grants and other mechanisms. The Base Alternative is carried through the Tier 1 EIS as the Base (Alternative is carried through the Tier 1 EIS as the Base Alternative (BA) to evaluate the cost and impacts of the program Build Alternatives in relation to the benefits gained by the public through this minimal upgrading of existing service on the existing right-of-way.

The Base Alternative represents a continuation of existing Amtrak service with limited operational and service improvements currently planned and funded to address previously identified capacity constraints. Such improvements would consist of new rail vehicles, maintenance, rehabilitation and improvement to track capacity, signal work, highway-rail crossings, and passenger stations. The key improvement projects under the Base Alternative are summarized in Exhibit C-1. Train frequency would remain unchanged from the existing frequency.

Despite increasing ridership, the Base Alternative makes no provision for any improvement of rail service beyond what is already being operated and programmed by Amtrak, Metro-North and/or NYSDOT. It would assume the continued operation of four daily round-trips of conventional speed Amtrak passenger trains between Penn Station, New York City and Niagara Falls on the Metro-North Rail Road and CSXT-owned alignment.

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*MAS refers to the maximum allowable speed for specific types of rail equipment based on track geometry and topography. Most passenger services will spend only a portion of the time at the MAS – steep hills and sharper curves interspersed along the right-of-way will require deceleration and acceleration that result in lower average speeds over the entire length of the segment.*
## 1.3. Alternatives Screening

The purpose of the screening process was to dismissed from further evaluation, alternatives that fail to meet the program objectives as articulated in the program Purpose and Need. The screening is also intended to ensure that all alternatives fall within an economically, environmentally and technologically feasible range. Given these premises, the 79, 160 and 220 mph MAS alternatives were eliminated from further evaluation in the Tier 1 EIS. The following is a brief description of the alternatives and an assessment of their shortcomings in meeting the program performance objectives. A summary of this analysis is provided in Exhibit C-2.

### Exhibit C-1 — Base (No Action) Alternative Passenger Rail Improvement Projects

<table>
<thead>
<tr>
<th>Project Name (Milepost)</th>
<th>ARRA Grant Application</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hudson Subdivision Signal Reliability (MP 75.8 to 140)</td>
<td>ES-3</td>
<td>Replace old signal poles (for electric power to signals and communication lines) with underground cable between Poughkeepsie and Rensselaer.</td>
</tr>
<tr>
<td>Highway-Rail Grade Crossings Safety Improvements CSXT Hudson Line (MP 75.8 to 140)</td>
<td>ES-1</td>
<td>Design and install grade crossing active warning device, roadway approach and/or pedestrian improvements to accommodate improved passenger rail operations between Poughkeepsie and Albany-Rensselaer.</td>
</tr>
<tr>
<td>Rensselaer Station Fourth Track Capacity Improvements (MP 141 to 143)</td>
<td>ES-9</td>
<td>Add fourth track and extend platform to increase station capacity, operating speeds, train frequency, routing, and reduce delays.</td>
</tr>
<tr>
<td>Albany-Schenectady Double Track (MP 143.2 to 160.3)</td>
<td>ES-10</td>
<td>Design, construct and rehabilitate a second main track between the Rensselaer and Schenectady stations to increase capacity, reduce bottleneck, and improve operations in congested single track segment.</td>
</tr>
<tr>
<td>Schenectady Station Renovation /Platform Improvements (MP 159.8)</td>
<td>EW-01</td>
<td>Complete station reconstruction, ADA-compliant platform and station access, viaduct repairs and parking improvements.</td>
</tr>
<tr>
<td>Syracuse Track Configuration and Signal Improvements (MP 287 to 291)</td>
<td>EW-6</td>
<td>Upgrade existing third track to reduce congestion, delays and interference between passenger and freight trains.</td>
</tr>
<tr>
<td>Rochester Subdivision Third Main Track (MP 382 to 393)</td>
<td>EW-20</td>
<td>New third main track and signal system to improve speed, frequency, and reliability.</td>
</tr>
<tr>
<td>Niagara Falls Station – New Intermodal Transportation Center (MP 28.2)</td>
<td>EW-13</td>
<td>New station with improved location in downtown Niagara Falls, function, operation, connectivity, border security, less delays.</td>
</tr>
</tbody>
</table>

ES=Empire Corridor South; EW= Empire Corridor West
Source: NYSDOT ARRA Grant Applications.
Exhibit C-2 — Overview of all Alternatives under Initial Consideration

