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**West Chester Line
Restoration**

Feasibility Study

Final Report

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Table of Contents

Glossary	1
Executive Summary	2
1 Introduction	5
1.1 Previous Studies Overview	5
2 Study Purpose and Needs	7
2.1 Study Purpose.....	7
2.2 Study Needs.....	7
2.3 Project Goals and Objectives	8
3 Study Area	10
3.1 Transportation Network.....	11
4 Environmental Assessment.....	13
4.1 Natural Resources	13
4.2 Cultural Resources.....	14
4.3 Constraints.....	15
5 Existing Infrastructure Assessment	16
5.1 Track.....	16
5.2 Overhead Contact System (OCS).....	17
5.3 Signal and Communications System.....	18
5.4 Electrical Power System	18
5.5 Bridges.....	19
5.6 Highway Crossings	20
5.7 Stations	22
6 Alternatives Screening	23
6.1 Alternatives Considered	23
6.2 Preliminary Screening of Alternatives	25
6.3 Engineering Assessment Overview.....	27
6.4 Secondary Screening of Alternatives	28
6.5 Recommended Alternative to be Advanced	31
7 Infrastructure Requirements.....	32
7.1 Alignment	32
7.2 Track and Roadbed.....	37
7.3 Electrification.....	39
7.4 Signal and Communication System	41
7.5 Bridges.....	42
7.6 Highway Crossings	44
7.7 Stations	46
7.8 Vehicles	48
7.9 Environmental Considerations	48
8 Ridership Assessment	50
8.1 Socio-Demographics.....	50
8.2 Transportation Network Update	51
8.3 Land Use Changes	52
8.4 Ridership Potential Evaluation Results	53
9 Operations	54
10 Public Engagement Summary.....	58

10.1 Stakeholder / Project Committee Meetings Overview	59
10.2 Public Open House Overview	59
10.3 Public Feedback.....	60
11 Conclusion	62
Appendix A.....	63
Appendix B.....	65

List of Figures

Figure 1-1 - West Chester Line between Wawa and West Chester	6
Figure 3-1 - West Chester Line Restoration Study Area	10
Figure 3-2 - SEPTA Suburban Street and Transit Map for Study Area	12
Figure 4-1 - Chester Creek near Hanson Quarry	13
Figure 4-2 - Chester Creek at Structure 25.09	14
Figure 4-3 - Tee It Up Golf	15
Figure 5-1 - Existing track structure with 100PS rail, single shoulder tie plates, timber ties and ballast.....	16
Figure 5-2 - Fouled ballast near quarry in Glen Mills.....	17
Figure 5-3 - Typical OCS Foundation with Exposed Rebar.....	17
Figure 5-4 - Bridge 18.50 3-Span Deck Girder.....	19
Figure 5-5 - Bridge 19.22 Cattle Pass	19
Figure 5-6 - Bridge 26.22 Overhead Bridge	20
Figure 5-7 - West Chester University Station (left) and Glen Mills Station (right)	22
Figure 6-1 - SEPTA Silverliner V EMU Vehicle Alternative A	24
Figure 6-2 - NJ Transit Dual-Mode Locomotive Vehicle Alternative B.....	24
Figure 7-1 - Wawa Siding.....	32
Figure 7-2 - West Chester Station Track.....	33
Figure 7-3 - Curve 19.4, 19.8 and 20.1	35
Figure 7-4 - Cheyney Siding and Curve 22.7	35
Figure 7-5 - Fouled ballast near quarry	38
Figure 7-6 - Deteriorated catenary pole foundation.....	39
Figure 10-1 - Public Open House Advertisement	60

List of Tables

Table 3-1 - Study Area Municipalities.....	10
Table 5-1 - Existing Bridges between Wawa and West Chester	21
Table 6-1. Alternatives Screening for Study Needs.....	26
Table 6-2. Alternatives Screening for Study Goals and Objectives	26
Table 6-3 - Comparison of Electrified Single and Double Track Alternatives	31
Table 7-1 - Station costs	48
Table 9-1 - Current SEPTA Single-Track Regional Rail Lines	54
Table 9-2 - West Chester Bound Schedule	56
Table 9-3 - Center City Bound Schedule.....	57
Table 10-1 - Stakeholder Group and Project Committee Members.....	58
Table 10-2 - Questionnaire Responses.....	61

Glossary

ADA	Americans with Disabilities Act of 1990, civil rights law that prohibits discrimination based on disability
Catenary Structure	Structure that supports the OCS wires, as well as other railroad system components
Dual-mode locomotive	Type of train locomotive powered either from electricity supply or by onboard diesel engine
DVRPC	Delaware Valley Regional Planning Commission
EMU	Electric Multiple Unit, train consisting of carriages with onboard electric motors, like the SEPTA Silverliners
Media/Elwyn Line	Name of current SEPTA regional rail service operating on the West Chester Line between Center City Philadelphia and Elwyn
NEPA	National Environmental Policy Act
NORAC	Northeast Operating Rules Advisory Committee
OCS	Overhead Contact System, wire system for the distribution of electricity to provide power to electric trains
Paoli/Thorndale Line	Name of current SEPTA regional rail service operating on the Mainline between Center City Philadelphia and Thorndale
PennDOT BPT	Pennsylvania Department of Transportation Bureau of Public Transportation
PTC	Positive Train Control, system for monitoring and controlling train movements to ensure safe operation
SEPTA	Southeastern Pennsylvania Transportation Authority
West Chester Line	Regional rail corridor between Center City Philadelphia and the Borough of West Chester owned by SEPTA

Executive Summary

The Southeastern Pennsylvania Transportation Authority (SEPTA) operates regional rail service between Center City Philadelphia and Elwyn on the Media / Elwyn Line. Service on the line formerly operated to West Chester until 1986. Currently, SEPTA is in the process of restoring service to a new Wawa Station. In response to interest by both Chester County and the Borough of West Chester, the Pennsylvania Department of Transportation Bureau of Public Transportation, in cooperation with SEPTA, has studied the feasibility of restoring regional rail service between Wawa and West Chester.

Study Purpose and Needs

The purpose of the West Chester Line Restoration Feasibility Study is to evaluate the potential demand and the engineering, environmental, and socioeconomic implications of restoring a cost-effective rail service between Wawa and West Chester Borough. The study area needs, or deficiencies, which prompted the study of rail service restoration include the following:

- Limited transit options in the study area
- Community interest in service restoration
- Regional connectivity
- Under-utilized right of way

Project Goals and Objectives

The following goals and objectives provide measures by which the various alternatives for restoring rail service have been evaluated against each other and the overall service restoration concept can be evaluated for continued investigation.

- Enhance local and regional connectivity
- Provide a cost-effective solution
- Increase transit ridership
- Support economic development
- Provide multimodal options
- Consider environmental effects

Mode Evaluation

Consideration was given to both electric multiple unit (EMU) vehicles consistent with SEPTA's current fleet which would require the electrification of the line, and dual-mode diesel-electric locomotives, a new technology for SEPTA that would avoid the need for electrification, but would need to be purchased for and dedicated to the West Chester service. The study determined that electrification was the preferred and more cost-effective solution because:

- Electrification has a lower capital cost than purchasing dual-mode locomotives.
- Dual-mode locomotives are a new technology to SEPTA, which requires a new maintenance shop and will have a higher maintenance cost.
- Use of dual-mode locomotives complicates through-routing to other lines.
- Dual-mode locomotives have a different operating profile than the existing fleet, which may require modifications to the electric distribution system.
- Using common equipment with the rest of the regional rail system provides for more reliable service.

- Dual-mode locomotives have a more negative local environmental impact.
- Dual-mode locomotives are heavier than electric vehicles, which may require evaluation and modification of existing structures.

Infrastructure Requirements

A field investigation was conducted as part of the feasibility study to assess the condition of the existing single track infrastructure. Based on the observed conditions, service restoration will require substantial infrastructure improvements to comply with current safety and accessibility standards, meet SEPTA's operational needs, and restore electric service to the line.

Initial consideration for the restoration of service consisted of an assessment of the infrastructure needs to restore the existing single track for electrified service, which includes:

Track and Roadbed Improvements:

- Replacement of over nine miles of existing track ties and rails
- Roadbed stabilization and widening, including construction of approximately 6500 feet of retaining walls
- Implementation of stormwater best management practices
- Replacement of track and pavement at all existing highway grade crossings

Electrification:

- Replacement of at least half of the existing catenary poles and foundations
- Installation of all new overhead contact system wires
- Construction of a new traction power switching substation

Signal and Communication Systems:

- New railroad signals and communications systems compliant with Positive Train Control (PTC) requirements
- New grade crossing warning devices

Bridges and Grade Crossings:

- Full replacement of 15 structurally deficient or functionally obsolete bridges
- Deck replacement of three bridges
- Rehabilitation of seven bridges
- Replacement of all grade crossings

Stations:

- Construction of three new ADA accessibility compliant high-level platform stations in new locations
- Modification of existing West Chester Station to meet ADA requirements and provide necessary parking

Yard:

- Rehabilitation and electrification of West Chester Yard for overnight storage and light vehicle maintenance

Vehicles:

- Purchase of additional vehicles to provide the necessary capacity

The order of magnitude cost for a single-track configuration with two passing sidings is based on historic cost for similar construction and recent SEPTA project costs. The construction cost for the single-track configuration is estimated to be \$380 million.

Construction of a second track was considered, which would provide additional scheduling flexibility and improve service reliability. The order of magnitude cost for the two-track configuration is estimated to be \$644 million. Based on the ridership forecast used in this study it was determined that a second track will likely not be required for the restored service to West Chester.

Ridership Forecast

In 2011, the Delaware Valley Regional Planning Commission (DVRPC) prepared a ridership forecast for the proposed service restoration to West Chester. The DVRPC analysis considered electrified service for a one-seat ride, like the electrified alternative presented in this feasibility study, and a diesel-only service requiring transfer to electric equipment. The electrified one-seat alternative was forecast to attract 1,910 additional daily trips on the line for the horizon year (2035 in DVRPC study, validated for 2040), of which 1,400 trips would be new transit trips and the remaining would be diverted from other SEPTA services. Analysis of the DVRPC inputs compared to currently available data for the study area validated the use of the ridership forecast for this feasibility study.

Conclusion

This study has found that restoration of regional rail service between West Chester and Wawa is feasible. The electrified, single track with passing siding alternative is the most cost-effective solution that meets the operational needs based on the ridership forecast. It is therefore recommended that any future advancement of this project only consider electrification and single track configurations for regional rail service.

Though restoration of regional rail service to West Chester is feasible, the relatively high capital cost and low ridership forecast make the project unlikely to meet requirements for Federal Capital Investment Grant funding, and SEPTA capital funds are dedicated to state of good repair projects for at least the next 12 years. Without Federal or SEPTA Capital funds dedicated to the project, it is unlikely to advance to the next phase of planning and engineering without a significant commitment of local funding.

1 Introduction

The Southeastern Pennsylvania Transportation Authority (SEPTA) currently operates passenger rail service between Center City Philadelphia and Elwyn, Delaware County on the Media/Elwyn Regional Rail Line. The current route operates over the inner 15 miles of the West Chester Line, which extends 27 miles from Center City to the Borough of West Chester in Chester County. Rail service between Elwyn and West Chester was discontinued in 1986 due to the high cost to replace deteriorated rail infrastructure and declining ridership. Since service was discontinued by SEPTA, the portion of the line between Glen Mills and West Chester has been utilized and maintained by a private operator for a scenic railroad service.

As part of its current Capital Budget, SEPTA is currently in the process of restoring regional rail service over a three-mile segment of the West Chester Line south of the current terminus in Elwyn to a new station in Wawa. Construction of this segment is anticipated to be completed in 2022. There is strong local support to continue restoration of passenger service for the remainder of the line to West Chester, an additional nine miles.

In cooperation with SEPTA, the Pennsylvania Department of Transportation's Bureau of Public Transportation (PennDOT BPT) contracted with HNTB Corporation's Philadelphia office to study the feasibility of restoring service between Wawa and West Chester. The study includes a preliminary assessment of existing conditions, identification of the project purpose and need, development and screening of alternatives, and order of magnitude capital cost estimate.

1.1 Previous Studies Overview

Within a decade of discontinuing service to West Chester, SEPTA began to investigate restoration of a portion of the service between Elwyn and Wawa and engineering studies were underway by 2005. The design includes rehabilitation of the rail infrastructure and construction a new Wawa Station, which includes a new ADA accessible station facility with level boarding and a parking structure with over 500 spaces located on the north side of Baltimore Pike. Construction is expected to begin in 2018 with service restored in 2022.

With work for the proposed restoration of service to Wawa underway, West Chester Borough began advocating for the resumption service between Wawa and West Chester. In 2011, Chester County and SEPTA requested a ridership forecast from the Delaware Valley Regional Planning Commission (DVRPC) for restored service to West Chester. The estimated projections, presented in the *DVRPC Wawa to West Chester Regional Rail Extension – Ridership Forecast* report, showed the potential for approximately 1,910 additional daily trips on the line in 2035 for a one-seat, electrified scenario. Some trips would be current riders utilizing other Media/Elwyn or Paoli/Thorndale Line stations. Overall, the restoration of service to West Chester was forecast to attract 1,400 new daily SEPTA trips in 2035.

Since the DVRPC report was issued, both Chester County and the Borough of West Chester have maintained a call for service restoration. In 2014, the Borough created an ad-hoc committee to investigate the potential for the return of rail service. The committee published a report in September 2015 concluding that service restoration was feasible and cost-effective.

SEPTA participated in a study entitled “Enhanced Bus Service on West Chester Pike,” issued in February 2016 by DVRPC. That study was designed to provide a “blueprint for improving the quality of transit service on the (West Chester Pike) corridor.” The study looked to accomplish three objectives, including developing express service operational concepts, strategies to enhance pedestrian access to high-priority bus stops and promote coordination between corridor municipalities. The study looked at four service characteristics: decreasing travel time, enhancing bus stop location, improving connectivity to bus stops and branding that would carry over to vehicles, bus shelters and signage. As a follow-up to the study, a West Chester Pike Coalition, consisting of planners from Delaware and Chester counties, DVRPC staff, municipal managers, SEPTA, and the Transportation Management Associations in Delaware and Chester Counties has been meeting on a quarterly basis to discuss issues of common interest. That group has been briefed on SEPTA’s Direct Bus program on Roosevelt Boulevard in Philadelphia and adjacent Bucks County to identify similar conditions and develop common approaches and funding opportunities to advance an enhanced bus strategy. The coalition is also looking at broader traffic congestion issues that affect the current local and express bus service.

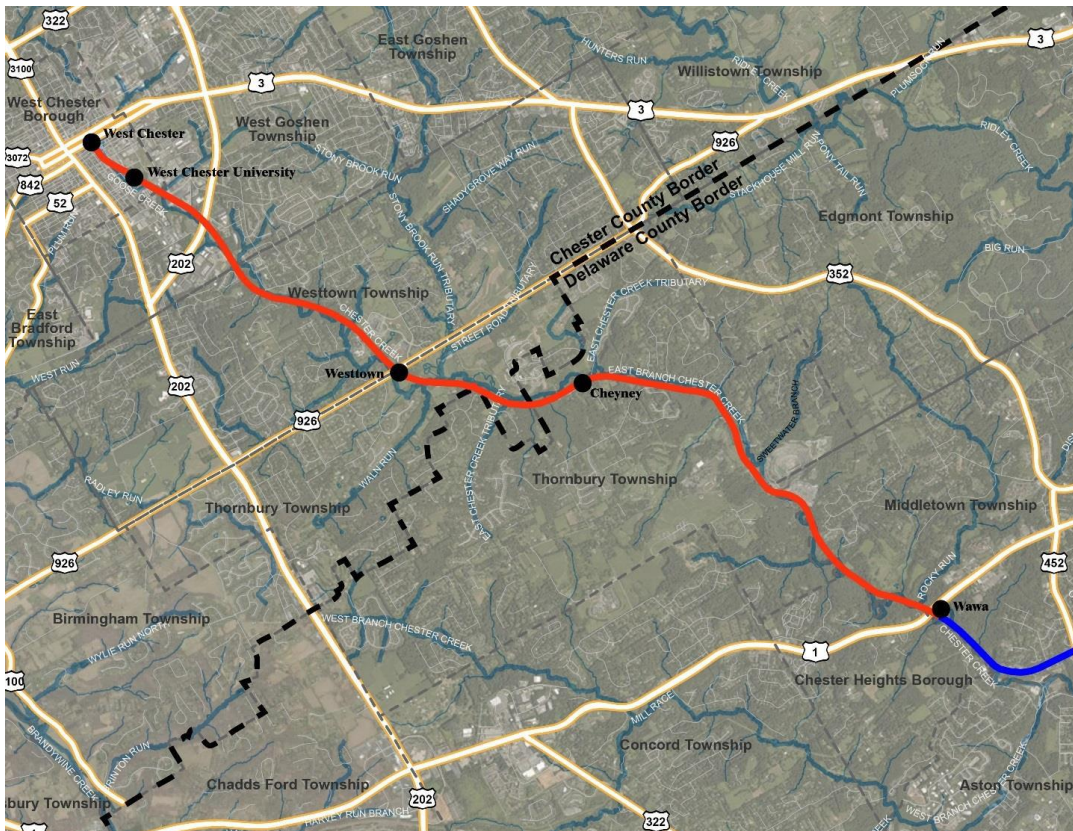


Figure 1-1 - West Chester Line between Wawa and West Chester

2 Study Purpose and Needs

This West Chester Line Restoration Feasibility Study provides a detailed analysis of the existing conditions, identifies the infrastructure needs to meet current railroad safety standards and the requirements of SEPTA's Regional Rail operation, with the goal of developing an order of magnitude cost for the different vehicle and track configurations under consideration. The conclusion of this report will determine if restoration of regional rail service to West Chester is feasible, identify the potential costs, and make recommendations for next steps. A Purpose and Need Statement (P&N) is a foundational element of the alternatives development process. The P&N for the West Chester Line Restoration Feasibility Study establishes the existing conditions which warrant the investigation of rail service restoration and provides a basis for which the No Build and Build alternatives will be evaluated. The alternative evaluation measures are the Goals and Objectives of the study, discussed further in Section 2.3. The P&N serves as a cornerstone for the development and evaluation of alternatives, and works to guide decision making through the evaluation process and to determine recommended solutions to be evaluated further in subsequent future stages of project development.

2.1 Study Purpose

The *purpose* of the West Chester Line Restoration Feasibility Study is to evaluate the potential demand and the engineering, environmental, and socioeconomic implications of restoring cost-effective rail service between Wawa and West Chester Borough.

2.2 Study Needs

The study area *needs*, or deficiencies, which prompted the study of rail service restoration include the following:

Limited Transit Options

Transit services that currently operate in the study area provide inadequate links between centers of activity within the corridor communities and to/from Philadelphia. Bus routes and capacity for the study area are limited, and traffic congestion on the arterial network impacts system performance. In addition, existing regional rail stations along the Paoli/Thorndale and Media/Elwyn lines are mostly outside the study area, with only a few at the outer edges, and parking at those stations is currently at capacity.

Community Interest in Service Restoration

There has been a persistent call to investigate the potential for restoring rail service to West Chester Borough for much of the time since it was discontinued. The Borough formed its own committee, which continues to meet regularly, and the DVRPC has conducted ridership assessments of potential service restoration.

Regional Connectivity

Currently, the Philadelphia metropolitan region has gaps in multi-modal regional transit connectivity resulting from the lack of convenient transportation modal alternatives. Lack

of rail-based transit, traffic congestion, tiresome mode transfer, and local bus service hamper access from the study area to and from Center City Philadelphia. Specifically, within the study area, West Chester is the only county seat in the region not currently served by regional rail. Additionally, Chester and western Delaware counties are currently growing in population, and both Cheyney University and West Chester University, two public higher education institutions, are in the study area. Because of the growing population and employment, travel demand in the study area is increasing. Future population and employment growth in the study area is expected to lead to increases in travel time, congestion, and delay for travelers along sections of the project area.

Under-Utilized Right of Way

The existing rail corridor connects West Chester Borough and West Chester University to Cheyney University and points in between with Media and Center City Philadelphia. Currently, the rail line serves a small tourist train from West Chester to Glen Mills, but is otherwise unused and unavailable for redevelopment.

2.3 Project Goals and Objectives

The following goals and objectives provide measures by which the various alternatives for restoring rail service can be evaluated against each other and the overall service restoration concept can be evaluated for continued investigation.

Enhance Local and Regional Connectivity

Practical travel times are necessary to optimize utilization of any proposed alternative. Trip times under one hour between West Chester and Center City Philadelphia are the goal. This would provide a reliable, convenient link to Center City and could effectively compete with nearby regional rail options, particularly the Paoli/Thorndale line with service out of Exton.

Cost Effective Solutions

The restoration of rail service must represent a sound investment of limited infrastructure funding. Cost benefit considerations may include cost per rider and overall cost in consideration of the available capital resources.

Increased Transit Ridership

With the restoration of service to Wawa, a continuation to West Chester would provide an opportunity to maximize the investment already made and reach additional riders not currently able to access the regional rail system.

Support Economic Development

Additional rail service could connect economic centers and available workforces. It could also provide improved access to cultural attractions and spur transit oriented development adjacent to station stops.

Provide Multimodal Options

Rail service restoration would provide commuters with an additional mode choice beyond only vehicular roadway travel.

Consider Environmental Effects

The existing rail line has multiple stream crossings, and abuts numerous resources such as wetlands, recreational facilities, and homes. The restoration of service along the line, including any required expansion of facilities, has the potential to impact these resources. Those potential impacts must be weighed against the potential benefits provided.

3 Study Area

The study area mimics the study area for both the 2011 DVRPC Ridership Forecast report and the Borough’s Rail Restoration Committee report. It includes the municipalities in eastern Chester County and western Delaware County listed in Table 3-1 and shown in Figure 3-1:

Table 3-1 - Study Area Municipalities

Chester County	Delaware County
Birmingham Township	Aston Township
East Bradford Township	Chadds Ford Township
East Goshen Township	Chester Heights Borough
Thornbury Township	Concord Township
West Chester Borough	Edgmont Township
West Goshen Township	Media Borough
West Whiteland Township	Middletown Township
Westtown Township	Rose Valley Borough
	Thornbury Township
	Upper Providence Township

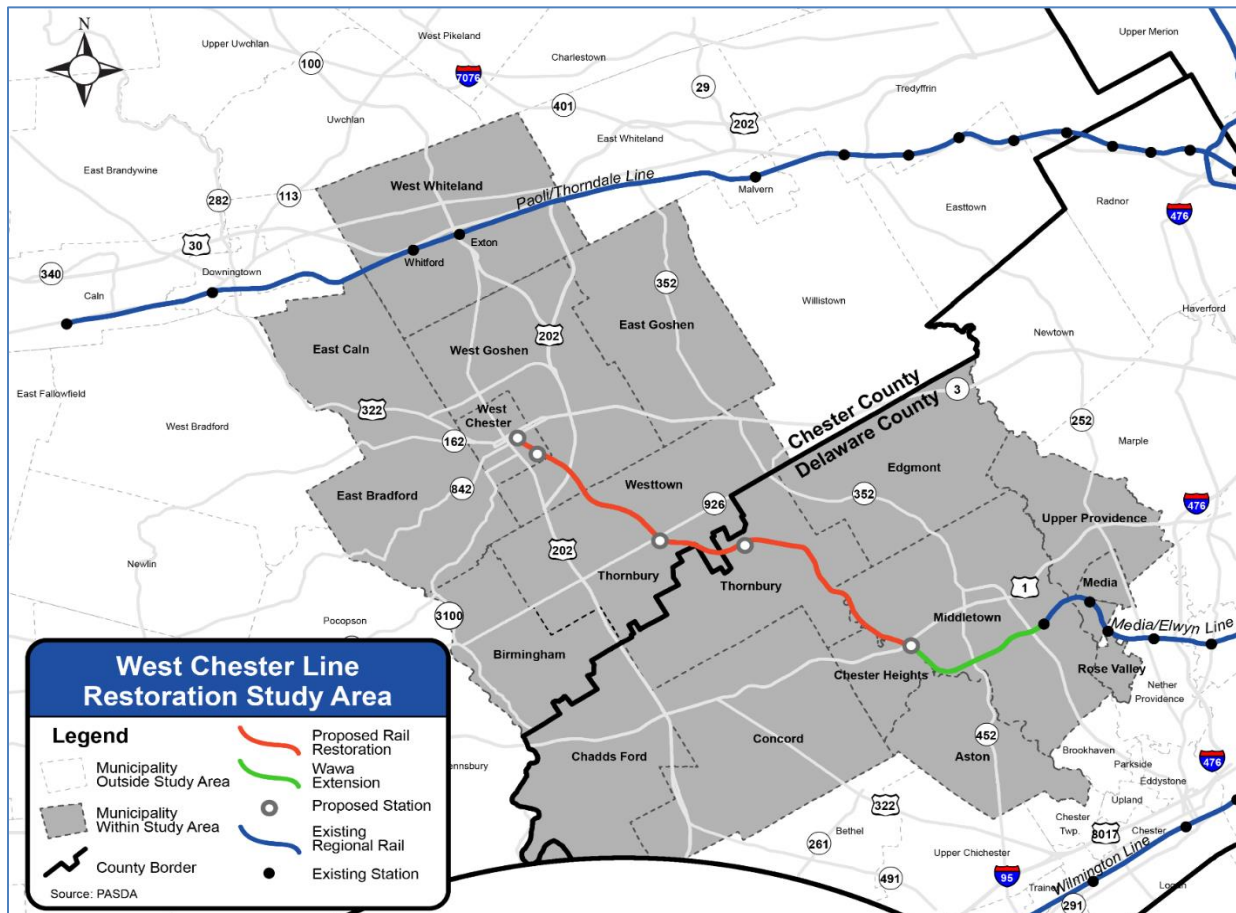


Figure 3-1 - West Chester Line Restoration Study Area

The following sections provide a brief overview of the existing conditions within the study area. In order to use the ridership projections developed by the DVRPC (see Section 8 for detailed discussion), this report used the same study area and proposed station locations.

3.1 Transportation Network

This section summarizes the roadway and transit elements of the transportation network in the study area that were used as travel demand model inputs in the 2011 DVRPC ridership forecast. As in 2011, automobile remains the primary mode of transportation in the study area.

Roadways

Major roadway facilities in the study area include:

- US 1 (Baltimore Pike), US 202 (West Chester Bypass), and US 322
- PA 3 (Market Street/West Chester Pike), PA 100 (Pottstown Pike), PA 352 (New Middletown Road/Chester Road), PA 452 (Pennell Road), and PA 926 (Street Road)
- I-76, I-95, and I-476 provide regional access for trips between the study area and more densely populated regional activity centers in Montgomery County.

Traffic demand has generally decreased on these roadways between 2011 and 2015.

Transit

The northern and western ends of the study area are most accessible to SEPTA's Paoli/Thorndale Line. The eastern edge of the study area will be served by the future Wawa Station on the Media/Elwyn Line. SEPTA operates five fixed-route bus lines within the study area.

Regional Rail

West Chester is the only county seat located within the SEPTA service area not served by regional rail. The nearest regional rail stations are Exton and Whitford on the Paoli/Thorndale Line, located five miles from West Chester and accessible via SEPTA Route 92 bus (approximately 22 minutes from downtown West Chester to Exton) or driving (10-12 minutes from downtown West Chester to either Exton or Whitford).

Parking availability is limited at nearly all stations along the Elwyn/Media Line. A parking structure with approximately 500 spaces planned at the future Wawa station will increase the parking supply. Along the Paoli/Thorndale Line, the most accessible stations to the study corridor, Exton and Paoli, are at capacity and have no daily parking available. The lack of available parking supply will likely affect potential ridership growth. SEPTA currently has a project in their capital budget to increase parking at Exton.

Bus

The study area is currently serviced by five SEPTA bus routes (92, 104, 111, 119, and 120), as well as Krapf's A and SCCOOT. The existing bus service within the study area

serves as a feeder into nearby regional rail or heavy rail stations, and facilitates cross-regional connections to major trip destinations in the area.

The Route 92 bus originates in West Chester and provides service north to the Exton Station, and then east to Valley Forge. Route 104 provides trunk service along West Chester Pike from West Chester to 69th Street Terminal in Upper Darby, with connections to the Market/Frankford Line and the Norristown High Speed Line, as well as several bus/trolley routes. Route 111 also connects to 69th Street Terminal, but from Chadds Ford and Penn State Brandywine campus. Route 119 runs from Cheyney University south and east to Chester City. Route 120 runs along West Chester Pike, but terminates at Cheyney University. Bus ridership has generally increased between 2009 and 2016, with an overall increase of 13% within the study area. The Route 104 bus offers 20-30 minutes peak service, but all other routes offer hourly peak service, with less frequent service off peak.

SEPTA discontinued several bus routes serving the study area since the 2011 DVRPC study due to low ridership. Terminated bus lines include Routes 202, 306 and 314. For SEPTA's Fiscal Year 2018 Annual Service Plan, the minimum acceptable operating ratio for Suburban Transit Division (STD) bus service is 15%. The Route 92 bus is below this threshold with an 11% operating ratio.

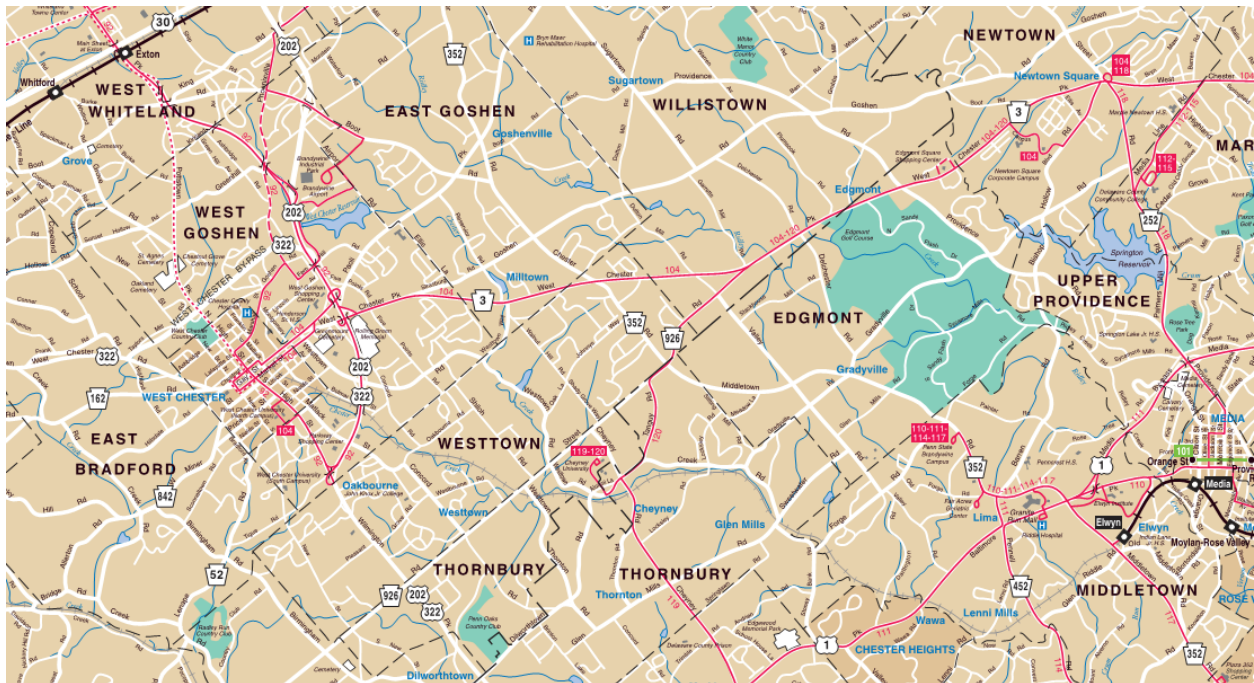


Figure 3-2 - SEPTA Suburban Street and Transit Map for Study Area (www.septa.org)

Additional Rail Operations

Passenger tourist excursion trains are currently operated on the portion of the West Chester Line between Glen Mills and West Chester by the West Chester Railroad Company, a subsidiary of 4 States Railway Service, Inc. In addition, Amtrak retains operational rights on the line to run ballast trains to the quarry in Glen Mills, but this operation has been restricted due to the condition of the tracks.

4 Environmental Assessment

The Wawa to West Chester extension study area is in a semi-developed section of Delaware and Chester Counties in the western Philadelphia suburbs. Much of the area immediately adjacent to the rail corridor remains undeveloped, but historic towns such as Glen Mills and West Chester along with Cheyney and West Chester Universities of Pennsylvania are located along the line. Suburban development has emerged in the surrounding areas. Natural and cultural resources are prevalent throughout the corridor.

Prior to the field investigation, background research was conducted utilizing the Pennsylvania Department of Environmental Protection eMap system¹ and Environmental Justice mapping², the Pennsylvania Historical and Museum Commission Cultural Resources Geographic Information System (CRGIS)³, the Pennsylvania Natural Heritage Program Conservation Explorer⁴ (PNDI), and US Fish and Wildlife Service National Wetlands Inventory (NWI)⁵ to assess previously identified resources.



Figure 4-1 - Chester Creek near Hanson Quarry

4.1 Natural Resources

Chester Creek and its tributaries meander through the rail corridor, often running parallel to and crossing under the tracks. Based on observations during the field investigation and information provided by SEPTA, the streams have eroded the embankments in various locations and have caused scouring at several of the structures. The streams have moved over time such that they often no longer align with the structure openings, causing increased flooding and erosion.

Near West Chester, Goose Creek, a Chester Creek tributary, is the main watercourse. All streams are listed as Trout Stocking Fishes and Migratory Fishes (TSF/MF) in Chapter 93 of the Pennsylvania Code. Some stocking by the Pennsylvania Fish and Boat Commission occurs between Wawa and Glen Mills.

¹ <http://www.depgis.state.pa.us/eMapPA/>

² http://files.dep.state.pa.us/PublicParticipation/Office%20of%20Environmental%20Advocacy/EnvAdvocacyPortalFiles/Southeast_Regional_Office.pdf

³ <https://www.dot7.state.pa.us/CRGIS>

⁴ <https://conservationexplorer.dcnr.pa.gov/>

⁵ <https://www.fws.gov/wetlands/>

Based on NWI mapping and cursory observation during the field view, emergent and forested wetlands may be located along several of the stream sections. One particularly large system is located near Cheyney University of Pennsylvania.

Protected species may be present in the project area, but further agency coordination and possible field investigations would be necessary to identify which, if any are present. The area may include habitat for the federally threatened bog turtle, federally endangered (Indiana) and threatened (Northern Long Eared) bats, the federally protected bald eagle, as well as several plant species and state-protected aquatic species.



Figure 4-2 - Chester Creek at Structure 25.09

Several parks and school recreational fields are close to the rail corridor. These include the Malvern School at Glen Mills, Thornbury Soccer Park, Greenfield Park, Goose Creek Park, and the Bayard Rustin High School. These may be Section 4(f) protected resources. Private facilities such as Tee It Up Golf and the Golf Course at Glen Mills are also along the line. Further investigation of ownership and use would be necessary to establish any protections afforded.

4.2 Cultural Resources

A review of the CRGIS system identified two historic districts listed on the National Register of Historic Places which encompass portions of the rail line. The Chester Creek Historic District is approximately centered on the Hanson Quarry near Glen Mills. The other, the West Chester Historic District, encompasses nearly all of West Chester Borough.

In addition to these, several individual resources and another district located along the line are eligible for or listed on the National Register. These include the Wawa Dairy Farm, the Cheyney log house, and Cheyney University. None appear to overlap boundaries with the corridor. Notably, the corridor itself appears to have been determined not eligible for the National Register.

Archaeological resource potential appears to be low. Although stream corridors are often high potential for pre-contact artifacts, and the rail corridor holds the potential for historic artifacts, the land near the roadbed has been significantly disturbed by the construction of the railroad and the presence of intact sites is unlikely. Several archaeological investigations documented in CRGIS indicated no eligible sites were found in proximity to the corridor.



Figure 4-3 - Tee It Up Golf

4.3 Constraints

The primary constraint throughout the line is the proximity of Chester Creek and its tributaries, including Goose Creek. The streams run parallel to the line at the toe of slope for considerable lengths in addition to crossing underneath the line in multiple locations. There also appears to be wetlands located along many of the creeks, including a large system near Cheyney University of Pennsylvania. The proximity of streams and wetlands may result in significant permitting efforts for widening the roadbed to accommodate a second track or additional passing sidings. In addition, the streams are all in non-attainment for water quality issues, meaning stormwater controls for any new impervious areas would likely be significant.

The two primary historic resources, the Chester Creek and West Chester historic districts, are not expected to be significant issues, unless contributing elements would need to be affected by the restoration of service. The rail corridor has been present throughout much of the area's history and would not otherwise be expected to have a negative impact on those resources.

The final consideration would be the presence of Environmental Justice (EJ) populations along the line. The Environmental Protection Agency defines Environmental Justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income. In practice, this means providing all communities with the same degree of protection from environmental hazards and equal access to the decision-making process. Consideration would be given to the presence of EJ populations along the corridor to ensure that the benefits of the service restoration are distributed equally among the affected communities and that no one community disproportionately experience negative environmental impact.

5 Existing Infrastructure Assessment

On September 7, 2016, representatives of HNTB and SEPTA conducted a field inspection of the rail corridor between Wawa and West Chester. The first part of the inspection utilized an engine and passenger coach provided by the West Chester Railroad, which carried the project team from downtown West Chester to the Glen Mills station. Periodic stops were made along the route at significant system elements. From Glen Mills, the team performed a walking inspection to the site of the future Wawa Station.

The following sections summarize the observations made both in the field and from materials provided by SEPTA or obtained from other secondary sources, which were documented in the *West Chester Restoration Feasibility Study – Existing Conditions / Field View Summary Memorandum (October/December 2016)*, part of the project technical file. For detailed recommendations for infrastructure improvements see Section 7.

5.1 Track

The existing corridor consists of a single track between the current terminus in Elwyn and West Chester. The service restoration to Wawa will include a new, two track station, with one track crossing Baltimore Pike to connect to West Chester. A passing siding located in Cheyney is evident on the valuation map for the line, but this track has been removed. A rail yard located in West Chester is currently used by the West Chester Railroad to store equipment for their tourist train operation on the line. The line runs north-south, with railroad north defined as the inbound direction toward Philadelphia, and railroad south the outbound direction toward West Chester. Stationing has been applied for the purposes of this study, with STA 100+00 located at the north project limit. Curve numbers have been applied based on decimal milepost location.

The track structure between Wawa and West Chester consists of steel rails on timber ties and ballast. Most of the existing rail on the line predates control cooling, a modern manufacturing method to reduce internal rail flaws, and is therefore prone to developing internal defects. Ties are timber and have typically been in service for 30-years, placing them at the end of their useful life. Ballast is generally in fair condition on over 90 percent of the line.



Figure 5-1 - Existing track structure with 100PS rail, single shoulder tie plates, timber ties and ballast



Figure 5-2 - Fouled ballast near quarry in Glen Mills

The track between Glen Mills and West Chester, which is currently leased to the West Chester Railroad and used for tourist-train operations, is generally in fair condition and compliant for Class 1 Operation (15 mph.), but the components of the track structure are not suited for Class 3 Operation (60 mph) associated with modern, high-density passenger service. Between Glen Mills and Wawa, the track is not in regular service and is in poor condition, particularly near the quarry where the ballast is completely fouled.

Complete replacement of the track is required for restoration of passenger service, which will include new timber ties and continuous welded rail.

5.2 Overhead Contact System (OCS)

The existing OCS infrastructure of the West Chester Branch from Wawa to the West Chester terminus has deteriorated since service was discontinued 1986. The original cantilever and portal structures, installed in the mid-1920s, are in fair condition but nearly all the existing foundations require rehabilitation, recapping or replacement.

The existing poles and portal structures along the alignment are wide flange shaped steel section that have been cast directly into the concrete foundation. They are typically in satisfactory condition with all exhibiting an expected amount of rusting but no significant section loss. Some poles are showing signs of delamination at the embedment point with the concrete foundation. A smaller percentage of poles showed significant rusting, displacement from vertical due to loading or damage due to physical impact.

Most of the cantilevers have been removed through the length of the project. The small percentage that remain show significant rust or have failed under load. It is recommended that all remaining cantilevers be replaced.



Figure 5-3 - Typical OCS Foundation with Exposed Rebar

It should be noted that all the existing structures south of Wawa are “short” structures which are not of sufficient height to carry traction power transmission line. Transmission lines between Lenni Substation (active), Cheyney Substation (removed) and West Chester Substation (removed) were routed on dedicated transmission towers parallel to the right-of-way. Cheyney and West Chester Substations were removed in the mid-1960s along with the transmission distribution infrastructure that supported them.

All OCS and auxiliary conductors as well as their support assemblies have been removed from the structures. Any future alternative that would restore electrified service to West Chester would require all new conductors, insulation and support assemblies.

5.3 Signal and Communications System

The existing railroad signal system is “out of service”. Since there is no functional signal system to control movement, trains running on the line between Wawa and West Chester operate on what is referred to as “dark territory” under Northeast Operating Rules Advisory Committee (NORAC) “Form D” authority. Consequently, trains operating on the line run at restricted speed for safety purposes.

There are seven at-grade crossings with public roads and an additional three private at-grade crossings. All grade crossing warning devices have been or will be removed in the near future, as application to the FRA has been made and approved for discontinuance of this protection. Trains are currently required to “stop and protect” at each road at-grade crossings where the protection has been removed.

5.4 Electrical Power System

Traction Power

The electrified portion of the Media/Elwyn Line is supplied power via the Amtrak 138kV transmission system from the #102 transmission circuit from Lamokin Substation in Chester, PA and the #12 transmission circuit from Arsenal Substation in Philadelphia. SEPTA has two traction power substations on the line located in Morton (MP10.23) and Lenni (MP17.6). Lenni Substation is the furthest south on the line, located 2.3 miles south of the current terminus in Elwyn and will be located 0.8 miles north of the proposed Wawa Station. There are also two 12kV catenary circuits from Arsenal Substation that feed the line up to the Morton Substation.

Signal Power

The current signal power system consists of 6.9kV, single phase, 100Hz, two-wire aerial feeder that extends from Walnut Signal Substation (MP1.5) in West Philadelphia, through Lenni Signal Substation (MP17.11), and extends toward US Route 1 (Baltimore Pike) in Wawa. All central instrument houses (CIH), location houses, and other C&S equipment between these substations are fed from 100Hz transformers that tap this 6.9kV, 100Hz line.