<table>
<thead>
<tr>
<th>Empire Corridor Alternatives</th>
<th>Maximum Authorized Speed</th>
<th>Average Speed (Including Stops)</th>
<th>Best Scheduled Travel Time NYC-NFL</th>
<th>Ext. Capital Costs (Billions USD)</th>
<th>Annual O&amp;M Cost (Millions USD)</th>
<th>Annual Ticket Revenue (Millions USD)</th>
<th>Annual Net Subsidy (Millions USD)</th>
<th>Est. Annual Ridership</th>
<th>Alternative Description</th>
<th>Notes</th>
<th>Train Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>8A</td>
<td>79 mph</td>
<td>53 mph</td>
<td>8:45</td>
<td>0.35</td>
<td>84.49</td>
<td>80.06</td>
<td>4.43</td>
<td>1,595,000*</td>
<td>Includes previously approved projects which provide improvements to: Station, Capacity, Signal System and Service Reliability.</td>
<td>Existing 110 mph speed maintained: Hudson-Albany-Schenectady.</td>
<td>79 mph Series: Current limit on CSX Empire Corridor West based on Class 4 track standards and lack of in-cab signaling. Uses current vehicle technology with possibility of integrated trainset.</td>
</tr>
<tr>
<td>79A</td>
<td>79 mph</td>
<td>55 mph</td>
<td>8:21</td>
<td>1.50</td>
<td>84.49</td>
<td>110.85</td>
<td>(26.36)</td>
<td>2,077,000*</td>
<td>Improvements to make service more reliable, including passing sidings, signals and station improvements.</td>
<td>Existing 110 mph speed maintained: Hudson-Albany-Schenectady.</td>
<td></td>
</tr>
<tr>
<td>79B</td>
<td>79 mph</td>
<td>59 mph</td>
<td>7:51</td>
<td>2.00</td>
<td>137.65</td>
<td>119.19</td>
<td>18.46</td>
<td>2,000,000*</td>
<td>Adds trains to increase frequency, including 4 express service trains. Infrastructure same as Alt. 79A.</td>
<td>Existing 110 mph speed maintained: Hudson-Albany-Schenectady.</td>
<td></td>
</tr>
<tr>
<td>79C</td>
<td>79 mph</td>
<td>60 mph</td>
<td>7:41</td>
<td>8.10</td>
<td>151.60</td>
<td>131.13</td>
<td>20.47</td>
<td>2,379,000*</td>
<td>Adds a new dedicated single main track to existing alignment (15-ft. track centers). Adds 4 express service trains.</td>
<td>Existing 110 mph speed maintained: Hudson-Albany-Schenectady.</td>
<td></td>
</tr>
<tr>
<td>90A</td>
<td>90 mph</td>
<td>60 mph</td>
<td>7:43</td>
<td>2.50</td>
<td>137.65</td>
<td>123.51</td>
<td>14.41</td>
<td>2,607,000*</td>
<td>Same improvements as 79B, but includes train control improvements to allow 90 MPH operation where supported by the alignment. Includes grade crossing warning system upgrades at all public crossings.</td>
<td>Existing 110 mph speed maintained: Hudson-Albany-Schenectady.</td>
<td>90 mph Series: Next step up (Class 5) in track standards (also requires PTC with in-cab signaling). Uses current vehicle technology with possibility of integrated trainset.</td>
</tr>
<tr>
<td>90B</td>
<td>90 mph</td>
<td>64 mph</td>
<td>7:09</td>
<td>9.90</td>
<td>152.60</td>
<td>144.79</td>
<td>7.81</td>
<td>2,589,000*</td>
<td>Adds a new dedicated single main track to existing alignment (15-ft. track centers) / Includes PTC Signal System for new main track.</td>
<td>Existing 110 mph speed maintained: Hudson-Albany-Schenectady.</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>110 mph</td>
<td>67 mph</td>
<td>6:51</td>
<td>10.80</td>
<td>154.70</td>
<td>155.62</td>
<td>(0.92)</td>
<td>2,775,000*</td>
<td>Adds trains to increase frequency, including 4 express service trains/Adds a new dedicated single main track to existing alignment (50-ft. track centers)/Includes PTC Signal System, including cab signals/Includes warning system upgrades</td>
<td>110 mph: Next step up (Class 6) in track standards (current top speed along dedicated track between Hudson-Albany/Rensselaer and Schenectady). Uses current vehicle technology with possibility of integrated trainset.</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>125 mph</td>
<td>74 mph</td>
<td>5:38</td>
<td>15.00</td>
<td>278.63</td>
<td>183.60</td>
<td>95.03</td>
<td>3,188,000**</td>
<td>New alignment on sealed corridor / Electrification of new track / Adds trains to increase frequency beyond level in 110 alternative/ New stations / Elimination of grade crossings / New PTC Signal System</td>
<td>Riderhip analysis based on the prior developed model and ridership numbers have a conservative bias. Buffalo to Albany is 18 miles shorter than existing Corridor, Albany - NYC on existing, Niagara Falls via 10 minute platform connection at Buffalo.</td>
<td>125 mph: the first speed threshold for electrified operation and the performance benefits achieved through electrically-powered trains.</td>
</tr>
<tr>
<td>160</td>
<td>160 mph</td>
<td>85 mph</td>
<td>4:54</td>
<td>27.00</td>
<td>321.50</td>
<td>237.65</td>
<td>83.85</td>
<td>4,067,000***</td>
<td>New alignment on sealed corridor / Electrification of new track / Adds additional trains in excess of 110 alternative / New stations / Elimination of grade crossings / New PTC Signal System</td>
<td>Riderhip analysis based on the prior developed model and ridership numbers have a conservative bias. Buffalo to Albany is 18 miles shorter, Albany - NYC is 39 miles longer than existing Corridor via connection to Northeast Corridor at Rye, NY. Niagara Falls via 10 minute platform connection at Buffalo.</td>
<td>160 mph: practical upper limit of electrified dynamic tilt trains, such as the Amtrak Acela, that provide faster operating speeds on curves.</td>
</tr>
<tr>
<td>220</td>
<td>220 mph</td>
<td>93 mph</td>
<td>4:29</td>
<td>39.00</td>
<td>333.40</td>
<td>298.83</td>
<td>34.57</td>
<td>5,122,000****</td>
<td>New alignment on sealed corridor / Electrification of new track / Adds trains to increase frequency beyond level in 110 alternative, including 4 express service trains / New stations / Elimination of grade crossings / New PTC Signal System / 220 mph includes specialized train sets</td>
<td>Riderhip analysis based on the prior developed model and ridership numbers have a conservative bias. Buffalo to Albany is 18 miles shorter, Albany - NYC is 39 miles longer than existing Corridor via connection to Northeast Corridor at Rye, NY. Niagara Falls via 10 minute platform connection at Buffalo.</td>
<td>220 mph: practical upper limit of world class high speed rail operations in France, Germany, Spain, Japan and China.</td>
</tr>
</tbody>
</table>

* Ridership numbers are based on initial operating plans with 13 round trips between NYP (Penn Station) and Buffalo
** Ridership numbers are based on operating plan with 125 MPH MAS operating speed in conjunction with the existing service plan along the Empire Corridor. Total number of 15 round trips between NYP-NFL, with stops at ALB, LCA, SYR, ROC and BFX
*** Ridership numbers are based on operating plans with 160 MPH MAS operating speed in conjunction with the existing service plan along the Empire Corridor. Total number of 15 round trips between NYP-NFL, with stops at ALB, LCA, SYR, ROC and BFX
**** Ridership numbers are based on operating plans with 220 MPH MAS operating speed in conjunction with the existing service plan along the Empire Corridor. Total number of 15 round trips between NYP-NFL, with stops at ALB, LCA, SYR, ROC and BFX
***** Ridership numbers are based on operating plans with 220 MPH MAS operating speed in conjunction with the existing service plan along the Empire Corridor. Total number of 15 round trips between NYP-NFL, with stops at ALB, LCA, SYR, ROC and BFX

1 Original Ridership model was designed to analyze the effect on the improvement of the Empire Corridor Rail Service. This model does not fully capture the ridership benefits associated with Very High Speed Rail which would be an much enhanced and new travel mode along this corridor.
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1.3.1. Alternative 79

The 79 mph MAS alternative was developed with three variations, each of which represented different levels of rail infrastructure improvements, and, therefore, associated costs. These sub-alternatives were termed Alternative 79A, Alternative 79B and Alternative 79C. All three of the 79 mph alternatives were to provide greater reliability and fewer conflicts with existing and future CSXT freight movements along the Empire Corridor West segment (under all cases, service characteristics along Empire Corridor South between Albany-Rensselaer and New York Penn Station would remain unchanged).