60Hz Power

Documentation of 60Hz sources providing power to the corridor between Elwyn and West Chester could not be found, nor were any service drops located in the field. If there are

any existing 60Hz power sources present, these sources are most likely inactive and abandoned at their locations.

5.5 Bridges

There are 28 bridges within the project limits, listed in Table 5-1. The bridges are classified as follows:

- Undergrade Bridges (UGBR) carry the railroad over crossing features. There are a total of 25 undergrade bridges within the project limits, which includes
 - 10 culverts
 - 7 deck girder bridges
 - 4 through girder bridges
 - 2 concrete slab bridges
 - 1 encased I-girder bridge
 - 1 I-beam bridge
- Overhead Bridges (OHBR) carry crossing features over the railroad. There were formerly three overhead bridges, but one (OHBR 26.38) has been removed.

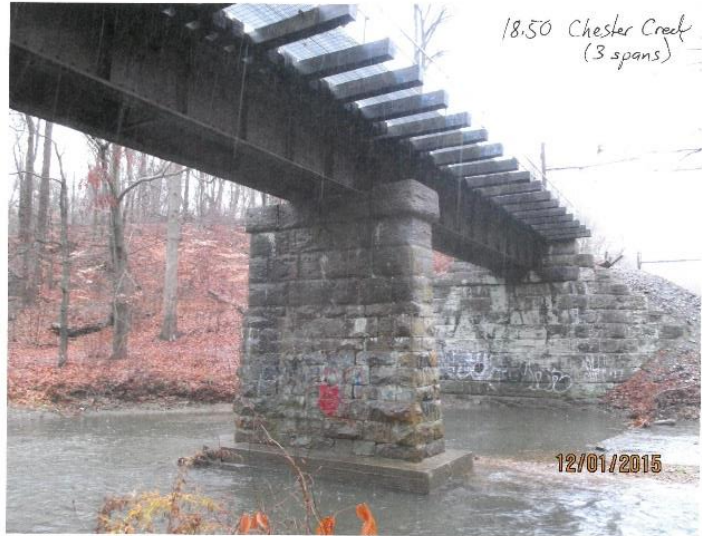


Figure 5-4 - Bridge 18.50 3-Span Deck Girder

Most the bridges within the project limits were constructed between 1852 and 1928 and typically have stone masonry abutments for substructure units. Most bridges are single span bridges with span lengths varying from 6 to 84 feet. The bridge over Chester Creek at MP18.50 is a three-span deck girder bridge. The short span bridges over streams typically consist of stone masonry arches. Bridge timbers on open deck bridges are generally in fair to poor condition and will need to be replaced. Generally, the embankment slopes are steep on each of the bridge approaches.

All undergrade bridges carry one track and do not have adequate superstructure width to accommodate a second track. Six of the undergrade bridges that carry the railroad over public roadways have low to very low clearance, ranging from 9'-2" to 13'-10".



Figure 5-5 - Bridge 19.22 Cattle Pass

Based on the previous inspection reports, photos, and existing bridge drawings received from SEPTA as well as the field inspection, most bridges appear to be in fair condition with some being in poor condition. The capacity to carry the design train live loading should be evaluated prior to the determination of whether replacement is required. It is assumed for this study that the design loading will be



Figure 5-6 - Bridge 26.22 Overhead Bridge

Cooper E-50 to E-60 for bridges that will not carry freight service. Since Amtrak retains rights to operate a ballast train to the quarry in Glen Mills, all bridges between Wawa and Glen Mills will need to meet Cooper E-80 live loading. It is assumed these ten bridges will be completely replaced as it is likely the existing bridge load carrying capacity would not be adequate to support the proposed freight live loading.

The two overhead bridges within the project limit (Street Road and US 202) both have spans that can accommodate two tracks, though horizontal clearances would be substandard and require approval and/or crash walls to protect the substructure. It is further assumed that the existing vertical clearance can be maintained at these locations and modification to the bridges will not be necessary.

5.6 Highway Crossings

There are seven at-grade public roadway crossings on the West Chester Line between Wawa and West Chester.

Delaware County

- Glen Mills Road SR4016 (MP20.40)
- Locksley Road (MP21.50)
- Station Road (MP22.15)
- Cheyney Road SR4015 (MP22.50)

Chester County

- Dilworthtown Road SR2029 (MP23.05)
- East Nields Street (MP27.05)
- East Union Street (MP27.35)

In general, the highway conditions at each crossing was found to be fair. In the event it is determined that public roadway crossings need to be replaced, a full survey will need to be conducted and gradient and sightlines may need to be improved to meet roadway standards. In addition to the public roadway crossings there are several non-signalized private crossings within the project limits, which were not evaluated for this study.

West Chester Line Restoration Feasibility Study
Task 1.7 – Final Report

Table 5-1 - Existing Bridges between Wawa and West Chester

Mile Post	Structure (Crossing)	Overhead or Undergrade	No. of Spans	Type	Year Built	No of Tracks	Superstructure Condition*	Substructure Condition*
<i>MP 18.21†</i>	<i>Baltimore Pike</i>	<i>UGBR</i>	<i>1 @ 59 ft.</i>	<i>Thru Girder / Concrete Deck</i>	<i>1937</i>	<i>2</i>	<i>5-Fair</i>	<i>6-Satisfactory</i>
MP 18.38	Rocky Run	UGBR	1 @ 16 ft.	Concrete Arch	1928	1	5-Fair	N/A
<i>MP 18.50</i>	<i>Chester Creek</i>	<i>UGBR</i>	<i>3 @ 49 ft.</i>	<i>Deck Girder / Open Deck</i>	<i>1904; Repaired 1937</i>	<i>1</i>	<i>5-Fair</i>	<i>6-Satisfactory</i>
<i>MP 18.62</i>	<i>Chester Creek</i>	<i>UGBR</i>	<i>1 @ 76 ft.</i>	<i>Girder / Concrete Deck</i>	<i>1922</i>	<i>1</i>	<i>5-Fair</i>	<i>5-Fair</i>
<i>MP 18.69</i>	<i>Darlington Road</i>	<i>UGBR</i>	<i>1 @ 35 ft.</i>	<i>Encased I-Girders / Concrete Deck</i>	<i>1936; Repaired 2006</i>	<i>1</i>	<i>6-Satisfactory</i>	<i>N/A</i>
<i>MP 19.22</i>	<i>Cattle Pass</i>	<i>UGBR</i>	<i>1 @ 10 ft.</i>	<i>Concrete Box</i>	<i>1928</i>	<i>1</i>	<i>6-Satisfactory</i>	<i>6-Satisfactory</i>
<i>MP 19.68</i>	<i>Forge Road</i>	<i>UGBR</i>	<i>1 @ 23 ft.</i>	<i>I-Beam / Open Deck</i>	<i>1910; Repaired 2001</i>	<i>1</i>	<i>7-Good</i>	<i>6-Satisfactory</i>
<i>MP 19.7</i>	<i>Stream</i>	<i>UGBR</i>	<i>1 @ 7 ft.</i>	<i>Stone Arch</i>	<i>1852</i>	<i>1</i>	<i>4-Poor</i>	<i>3-Serious</i>
<i>MP 20.31</i>	<i>Chester Creek</i>	<i>UGBR</i>	<i>1 @ 84 ft.</i>	<i>Thru Girder / Open Deck</i>	<i>1890; Repaired 1988</i>	<i>1</i>	<i>5-Fair</i>	<i>5-Fair</i>
<i>MP 20.41</i>	<i>Stream</i>	<i>UGBR</i>	<i>1 @ 6 ft.</i>	<i>Stone Arch</i>	<i>1852</i>	<i>1</i>	<i>5-Fair</i>	<i>4-Poor</i>
<i>MP 20.73</i>	<i>Cattle Pass</i>	<i>UGBR</i>	<i>1 @ 16 ft.</i>	<i>Concrete Slab</i>	<i>1916</i>	<i>1</i>	<i>5-Fair</i>	<i>5-Fair</i>
<i>MP 20.92</i>	<i>Stream</i>	<i>UGBR</i>	<i>1 @ 7 ft.</i>	<i>Stone Arch</i>	<i>1852</i>	<i>1</i>	<i>5-Fair</i>	<i>3-Serious</i>
<i>MP 22.58</i>	<i>Stream</i>	<i>UGBR</i>	<i>1 @ 6 ft.</i>	<i>Stone Arch</i>	<i>1852</i>	<i>1</i>	<i>5-Fair</i>	<i>5-Fair</i>
<i>MP 22.78</i>	<i>Stream</i>	<i>UGBR</i>	<i>1 @ 10 ft.</i>	<i>Concrete Slab</i>	<i>1916</i>	<i>1</i>	<i>6-Satisfactory</i>	<i>5-Fair</i>
<i>MP 22.97</i>	<i>Stream</i>	<i>UGBR</i>	<i>1 @ 6 ft.</i>	<i>Stone Arch</i>	<i>1852</i>	<i>1</i>	<i>4-Poor</i>	<i>4-Poor</i>
<i>MP 23.71</i>	<i>Chester Creek</i>	<i>UGBR</i>	<i>1 @ 48 ft.</i>	<i>Deck Girder / Open Deck</i>	<i>1916 (1852 Abuts; 1888 Girders)</i>	<i>1</i>	<i>4-Poor</i>	<i>5-Fair</i>
MP 23.74	Thornton Road	UGBR	1 @ 35 ft.	Deck Girder / Open Deck	1916	1	5-Fair	5-Fair
MP 23.93	Street Road	OHBR	1 @ 44 ft.	Precast Concrete	1989	1	7-Good	6-Satisfactory
MP 24.23	Cattle Pass	UGBR	1 @ 12 ft.	Deck Girder / Open Deck	1989 (1852 substructure)	1	7-Good	6-Satisfactory
<i>MP 24.75</i>	<i>Stream</i>	<i>UGBR</i>	<i>2 @ 4 ft.</i>	<i>Corrugated Metal Pipe</i>	<i>1969</i>	<i>1</i>	<i>4-Poor</i>	<i>N/A</i>
MP 25.09	Chester Creek	UGBR	1 @ 36 ft.	Deck Girder / Open Deck	1909 (1899 Abutments)	1	5-Fair	5-Fair
MP 25.40	Oakbourne Road	UGBR	1 @ 28 ft.	Thru Girder / Open Deck	1899	1	5-Fair	5-Fair
MP 25.75	Chester Creek	UGBR	1 @ 35 ft.	Deck Girder Open Deck	1891 (1852 Abutments)	1	5-Fair	5-Fair
MP 26.22	Route 202	OHBR	1 @ 51 ft.	Prestressed Conc. Beams w/ Concrete Slab	1953; Repaired 2010	1	7-Good	7-Good
MP 26.38	Eachus Street	OHBR		No information		1	Removed	Removed
MP 26.80	Stream	UGBR	4 @ 3.5 ft.	Concrete Pipe	2003	1	7-Good	N/A
MP 27.35	Goose Creek	UGBR	1 @ 8 ft.	Stone Arch extended with Concrete Arch	1852; Extended in 1912	1	5-Fair	5-Fair
<i>MP 27.45</i>	<i>Barnard Street</i>	<i>UGBR</i>	<i>1 @ 41 ft.</i>	<i>Thru Girder / Open Deck</i>	<i>1906 (1886 Abutments); Repaired 1917</i>	<i>1</i>	<i>4-Poor</i>	<i>5-Fair</i>

* From SEPTA Inspection Report

Red italics indicate bridges that will require full replacement / green italics indicate bridges that will require deck replacement

† Bridge being replaced with a single-track bridge for Wawa project; deck to be widened for service to West Chester.

5.7 Stations

The former service made nine station stops between Wawa and West Chester (Wawa, Darlington, Glen Mills, Locksley, Cheyney, Westtown, Oakbourne, West Chester University and West Chester). Only West Chester Station is currently in use for passenger boarding and alighting by the West Chester Railroad for its tourist train operation. West Chester Station has a 200-foot low-level side platform and approximately 60 unmarked surface parking spaces in a partially paved lot.

The other stations are not currently used as passenger stations and have either been repurposed, abandoned or demolished. Each remaining station has a single low-level side platform and minimal or no parking facilities. Full station buildings are located at Glen Mills, Cheyney and Westtown Stations, but all have been repurposed. Locksley and West Chester University Station have only small covered shelters. The remaining stations have no permanent structures in place.



Figure 5-7 - West Chester University Station (left) and Glen Mills Station (right)

6 Alternatives Screening

This study considers four build alternatives for the restoration of rail service to West Chester, with two infrastructure alternatives (single track with passing sidings and full double track) and two vehicle alternatives (EMUs and dual-mode diesel electric locomotives). All options provide a one-seat trip to Center City. Previous studies included a two-seat “shuttle” service using diesel locomotives. Diesel-only locomotives are prohibited from operating through the Center City Tunnel, restricting their functionality on the system. Also, the two-seat trip resulted in lower ridership forecasts. For these reasons, the diesel locomotive shuttle option was dismissed from further consideration.

6.1 Alternatives Considered

Alignment Alternatives

This report will consider two primary alignment alternatives, single-track with passing sidings (Alternative 1) and full double-track (Alternative 2). Both alternatives closely follow the existing corridor to minimize infrastructure costs, right of way requirements and environmental impacts.

Alternative 1 restores the existing single track and limits the widening of the corridor to two tracks for passing sidings strategically located to best serve the operating needs of the line. Alternative 1 considers a single-track operation in areas through which double tracking would have a high cost of construction and high environmental and/or right of way impacts while providing minimal operational benefit.

Alternative 2 widens the corridor to two tracks from Wawa to West Chester. As the existing corridor is only single track, this will require roadbed widening throughout, with additional impacts to private property, streams, wetlands, bridges, grade crossings, existing catenary poles, and the need for additional retaining walls.

Vehicle Alternatives

In addition to the alignment alternatives, there are two vehicles considered in this report, electric multiple units (EMU) like the existing SEPTA Silverliner fleet (Vehicle Alternative A) and dual-mode diesel-electric locomotive push-pull consists (Vehicle Alternative B). The selection of the vehicle is relevant in the type and cost of the infrastructure improvements.

Vehicle Alternative A is compatible with the existing SEPTA Regional Rail system, using the same overhead contact system to distribute traction power. The corridor was previously electrified, though only the poles remain from the original system. A new overhead contact system would be required to electrify the line. A traction power substation located in Cheyney that previously served this line has been removed and would need to be restored. Existing SEPTA vehicles can operate on the line, but some new vehicles may be required to meet the additional capacity demand. This study did not determine the number of additional vehicles required. An additional 12 cars was assumed for the cost estimate.

Vehicle Alternative B would require a new fleet of dual-mode locomotives. The locomotives can operate with onboard diesel engines, allowing service to be restored on the line without the need for electrification. Additional coaches and cab cars would also be required. SEPTA does not have the facilities to maintain dual-mode locomotives so a new shop facility would have to be constructed in this alternative. These locomotives would be unique to the West Chester Line.



Figure 6-1 - SEPTA Silverliner V EMU Vehicle Alternative A
(https://commons.wikimedia.org/wiki/File:Silverliner_V_Train_.jpg)



Figure 6-2 - NJ Transit Dual-Mode Locomotive Vehicle Alternative B
(http://locomotive.wikia.com/wiki/Bombardier_ALP-45DP?file=NJTALP-45DP-4531LB.jpg)

Alternatives Studied

Combining the alignment and vehicle alternatives results in the following four build alternatives:

- **No Build**
- **Alternative 1A:** Single-Track with Passing Siding – EMU
- **Alternative 1B:** Single-Track with Passing Siding – Dual-Mode
- **Alternative 2A:** Double-Track – EMU
- **Alternative 2B:** Double-Track – Dual-Mode

The alternatives development and assessment was done in consultation with project area stakeholders (see Section 10).

6.2 Preliminary Screening of Alternatives

Each alternative was first evaluated based on the Purpose and Needs and Goals and Objectives based only on the alternative descriptions in Section 6.1. The ratings shown in **Table 6-1** and **Table 6-2** provide a visual capture of the comparison between alternatives. This section summarizes the preliminary screening results originally documents in the *West Chester Line Restoration Feasibility Study – Preliminary Screening of Alternatives* technical memorandum (March 15, 2017).

Alternative Meets the Purpose and Needs

All Build alternatives meet all four of the identified needs for the study to varying degrees. However, the double-track alternatives were found to not meet the need for utilization of the existing right of way as well as the single-track alternatives, since they would require the acquisition of additional right of way. The No Build fails to meet the need for improving transit options and connectivity.

Alternative Meets the Goals and Objectives

Based upon this preliminary assessment, all Build alternatives meet the Goals and Objectives to some level, varying between the single and double-track alternatives. Any restoration of service will increase access to transit and thereby increase ridership, improve connectivity within the project area and to the greater region, and afford greater economic opportunity. Double-track alternatives have the potential to provide more frequent and more reliable service, which may better serve economic goals. However, the frequency of service necessary to serve the stations within the project limit could be achieved with strategically located passing sidings, minimizing the effectiveness of the full second track, which comes at considerable increased costs and environmental and community impacts (detailed in Section 6.4).

KEY



Fully Meets



Partially Meets (+)



Partially Meets (-)



Does Not Meet

Table 6-1. Alternatives Screening for Study Needs

	Meets Transit Need	Meets Restoration Need	Meets Connectivity Need	Meets ROW Need
<i>No Build</i>				
<i>Dual Mode Single Track</i>				
<i>Dual Mode Double Track</i>				
<i>Electric Single Track</i>				
<i>Electric Double Track</i>				

Table 6-2. Alternatives Screening for Study Goals and Objectives

	Enhances Connectivity	Cost Effective	Improves Ridership	Affords Economic Opportunity	Environmental Impacts
<i>No Build</i>					
<i>Dual Mode Single Track</i>					
<i>Dual Mode Double Track</i>					
<i>Electric Single Track</i>					
<i>Electric Double Track</i>					

6.3 Engineering Assessment Overview

An engineering assessment was conducted considering each of the four alternatives. The assessment identified the infrastructure needs to restore rail service, estimated the vehicle fleet requirements and considered potential station locations and configurations. Conceptual plans for both the single-track with passing sidings and the double track alignment alternatives were designed and an order of magnitude cost estimate was prepared for each alternative.

Minimum Requirements for Restoration of Rail Service

Any restoration of passenger rail service to West Chester will require improvements to the existing infrastructure. At a minimum, this will include:

- Replacement of 9.2 miles of existing ballasted track
- Construction of interlockings and sections of passing siding track to allow for improved bidirectional operation
- Installation of new railroad communications and signaling systems, including positive train control (PTC)
- Rehabilitation/replacement of structurally deficient or obsolete bridges
- Construction of retaining walls for roadbed widening and stabilization
- Implementation of stormwater best management practices
- Replacement of existing highway grade crossings and installation of new warning devices
- Development of new ADA compliant accessible station facilities with parking and high-level platforms
- Rehabilitation of the existing West Chester Yard for overnight storage and light maintenance of vehicles and facilities for train crews
- Purchase of additional vehicles to provide the necessary capacity

Additional Requirements for Each Alternative

The above will be required regardless of the selected alternative. In addition, depending on the type of service selected, the improvements may also include:

- **Alternative 1A:** Installation of overhead contact system; construction of a traction power switching station
- **Alternative 1B:** Purchase of a new fleet of dual-mode locomotives; construction of a new vehicle maintenance facility
- **Alternative 2A:** Installation of overhead contact system; construction of a new 138kV traction power substation and transmission lines; replacement of additional bridges; roadbed widening

- **Alternative 2B:** Purchase of a new fleet of dual-mode locomotives; construction of a new vehicle maintenance facility; replacement of additional bridges; roadbed widening

6.4 Secondary Screening of Alternatives

The engineering assessment was the basis for performing a secondary screening to identify potential impacts and other considerations that may affect the advancement of alternatives for further study. With additional detail regarding the associated engineering and an order of magnitude cost for each alternative, a quantitative comparison was performed. The secondary screening revisited the goals and objectives. The two that showed the clearest differential between alternatives were:

- Cost Effectiveness
- Environmental Impacts (including Right of Way needs)

The following sections summarize the findings of the engineering assessment for the alternatives that were dismissed. The engineering assessment for all four build alternatives can be found in the *West Chester Line Restoration Feasibility Study - Engineering Assessment Report* (June 16, 2017), included in the project technical files.

Dual Mode Locomotives (Alternative 1B and 2B)

Seven dual mode locomotives are required for the anticipated service pattern and frequency, as well as to provide the necessary reserve to avoid service interruptions due to scheduled maintenance and break downs. Twenty coaches would be dedicated to the West Chester operation. It was assumed that existing coaches would be used to save on the cost of purchasing new coaches. The cost to overhaul the coaches was included in the estimate. SEPTA's maintenance facilities are designed for the existing electric locomotives and EMU fleet. Maintenance of the dual mode locomotives would require a new maintenance facility. The total cost of the dual modes locomotives, coaches and maintenance facility is estimated at \$106 million.

Dual mode diesel electric locomotives were considered for the restoration of service to West Chester primarily to avoid the cost of electrifying the line. The total cost of electrification is estimated between \$64.5 million to \$80.4 million (includes the cost of 12 additional EMUs, although more may be necessary based on finalization of the operating profiles and schedules) for the single track and double track alternatives, respectively. Electrification is a more cost effective solution for the restoration of rail service to West Chester.

In addition to the cost savings, electrification of the line has several benefits over the dual mode locomotives:

- Dual modes must be dedicated to West Chester service, complicating through-routing to other regional rail lines through Center City.
- Using common equipment with the rest of SEPTA's system will allow for more reliable service to West Chester.

- When using the diesel engine, the dual mode locomotives have a greater negative local environmental impact on noise than electric locomotives.
- New technology and dedicated facility results in higher maintenance cost.
- Dual modes have a different operating profile than the rest of SEPTA's fleet, which may require modifications to the electric distribution system (evaluation and cost not included in this study).
- Dual-mode locomotives weigh 282-286 kips, substantially more than the current fleet of electric vehicles operated by SEPTA and exceeding the design weight of 263 kips for much of the regional rail system, necessitating a system-wide analysis of bridge and culvert load ratings.
- Dual-mode locomotives will require dedicated fueling facilities and a new maintenance facility.

Double Track (Alternatives 2A and 2B)

Consideration was given to constructing two tracks between Wawa and West Chester to allow for more operational flexibility in scheduling and better reliability as compared to single track operation. The following sections discuss the specific differences between the single and double-track alternatives.

Track Construction

The addition of a second track adds over seven miles of track construction to the project as compared to the single-track option. The existing track follows the terrain and generally parallels Chester Creek. The single-track option follows the existing track alignment with only minor deviations and utilizes the existing roadbed except where passing sidings require widening. Widening for a second track will require significant earthwork and retaining walls.

Bridges

It is assumed that all 25 single-track undergrade bridges will be fully replaced with two-track bridges, an additional nine bridge replacements as compared to the single-track alternative. Bridges over roadways will need to meet the current standards for horizontal and vertical clearances. A typical bridge width of 36 feet with 14-foot track centers is assumed for this alternative.

Construction of a second track under Street Road (OHB 23.93) and US 202 (OHB 26.22) overhead bridges will require crash walls to protect bridge piers since clearance will be less than 25 feet. It is assumed that the existing vertical clearance can be maintained at these locations and raising of the bridge deck will not be necessary.

Electrification

Comparing Alternative 1A and 2A (single-track electrified versus double-track electrified), the critical assumption for providing electrified, double-track service from Wawa to West Chester is that an additional traction power substation would be needed to maintain voltage requirements throughout the system. For the single-track alternative, it is assumed that the voltage requirements could be met with a lower cost 12kV switching station that could be fed from Lenni Substation. The additional potential load for the full

double track will likely require a full traction power substation with 138kV transmission from Lenni. Adding service to West Chester would require that every other structure along the 1.1 track-miles of right-of-way (12 structures in total) from Lenni Substation to proposed Wawa Station be modified with heavier foundations, column splices and overbuild steel to accommodate the necessary clearances for transmission conductors. At least one circuit (two conductors) of 138kV transmission lines must be carried by alternating, new taller structures (roughly 45 new transmission-carrying OCS Portal structures) from Wawa Station to proposed Cheyney Substation four track-miles south of the proposed Wawa Station.

The cost of the overbuild structures for the 138kV transmission and the traction power substation is in addition to the increased cost for electrifying two tracks. The proposed catenary design will be a two-wire, fixed termination system on two mainline tracks and storage yard at West Chester Terminus. All new ancillary conductors and support assemblies will be required, including signal power, 12kV feeder and grounding wire.

Stations

Stations on double-track sections require vertical circulation for passenger access. The exact needs would depend on the station configuration and the location of parking, but at a minimum grade separated, ADA accessible crossing of one track will be needed. Based on the conceptual alignments and assumed station locations for this study, Cheyney and West Chester Stations would be located on double track sections and would require pedestrian crossings for either alternative. Westtown Station and West Chester University Stations would be located on single-track sections for Alternative 1A/1B. Expanding the facilities at these two locations to accommodate a second track would add an estimated \$15 million.

Right of Way

The right of way is wide enough to accommodate a second track over much of its length, but there are several locations where the right of way narrows and only a single track can fit within the right of way. Several narrow “sliver” takes of adjacent properties would be necessary in these locations, amounting to an additional 4 acres of right of way. Right of way acquisitions have been minimized by assuming that retaining walls would be used.

The right-of-way cost difference between the one and two track options are not substantially different, if retaining walls are used to limit the widening of the roadbed, as has been assumed for this study. The additional property acquisitions typically have the potential to complicate and delay the project by involving private property owners and challenges from the owners.

Natural Resources

Impacts to natural resources have the potential to complicate and delay the project. It is assumed that retaining walls will be utilized to minimize these impacts as much as practical. The double track option would require the replacement of 19 bridges over waterways. There is also the potential for significant stream impacts where the waterways run parallel to the rail line. Wetland impacts would result from the widened section as well.

Cost Comparison

An order of magnitude cost estimate was prepared for all four build alternatives based on the results of the engineering assessment. A comparison of the cost for the single track and double track alternatives for the electrified options (Alternatives 1A and 2A) is presented in Table 6-3. Accommodating a second track from Wawa to West Chester is estimated to cost over \$644 million, a cost difference of over \$264 million as compared to the single-track with passing siding (69% cost increase).

Table 6-3 - Comparison of Electrified Single and Double Track Alternatives (1A and 2A)

Item	Description	Alt 1A Single Track	Alt 2A Double Track	Increased Cost for Double Track
1	Mobilization (10% Construction Costs)	\$17,500,000	\$30,700,000	\$13,200,000
2	Track, Roadbed and Special Trackwork	\$24,500,000	\$49,000,000	\$24,500,000
3	Electrification (Overhead Contact System)	\$20,000,000	\$34,500,000	\$14,500,000
4	Retaining Walls	\$12,000,000	\$53,000,000	\$41,000,000
5	Bridge Rehabilitation and Reconstruction	\$34,000,000	\$63,000,000	\$29,000,000
6	Stations (Platforms / Parking / Access)	\$51,600,000	\$66,600,000	\$15,000,000
7	Railroad Signal and Communication Systems	\$19,100,000	\$21,700,000	\$2,600,000
8	Electric Power Systems	\$10,900,000	\$12,300,000	\$1,400,000
9	Highway Grade Crossings	\$2,700,000	\$6,600,000	\$3,900,000
10	Subtotal, Construction Costs (Items 1 through 9)	\$192,300,000	\$337,400,000	\$145,100,000
11	Bonds & Insurance, Overhead, Profit (10% of Items 2, 4, 5, 6 and 9)	\$12,480,000	\$23,820,000	\$ 11,340,000
12	Contingency (30% of Items 10 and 11)	\$61,434,000	\$108,366,000	\$ 46,932,000
13	Total, Construction Cost (Items 10 through 12)	\$266,214,000	\$469,586,000	\$203,372,000
14	Engineering Design (10% of Item 13)	\$26,621,400	\$46,958,600	\$ 20,337,200
15	Right-of-Way Acquisition	\$150,000	\$190,000	\$40,000
16	SEPTA Project Management, Permitting, Construction Inspection, Administration and Flagging (20% on Item 13)	\$53,242,800	\$93,917,200	\$ 40,674,400
	Total, Construction, Right of Way and Management Costs	\$346,228,200	\$610,651,800	\$264,423,600
	Vehicles	\$33,600,000	\$33,600,000	\$-
	Vehicle Maintenance Facility	\$-	\$-	\$-
	Total, Project Cost	\$379,828,200	\$644,251,800	\$264,423,600

Single track presents a significant cost savings as compared to double track. As detailed in Section 9, the anticipated operational needs of the line can be met with a single track and strategically located passing sidings, which is common near the termini of existing SEPTA regional rail lines.

6.5 Recommended Alternative to be Advanced

Electrified single track with passing sidings (Alternative 1A) is recommended for further study if the project progresses. It provides the most cost effective solution to providing a satisfactory level of service to meet projected ridership demand. A detailed discussion of the infrastructure requirements of the electrified single track option follows in Section 7.

7 Infrastructure Requirements

The following sections discuss the track alignment and other requirements for single-track service restoration, organized by infrastructure category including track and roadbed, overhead contact system, signal and communication system, electrical power system, bridges, highway grade crossings, stations and vehicles. Order of magnitude costs are discussed at the end of each section, and are presented in tabular form in Appendix A. Conceptual plans have been developed and are presented in Appendix B.

7.1 Alignment

The conceptual track alignment limits the widening of the corridor to two tracks for passing sidings that are strategically located to best serve the operating needs of the line, while limiting to one track in areas through which a second track would have a high cost of construction and provide minimal operational benefit. The proposed alignment has the following three sections of double-track:

Wawa Siding: The planned service restoration to Wawa will include a single track from Elwyn to Wawa, with a second station pocket track at the terminal in Wawa on either side of a proposed center island platform. The main track in Wawa will connect to the existing track to West Chester, while the second track will terminate before crossing Baltimore Pike. With this configuration as the assumed existing condition for the restoration of service to West Chester, the proposed alignment would extend the station pocket track in Wawa over Baltimore Pike and continue south approximately 1300 feet, where the corridor will return to single track north of the Chester Creek UGB 18.50. This allows for the optimal use of the Wawa Station configuration to either platform trains in two directions at scheduled meets or to allow for trains terminating in Wawa to be overtaken by through trains to/from West Chester. Returning to single-track operation north of Chester Creek UGB 18.50 avoids the need for widening of the bridge to two tracks (see Section 5.5 for discussion of bridge rehabilitation needs).

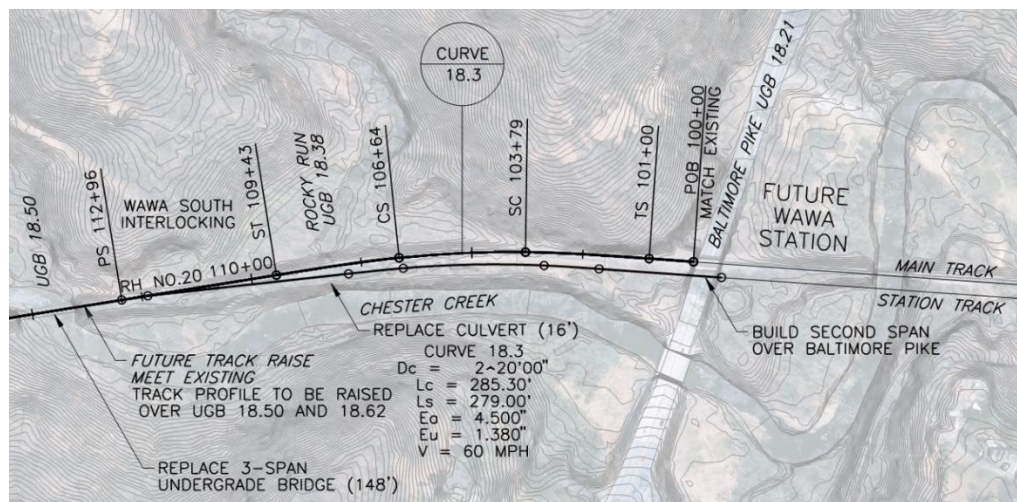


Figure 7-1 - Wawa Siding

West Chester Station Track: The line terminates at West Chester Station. Developing West Chester Station as a two-track terminal is recommended, similar to the current plan for Wawa Station. This provides desired operational flexibility for normal terminal operations as well as redundancy for storage and to limit service interruptions due to a disabled train occupying a platform track. A track configuration has been developed that opens the second terminal track south of the potential West Chester University Station location.

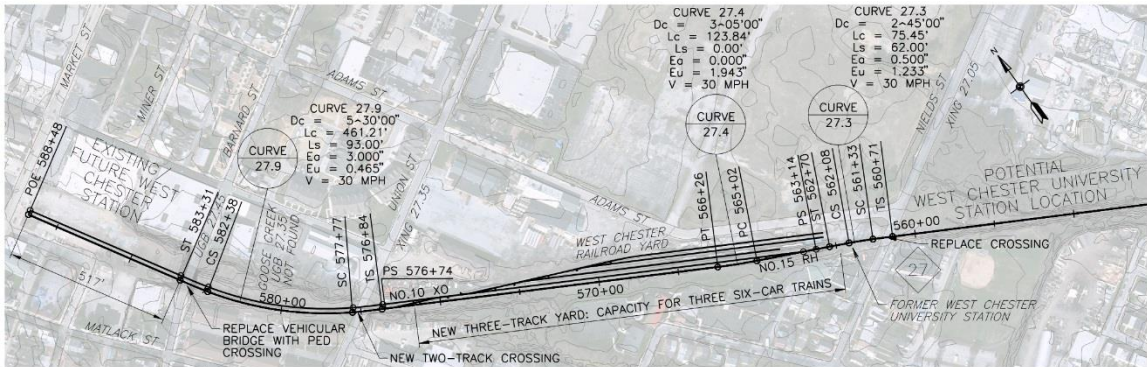


Figure 7-2 - West Chester Station Track

Cheyney Siding: An intermediate passing siding has been included in the conceptual configuration. At 12.1 miles, the length of single track would be the longest on the SEPTA system, so an additional siding is advisable for operational flexibility. It is assumed that trains would not pass at speed, but one train would be held on the siding to allow for the opposite train to pass on the main, which is the standard practice on the other SEPTA regional rail lines. The following approach was taken to locating the intermediate passing siding:

1. Locate the approximate mid-point between the ends of Wawa Siding and second track in West Chester – Milepost (MP) 22.7
2. Consider restoring all or some of the former siding in Cheyney – MP 22.1 to MP 22.4
3. Identify major constraints that would limit the two-track section on either side of the desirable location – Steep embankment between Locksley Road Crossing 21.50 and Station Road Crossing 22.15 to the north and UGB 23.71 and UGB 23.74 to the south
4. Identify tangents between the constraining points that can accommodate the interlockings and provide the maximum length of siding – MP 22.3 and MP 23.5

The siding, referred to as Cheyney Siding in this report, is approximately 1.2 miles long. This is considerably longer than sidings on other regional rail lines and may be longer than necessary to meet SEPTA’s operational needs, but the relatively limited tangent length over this section of the corridor severely limits the potential interlocking locations. Cheyney Siding contains the location for Cheyney Station, which would require that it be built for two tracks (see Section 7.7 – Stations), which

increases the construction cost, but allows for scheduled meets to occur at a station platform. The siding presented in this report is just one potential configuration; future studies may consider other configurations that may be further coordinated with the proposed operations.

Cheyney Siding as conceptualized in this report requires the widening of three culverts over tributaries to Chester Creek (see Section 7.5) and the widening of two at-grade public road crossings at Cheyney Road and Dilworthtown Road (see Section 7.6) to accommodate the second track. In addition, there are potential wetlands between Cheyney Road and Dilworthtown Road that may be impacted by the widening. To minimize the impacts, retaining walls have been assumed through this area (see Section 7.5).

Though additional sections of double track are feasible, their operational functionality would be limited and may not justify the additional investment to construct and maintain.

Design Speed: The allowable speed for the corridor is currently FRA Class 1 - 10 mph freight / 15 mph passenger. When previously in service, the alignment supported a 50 mph operation, with speed restricted to 40 mph for the curves at the quarry in Glen Mills and reduced to 10 mph in West Chester. Applying current SEPTA design standards for track geometry, a conceptual horizontal alignment has been developed. The following criteria applied:

- Equilibrium Elevation: $E = 0.0007V^2D$, where:
 - V = velocity in miles per hour
 - D = degree of curve (chord definition)
- Length of Spiral: $L_s = 1.63 E_u V$, where:
 - E_u = underbalance elevation in inches
- Applied Superelevation: $E_a = 5.5$ inches
- Underbalance:
 - Preferred $E_u = 1.5$ inches
 - Maximum $E_u = 2.5$ inches
- Elevation Runoff: 1/2 inch per 31 feet
- Minimum Length of Tangent between Reverse Curves: 100 feet
- Track Centers:
 - Adjacent Main or Yard Tracks: 14 feet
 - Between Adjacent Main Track and Yard Track: 17 feet
- Grades:
 - Preferred that no grade exceed the ruling grade on the line (1.50 percent)
 - Absolute maximum grade is 2.50 percent

Based on the data available for this study it is anticipated that the geometry can generally support a maximum authorized speed (MAS) of 60 mph for FRA Class 3 following the existing alignment with relatively minor modifications to curvature, spirals and applied superelevation.

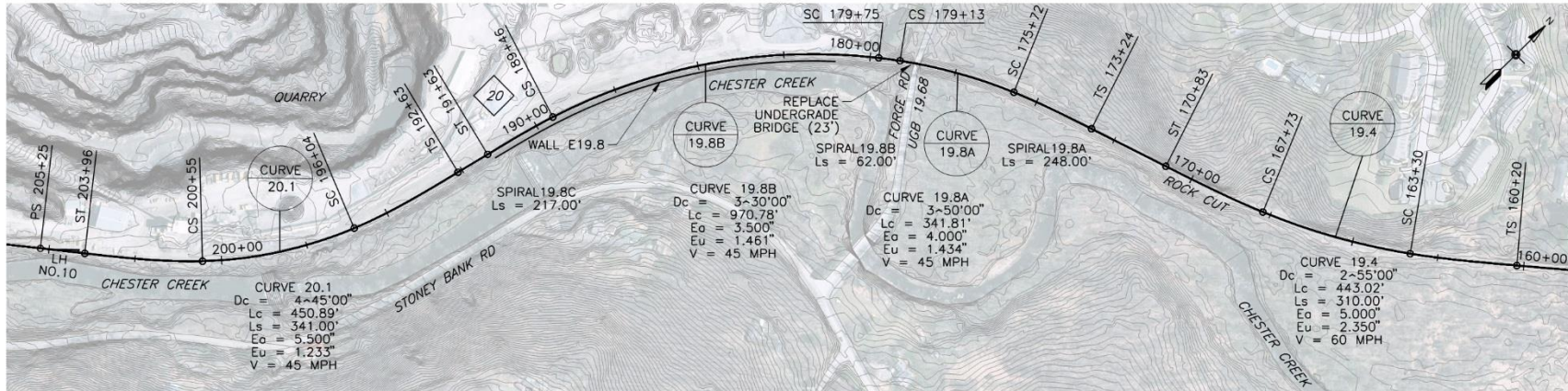


Figure 7-3 - Curve 19.4, 19.8 and 20.1

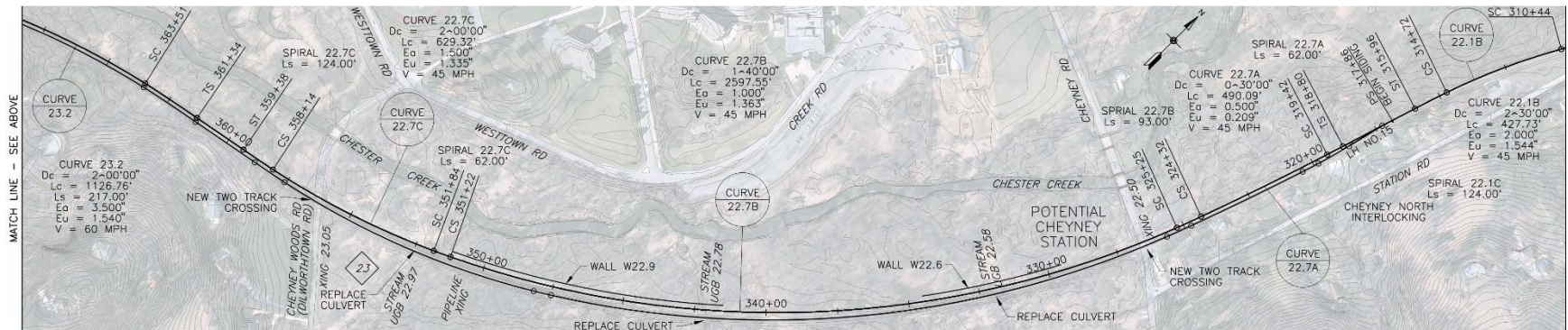
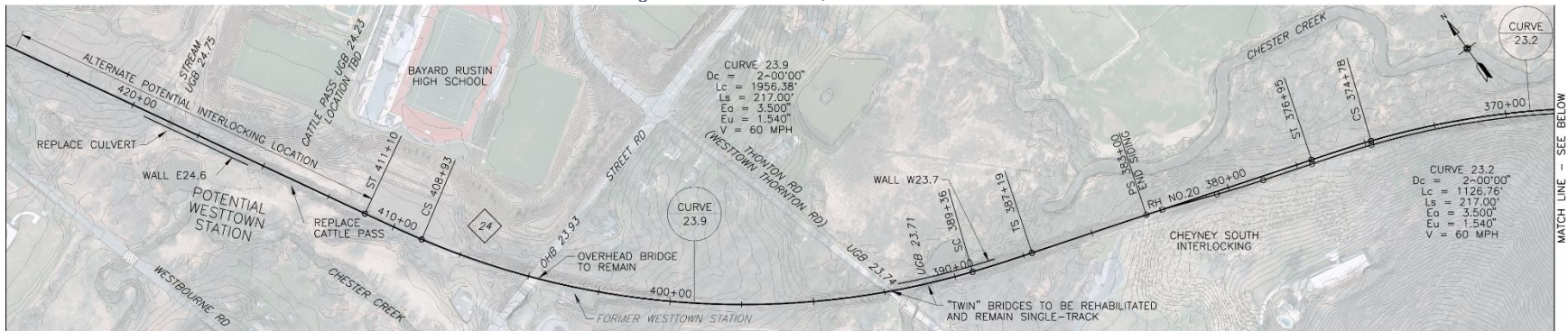


Figure 7-4 - Cheyney Siding and Curve 22.7

The following locations require speed restrictions below 60 mph due to constraints on the geometry. The combined travel time delay resulting from these curve restrictions is approximately 50 seconds. These restrictions may be revisited in future studies to determine if the benefit of increasing the speed justifies the cost and impacts of realigning the corridor.