**Alignment and Service**

Alternative 79A is focused on improving the reliability of existing passenger rail service. The frequency of service would remain at four round trips a day. Current on-time performance is low, discouraging ridership and adding to Amtrak operating costs. The goal of the 79 alternatives is to incorporate sufficient capital improvements to the rail system to ensure 85-90 percent on-time performance between Albany, Buffalo and Niagara Falls. To accomplish this, under Alternative 79A, the existing Empire Corridor track alignment would be used, which includes track, signal and station projects already approved by FRA as part of the Base Alternative, and additional capacity and station improvements.

Alternative 79B includes each of the improvements identified under Alternative 79A, along with service improvements that increase train frequency from four (4) to eight (8) round trips a day. Under Alternative 79C, all capacity and service improvements made under Alternative 79B would be made in addition to the construction of a dedicated third main track reserved largely for passenger trains, and segregated both physically and operationally from virtually all freight rail traffic. For Alternative 79C, the conceptual track improvements include a dedicated passenger track between MP 167 and MP 433, and the addition of five segments of fourth main track to facilitate “flying meets” between opposing direction passenger trains, in which trains can pass at normal speeds, with neither train needing to slow or stop to allow the other to pass.

**Ridership Travel Time and Capital Costs**

As indicated in Exhibit C-2, Alternatives 79A-79C have an estimated cost of 4.3 to 23 times greater than the Base Alternative cost of $350 million, and result in a 30 - 50 percent increase in ridership. Alternative 79A results in a minimal 24 minute time savings over the Base Alternative with a $1.15 billion dollar greater investment required, while 79C results in a 54 minute time savings and a $7.8 billion dollar greater investment over the base. When compared to the other alternatives, a similar or even lesser investment results in much greater time savings and slightly more ridership gains.

**Conclusion**

None of the 79 mph MAS alternatives provide a significant operational or cost advantage over the 90 mph MAS alternatives, which are distinguished primarily by track structure improvements to support higher passenger train speeds where feasible within the existing corridor alignment.
Because there was no substantive and positive differentiator of the 79 mph alternatives, they were not advanced for further consideration, as they did not meet the program purpose and need. In each case, the comparable 90 mph alternative showed superior trip time and ridership with a relatively small variance in estimated cost, resulting in the 90 mph MAS alternatives being retained over their slightly inferior 79 mph counterparts.

### 1.3.2. Alternative 160 and Alternative 220

The Very High Speed (VHS) Alternative 160 represents the practical upper limit of the existing Amtrak Acela-like electrified dynamic-tilt trains. The VHS Alternative 220 represents the current practical upper limit of world-class high speed rail operations as seen in France, Germany, Spain, Japan and China. Both involve the construction of a new, sealed two-track electrified railway paralleling Empire Corridor West and South, dedicated exclusively to high-speed passenger train service.

**Alignment and Service**

As distinct from current operations running along the west side of Manhattan and over the Spuyten Duyvil bridge, the VHS alternatives would emerge from New York City on the existing Northeast Corridor heading east towards New Haven along the I-95 corridor. On Empire Corridor South, it is not feasible to augment or supplant the existing right-of-way parallel to the Hudson River with a VHS alignment, due to the lack of physical space: the current railway is bounded to its immediate west by the Hudson River and by various town centers and rock formations to its immediate east, such that widening the right-of-way could only be accomplished with severe disruption to the natural River environment and local communities and their town centers, and at extraordinary cost. The course of the river and the surrounding terrain being densely developed and relatively undulating would not support the addition of new tracks or the much straighter geometry required to attain VHS.

Given the difficulties associated with VHS train operation in the existing Empire Corridor South, a number of new corridors between New York City and Albany were considered, all of which include difficult terrain in their own right, as well as service through densely populated areas or aligned with intensively used regional highways for much of the route. The corridors selected, however, while complicated by highway geometry, overpasses and interchanges, are designated as transportation corridors and could potentially support additional infrastructure, should it prove appropriate and affordable.

The proposed VHS routing would branch onto a new, high-speed alignment just north of New Rochelle/Rye, heading northwest along the I-684 median on structure or at grade. The routing would merge onto I-84 and cross the Hudson River via a new heavy rail bridge (the I-84 Bridge cannot be cost-effectively re-engineered to accommodate the additional load of heavy inter-city trains). Roughly paralleling the I-84 alignment, the routing would either loop around Stewart Airport or proceed directly up the New York State Thruway (I-87) median to Albany, generally on viaduct structure to allow smoothing of tight curves while minimizing property acquisition and environmental impacts. This would result in an entirely new station and market configuration. In either case, however, conflicts with existing highway overpasses would require extraordinary
solutions, with the VHS right-of-way passing either deeply beneath or well above them, with concomitant engineering challenges and high costs.

On the western corridor, the VHS options would connect the northern cities of Buffalo, Rochester, Syracuse and Albany, with new “rural” corridors away from the existing right-of-way, through generally open land. These new segments would re-connect with the existing right-of-way as it passes through the major cities via open areas or on structure, with some property acquisition likely required.

Presuming an entirely separate VHS right-of-way between New York City and Albany as described above, attaining the high average speeds commensurate with the proposed investment would result in the likely diversion of VHS service from all but four of the existing Empire Corridor West stations. Albany-Rensselaer, Syracuse, Rochester and Buffalo-Exchange Street stations would serve both the VHS and any continued “legacy” Empire Corridor passenger service; the other stations – Utica, Rome, Schenectady – would be provided only the existing service, with no VHS stop in those cities. As such, there would be no synergies between existing commuter rail and high speed rail services in the corridor under these alternatives. With displacement of the VHS Empire Corridor South right-of-way to a corridor west of the Hudson River, it would not be possible to use Metro-North Railroad (MNR) commuter services to originate at a suburban station and connect to a high speed rail train.

**Ridership, Travel Time and Capital Costs**

The dedication of segregated right-of-way under the VHS alternatives would result in significant travel time savings between New York City and Niagara Falls (4:54 and 4:29 respectively for Alternative 160 and Alternative 220, versus the current 9:00 hour travel time using existing services), and commensurately higher estimated ridership (4.06 and 5.12 million respectively for Alternative 160 and Alternative 220). Travel gains for Alternative 160 and Alternative 220 would be roughly proportionate with the increase in speed, as the overall alignments would be of generally similar length, number of stops and service offerings.

The costs for the two VHS alternatives include 40 additional route miles between Albany and New York and complex and costly viaduct construction for portions of the route. If Alternative 160 or 220 options were advanced further, a “compromise” corridor alignment could possibly result that better balances use of existing and new corridors, which might result in lower viaduct costs. For purposes of this analysis, however, the VHS alignment is assumed to require a fully separate right-of-way, and therefore, results in a conservative estimate of capital cost.

Mile-by-mile infrastructure quantities were not developed for the VHS alternatives. Rather, the work items associated with constructing the alternatives were aggregated into broad categories using average costs from industry standards. Property acquisition, miles of viaduct, major and minor river crossings, grade separations, and average track, signal and electric catenary wire system construction values were taken from other high-speed systems. Overall, the estimated costs for Alternatives 160 and 220, in 2015 dollars, are $27 billion and $39 billion, respectively. These costs range from 1.8 to 2.6 times more than the cost of Alternative 125, as shown in Exhibit C-2.

**Conclusion**

Both the 160 and 225 mph MAS alternatives have been screened from this Tier 1 EIS, as only modest (compared to Alternative 125) ridership and travel time gains would be gained at an immense cost, and with significant environmental and community impacts. An extraordinary level of capital
investment would be required for straight, electrified track in a tightly constrained corridor where
the right-of-way occupies a narrow sliver of land between the Hudson River to the west and
challenging natural (rock outcroppings) and community features (densely populated towns
surrounding the stations) to the east. Although these alternatives would meet program performance
objectives and thereby satisfy the Purpose and Need, the improvements would come at a cost that is,
by any current measure, financially infeasible at $37 billion (160 mph MAS) and $39 billion (220
mph MAS), costs that are 30 to 43 times greater than the Amtrak intercity rail capital program for
the entire United States was in FY2011.

For all of these reasons, the VHS alternatives are not advanced for further development in the Tier 1
Draft EIS. More prudent and feasible alternatives exist which confer transportation benefits more
proportional to their costs, and which do not have such substantial negative costs, including
property-takings, and community and environmental impacts.

1.4. Feasible Alternatives Advanced for Further Study

As a result of the preliminary screening, it was determined that Alternatives 90, 110 and 125 were
appropriate for further development. Within Alternative 90, sub-alternatives were developed that
were distinguished by their degree of reliance on existing CSXT mainline track for movement of
passenger trains or by their inclusion of a new dedicated third main track (with fourth main track in
selected locations) that would support most passenger train movements on tracks that do not also
host freight trains.

During alternatives screening, future ridership was forecast using a methodology that would permit
a reasonable assessment of the mobility benefits of each alternative. From this analysis, it was clear
that all of the alternatives considered would produce higher inter-city rail ridership in response to
higher speed and shorter trip times compared to the Base Condition. Therefore, ridership was not a
primary factor in eliminating any of the alternatives. For the alternatives retained for further
analysis, these preliminary ridership estimates were further refined using a statistical ridership
model based on detailed simulations of passenger rail service that were conducted to minimize
conflicts between passenger and freight trains sharing Empire Corridor tracks and switches.

The following is an overview of the four build alternatives plus the Base Alternative that were
advanced for further study:

- **Base Alternative**: consists of eight capital improvement projects that have been funded from
TIGER grants and other sources.

- **Alternative 90A**: consists of 20 capital improvement projects previously identified for potential
TIGER grants and other funding. This alternative would provide a 90 mph MAS and limited
express service, and also includes the Base Alternative projects.

- **Alternative 90B**: consists of additional areas of third track and fourth track and station
improvements to accommodate a 90 mph MAS. This alternative also incorporates the 20
Alternative 90A improvements, in addition to the eight Base Alternative projects.

- **Alternative 110**: consists of additional areas of third track and fourth track and station
improvements to permit of 110 mph MAS. This alternative also incorporates the 20 Alternative
90A improvements, in addition to the eight Base Alternative improvements.
• **Alternative 125:** maintains existing ("legacy") Empire Service and incorporates express service over a new, electrified, grade-separated two-track right-of-way for the Empire Corridor West segment, providing a 125 mph MAS between Albany-Rensselaer and Buffalo Exchange Street. At Syracuse and Rochester, the segregated right-of-way rejoins existing CSXT tracks and serves those stations. Alternative 125 incorporates Base Alternative improvements and those Alternative 90A improvements along the Hudson Line and Niagara Branch and the portions of Empire Corridor West that overlap with the new route.

### 1.4.1. Alternatives without Significant New Mainline Track

Alternative 90A features significant capital improvements, but not a new third or fourth main track on the existing Empire Corridor. The specific improvements included are based on an evaluation of potential capital projects developed for each segment of the corridor. Between New York and Albany-Rensselaer, improvements are based on those identified in the *Hudson Line Corridor Railroad Transportation Plan (2005)*, a joint effort among NYSDOT, CSXT, MNR and Amtrak. These fourteen improvements were identified in the plan with a likely year of implementation, based on operational need, capital cost, available funding and permitting/design status.

West of Albany, some 33 improvement projects not already included in the Base Alternative were identified. These include projects from:

- NYSDOT ARRA grant applications to the FRA, which are, in turn, based on CSXT suggestions;
- The New York State Rail Plan; and
- Improvements suggested by the HNTB Team.

As with New York-to-Albany projects, these improvements were designated with a likely year of implementation based on operational need, capital cost, available funding and permitting/design status. Priority was given to projects that reduce the incidence and severity of delays caused by passenger and freight trains conflicts on shared tracks. These delays were identified from the 2008 Empire Corridor baseline simulation model, which was calibrated to reflect current operations in 2010, when this analysis was performed. The scatter plot shown in Exhibit C-3 — Empire Corridor West: 2008 Delays shows the location of the current delays, along with their magnitude (the vertical axis represents the duration of a single delay event, with the top of the chart representing a single delay lasting 4 ½ hours). While passenger train delays (shown in magenta in the graph) were given highest priority for resolution, freight train delay (shown in blue) mitigation was also pursued. This is because the program Purpose and Need includes a goal to avoid degradation of freight rail service in the corridor as passenger rail service improvements are implemented. Further, delayed freight trains often result in secondary delays to passenger trains due to congestion and loss of dispatching flexibility, so it is in the interest of both passenger and freight rail services to minimize them.
Exhibit C-3 — Empire Corridor West: 2008 Delays

2008 Baseline Simulation Results - Empire Corridor West Delay Scatter Plot

West of Albany, the locations with the greatest magnitude of passenger delays in the simulation model are Syracuse, Rochester and Buffalo-Depew. Each of these stations has just a single passenger train platform edge, meaning that passenger trains are likely to be delayed by opposing direction passenger trains seeking to make a station stop at the same time. For this reason, double edge (one west-bound and one east-bound) platforms were given priority in the development of Alternative 90A at these three stations.