- **Curves 19.4, 19.8 and 20.1:** As in the past, a speed restriction is necessary through the curves in Glen Mills between MP 19.4 and MP 20.2, where a maximum passenger train speed of 45 mph can be achieved. The geometry through this area is highly curved, with degree of curvature ranging from 3°30' to 4°45'. Adjacent curves of opposite hand also require a minimum tangent length of 100 feet between. Attempts to improve the geometry are constrained by the undergrade bridges at each end (Forge Road UGB 19.68 and Chester Creek UGB 20.31). The alignment is further constrained by Chester Creek, which is parallel and immediately east of the track through this area, and the Hanson Aggregates quarry facility to the west. With these considerations, it was determined that the negative impact of improving the speed through this area to 60 mph would be too great, requiring realignment of both bridges, right of way take from the quarry and impact to Chester Creek.
- **Curve 21.0:** Curve is constrained by a steep slope to the east and Chester Creek to the west. The curvature would have to be reduced from 4°15' to 3°10' to achieve 60 mph operation, requiring cutting back the slope 30 feet and constructing approximately 600 feet of retaining wall.
- **Curve 22.7:** The geometry of this curve can support 60 mph operation, but this location is one of the four potential station locations that have been identified. As such, the track geometry must be modified to meet the requirements for curvature adjacent to a high-level platform, which limits degree of curve to 1°45' and applied superelevation to 1 inch. Curve 22.7 is a 4,000-foot long multi-part compound curve, a 2,500-foot segment of which has been designed to 1°45' with 1 inch of superelevation to accommodate the potential Cheyney Station platforms. This results in a speed restriction of 45 mph.
- **Curves 27.3, 27.4 and 27.9:** These curves are all located in West Chester, south of the potential West Chester University Station. This area had previously been restricted to 10 mph, likely due to grade crossings and terminal operation. The track geometry through this area can support 30 mph operation. Operating requirements of positive train control on approach to terminal stations may require a reduction of speed below 30 mph and should be coordinated in design.

A designed profile is not included in this study, but consideration has been given to the existing and proposed track grade. The maximum grade is 1.50 percent, which is less than SEPTA's standard for a maximum allowable grade of 2.50 percent.

Interlockings: There are three interlockings proposed to support the siding configuration. The preferred turnout size for mainline interlockings is No.20 (45 mph) with No.15 (30

mph) minimum for revenue moves. Turnout size No.10 (15 mph) are acceptable for non-revenue moves and terminal / yard tracks. For a discussion of the signal requirements for the interlockings see Section 7.4.

- **Wawa South Interlocking** located at MP 18.4 at the end of Wawa Siding, consisting of a single righthand No.20 turnout.
- **Cheyney Interlocking** north end of siding located at MP 22.4, consisting of a single lefthand No.15 turnout. South end located at MP 23.6, consisting of a single righthand No.20 turnout.
- **West Chester Interlocking** located between MP 27.0 and MP 27.2, consisting of a righthand No.15 turnout to go from one track to two, a No.10 lefthand crossover and a No.10 turnout to allow moves from both terminal tracks to the yard.

In addition to the interlockings, there is a single lefthand No.10 turnout proposed to provide access for Hanson Aggregates quarry operation in Glen Mills. It is assumed for this study that any improvement of the track condition through Glen Mills would require that quarry access be accommodated. The Glen Mills siding tracks are in a state of disrepair and depending on business necessity would require rehabilitation. The siding rehabilitation is not included in the scope of this service restoration project.

Storage Yard: There is a three-track storage yard located just north of the terminal in West Chester, between Niels Street Crossing 27.05 and Union Street Crossing 27.35, currently used by the West Chester Railroad. Restoration of the yard for use by SEPTA is assumed for all alternatives. The yard provides a location to store train consists overnight and can be configured to allow for cleaning and light vehicle maintenance. The nearest yard on the line is in Lenni at MP 17.7. Constructing a yard in West Chester eliminates the requirement for 20 miles of deadhead (non-revenue) moves per train every day, which is undesirable as it increases crew utilization and operating costs. Staging trains at the end of the line for next day service reduces the risk associated with deadhead moves during the morning peak across a single-track operation, during which a delayed train or a break down could have a cascading effect through the entire schedule on the line. The existing yard must be reconfigured to allow for the second track to West Chester Station. This concept has been developed to provide storage for three, six-car train consists on three, stub-end storage tracks with access from the south through a series of No.10 turnouts. The yard is entered through a No.10 turnout from the main that is part of West Chester Interlocking.

7.2 Track and Roadbed

Restoration of service on the corridor would require the complete replacement of the existing ties and rails to meet current SEPTA standards and FRA requirements for passenger rail service. The proposed track structure would consist of 115RE continuous welded rail (CWR). This report assumes the use of timber ties. Concrete ties would come at a higher capital cost, but may have a lower life-cycle cost and should be considered during the future engineering phase. Installation of concrete ties may also require additional ballast depth and may require a general raise of the track profile in rock cut areas which may affect the track profile at existing undergrade bridges. Other types of

track structure, such as direct fixation or slab track are more costly and are not suited for this application. There are numerous open-deck undergrade bridges on the corridor. It is assumed that these bridges would remain “open” and be re-decked with new bridge timbers at a minimum (for specific discussion of bridge rehabilitation see Section 7.5).



Figure 7-5 - Fouled ballast near quarry

The ballast is generally in fair condition on over 90-percent of the line between Wawa and West Chester and complete replacement is not necessary.

The existing ballast can be retained, with additional clean top ballast and some ditching and shoulder cleaning. Isolated locations of fouled ballast, indicative of poor track drainage, and erosion were evident (typically 20-50 feet in length), and would require specific attention to remedy the problems and full-depth ballast replacement. The area of primary concern for the ballast condition is adjacent to the quarry in Glen Mills between Forge Road UGB 19.68 and Chester Creek UGB 20.31 (approximately 3,300 feet). The ballast in this area is severely fouled due to fine particles running off from the quarry (Figure 7-5). Since passenger service ceased, SEPTA has occasionally allowed the quarry to move stone trains on this section of track, but the section of track is currently out of service due to its condition. Restoration of passenger service over this section of track would require complete roadbed reconstruction. To prevent future fouling of the ballast the track can be raised 18-24 inches through this area and a drainage ditch would be constructed between the track and quarry.

Continuous welded rail requires a minimum 12-inch ballast shoulder. The existing track has jointed rail and ballast shoulders are typically less than 12 inches (8 inches is typical). It is assumed that additional ballast would be required throughout to widen the shoulder. Existing shoulder slopes are 2:1, which meets current standards and it is assumed the additional shoulder ballast would not necessitate retaining structures.

It is understood that roadbed widening to provide a 10-foot wayside access road would only be required to provide access to all signal houses and interlocking equipment from the nearest public highway grade crossing to allow for testing and maintenance. This assumption is relevant as widening the roadbed to provide an access road across the entire right of way would require extensive retaining structures and/or embankment widening. Interlockings are located in relatively level terrain, so access can be provided without substantial earth work or additional retaining structures.

Retaining Walls: Approximately 6500 linear feet of retaining walls are required to support the roadbed widening for the second track at the passing siding and to avoid impacts to environmentally sensitive resources. The anticipated location of the retaining walls are shown on the plan in Appendix B. The retaining walls are anticipated to be placed at or near the toe of railroad embankment slopes to minimize the effect of railroad live load on the design of walls. It is also assumed that T-Walls would be used as they are cost effective and commonly used by railroads. Retaining walls would be designed in accordance with SEPTA and AREMA standards and using live loading agreed upon with SEPTA. An average total height of 12 feet is assumed for the retaining walls. Because most of the line would remain single-track following the existing alignment, the length of retaining walls required is 80 percent less than is required for the full double-track alternative.

Cost: \$36.5 million

The order of magnitude cost for track and roadbed improvements is based on the following items and approximate quantities:

- 43,400 feet of track rehabilitation
- 14,600 feet of new mainline track construction
- 2,700 feet of yard track
- 5,500 feet of track raise
- 10 turnouts for interlockings and yard
- 5,300 cubic yards of embankment widening
- 6,450 feet of retaining wall

7.3 Electrification

Overhead Contact System

Most of the cost incurred for electrification would be the material, equipment and labor prices associated with constructing entirely new cantilever structures. It is estimated that roughly 50 percent of the existing structures would require complete replacement due to deterioration and the resulting structural deficiency as well as locations of conflict with the proposed alignment and/or signaling arrangement.

All new conductors, support assemblies and insulation would be required for the overhead contact system as well as the ancillary systems necessary for providing power to the system. These would include grounding wire and signal power conductors the entire length of the



Figure 7-6 - Deteriorated catenary pole foundation

9.2-mile corridor from Wawa to West Chester as well as feeder conductors from Lenni Substation to a Central Instrument House (CIH) and tap arrangement roughly four track-miles south of Wawa. The proposed catenary design would be a two-wire, fixed termination system on the mainline as well as the intermittent passing sidings and storage yard near the West Chester terminus.

Traction Power Distribution

The critical assumption for returning electrified, single-track service with passing sidings is that feeder conductors with properly placed feeder taps would provide enough voltage for the restored service to West Chester, including a proposed storage yard near the West Chester terminus. Therefore, it is assumed that new structures with overbuild to accommodate 138kV transmission conductors would not be required.

West Chester is located 10.8 miles from Lenni Substation. Substation spacing on SEPTA's traction power network range from six to ten miles. Beyond ten miles, electrical losses and catenary voltage decrease become a concern and may negatively impact the operation and reliability of service. Due to the uncertainty of traction power distribution at this distance a new lower cost 12kV traction power switching substation is recommended and has been included in the cost estimate. A traction power study, which is not part of the scope of this study, would be needed to determine the requirement for a full substation. A traction power study would consider the anticipated frequency of service, size of train consists and other factors to simulate the performance of the existing traction power system. If the results were acceptable to SEPTA the cost of an additional full substation may be avoided.

The 12kV switching station would provide a parallel path for traction power current at the 12kV distribution level. This configuration would reduce electrical losses and aid in keeping the catenary voltage within acceptable levels. The switching station would ideally be located near the terminus. However, to reduce cost the switching station is assumed to be located on the site of the former traction power substation in Cheyney. The switching substation would receive power from Lenni Substation via two, 12kV feeders mounted to the catenary poles.

The equipment in the proposed 12kV switching substation would consist of:

- Two 12kV feeder breakers;
- One 12kV bus for the new switching substation with a bus tie switch between the feeders;
- One 12kV breaker to feed power from the 12kV bus to the 12kV catenary contact wire towards Lenni;
- Depending on yard layout and number of tracks additional sectionalizing or 12kV breaker may be required; and
- Ancillary equipment typical to a traction power substation.

Signal Power System

Proposed signal equipment at each interlocking location would require 6.9kV, single phase, 100Hz power. Two open-air conductors mounted to the catenary poles is

proposed. A motor-generator set may be installed in the proposed switching station to provide secondary power. Alternatively, 100Hz inverters may be installed at each signal location.

60Hz Power:

Each of the four proposed passenger stations would require 60Hz power for lighting, ticketing equipment, general power receptacles, public address systems and other equipment. Each station would require a service drop from PECO.

Interlockings and the yard in West Chester would require 60Hz power for lighting, switch heaters and general power requirements for communications and signal equipment. Again, service drops from PECO at each location is recommended.

Cost: \$30.9 million

Most of the cost for electrification is influenced by the number of new structures, and therefore foundations, that would be required. Installation of each new foundation is estimated to cost \$45,000, including material, equipment and labor, based on recent SEPTA construction and other similar projects. Structural steel and erection for cantilever structures is estimated at \$55,000 each. The total cost of the OCS system is based on the cost per linear foot of the conductors (messenger and contact wire) and the number of hangers and support assemblies. The total linear feet of electrification is 12 miles, including mainline, siding and yard tracks. Ancillary costs per linear foot include material, equipment, and labor. The 12kV traction power feeder, 100Hz signal power, and static wire conductors are required and will be mounted to the catenary structures.

7.4 Signal and Communication System

Restoration of service to West Chester would require a modern signal system that is fully compliant with the latest SEPTA and FRA requirements for positive train control (PTC). The signal system would support bi-directional running on all tracks in accordance with NORAC Rule 261. Cab signals are assumed, with no wayside signals (NORAC Rule 562). Interlocking wayside signals at “home” would be provided identifying the limits for each interlocking and all interlocking would be remotely controlled from SEPTA’s Rail Operations Center (ROC).

PTC

To provide the necessary communications for the line a single-mode fiber optic cable consisting of a 12, 24 or 48 strand cable would be attached to the catenary structures. The fiber optic cable terminates in transmission equipment located at each interlocking. A PTC radio station, consisting of a house, tower or pole, and power, is recommended approximately every three miles along the corridor. The house would also contain the OTN equipment. In addition to the PTC radio the center interlocking radio house would also have a Road radio and a Police radio installed.

Grade Crossings

The existing highway warning devices at the seven at-grade crossings would be removed and replaced with modern active “fail safe” train detection systems, including cross bucks

with flashing lights and automatic gates. It is assumed that private crossings would be eliminated where possible. The private at-grade crossing for the A. Duie Pyle Company's driveway would require warning devices like the public crossings due to the large volume of truck traffic at this location.

Signals

The proposed track configuration includes three new interlockings located between Wawa and West Chester which would be controlled by SEPTA's ROC. Names have been assumed for each of the interlockings based on their geographic location for the purposes of this report narrative:

- **Wawa South Interlocking:** south end of Wawa Siding located at MP 18.4 south of Wawa Station, consisting of one controlled No.20 turnout, three wayside signals and track circuits according to the applicable design.
- **Cheyney Interlocking:** north end of the Cheyney Siding located at MP 22.4, consisting of one controlled No.15 turnout, three wayside signals and track circuits according to the applicable design. South end of the Cheyney Siding located at MP 23.6, consisting of one controlled No.20 turnout, three wayside signals and track circuits according to the applicable design.
- **West Chester Interlocking:** controlled universal interlocking at north end of West Chester Station Track adjacent to the West Chester Yard located between MP 27.0 and MP27.2, consisting of one No.15 turnout at the north end to open the second track, a No.10 crossover at the south end that would be used for non-revenue moves, and a No.10 turnout to enter West Chester Yard. The interlocking would have five new wayside signals and track circuits according to the applicable design.

In addition to the interlockings, a No.10 electric lock turnout is assumed at STA 205+25 to provide access for Hanson Aggregates quarry in Glen Mills to build an industrial siding. Along with the above approximately 14 intermediate locations are assumed for this study. and 10 at grade crossing locations (The number of wayside locations may vary according to design).

Cost: \$19.1 million

The cost assumes a PTC compliant fully controlled system with signals only at the interlockings and the listed equipment.

7.5 Bridges

Since the corridor between Wawa and West Chester has not been used for regular passenger service since 1986, the existing bridges have not been subjected to the routine maintenance that is required for an operational line. The original design live loading for the existing bridges is not available from SEPTA at this time and therefore is unknown.

Undergrade Bridges: This option considers complete replacement of bridges in the areas of the proposed siding track, where the corridor would be widened from one to two tracks, and in the areas where freight railroad traffic is anticipated from the quarry in Glen

Mills heading north. In the remaining areas, bridge rehabilitation is considered, except as noted below.

Prior to their reuse, the existing bridges anticipated to be retained should be inspected and load rated to determine their capacity to support the proposed design live loading. Deck girders and through girders on bridges are fracture critical members (FCM) as these superstructures typically consist of two riveted girders that support a railroad track. Substructure units should also be evaluated and analyzed to determine their capacity to support the proposed live loading. If archived plans for the existing bridges are not available, subsurface probing and borings to determine substructure and foundation configuration may be necessary.

The proposed design loading is anticipated to be Cooper E-50 to E-60 for bridges that would not carry freight service (south of Glen Mills). Cooper E-80 live loading is anticipated for the bridges subjected to freight railroad traffic. This includes 10 undergrade bridges between MP 18.38 and MP 20.73. It is assumed these bridges would be completely replaced as it is likely the existing bridge load carrying capacity would not be adequate to support the proposed freight live loading. In addition, bridges at MP 18.50 and 18.62 over Chester Creek would also need to be raised to improve the hydraulic opening, which has been identified as an existing deficiency. SEPTA has identified that all new bridges would be closed deck with ballast.

Vertical roadway clearances under existing UGB 18.21, 19.68, 23.93, 25.40 and 27.45 are substandard and vary from approximately 9'-2" to 13'-10". For any bridge being fully replaced it is assumed that vertical clearances per current standards and design criteria would be required and would need to be achieved through raising the track profile. It is assumed that the substructure for the Baltimore Pike UGB 18.21 would be replaced as part of the service restoration to Wawa, which would precede the Wawa to West Chester Restoration. It is further assumed that the substructure would be built to accommodate two tracks and that the restoration of service to West Chester would only require construction of superstructure. The proposed superstructure would be designed to sit on the previously constructed abutments. It is assumed that the replacement bridge span arrangement and substructure design completed as part of the service restoration to Wawa would satisfy the horizontal and vertical roadway clearance design criteria per current PennDOT standards.

The existing Barnard Street UGB 27.45 has a posted vertical clearance of 9'-2" and is anticipated to be replaced with a pedestrian underpass that would provide access to the West Chester Station. Barnard Street would be closed to vehicular through traffic. A 10-foot horizontal opening is assumed for the pedestrian underpass.

Three single-span culverts over tributaries to Chester Creek would require replacement to accommodate two tracks for Cheyney Siding (UGB 22.58, UGB 22.78 and UGB 22.97). The new structures would be precast concrete box culverts, 36 feet wide to support two tracks with 14-foot track centers. UGB 20.92, a stone arch bridge over a tributary to Chester Creek, would also likely need replacement due to the serious condition of its substructure reported by SEPTA. UGB 24.75 is a corrugated metal pipe

structure that would be replaced due to its poor condition reported in SEPTA inspection. All other bridges are anticipated to be rehabilitated for the purposes of this study.

Overhead Bridges: The proposed alignment keeps a single track under both existing overhead bridges. It is further assumed that the existing vertical clearance can be maintained at these locations and modification to the bridges would not be necessary.

Cost: \$34 million

An order of magnitude construction cost of \$34 million for bridge replacement. Construction cost estimate is based on recent contractor bids for the restoration of service to Wawa. This option assumes repair and restoration where bridge rehabilitation is indicated.

7.6 Highway Crossings

Each signalized roadway grade crossing along the restored rail line would be reconstructed. There are five roadway grade crossings along the single-track alignment. Most of these roadways are classified as Local Roads except for Glen Mills Road, which is considered a Collector. This alternative would not have substantial impact to the existing condition and it is assumed that roadway reconstruction at these locations would be limited to the pavement immediately adjacent to the at-grade crossing. It is also assumed that addressing functional deficiencies in the roadway such as lane and shoulder widths would not be included in the scope of the track restoration. However, safety deficiencies such as roadway grade and decision sight distance would be addressed where applicable.

A 6500-foot passing siding is included in the conceptual design, which would cross Cheney Road and Dilworthtown Road. At these grade crossings, the roadway would be reconstructed to accommodate the additional track crossing and address site specific safety criteria such as sight distance requirements. As such, it is anticipated that the limit and scope of roadway reconstruction would be greater at these locations due to roadway profile adjustments and roadside grading.

For this study, a prefabricated crossing panel system mounted on ties is assumed for the roadway grade crossings. This type of crossing provides for an economical and long-lasting system that is easy to install and maintain. Other crossing materials may be considered as the project progresses. New signalization would be incorporated at all roadway grade crossings (see Section 7.4).

There are six roadway underpass crossings within the project limits. At two of these underpass crossings, Darlington Road and Forge Road, the overpass structure would be reconstructed to accommodate freight loads. In accordance with PennDOT Publication 13M (DM-2), Chapter 2, Section 20, Table 2.2 – *Required Vertical Clearances for Structures over Highways*, the minimum vertical clearance for Reconstruction projects over Local and Collector Roads is 14'-6" and 16'-6" over Arterials. It is assumed that the required vertical clearances would be achieved through the new structure design in conjunction with adjustments to the track profile. Since this work involves the replacement of the overpass structures and is classified by PennDOT as a Reconstruction project, the

roadway must be reconstructed to meet current design standards and address roadway deficiencies, as required by PennDOT.

At the remaining roadway underpass crossings within the project limits, it is assumed that existing vertical and horizontal clearances would be maintained or nominally improved because of necessary superstructure rehabilitation work (classified by PennDOT as a Deck Replacement project), except for Barnard Street which would be replaced by a pedestrian underpass. In accordance with PennDOT DM-2, Chapter 2, existing vertical clearances below minimum requirements shall not be further reduced. According to Table 2.2, the minimum vertical clearance for Deck Replacement projects over Local and Collector Roads is 14'-0" and 16'-0" over Arterials. Therefore, the superstructure rehabilitation work would require design exception approval from PennDOT as these minimum clearances would not be met at the underpass crossings in this alternative. Refer to Section 7.5 for more information regarding the superstructure work at the roadway underpass bridges.