1.4.2. Alternatives with Significant New Mainline Track

Alternatives 90A, 90B and 110 present an incremental approach to providing improved rail services on the Empire Corridor. The improvements common to all three alternatives include installation of increasing lengths of new third track along the Empire Corridor West right-of-way, straightening of curves to allow higher speeds, improvements to signal systems, improvements to existing or installation of new interlockings, and reconfigured stations and platforms. These options result in improved operational flexibility and reduced trip times. However, conflicts with freight trains are only reduced, not eliminated, and curves with reduced allowable speeds remain. Compared to Alternative 90A, Alternatives 90B and 110 feature significant new mainline track between Schenectady and Niagara Falls. These two alternatives are distinguished largely by the higher
design speed, 90 mph and 110 mph, respectively. Alternative 110 therefore produces somewhat faster speed due to its higher speed and the inclusion of additional passing sidings (fourth track) that are not included in Alternative 90B.

Per FRA regulations, both of these alternatives will all require a new train control system (such as Positive Train Control) over the Empire Corridor West right-of-way to support operating speeds higher than the current 79 mph.

The alternatives with significant new mainline track include new Empire Corridor tracks between milepost (MP) 167 (just east of the junction with the Selkirk Branch at a location known as Hoffmans within the town of Glenville), to MP 433 (just west of Depew Station, Buffalo). These alternatives have been developed based on the requirements of single train simulations and meet locations, levels of service, desire to limit potential freight impacts and engineering requirements.

Each alternative, at a minimum, would provide the same level of freight operational flexibility as exists currently, and each seeks to improve freight capacity by moving the passenger trains off of freight mainlines onto dedicated passenger tracks.

For Alternative 90B, the conceptual track alignment consists of a dedicated passenger track between MP 167 and MP 433 with five additional segments of fourth main track to facilitate “flying meets” between opposing direction passenger trains. The new passenger track mainline is generally located 15 feet (ft.) to the north of the existing freight mainlines with the fourth main track segments located 15 ft. to the north of the dedicated passenger third track.

To limit conflicts between passenger and freight trains, several grade separations have been included in Alternative 90B. These are located near MP 279 (the east side of Dewitt Yard), MP 366 (the east side of Rochester Yard), and MP 427 (just east of Buffalo-Depew), which are the locations of the most significant freight-passenger conflicts.

Alternative 110 adheres to a May 2010 framework agreement between CSXT and NYSDOT. It is intended to support 110 mph maximum speed passenger train operation, while remaining in compliance with CSXT design and safety standards, guidelines and policies. Most notably, it provides for a separated and dedicated track for any passenger train operating at speeds in excess of 90 mph, with a minimum of 30 ft. measured from the center line of the freight track to the center line of the proposed passenger track. In locations where it was not practical to meet the required 30 ft. offset, the dedicated passenger track is located 15 ft. from the freight mainline and the maximum speed is 90 mph. Alternative 110 includes six segments of dedicated fourth main track to facilitate “flying meets” between opposing direction passenger trains. Because the existing two mainline tracks and former (now removed) third and fourth tracks are at 13-foot track centers or less, the 30-foot minimum separation has significant implications for this alternative. While it is possible to locate the new passenger third mainline 30 ft. from the existing freight tracks, providing a further 15 ft. for any fourth main track (a full 45 ft. from the existing freight mainlines) is problematic and possibly cost-prohibitive. Therefore, the segments of fourth main track have been located between the existing freight mainline and the proposed passenger third track; the maximum allowable speed on the fourth main track will be limited to 90 mph to comply with CSXT requirements.
1.4.3. Very High Speed Alternatives with Complete Grade Separation

The upper speed limit for dual-mode diesel and electric locomotives is 125 mph. As previously discussed, it is not feasible to augment or supplant the existing Empire Corridor South/Hudson River right-of-way between New York City and Albany, with a VHS alignment that could support 125 mph train operation. Such an alignment would result in significant impacts to existing communities and infrastructure along the Hudson River, or to the River itself. Under Alternative 125, train operation would be diesel between New York City and Albany at the current maximum authorized speed of 110 mph, and electric operation via overhead catenary wire on a new Empire West Corridor built for a 125 mph MAS to Buffalo, with a transfer at Buffalo Depew Station for the final leg to Niagara Falls.

For passenger train speeds exceeding 110 mph up to 125 mph, FRA standards for protection of rail and road traffic state that “the railroad shall submit for FRA's approval a complete description of the proposed barrier/warning system to address the protection of highway traffic and high-speed trains.” FRA guidelines indicate that such a barrier/warning system technology may not exist at this time. Alternatives to grade separation include consolidation and closure of highway, public or private crossings, which is possible at some locations, but impractical at others if rail freight services are to be maintained. At this time, therefore, complete grade separation at all crossings is assumed for Alternative 125.

In general, Alternative 125 connects the major Empire Corridor West cities of Buffalo, Rochester, Syracuse and Albany with a new “rural” corridor away from but parallel to the existing right-of-way, through generally open land. These new segments re-connect with the existing right-of-way in the major cities via open areas or on structure, with some property acquisition likely to be required. This new, high speed passenger train-dedicated corridor at 125 mph MAS, making express stops only, reduces trip time by 45 percent.

2. Engineering Assumptions and Discussion: Alternatives 90, 110 and 125

The following engineering assumptions were derived based on review of both the NYSDOT/CSXT Framework Agreement (May 2010) and program goals. These assumptions served as initial information for discussion of the alternatives, and have since been modified based on further input:

2.1. Alternative 90A

Proposed tracks are assumed to be mixed use tracks and have been primarily laid out using CSXT design criteria of 5 inch Ea (superelevation), with 1.5 inch Eu (underbalance) for freight and 5 inch Eu for Passenger, and No. 20 turnouts where feasible.

- Proposed Tracks will be offset 15 feet from the existing tracks where feasible.
- Existing track centers will be maintained in location where right-of-way is constrained.
- Proposed improvements will be constructed within the existing right-of-way.
• Proposed tracks will allow 79 mph MAS where feasible. There are several existing physical constraints that prevent the proposed projects from obtaining 79 mph MAS.

• Private and public crossings will be modified to accommodate the proposed tracks alignments. Crossing protection will be upgraded as necessary to accommodate the additional tracks and/or reconfigurations.

• Passing sidings (4th track) have been provided where feasible under alternative 79C to provide opportunities for meets without incurring delays.

• In some locations, the existing tracks were shifted or realigned to meet the program requirements.

2.2. Alternatives 90B and 110

• New passenger tracks are assumed to be dedicated passenger tracks. The only time freight would be on these tracks is for local freight operations over short distances and occasional use during major track maintenance windows or operational emergencies. This means that 6" Ea, 5" Eu, and No. 32.75 turnouts would be used on the new passenger tracks instead of the CSXT design criteria of 5" Ea, 1.5" Eu, and No. 20 turnouts.

• Private and public crossings locations will be identified. Crossing protection options will be evaluated in Tier 2 consistent with the FRA’s Highway Rail Grade Crossing Guidelines for High Speed Rail.

• For 110 mph operations, passing sidings (4th track) were assumed to have a 90 mph MAS and located 15 ft. from the existing mainline (that is between the existing mainline and the 30 ft. offset to a proposed 110 mph passenger track). Due to 80 mph operation through the diverging side of the number 32.75 turnouts at each end of the sidings and the distance required for the typical diesel powered train consist to accelerate from 80 mph to 110 mph (approximately 7.5 miles compared to a little over one mile from 80 to 90 mph), the 90 mph limitation would not be considered significant to overall run times on a 10 mile long segment of fourth track. The cost of placing the sidings to the outside of the proposed passenger main, or 45 ft. from the existing number 1 track, exceeds the value of the slight improvement in run times of trains running through the sidings. The 110 mph alternative would include sections of dedicated single passenger mainline that would require significant right-of-way to achieve speeds greater than 90 mph, and have been designed using a 15 ft. track center from the existing mainline and assigned a maximum speed of 90 mph. An example can be found from MP 328 to MP 350 shown on the 110 mph engineered track schematic.

• Where existing/relocated local freight sidings are present, it is assumed that the 110 mph track can be as close as 15 ft. to the freight siding. (If a 30-ft. track spacing is desired in these types of locations to achieve 110 mph, the passenger track MAS may need to be reduced to 90 mph through the area in question due to proximity of additional industry tracks and buildings, or may require relocation to create greater physical separation.)
• Where passenger trains need to co-mingle with freight, No. 20 turnouts were used; where passenger only, No. 32.75 turnouts were used, generally at the ends of the passenger train passing sidings.

• In some locations, the existing tracks were shifted or realigned to meet the design requirements. Grade separations of the new passenger mainline from the existing mainlines were used to avoid significant conflicts with freight trains at critical locations including the east approaches to Syracuse/ Dewitt Yard, Rochester, Buffalo-Depew.

2.2.1. Alternative 110 – Brief Overview from a Track Engineering Perspective

A conceptual alignment to achieve 110 mph operation with 30 ft. track centers from the existing mainline tracks was developed in CADD using an ideal design approach to curve modifications, if it were physically possible to achieve the curve geometry and 30 ft. track centers, along with engineer’s judgment to determine the highest speed attainable. Isolated curves with a design speed less than 110 mph and locations where 30 ft. track centers were not feasible were given close scrutiny to determine an optimum balance among the goal of reduced trip time, cost, and environmental consequences. In some locations, a design speed of 90 mph was considered the best alignment possible and a 23-mile segment of very restrictive curves west of Syracuse, where an increase above 80 mph would incur miles of major realignment.

2.2.2. Examples of Where Desired Speeds Were Attained With Additional Work

1. Big Nose Curve

At Big Nose curve (MP 192.5, west of Amsterdam), 60 mph is the highest speed if the present alignment is retained. Recognizing the significant impact that an isolated 60 mph curve has on the 110 mph alternative, a 90 mph curve easement was defined onto the present NY State Route 5 location at the foot of the significant rock cut at the “nose.” Since NY State Route 5 is about 20 ft. higher than the railroad at the base of the rock cut, it was determined that, rather than cutting the highway alignment further into the steep rock face, NY State Route 5 could instead straddle the relocated railroad on a viaduct more or less parallel to the railroad. Construction phasing of this improvement under both rail and highway traffic would be difficult and even slight alteration to the significant regional visage of the “nose” could generate opposition. However, a workable solution to this very restrictive curve would provide significant benefits to the program.

2. Tribes Hill Curve

At Tribes Hill curve (MP 182 west of Amsterdam), an existing curve of 60 mph is followed immediately by an eased curve in the opposite direction of 80 mph. A 90 mph design was
achieved through both curves with a major realignment, including a 3,000 ft. cut up to 65 ft. deep through adjacent forest and farmland.

### 2.2.3. Examples of Where Desired Speeds Were Not Attained Due to Physical Constraints

1. **Little Falls**

Little Falls (east of Utica) remains highly problematic due to both a very restrictive right-of-way width and sharp curves. Currently, a double-ended freight siding passes through Little Falls between CP215 and CP218. There is not enough room to maintain both the siding and a new passenger track through the narrowest part of the right-of-way in the town center. With several apparent freight consignees in Little Falls, access was maintained for local freight service from the west at CP218, with a separate siding ending in the center of Little Falls before the most restrictive section, where a short runaround track was provided at the end of that track. An existing three-degree curve in the center of town dictates a speed of only 60 mph. Several curves on both approaches to Little Falls have speeds less than 110 mph, which is not a significant issue since actual speeds on those curves will be much lower in light of the governing 60 mph curve at Little Falls.

2. **Restrictive Curves West of Syracuse**

From MP 328 to 351, there is a series of consecutive curves that limits speeds from 70 to 100 mph, with many at 80 mph. Although it may be possible to remedy a few of these curves, given the fact that it takes so long for a train to recover speeds in the range of 80 to 110 mph, unless all of the curves can be modified, there is little to be gained in modifying the few curves that can be feasibly realigned for 110 mph operation.

### 2.3. Alternative 125

- Two-track, electrified, dedicated high speed passenger corridor between Albany and Buffalo.

- In general, Alternative 125 connects the major Empire Corridor West cities of Buffalo, Rochester, Syracuse and Albany with a new “rural” corridor away from and parallel to the existing right-of-way, through generally open land. These new segments re-connect with the existing right-of-way in the major cities via open areas or on structure, with some property acquisition likely to be required.