Due to its proximity to the anticipated West Chester Station location and its severely deficient vertical clearance (9'-2"), it is assumed that the Barnard Street underpass crossing would be closed to vehicular traffic and the existing structure replaced with a new pedestrian underpass to facilitate future station access and pedestrian mobility at this location. With concurrence from the Borough of West Chester, vehicular through traffic on Barnard Street would be permanently rerouted to Union Street, which is similar in roadway class and function. Raising the tracks to improve the clearance is not feasible.

The Baltimore Pike Bridge is being modified as part of the Wawa Station project. It is assumed that highway modifications will not be required under the West Chester restoration project.

Existing private crossings would be eliminated where possible. Where private crossings must remain, they will be reconstructed, but it is anticipated that these crossings would not be reconstructed to the same degree as a public roadway grade crossing. There are five private crossings within the project limits, each functioning primarily as property access driveways. Where required, the private crossings would be reconstructed with new prefabricated crossing panels with compacted coarse aggregate roadway approaches. However, it is anticipated that the A. Duie Pyle driveway at MP 26.70, which provides access to a large storage and distribution business, would be reconstructed to accommodate the needs of the business. It is assumed that highway warning devices and new crossing construction similar to the proposed at-grade roadway crossings, including new pavement, would be installed at this location.

Railroad-roadway grade crossings come under the jurisdiction of the Public Utility Commission (PUC). As such, project design and construction would have to be coordinated with the PUC. Depending on funding sources, coordination with the Federal Highway Administration may also be required. Roadway grade crossing reconstruction would also require detouring traffic temporarily. This would be coordinated with PennDOT and the local municipalities in both the design and construction phases.

Cost: \$2,700,000

Assumptions: Roadway reconstruction, earthwork and drainage work would be minimized at single-track crossings (reconstructed pavement length of 200 feet). Reconstruction at proposed siding would include moderate upgrades to address deficiencies (reconstructed pavement length of 500 feet). Approaches to private driveway crossings to consist of compacted coarse aggregate. Barnard Street Bridge replacement costs include curb and sidewalk (refer to structural estimate for mobilization and earthwork costs). Anticipated stormwater BMP costs included. Refer to signals estimate for costs associated with signalization at crossings.

7.7 Stations

Proposed stations would require 600-foot long high-level platforms for level boarding, parking, and access in compliance with ADA requirements. This may include the need for vertical circulation (pedestrian under/overpasses, stairs, ramps and/or elevators) depending on the station configuration. Development of station and site conceptual layouts is not included in the scope of this study, but geometry constraints, platform length and site requirements have been considered in analyzing the potential station locations.

For the purposes of this study four potential station locations have been considered – Cheyney, Westtown, West Chester University and West Chester. These locations are the same that were considered in the DVRPC’s 2011 *Wawa to West Chester Regional Rail Extension – Ridership Forecast*.

The existing station locations were considered for restoration. However, modern station design standards cannot be met due to geometry and right of way constraints at these locations except at West Chester Station. Locations at or near former Darlington, Glen Mills, Locksley and Oakbourne Stations were not considered for this study. The number and location of the stations along the restored service to West Chester should be considered in greater detail in future studies.

Cheyney Station: The existing station is located just south of Station Road Crossing 22.15 on a 2°30’ curve. This exceeds the maximum allowable curvature for a high-level platform. Flattening the curve to meet the design requirements is impractical at this location as it would result in impacts to the existing station building, which is currently in use as a Post Office. The curve continues north of Station Road, making relocation to the north infeasible. A tangent between reverse curves is located just south of the existing station, but this is adjacent to several residential properties, so station site development at this location is not possible. The nearest potential station location is located approximately 2000 feet south of the existing station, between Cheyney Road Crossing 22.50 and Dilworthtown Road Crossing 23.05 along Curve 22.7, which has been designed to 1°40’ with 1 inch of superelevation to accommodate high-level platforms. This coincides with the proposed passing siding, which means the station would have to be built for two tracks. Either two high-level side platforms or a single high-level center island platform may be used at this location. Regardless of the chosen platform configuration, the two tracks at this location would require facilities for vertical

circulation. Wetlands are likely present near the proposed facility. If field investigations confirm the presence of regulated resources, avoidance and minimization measures would be considered. If impacts cannot be avoided, mitigation would be required.

Westtown Station: The existing Westtown Station is located just north of Street Road OHB 23.93 on Curve 23.9, which has a 2°00' degree of curvature. Curve 23.9 extends under OHB 23.93 to the south and over UGB 23.74 to the north, making any modification of the curve complex and costly. A tangent exists about 600 feet south of OHB 23.93, which can accommodate a high-level platform. Access to the potential station can be achieved by way of Westbourne Road, located east of the corridor. The station is located on a single-track section. If parking is developed on one side of the track access may be provided without the need for passengers to cross the tracks.

West Chester University Station: The existing station is located on a reverse curve south of Niels Street Crossing 27.05. Locating the station at this location is limited by the curvature and is constrained by development to the east and West Chester Yard to the west. A tangent located north of Niels Street presents a potential location for the development of the West Chester Station. The east side of the track is constrained by an existing park, so the station would have to be developed west of the corridor. Like Westtown Station, West Chester University is located on a single-track section and would not require passengers to cross the tracks.

West Chester Station: The existing terminal station is assumed to be reconstructed to meet current standards. The existing low-level platforms would be removed and replaced with high-level platforms. Two station tracks are required for terminal operation, so a second track would be restored. Side platforms are assumed for this study. The distance from Barnard Street UGB 27.45 to the end of the platform is only 530 feet, so the proposed platforms would need to extend over Barnard Street to meet the minimum length of 600 feet. Closing UGB 27.45 to vehicular traffic and redeveloping for passenger station access has been assumed for this study (see Sections 7.5 and 7.6 for structures and civil requirements).

Cost: \$51.6 million

The following order of magnitude unit costs for the anticipated station features are assumed based on recent SEPTA and Amtrak station projects:

- 600-foot-long high-level side platform with canopy: \$5 million each (factor at 1.5 for center island platform)
- Surface parking lot: \$4 million per station
- Parking Structure at \$32,000 per space (300 space structure at West Chester = \$9.6 million)
- Passenger vertical circulation: \$5 million dollars each

Table 7-1 - Station costs

Station	No. of Tracks	Platforms / Canopies	Parking / Site	Vertical Circulation	Total Cost
Cheyney	2	\$7.5 million	\$4.0 million	\$5.0 million	\$16.5 million
Westtown	1	\$5.0 million	\$4.0 million	-	\$9.0 million
West Chester University	1	\$5.0 million	\$4.0 million	-	\$9.0 million
West Chester	2	\$7.5 million	\$9.6 million	-	\$17.1 million
Total					\$51.6 million

7.8 Vehicles

Electric multiple units (EMU) are self-propelled rail cars with onboard electric motors that collect traction power with a pantograph from the overhead contact system. SEPTA currently operates Silverliner IV and Silverliner V EMU train consists for the majority of their regional rail service. In addition to the fleet of EMUs, SEPTA operates push-pull train consists with electric locomotives. Electrification of the line would enable use of any of SEPTA's current fleet of passenger trains. For the purposes of this study it is assumed that any new vehicles required for the restored service would be Silverliner V cars.

Each Silverliner V car has a capacity of 107 passengers. They allow level boarding at high-level platform stations and are equipped with traps to enable platforming at low-level stations. Each car is 85 feet long from coupler to coupler. They come as either single cars or married pairs, allowing for consist lengths tailored to ridership demand. Peak hour consist lengths of six cars would have an overall length of 510 feet and a capacity of 642 passengers.

The number of additional cars required for the restoration of service to West Chester would depend on several factors, including the frequency of peak hour service and how that service would be integrated into the service to Wawa, which has not been determined at this time. A total of 12 additional cars has been assumed for this study.

Cost: \$33.6 million

A total of 12 new Silverliner V EMU cars are assumed for the restored service. SEPTA purchased 120 Silverliner V cars for \$274 million in 2010, approximately \$2.3 million per car (\$2.8 million in 2017 dollars). The total cost of 12 cars is estimated at \$33.6 million.

7.9 Environmental Considerations

Environmental impacts for the single track EMU option are primarily associated with the replacement of existing structures over Chester Creek and its tributaries. Additional considerations include stormwater management and potential waste concerns.

Hazardous and Residual Waste

Railroad corridors may have various wastes associated with them as a result of historic train operations. This can include heavy metals, polychlorinated biphenyls (PCBs) and

petroleum products. If contaminated soils are identified and cannot be re-used onsite, offsite disposal at an approved facility would be required.

Stormwater Management

Stormwater BMPs and other associated drainage work, such as roadside swales, drainage pipes, inlets and outfalls, roadway base drains, etc., would be required to manage and treat runoff in accordance with Pennsylvania Clean Streams Law (35 P.S. §§ 691.1-691.1001); Pennsylvania Stormwater Act (32 P.S. §§ 680.1-680.17); Federal Clean Water Act (33 U.S.C.A. § 1342), 40 CFR Part 122 and 25 Pa Code Chapters 92, 93, 102, 105 and 111. Based on the anticipated areas of disturbance, it is assumed the project would require an NPDES permit for stormwater associated with construction activities, and that station and parking areas would require stormwater management basins. Estimated costs associated with this work, including permitting fees, have been accounted for in the project estimate.

Waterway / Wetland Impacts

The single-track option replaces 15 bridges and culverts, including the undergrade bridges 18.50 and 18.62 over Chester Creek. Temporary crossings, streambank stabilization and additional protections would likely be required. Based on the proposed widening for the passing siding, the culverts in that section would be extended beyond the allowable criteria for the use of the Pennsylvania Department of Environmental Protection General Permit 11. This would also include wetland impacts resulting from the construction of stations or other improvements. It is assumed the project would require a full Joint Permit Application (JPA). Estimated costs associated with this work, including permitting fees, have been accounted for in the project estimate.

8 Ridership Assessment

DVRPC's *Wawa to West Chester Regional Rail Extension – Ridership Forecast* released in 2011 estimated that restored electrified, one-seat service between the planned Wawa Station and downtown West Chester via intermediate station stops in Cheyney, Westtown, and West Chester University could attract 1,910 daily trips in 2035, of which 1,400 would be new SEPTA trips. To validate these results and confirm that the forecast can still be used to evaluate ridership potential for this feasibility study, the base year and horizon year inputs used for the DVRPC study were compared with current year data inputs.

The travel demand model used for the 2011 ridership analysis was developed based on a set of assumptions by DVRPC. The ridership forecasts were prepared using DVRPC's Travel Improvement Model (TIM) 1.0 and compared horizon year 2035 forecasts under a No-Build scenario, an electrified extension alternative (one-seat ride), and a diesel extension alternative (requiring a transfer at Wawa).

A cursory model validation was used to determine whether the previously developed ridership forecasts accurately represent current year conditions. The base year and key model inputs were updated from 2010 to 2016, with the horizon year moved from 2035 to 2040. The model validation included a high-level comparative review of the following criteria to determine their potential ridership impacts in the context of future year build alternatives:

- Socio-demographics
- Travel network and patterns
- Land use changes

8.1 Socio-Demographics

The 2011 ridership analysis relied on population and employment forecasts developed for the Philadelphia metropolitan area's 2035 long-range plan, with base year 2005 population updated to 2010. To be consistent with a 25-year horizon approach, this study compared the 2011 ridership study's socio-economic inputs and a 2010-2035 forecast timeframe to currently available 2015-2040 estimates for the study area's 18 municipalities in Chester and Delaware Counties.

Population

Changes in population estimates for the project area's municipalities show:

- In absolute numbers, DVRPC estimates show just a 1% decrease in overall population within the study area between the two timelines.
- A 1% decrease in rate of population growth, from nearly 13% between 2010 and 2035 to 12% for 2015-2040 in the 18 municipalities.

Employment

Changes in employment projections for the project area's municipalities show:

- In absolute numbers, DVRPC estimates show a 0.3% decrease in overall employment within the study area between the two timelines.
- Employment opportunities in the study area were projected to increase by nearly 16% between 2010 and 2035. Between 2015 and 2040, employment growth is estimated above 15%, with the same set of municipalities expected to post the largest increases in employment.
- Compared to the 2010-2035 employment projections used in the 2011 ridership study, the updated 2015-2040 employment forecast calls for an increase in the percentage of created jobs for the study area's municipalities located in Chester County (4% total), but a decrease in Delaware County (-6% total). Added jobs in Chester County are projected in townships already near SEPTA's Main Line, and would not affect the restored service to West Chester.
- The study area's average job ratio of approximately 0.7 workers to available jobs has not changed from 2010 to 2015 and highlights the area as being a net importer of workers.

8.2 Transportation Network Update

Travel Network

The roadway and transit elements of the transportation network that were used as travel demand model inputs in the 2011 ridership study were reviewed against current conditions for changes in traffic volumes, SEPTA ridership trends, and parking supply and demand at area regional rail stations.

Roadways

Traffic demand has generally decreased across sampled areas, with the West Chester Bypass (US 202) experiencing the largest decrease in traffic counts from 2011 to 2015 (29%). However, some sampled roadway facilities have experienced an increase in traffic demand within the same timeframe, with West Chester Pike and PA 352 recording an increase in traffic counts.

Regional Rail

Access to the SEPTA Paoli/Thorndale Line is available by driving to Exton or Whitford Stations located five miles from West Chester (10-12 minutes from downtown West Chester to either Exton or Whitford) or taking SEPTA Route 92 (approximately 22 minutes from downtown West Chester to Exton) serving the former West Chester Station. Elwyn Station is also accessible by car.

Ridership counts from 2016 were compared to passenger counts from 2005 and 2009 used by DVRPC in the 2011 study. Baseline ridership counts used by DVRPC to calibrate the model and develop base-year results have increased from 2009 to 2016 between Downingtown and Paoli, but remained constant between Elwyn and Swarthmore. Overall, current regional rail ridership counts are similar or slightly higher than 2005. The

availability of parking at nearly all stations along the Media/Elwyn Line is constrained, although a parking deck with approximately 500 spaces planned at the future Wawa Station will increase the parking supply. Along the Paoli/Thorndale Line, the most accessible stations to the study corridor Exton and Paoli currently have no daily parking available and the absence of available parking supply will likely affect potential ridership growth.

Bus

The study area is currently served by five SEPTA bus routes (92, 104, 111, 119, and 120), as well as Krapf's A and SCCOOT. The existing bus service within the study area serves as a feeder to regional rail stations and facilitates cross-regional connections to major trip destinations in the area.

Bus ridership counts from 2016 were compared to passenger counts from 2005 and 2009 utilized by DVRPC in the 2011 study. Baseline bus ridership counts used by DVRPC to calibrate the model and produced base-year results have generally increased between 2009 and 2016 except for the Route 92 bus. Across the entire study area, SEPTA bus ridership increased nearly 13% between 2009 and 2016, amounting to a 2% average annual growth. In absolute number of additional riders, Route 104 has gained the most riders between 2009 and 2016 (431 passengers), but this recent increase only placed its average weekday ridership count on par with ridership levels in 2005. Route 111 has sustained ridership growth. Despite offering the only direct public transportation bus service between West Chester and King of Prussia, a major regional activity center, Route 92 has struggled to gain ridership in recent years. Due to low ridership SEPTA discontinued three bus routes (202, 306 and 314) serving the study area since the 2011 DVRPC study.

Travel Patterns

Commuter travel within Chester County and to neighboring suburban counties exceeds travel to Philadelphia. The travel mode to work within the study area showed little change, with driving remaining the dominant commuting mode at 86% in 2015, a slight decrease from 88% in 2010. Less than 4% of employed residents take public transportation to work yet transit services in the study area have attracted 400 additional transit riders since 2010, likely a function of increased population.

8.3 Land Use Changes

Updated 2015 data for housing units, residential units, and single and multi-family housing density for the municipalities within the study area were compared to the 2010 conditions reflected in the 2011 DVRPC ridership forecasts. The results indicate:

- Between 2010 and 2015 - the study area's housing supply increased by nearly 1,700 residential units, or 2.3%;
- Residential acreage increased by approximately 1.2%;
- Housing density has remained steady within the study area, ranging from 1.1 homes per acre in Birmingham Township to more than 14 houses per acre in both West Chester and Chester Heights;

- Multi-family residential acreage decreased within the study area by nearly 11%; and
- Commercial, industrial, utility, and other land uses by acreage have not changed significantly.

8.4 Ridership Potential Evaluation Results

The evaluation of the ridership model validated that the 2035 Build forecasts developed in 2010 by the DVRPC can be applied to represent current base year conditions within the study area for planning-level investigation and do not need to be updated for this study. The variance between the model inputs does not warrant the development of a new 2040 ridership forecast.

9 Operations

SEPTA currently operates five regional rail lines with sections of single track. SEPTA typically pairs lines with single-track operation with those with two or more tracks to facilitate schedule recovery. The following table lists the existing SEPTA Regional Rail Lines that have single track sections, with the lengths and locations of passing sidings, where applicable:

Table 9-1 - Current SEPTA Single-Track Regional Rail Lines

Line (Current Service)	Length of Single Track	Longest Single-Track Segment	Length of Passing Siding	Stations on Single Track	Inbound Service	Outbound Service
	[miles]	[miles]	[miles]		[trains/day]	[trains/day]
Doylestown (Lansdale/Doylestown)	9.7	6.3	0.5	8	19	19
Fox Chase (Fox Chase)	5.2	2.8	0.3	5	24	17
Ivy Ridge (Cynwyd)	1.6	NA	NA	3	33	37
Neshaminy (West Trenton)	1.9	NA	NA	2	11	6
Warminster (Warminster)	6.8	3.1	0.4	5	30	26
Future West Chester†	12.1	3.7	0.6 1.2	6	15‡	10‡

† Includes single track section from Elwyn to Wawa

‡ Number of trains taken from sample schedule from DVRPC Wawa to West Chester Regional Rail Extension – Ridership Forecast

The proposed service restoration to West Chester compares most closely to the current Lansdale/Doylestown Line service. SEPTA currently operates 19 trains per day to Doylestown over a 9.7-mile section of single track, serving eight stations with a single 0.5-mile passing siding. A total of 38 trains per day operate to Lansdale Station, which is at the end of the two-track territory. The minimum headway is 24 minutes at Doylestown Station and there is capacity to store three five-car and two three-car train consists at Doylestown Station.

The configuration and service provided on the Lansdale/Doylestown Line is similar to the concept for single-track restoration to West Chester. The proposed single-track territory is 12.1 miles, which is longer than the Lansdale/Doylestown Line, but there are two proposed passing sidings (Wawa and Cheyney). On the West Chester Line, the longest segment of single track would be 3.7 miles, which compares favorably to other single track sections. The location and length of passing sidings was assumed for this study to

determine the feasibility and cost of restoring service for a single-track operation. Future studies should include a detailed operational analysis to optimize the passing sidings and to consider how best to integrate the restored single-track service with the rest of the regional rail system.

A yard at West Chester has been included in the conceptual layout for light maintenance and overnight storage for up to three six-car consists. This yard provides capacity to meet morning northbound peak demand without running non-revenue deadhead southbound moves. If future service demands, storage capacity can be increased by housing two more trains on the West Chester station tracks. However, because of the potential for vandalism and the inability to perform maintenance it is not recommended to store trains along passenger platforms overnight.

Preparation of a service schedule was not included in the scope of this feasibility study. The schedule presented in the 2011 DVRPC Report had 15 northbound trains per day to Center City from West Chester, and 10 southbound trains per day to West Chester, out of a total of 31 and 27 trains per day operating on the line, respectively. The current operating schedule has a total of 29 northbound and 26 southbound trains per day.

The following tables present the schedule developed by the DVRPC updated to the current Media/Elwyn Line schedule, with the number of trains per day in each direction serving West Chester the same as the 2011 report. Travel time between Wawa and West Chester has been adjusted to match the travel time estimated for the feasibility report concept. The minimum travel time between West Chester and Suburban Station is 65 minutes for express trains bypassing six stations between Primos and University City. Local trains have an average travel time is 72 minutes.

Achieving the project goal of a one hour travel time between West Chester and Center City may be possible for express trains if more stations are skipped. This can be achieved by skipping additional stations with the current express service, but this would result in a reduction of service to those stations that are bypassed. Several existing trains on the Media/Elwyn Line that currently operate with six car train sets are at capacity. Extending these trains to serve West Chester may result in additional overcrowding. Alternatively, trains could be added to the schedule to provide the desired travel time without reducing existing service levels. However, it is not known if there is adequate capacity in the Center City tunnel to accommodate more trains during peak hours.

The schedule prepared by the DVRPC assumes that current service operations can be expanded to serve West Chester. The restoration of service to Wawa may result in changes to the infrastructure of the existing line that would require new service patterns. Future investigation of the restoration of service to West Chester should consider the new service patterns for Wawa and include an operational study to determine how to best serve stations beyond Wawa. The resulting schedule can be used to optimize the siding location and length as well as the yard configuration.