- New York City to Albany will be diesel operation on existing Empire Corridor track.
3. High-Level Costs for Alternatives 90, 110 and 125

3.1. Engineering Cost Estimate Methodology and Assumptions for Alternatives 90 and 110

*Infrastructure Capital Costs*

The cost estimates for the alternatives are derived from the conceptually engineered track alignments created to define the infrastructure improvements necessary for each alternative. In conjunction with the engineered track alignments, aerial photography, approximate right-of-way lines, locations of existing freight mainlines and sidings, grade crossings, overhead and undergrade bridge locations, and existing topography were used to develop the associated order-of-magnitude cost estimates. Signal costs (where applicable) have been developed using a per-mile cost based on the proposed infrastructure.

*Rolling Stock Assumptions and Costs*

The cost estimates assume that only the additional rolling stock necessary to allow the incremental additional trips between New York City Pennsylvania Station and Niagara Falls will be included in the cost estimates for the alternatives. The cost of rolling stock necessary to operate the current service is not considered part of this analysis. The program assumes that out of the four additional round trips, two trips will be addressed with two train sets, while the other trips will be covered by one-way daily trips per train set. This means a total of six new train sets with two spare train sets; therefore, a total of eight train sets are assumed for this program. For conventional locomotive-hauled train sets, $5 million per locomotive and $3 million per coach were assumed, including spare parts, training programs, manuals, soft costs, etc. In sum, $26 million per train set, or $208 million for new rolling stock, was assumed. As rolling stock values are reasonably well documented, a 5 percent contingency is applied to account for uncertainties in final specifications for the particular service characteristics and signal control requirements yet to be determined.

*Contingency Factor*

Planning studies typically have large contingency factors (30%-35% or greater). Considering the length of this study area at 463 miles (over approximately 300 miles of which there are to be considerable infrastructure improvements), the diversity of the proposed alternatives (the 90 mph and 110 mph alternatives have considerable lengths of proposed track re-alignments outside the current railroad right-of-way), and the sheer magnitude of unknowns (bridge replacements vs. rehabilitations, volume of earthwork, property/building acquisitions, station design and amenities, final interlocking configurations, utility relocations, construction phasing issues, stakeholder requirements, etc.), a contingency of 35 percent was applied to estimates for alternatives with maximum operating speeds of 90 mph and higher. The Base Alternative has no contingency, since the component improvements have been approved and funded, and design is far along or complete.
Design/Engineering Costs

It was assumed that an additional 20 percent of the infrastructure costs would be allocated for engineering, permitting, construction inspection, administration and force account fees.

Escalation Costs

The estimates were developed with 2015 as the base year, to allow easy comparison among alternative capital costs in relatively current dollars. Where costs were estimated (or, as in the case of rolling stock purchases, known) in 2009, 2010, or 2011 dollars, these costs were escalated at 4 percent compounded annually until the 2015 base year value was established.

Details of Alternative-specific estimates

3.2. Alternative 90A

Alternative 90A is essentially contained within the current and/or historic New York Central/CSXT railroad footprint. Estimating its cost was accomplished with five major categories of improvements: Track, Control Points, Grade Crossings, Bridges, and Station Facilities. Refer to Exhibit C-4 for additional information.
### Exhibit C-4 —Unit Cost Assumptions for All Alternatives

<table>
<thead>
<tr>
<th>Property</th>
<th>Track &amp; Signals</th>
<th>Bridges &amp; Structures</th>
<th>Roads &amp; Crossings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Subgrade Prep. &amp; Sub-Ballast</td>
<td>Erosion Control</td>
<td>Highway Reloc. (Per Sy)</td>
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<td>Property Acq. (Per Acre)</td>
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<td>$800,000</td>
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<tr>
<td>Building Acquisition And Removal (Per Sf)</td>
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<td>Drainage Pipes &amp; Box Culverts (Per Sf)</td>
<td>Grade Crossings Private (Each)</td>
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<td>Residence</td>
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<td>$225 Main Track</td>
<td>$1,000 60-100 sf</td>
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<td>Track Throws (Per Track-Foot)</td>
<td>Bridge Demo (Per Sf)</td>
<td>Grade Crossings Public (Per Track-Foot)</td>
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<td>Retire Track (Per Track-Foot)</td>
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<td>$900 Steel 80-120'</td>
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<td>Excavation (Per Cy)</td>
<td>Retire Turnouts (Each)</td>
<td>Walls (Per Sf)</td>
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<td>Rock</td>
<td>$32,000 No 10</td>
<td>$65 2-10' Conc 10-20'</td>
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<td></td>
<td>$54,000 No. 15</td>
<td>$120 Cant.</td>
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<td>Fencing (Per Lf)</td>
<td>Turnouts (Each)</td>
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<td>8' w/BW</td>
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<td>$12</td>
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<td>20% to 150% of Trackwork Value</td>
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3.3. Alternative 90B and 110

Alternatives 90B and 110 encompass a combination of new and existing right-of-way requirements. For these alternatives, a more in-depth analysis was performed to capture as many potential costs as possible. For example, property acquisitions, highway relocations, retaining walls and an additive for complex phasing are a few examples of items quantified for Alternatives 90B 110. These costs have been totaled on a per-mile basis. For a complete list of items quantified, refer to Exhibit C-4 — Unit Cost Assumptions for All Alternatives.

3.3.1. Engineering Cost Estimate Methodology and Assumptions for Alternative 125

The estimating methodology described in Section V. Engineering Cost Estimate Methodology and Assumptions: 90 and 110 was used as a basis for cost estimating Alternative 125. However, since mile-by-mile infrastructure quantities were not developed, the work items associated with constructing the alternatives were aggregated into the following broad categories: Right-of-way; Roadbed, Drainage, Access & Security; Structures; Track and Systems; Yards and Shops; and Station Improvements, as shown in Exhibit C-4 — Unit Cost Assumptions for All Alternatives.

3.3.2. Additional Details on Selected Estimate Items

Property Acquisitions.

Due to the geographically extensive occurrence of property acquisition under both alternatives, five land categories were established: Prime City, Town, Suburban, Farmland and Marsh, to each of which was assigned a per-acre cost. With regard to building acquisition, three distinct categories were developed: Business, Residence, and Outbuilding. The costs were then assigned using a dollars-per-square-foot (SF)-of-building-size factor based on the building footprint.

Additive for Complex Track Construction Phasing.

Various locations along the corridor will require complex construction phasing plans to maintain existing freight and passenger service during construction. An additional cost ranging from 20 percent to 150 percent of the standard trackwork cost, was assigned based on expected complexity.

Status of PTC

CSXT is in the early stages of implementing a PTC system for the Empire Corridor, having filed an Implementation Plan with the FRA. If additional tracks are implemented for passenger-only operation at speeds exceeding 90 mph, they will be required to include PTC. Therefore, capital costs for Alternatives 90, 110 and 125 include the cost of PTC on all new (and assumed to be dedicated passenger) mainline tracks. The cost of PTC implementation on existing CSXT
track is the responsibility of CSXT, however, and is not included in the Tier 1 EIS capital cost estimates.