*West Chester Line Restoration Feasibility Study
Task 1.7 – Final Report*

Table 9-2 - West Chester Bound Schedule

Station												WCT Travel Time [min]		
Temple University	Suburban	University City	Primos	Morton	Media	Elwyn	Wawa	Cheyney*	Westtown*	WC University*	WC Terminal*	Temple	from Suburban	UCity
6:04AM	6:15AM	6:23AM	6:39AM	6:46AM	6:59AM	7:03AM	7:08AM							
7:07AM	7:16AM	7:24AM	7:41AM	7:46AM	7:59AM	8:03AM	8:08AM							
7:39AM	7:50AM	7:58AM	8:15AM	8:21AM	8:32AM	8:36AM	8:41AM	8:49AM	8:53AM	8:58AM	9:01AM	82	71	63
8:10AM	8:21AM	8:29AM	8:45AM	8:51AM	9:02AM	9:07AM	9:12AM							
8:34AM	8:45AM	8:53AM	9:11AM	9:19AM	9:30AM	9:34AM	9:39AM							
9:27AM	9:39AM	9:47AM	10:0AM	10:12AM	10:22AM	10:26AM	10:31AM							
10:31AM	10:42AM	10:50AM	11:0AM	11:11AM	11:23AM	11:27AM	11:32AM							
11:29AM	11:40AM	11:48AM	12:0PM	12:09PM	12:21PM	12:25PM	12:30PM							
12:25PM	12:36PM	12:44PM	1:03PM	1:08PM	1:20PM	1:24PM	1:29PM							
1:25PM	1:36PM	1:44PM	2:03PM	2:08PM	2:20PM	2:24PM	2:29PM							
2:39PM	2:50PM	2:58PM	3:14PM	3:22PM	3:36PM	3:40PM	3:45PM	3:53PM	3:57PM	4:02PM	4:05PM	86	75	67
3:16PM	3:27PM	3:35PM	3:53PM	4:01PM	4:12PM	4:16PM	4:21PM							
3:49PM	4:00PM	4:08PM	4:21PM	4:27PM	4:39PM	4:43PM	4:48PM	4:56PM	5:00PM	5:05PM	5:08PM	79	68	60
4:15PM	4:26PM	4:34PM	4:51PM	4:58PM	5:09PM	5:13PM	5:18PM							
4:41PM	4:52PM	5:00PM	5:10PM	5:14PM	5:28PM	5:32PM	5:37PM	5:45PM	5:49PM	5:54PM	5:57PM	76	65	57
4:55PM	5:06PM	5:14PM	5:31PM	5:37PM	5:51PM	5:55PM	6:00PM							
5:10PM	5:22PM	5:30PM	5:41PM	5:47PM	6:01PM	6:05PM	6:10PM	6:18PM	6:22PM	6:27PM	6:30PM	80	68	60
5:16PM	5:27PM	5:35PM	5:54PM	6:01PM	6:07PM	6:12PM								
5:49PM	6:00PM	6:08PM	6:26PM	6:32PM	6:44PM	6:48PM	6:53PM	7:01PM	7:05PM	7:10PM	7:13PM	84	73	65
6:23PM	6:35PM	6:43PM	7:00PM	7:06PM	7:18PM	7:22PM	7:27PM	7:35PM	7:39PM	7:44PM	7:47PM	84	72	64
7:14PM	7:25PM	7:33PM	7:51PM	7:57PM	8:08PM	8:13PM	8:18PM	8:26PM	8:30PM	8:35PM	8:38PM	84	73	65
8:19PM	8:31PM	8:39PM	8:55PM	9:02PM	9:13PM	9:17PM	9:22PM							
9:05PM	9:16PM	9:24PM	9:40PM	9:47PM	9:58PM	10:02PM	10:07PM	10:15PM	10:19PM	10:24PM	10:27PM	82	71	63
9:54PM	10:05PM	10:13PM	10:2PM	10:36PM	10:47PM	10:51PM	10:56PM	11:04PM	11:08PM	11:13PM	11:16PM	82	71	63
10:56PM	11:07PM	11:15PM	11:3PM	11:39PM	11:50PM	11:54PM	11:59PM							
11:52PM	12:02AM	12:10AM	12:2AM	12:32AM	12:43AM	12:47AM	12:52PM							
Number of Trains												Min. Travel Time		
26	26	26	26	26	26	26	25	10	10	10	10	76	65	57

Express from University City to Primos

Express from Morton to Media

Source: 2011 DVRPC Wawa to West Chester Regional Rail Extension – Ridership Forecast (adjusted to reflect current Media/Elwyn schedule)

* Travel times adjusted to match feasibility study conceptual design travel time estimate

West Chester Line Restoration Feasibility Study
Task 1.7 – Final Report

Table 9-3 - Center City Bound Schedule

Station												WCT Travel Time [min]		
WC Terminal*	WC University*	Westtown*	Cheyney*	Wawa	Elwyn	Media	Morton	Primos*	University City	Suburban	Temple University	UCity	Suburban	Temple
				5:27AM	5:32AM	5:37AM	5:47AM	5:53 AM	6:12AM	6:20AM	6:29AM			
5:35AM	5:38AM	5:43AM	5:47AM	5:55AM	6:00AM	6:05AM	6:15AM	6:21 AM	6:40AM	6:48AM	6:57AM	65	73	82
6:12AM	6:15AM	6:20AM	6:24AM	6:32AM	6:37AM	6:42AM	6:53AM	6:59AM	7:18AM	7:26AM	7:36AM	66	74	84
6:25AM	6:28AM	6:33AM	6:37AM	6:45AM	6:50AM	6:55AM	7:02AM	7:08 AM	7:30AM	7:38AM	7:47AM	65	73	82
						7:10AM	7:23AM	7:29 AM	7:41AM	7:49AM	7:58AM			
6:58AM	7:01AM	7:06AM	7:10AM	7:18AM	7:23AM	7:28AM	7:34AM	7:41 AM	8:00AM	8:08AM	8:18AM	62	70	80
								7:50 AM	8:09AM	8:17AM	8:26AM			
7:17AM	7:20AM	7:25AM	7:29AM	7:37AM	7:42AM	7:47AM	8:03AM	8:09 AM	8:20AM	8:28AM	8:37AM	63	71	80
						8:00AM	8:16AM	8:23 AM	8:41AM	8:49AM	8:58AM			
7:56AM	7:59AM	8:04AM	8:08AM	8:16AM	8:21AM	8:26AM	8:37AM	8:43 AM	8:54AM	9:02AM	9:11AM	58	66	75
				8:28AM	8:33AM	8:38AM	8:49AM	8:55AM	9:14AM	9:22AM	9:31AM			
8:35AM	8:38AM	8:43AM	8:47AM	8:55AM	9:00AM	9:05AM	9:16AM	9:23 AM	9:41AM	9:49AM	9:58AM	66	74	83
9:32AM	9:35AM	9:40AM	9:44AM	9:52AM	9:57AM	10:02AM	10:13AM	10:1 AM	10:37AM	10:45AM	10:54AM	65	73	82
				10:45AM	10:50AM	10:55AM	11:07AM	11:1 AM	11:31AM	11:39AM	11:48AM			
				11:45AM	11:50AM	11:55AM	12:07PM	12:1 PM	12:31PM	12:39PM	12:48PM			
				12:48PM	12:53PM	12:58PM	1:10PM	1:16 PM	1:34PM	1:42PM	1:51PM			
				1:49PM	1:54PM	1:59PM	2:11PM	2:17 PM	2:35PM	2:43PM	2:52PM			
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				3:24PM	3:29PM	3:34PM	3:44PM	3:49 PM	4:08PM	4:16PM	4:25PM			
3:50PM	3:53PM	3:58PM	4:02PM	4:10PM	4:15PM	4:20PM	4:29PM	4:34 PM	4:52PM	5:00PM	5:09PM	62	70	79
				4:34PM	4:39PM	4:44PM	4:55PM	5:00 PM	5:19PM	5:27PM	5:37PM			
4:37PM	4:40PM	4:45PM	4:49PM	4:57PM	5:02PM	5:06PM	5:17PM	5:22 PM	5:40PM	5:48PM	5:57PM	63	71	80
				5:51PM	5:56PM	6:01PM	6:12PM	6:18 PM	6:38PM	6:46PM	-			
6:08PM	6:11PM	6:16PM	6:20PM	6:28PM	6:33PM	6:38PM	6:49PM	6:55 PM	7:14PM	7:22PM	7:31PM	66	74	83
7:07PM	7:10PM	7:15PM	7:19PM	7:27PM	7:32PM	7:36PM	7:46PM	7:51 PM	8:06PM	8:14PM	8:23PM	59	67	76
7:50PM	7:53PM	7:58PM	8:02PM	8:10PM	8:15PM	8:20PM	8:31PM	8:36 PM	8:53PM	9:01PM	9:10PM	63	71	80
8:47PM	8:50PM	8:55PM	8:59PM	9:07PM	9:12PM	9:17PM	9:28PM	9:34 PM	9:53PM	10:01PM	10:11PM	66	74	84
9:47PM	9:50PM	9:55PM	9:59PM	10:07PM	10:12PM	10:17PM	10:28PM	10:3 PM	10:53PM	11:01PM	11:11PM	66	74	84
				11:07PM	11:12PM	11:17PM	11:28PM	11:3 PM	11:53PM	12:01PM	12:10AM			
Number of Trains												Min. Travel Time		
15	15	15	15	26	26	28	28	29	29	29	28	58	66	75

Express from Primos to University City

Express from Media to Morton

Source: 2011 DVRPC Wawa to West Chester Regional Rail Extension – Ridership Forecast (adjusted to reflect current Media/Elwyn schedule)

* Travel times adjusted to match feasibility study conceptual design travel time estimate

10 Public Engagement Summary

Much of the impetus for the West Chester Rail Restoration Feasibility Study came from ongoing community interest in the restoration of service. The project team created both a stakeholder group and project committee to engage the community throughout the project. The stakeholder group is intended to provide guidance to the study team and is comprised of core local and regional entities including the West Chester Rail Committee. The project committee is more wide-ranging, including adjacent municipalities, state government representatives, business groups and employers, educational institutions, and transportation agencies. The committee’s role is to advise on regional interests and assist in relaying project information back to the community. Table 10-1 identifies the participants in each group.

Table 10-1 - Stakeholder Group and Project Committee Members

	Stakeholder Group	Project Committee
SEPTA	X	X
PennDOT	X	X
Delaware Valley Regional Planning Commission		X
West Chester Rail Ad hoc Committee	X	X
Chester County	X	X
Delaware County	X	X
Middletown Township	X	X
Chester Heights Borough	X	X
Thornbury Township (Chester Co.)		X
Thornbury Township (Delaware Co.)	X	X
Westtown Township		X
West Goshen Township	X	X
West Chester Borough	X	X
Lower Merion Township		X
Senator Andy Dinniman		X
Councilman John McBlain		X
Representative Christopher B. Quinn		X
Senator Tom Killion		X
Representative Carolyn T. Comitta		X
West Chester Government Services Center		X
West Chester University		X
Cheney University		X
Westtown School		X
Transportation Management Association of Chester County (TMACC)		X
Delaware County Transportation Management Association (DCMTA)		X
Chester County Economic Development Council		X
Chester County Chamber of Business and Industry		X
West Chester Business Improvement District		X
Greater West Chester Chamber of Commerce		X
Delaware County Chamber of Commerce		X
Delaware County Commerce Center		X
Life Care Hospitals of Chester County		X
West Chester Railroad		X

10.1 Stakeholder / Project Committee Meetings Overview

The first stakeholder meeting was held February 24, 2017. The project team presented the Purpose, Needs, Goals and Objectives that had been identified for the study for the group's consideration and feedback, and provided an overview of the field investigations completed in September 2016.

Based on input from the stakeholders, the project committee was expanded, and the first meeting was held on June 1, 2017, to present the results of the conditions assessment which found much of the existing infrastructure in need of repair or replacement, and the alternatives to be examined. The main points of discussion centered on the travel time for restored service, and whether it should be compared to other modes; the previous ridership modeling and whether the data should be updated; and the cost-effectiveness of the service restoration.

Following the completion of the engineering feasibility phase, a combined stakeholder and project committee meeting was held December 15, 2017. The results of the feasibility analysis were presented to both groups. Key findings include:

- Dual-mode locomotives will not be considered, as they are inconsistent with the overall SEPTA system and therefore actually result in higher costs.
- Service restoration is feasible for either single or double track configurations.
- Costs for double track are nearly 75% greater than single track.
- Neither federal programs such as the Capital Investment Grants nor SEPTA funds are expected to cover the project costs.

The committees were asked to consider local or alternate funding sources if there is a desire to advance the project.

10.2 Public Open House Overview

Following the presentation of the study results to the Stakeholders and Project Committee, a Public Open House was held to report the findings to the broader community. Hosted at the Marian Anderson Center at Cheyney University on January 25, 2018, the Open House provided a series of displays illustrating the various components of the study and its conclusions.

The Open House was advertised in both the Delaware County Daily Times and West Chester Daily Local News on January 11, 2018. The ad, shown in Figure 10-1, was distributed by numerous stakeholder groups such as the Ad Hoc Committee as well, through web pages and social media.

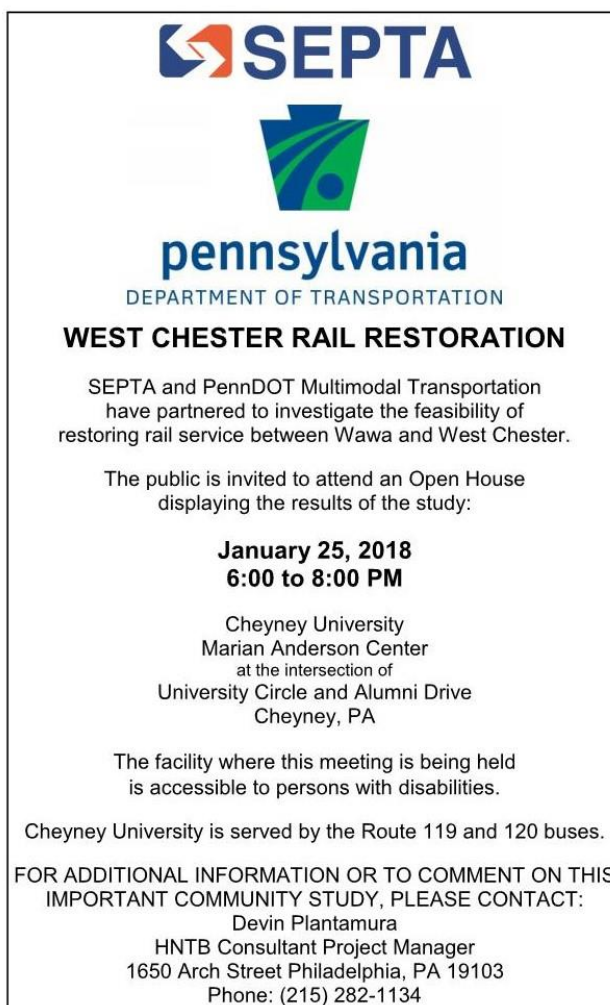


Figure 10-1 - Public Open House Advertisement

The Open House displays provided an overview of the study Purpose, Needs, and Goals, the study area and stakeholders, existing conditions along the line, ridership estimates, cost estimates for single and double track options, and conclusions. In addition, the single-track option was displayed. Project Team members Liz Smith, Joe Guzzi, Devin Plantamura, Chris Howsare, Mike Hartley and James Irwin circulated among the displays to provide additional detail and answer questions.

10.3 Public Feedback

Over 110 people attended the Open House, with many arriving nearly half an hour prior to the scheduled start, which points to the strong local interest in potential restoration of service. Attendees were genuinely interested in the study and results, and most clearly recognized the financial limitations of transit funding. A few commented that the ridership numbers seemed low or that the costs seemed high, but overall those in attendance were appreciative that PennDOT and SEPTA had undertaken the study, and happy to learn that service restoration is feasible, even if the funding is not currently available.

A questionnaire was provided for attendees to fill out and return at the open house or by mail afterward. Forty-five completed questionnaires were received at the open house and another four returned by mail in the two weeks following. Every respondent indicated that they would use SEPTA more often if rail service was restored to West Chester, with most utilizing the West Chester Borough station. Most were occasional SEPTA riders, primarily using the regional rail lines for shopping or other trips. The results are shown in Table 10-2.

Written comments covered a range of topics. The most frequent was a request for a copy of the final report, and support for restoring service. Numerous respondents also cited the potential for restored service to improve the economic vitality of the study area as well as provide economic opportunities to those in Philadelphia and other connected communities. Several noted that increased transit could help alleviate current and future traffic congestion, as well as the environmental benefits. A few expressed concern over the costs, and who would bear them, with some suggesting the regional businesses and institutions which might stand to benefit could assist.

Table 10-2 - Questionnaire Responses

Question	Response	Percent of Respondents
How often do you ride SEPTA?		
	Daily	11%
	Occasionally	71%
	Weekends	22%
What modes of transit do you use?		
	Regional Rail	93%
	Bus	20%
	Subway	31%
	Trolley	11%
	High Speed Line	4%
	N/A	4%
How do you use SEPTA?		
	Commute to work	18%
	Commute to School	2%
	To Shop	38%
	Other	76%
	N/A	4%
Would you use SEPTA more often if rail service as available to West Chester?		
	Yes	100%
	No	0%
Where would you access the restored service?		
	West Chester Borough	62%
	West Chester University	24%
	Westtown	29%
	Cheyney University	13%

11 Conclusion

The restoration of regional rail service between Wawa and West Chester on the SEPTA West Chester Line is feasible. Electrification for operation of existing SEPTA regional rail vehicles on a restored single track with passing siding was found to be the most cost effective solution that best meets the project goals and objectives. The two-track option has a much higher capital cost and does not offer a significant improvement to operations. Dual mode vehicles, which are less desirable operationally, were found to have a higher initial capital cost than electrification. It is the recommendation of this study that any future advancement of the project only consider electrified single track with passing sidings for restoration of regional rail service to West Chester.

This study focused exclusively on the restoration of regional rail service to West Chester on the existing, underutilized rail right of way south of Wawa. If the project progresses, NEPA studies will require identification of transportation needs for the area which may warrant investigating other transportation improvements.

The Federal Transit Administration Capital Investment Grant (CIG) program is a discretionary grant program, which includes the New Starts, Small Starts and Core Capacity programs. Projects that achieve a minimum “medium” rating for Project Justification and Local Financial Commitment are eligible to compete for funding. A CIG Project Evaluation and Rating was not included in the scope of this feasibility study. However, it is anticipated that the ridership and estimated capital costs for the project will not provide sufficiently high enough ratings to achieve the “medium” Project Justification rating to qualify the project for federal funding. SEPTA’s Fiscal Year 2018 Capital Budget and Fiscal Years 2018-2029 Capital Program focuses capital investments for existing backlog of state of good repair projects for at least the next 12 years. SEPTA does not have the funds available for service expansion.

Approximately \$20 million would be needed to advance the project to the next phase of planning and engineering. Without Federal or SEPTA Capital funds dedicated to the project, it is unlikely to advance to the next phase of planning and engineering without a significant commitment of local funding.

Appendix A

Order of Magnitude Cost

West Chester Line Restoration Feasibility Study Order of Magnitude Cost Estimate					
Item	Description	Alt 1A Single Track Electrified	Alt 1B Single Track Dual-Mode	Alt 2A Double Track Electrified	Alt 2B Double Track Dual-Mode
1	Mobilization (10% Construction Costs)	\$ 17,500,000	\$ 14,500,000	\$ 30,700,000	\$ 26,100,000
2	Track, Roadbed and Special Trackwork	\$ 24,500,000	\$ 24,500,000	\$ 49,000,000	\$ 49,000,000
3	Electrification (Overhead Contact System)	\$ 20,000,000	\$ 500,000	\$ 34,500,000	\$ 1,250,000
4	Retaining Walls	\$ 12,000,000	\$ 12,000,000	\$ 53,000,000	\$ 53,000,000
5	Bridge Rehabilitation and Reconstruction	\$ 34,000,000	\$ 34,000,000	\$ 63,000,000	\$ 63,000,000
6	Stations (Platforms / Parking / Access)	\$ 51,600,000	\$ 51,600,000	\$ 66,600,000	\$ 66,600,000
7	Railroad Signal and Communication Systems	\$ 19,100,000	\$ 18,500,000	\$ 21,700,000	\$ 20,600,000
8	Electric Power Systems	\$ 10,900,000	\$ 800,000	\$ 12,300,000	\$ 700,000
9	Highway Grade Crossings	\$ 2,700,000	\$ 2,700,000	\$ 6,600,000	\$ 6,600,000
10	Subtotal, Construction Costs (Items 1 through 9)	\$ 192,300,000	\$ 159,100,000	\$ 337,400,000	\$ 286,850,000
11	Bonds & Insurance, Overhead, Profit (10% of Items 2, 4, 5, 6 and 9)	\$ 12,480,000	\$ 12,480,000	\$ 23,820,000	\$ 23,820,000
12	Contingency (30% of Items 10 and 11)	\$ 61,434,000	\$ 51,474,000	\$ 108,366,000	\$ 93,201,000
13	Total, Construction Cost (Items 10 through 12)	\$ 266,214,000	\$ 223,054,000	\$ 469,586,000	\$ 403,871,000
14	Engineering Design (10% of Item 13)	\$ 26,621,400	\$ 22,305,400	\$ 46,958,600	\$ 40,387,100
15	Right-of-Way Acquisition	\$ 150,000	\$ 150,000	\$ 190,000	\$ 190,000
16	SEPTA Project Management, Permitting, Construction Inspection, Administration and Flagging (20% on Item 13)	\$ 53,242,800	\$ 44,610,800	\$ 93,917,200	\$ 80,774,200
Total, Construction, Right of Way and Management Costs		\$ 346,228,200	\$ 290,120,200	\$ 610,651,800	\$ 525,222,300
Vehicles		\$ 33,600,000	\$ 81,000,000	\$ 33,600,000	\$ 81,000,000
Vehicle Maintenance Facility		\$ -	\$ 25,000,000	\$ -	\$ 25,000,000
Total, Project Cost		\$ 379,828,200	\$ 396,120,200	\$ 644,251,800	\$ 631,222,300

Notes:

1. Costs represent an order of magnitude based on concept level design.
2. Concepts are based on aerial mapping and information collected from one field visit.
3. Unit costs are based on recent project costs for SEPTA and other passenger railroads in the Philadelphia region.
4. Additional productivity for working on out of service track has been factored into unit costs where appropriate.
5. A traction power study has not been conducted for this report. Items 3 and 8 include costs for assumed electric distribution infrastructure needs.
6. Station concepts have not been developed for this report. Costs are included based on assumed facility requirements.
7. Operations have not been coordinated with SEPTA at the time of this report.
8. Vehicle requirements are based on assumed service frequencies and patterns similar to the former service operated on the corridor.
9. Project soft costs (engineering design, project management, etc.) are based on the estimate for the West Trenton Separation Project.
10. All costs have been adjusted to 2017 dollars.
11. Vehicle maintenance facility cost is based on recent project estimates and includes all railroad system and facility costs.
12. Right of way costs do not include cost for station right of way.