4. Constructability and Phasing Implications

4.1. Constructability and Phasing Implications for Alternatives 90 and 110

The following section has been prepared pursuant to the Program Scope to identify the optimal sequencing of construction staging in order to verify constructability. It also documents the operational implications of track outages and temporary speed restrictions. This has been done for the following two improvement scenarios:

1) Construction of new passenger mainline tracks adjacent to existing mixed use mainlines
   a. Example chosen from Alternative 90mph - MP 204 to MP 215
2) Construction of proposed flyover
   a. Example chosen from Alternative 110mph - MP 278 to MP 281

4.1.1. Example 1 – New Passenger Mainline Tracks in Alternative 90mph - MP 204 to MP 215

**Major Construction Components**

The track work proposed in Alternative 90mph between MP 204 and MP 215 consists primarily of the following:

- Approximately 12 miles of new dedicated passenger track (3rd track)
- Approximately 10 miles of new dedicated passenger track (4th track/second main)
- Installation of two new No. 32.75 turnouts
- Approximately three miles of existing freight siding realignments
- Installation of four new No. 20 crossovers
- Reconfiguration of four existing freight turnouts
- Rehabilitation/Extension of six Under Grade Bridges to accommodate the 3rd and 4th tracks
- Rehabilitation/extension of existing culverts to accommodate 3rd and 4th tracks, as well as relocated freight siding and potential service road
- One major curve geometry realignment and associated earth work
• Two minor curve geometry realignments
• One public railroad-highway grade crossing reconstruction
• Fifteen private grade crossings
• Up to 12 miles of service road construction.

Construction Phasing/Sequencing Considerations

All construction activities along the Empire Corridor shall be sequenced and phased to minimize negative impact on existing freight and passenger services. Additional consideration and planning will need to occur outside this Tier 1 analysis to ensure minimal delays and impacts on service. Some noteworthy items that need further investigation in Tier 2 are highlighted below:

• Determine whether existing under grade bridge bays can be reused for the proposed tracks or if the bridges need to be extended;
• Determine whether the existing overhead bridge can accommodate the proposed tracks without modifications;
• Determine the type of grade crossing protection to be required at both the public and private crossing;
• Determine the length and times work windows can be obtained for work near existing mainlines and track tie-ins;
• Determine property acquisition requirements; and
• Identify construction vehicle access points and obtain construction easements.

Potential Construction Sequencing

There are numerous construction sequences that would allow for the construction of the proposed program. One of those logical construction sequences is detailed below:

• Obtain construction access easements and prepare the subgrade up to the clearance limits allowed, while still maintaining existing service;
• Extend culverts as necessary;
• Extend/modify existing under grade bridges to accommodate proposed tracks;
• Finish preparing subgrade up through and including tie-in points. Coordinate work windows;
• Install crossovers from existing mainline to relocated freight tracks to maintain service;
• Build as much of the relocated freight track in the clear. Tie the ends back to existing track over a work window, potentially without service delays;
• Remove existing freight track no longer in service;
• Build passenger tracks up to tie-in points;
• Initiate grade crossing work;
• Staged signal installation and testing to occur throughout construction; and
• Finalize track and signal tie-ins.

4.1.2. Example 2 – Proposed Flyover in Alternative 110mph - MP 278 to MP 281

Major Construction Components

The track work proposed in Alternative 110mph between MP 278 and MP 281 is a grade separated overhead bridge and consists of primarily of the following:

• Approximately two miles of new dedicated passenger track (3rd track)
• Approximately four miles of rehabilitated passenger track (3rd and 4th track)
• Installation of one new No. 32.75 turnout
• Approximately nine miles of existing freight mainline realignments
• Installation of three new No. 20 crossovers
• Installation of one new No. 20 turnout
• Construction of retaining walls and Bridge Structure
• Rehabilitation\extension of three Under Grade Bridges
• Rehabilitation\extension of existing culverts
• One major curve geometry realignment and associated earth work
• Two minor curve geometry realignments
• Two public railroad-highway grade crossing reconstruction
• Two private grade crossings
• Up to two miles of service road construction

Construction Phasing/Sequencing Considerations

All construction activities along the Empire Corridor shall be limited in their negative impact on existing freight and passenger services. Additional consideration and planning will need to occur outside this Tier 1 analysis to ensure minimal delays and impacts on service. Some noteworthy items that need further investigation in the Tier 2 are highlighted below:

• Determine if the existing under grade bridge bays can be reused for the proposed tracks or if the bridges need to be extended;
• Due to the large quantity of existing mainline relocations through this area, take great care to build as much of the new track while the existing mainlines stay in service. Minimize cutover and tie-in limits and complete within the allowable work windows;
• Determine the type of grade crossing protection required at both the public and private crossings;

• Determine the length and times work windows can be obtained for work near existing mainlines and track tie-ins;

• Identify property acquisition; and

• Finalize construction vehicle access points and obtain temporary construction easements.

**Potential Construction Sequencing**

There are many different construction sequences that would allow for the construction of the proposed program. One of those logical construction sequences is detailed below:

• Obtain construction access easements and prepare the subgrade up to the clearance limits allowed – while still maintaining existing service. This includes retained fill areas approaching the bridge structure;

• Build new sections of track up to the clearance limits allowed;

• Tie-in the new freight track ends with the existing mainlines;

• Build the bridge structure and remaining retaining walls;

• Install remaining new passenger track;

• Initiate grade crossing work; and

• Finalize signal installation and testing to occur throughout construction.

### 4.2. Constructability and Phasing Implications for Alternative 125

The constructability and phasing implications of the very high speed corridor alternatives differ considerably from the alternatives that construct and modify track on the existing CSXT/Amtrak/Metro-North railroad corridors. In general, these differences are as follows:

**Advantages**

• Reduced need for freight railroad Roadway Worker Protection (RWP) support during construction;

• Eliminated or reduced complexity of staging modifications to active freight tracks;

• Eliminated conflicts with existing industrial and branch lines; and

• Eliminated complexity of expanding/ modifying existing at-grade roadway crossings.
Disadvantages

- Increased permitting and remediation requirements;
- Significantly greater right-of-way acquisition for both right-of-way and for new power distribution substations and power line towers;
- No potential for re-use of previously-constructed four-track right-of-way; and
- Increased need for construction and management-related infrastructure and institutional processes.