Appendix B

Conceptual Plans

CHIEF ENGINEER - EN&C
CHIEF ENGINEERING OFFICER - BAB
CHIEF RAIL TRANSPORT OFFICER
SYSTEM SAFETY
DIRECTOR OF ENGINEERING - BAB
MANAGER - ARCH/ENGINEERING
PROJECT MANAGER

REV	DATE	DESCRIPTION	BY	CHKD	APD



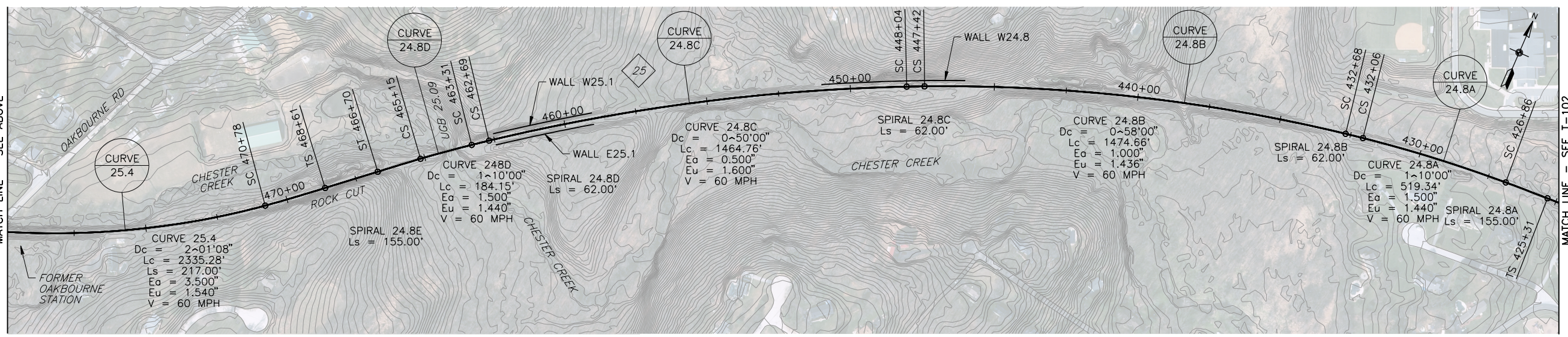
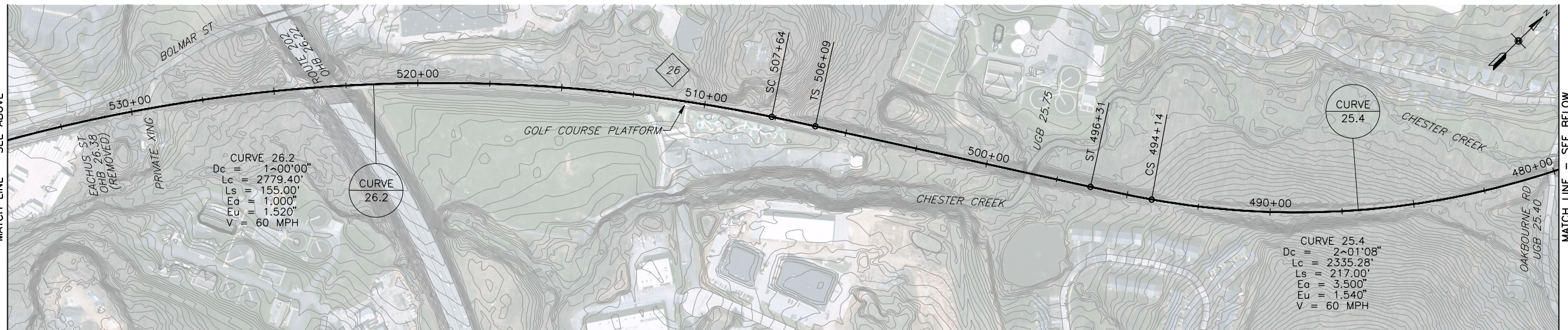
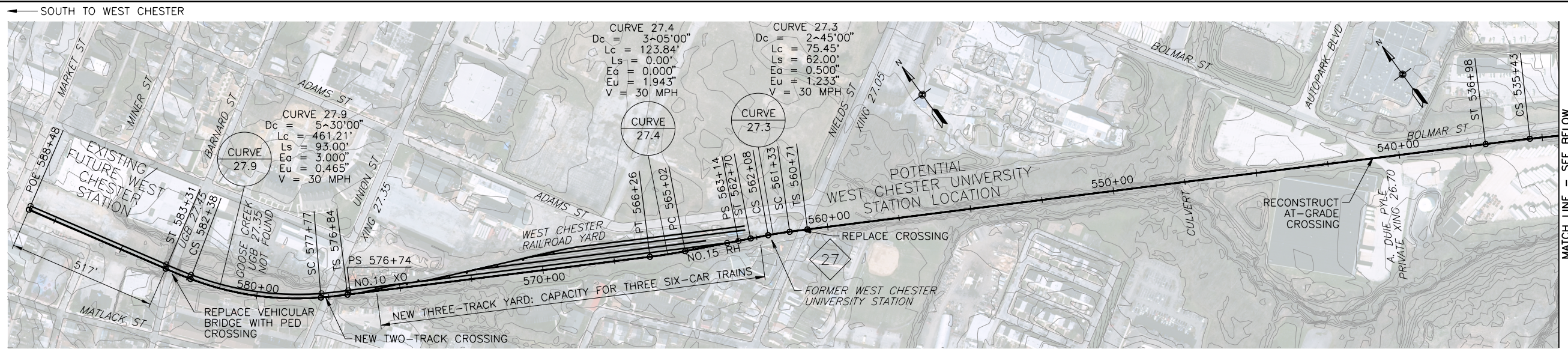
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 ALTERNATIVE 2A/2B - DOUBLE TRACK: T-111, T-112, T-113

1500 750 0 1500
 SCALE: 1"=1500'

WEST CHESTER TO WAWA, PA
 WEST CHESTER LINE
RESTORATION
 FEASIBILITY STUDY
 CONCEPTUAL PLANS
 KEY PLAN

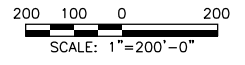
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SHT. NO.:	1	OF	1
ARCHIVE NO.:	ARCHIVE NO		
COMPUTER FILE NO.:	COMPUTER FILE NO		
REV. NO.:	0		

6136317-rs-rd001.dgn DATE PRINTED: 12/29/2017 STATUS



- NOTES:**
- UNDERGRADE BRIDGES (UGB), OVERHEAD BRIDGES (OHB) AND GRADE CROSSINGS (XING) SHOWN ARE BASED ON THE SEPTA TRACK CHARTS.

ALTERNATIVE 1A/1B CONCEPTUAL PLAN
SINGLE-TRACK WITH PASSING SIDINGS



CHIEF ENGINEER - EM&C
CHIEF ENGINEERING OFFICER - BAB
CHIEF RAIL TRAFFIC OFFICER
SYSTEM SAFETY
DIRECTOR OF ENGINEERING - BAB
MANAGER - ARCH/ENGINEERING
PROJECT MANAGER

REV	DATE	DESCRIPTION	BY	CKD	APD

WEST CHESTER TO WAWA, PA
WEST CHESTER LINE
RESTORATION
FEASIBILITY STUDY
ALTERNATIVE 1A/1B - SINGLE-TRACK
CONCEPTUAL PLAN (1 OF 3)

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SHT. NO.:	1 OF 3		
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ARCHIVE NO.:			
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COMPUTER FILE NO.:			

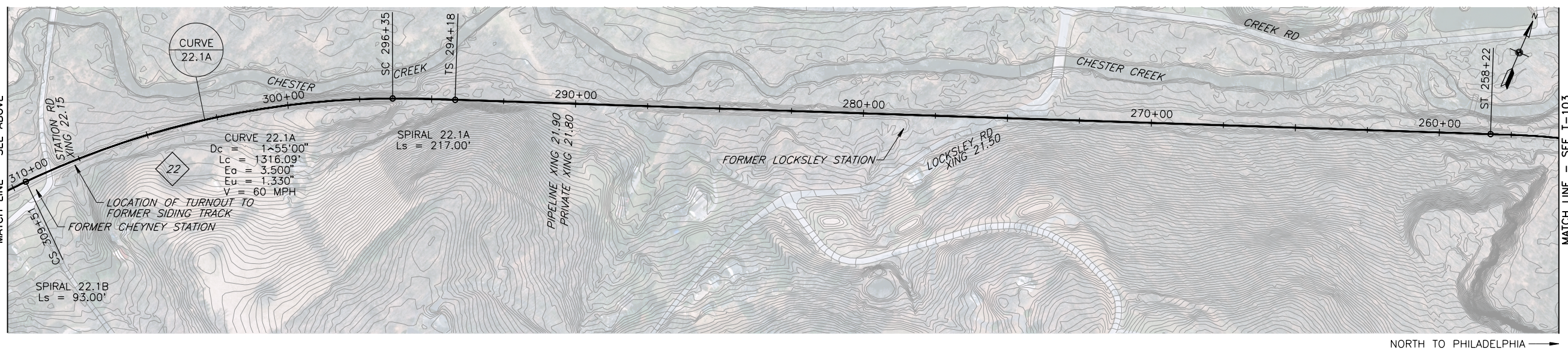
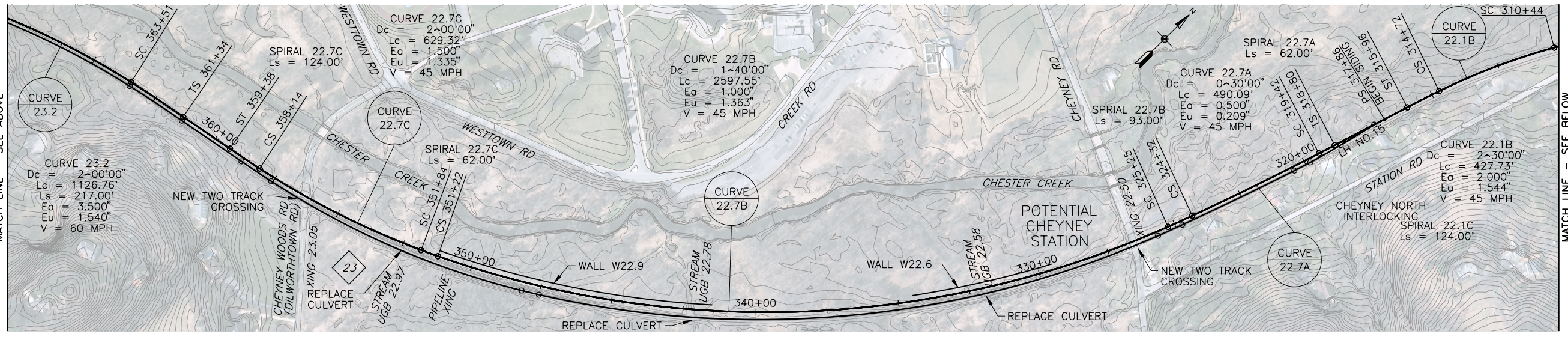
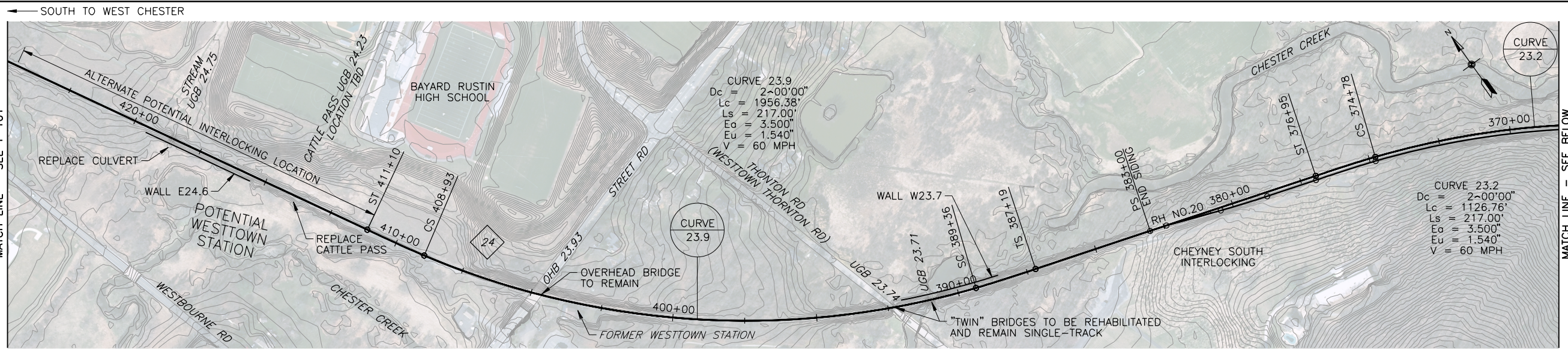
6/13/317-rs-rplm101.dgn DATE PRINTED: 12/29/2017 STATUS

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CHIEF ENGINEERING OFFICER - BAB	
CHIEF RAIL TRAVEL OFFICER	
SYSTEM SAFETY	
DIRECTOR OF ENGINEERING - BAB	
MANAGER - ARCHITECTURE	
PROJECT MANAGER	

REV	DATE	DESCRIPTION	BY	CKD	APD

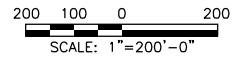
WEST CHESTER TO WAWA, PA
WEST CHESTER LINE
RESTORATION
FEASIBILITY STUDY
ALTERNATIVE 1A/1B - SINGLE-TRACK
CONCEPTUAL PLAN (2 OF 3)

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- NOTES:**
- UNDERGRADE BRIDGES (UGB), OVERHEAD BRIDGES (OHB) AND GRADE CROSSINGS (XING) SHOWN ARE BASED ON THE SEPTA TRACK CHARTS.

ALTERNATIVE 1A/1B CONCEPTUAL PLAN
SINGLE-TRACK WITH PASSING SIDINGS



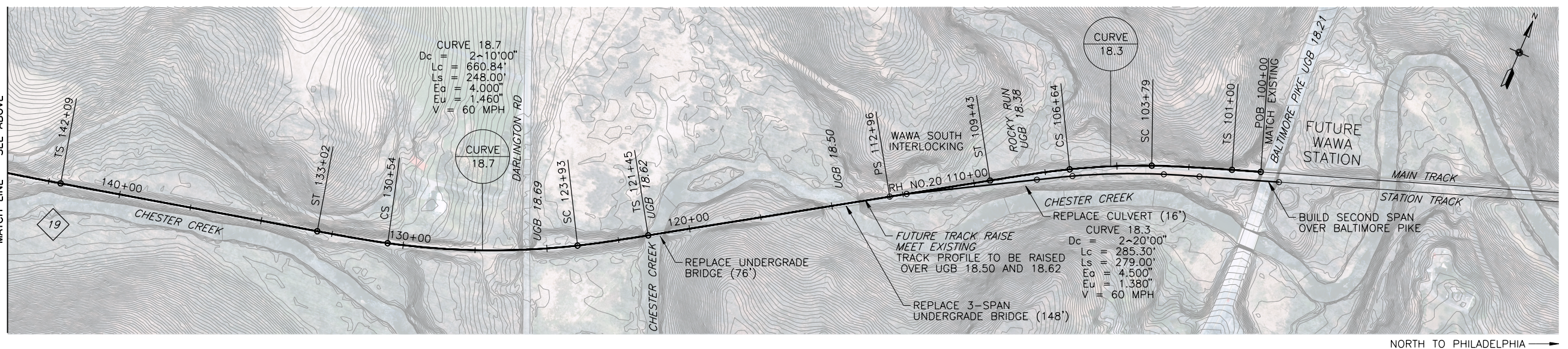
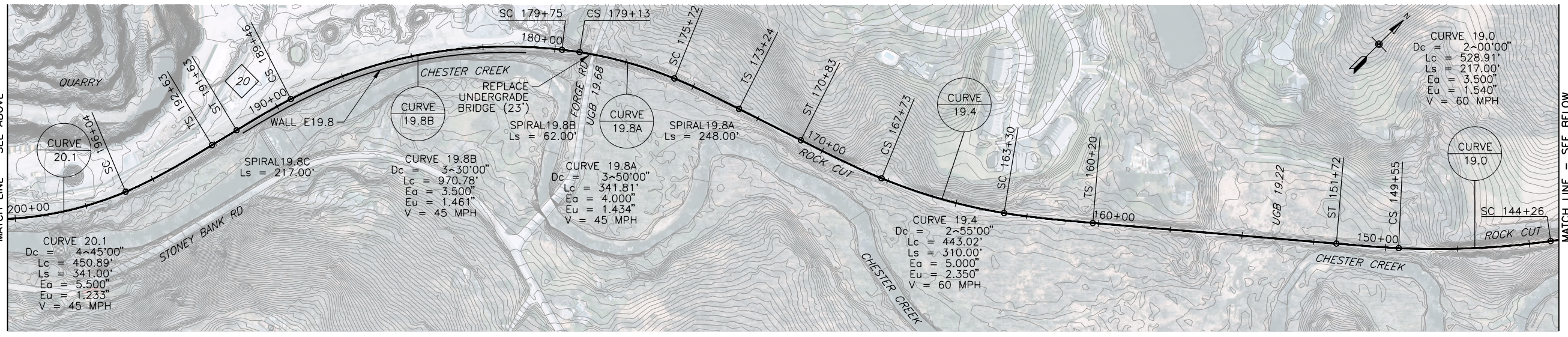
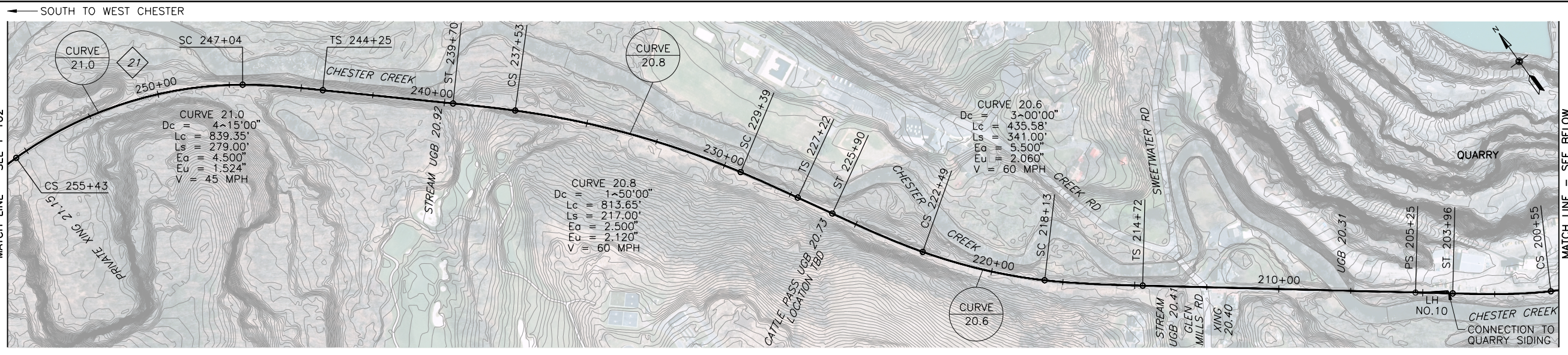
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CHIEF ENGINEERING OFFICER - BAB
CHIEF RAIL TRAVEL OFFICER
SYSTEM SAFETY
DIRECTOR OF ENGINEERING - BAB
MANAGER - ARCHITECTURE
PROJECT MANAGER

REV	DATE	DESCRIPTION	BY	CKD	APD

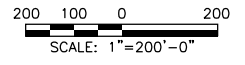
**WEST CHESTER TO WAWA, PA
WEST CHESTER LINE
RESTORATION
FEASIBILITY STUDY
ALTERNATIVE 1A/1B - SINGLE-TRACK
CONCEPTUAL PLAN (3 OF 3)**

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SCALE FACTOR: 1:1
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CHECKED BY: DP
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SHEET NUMBER
T-103
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SHT. NO.: 3 OF 3
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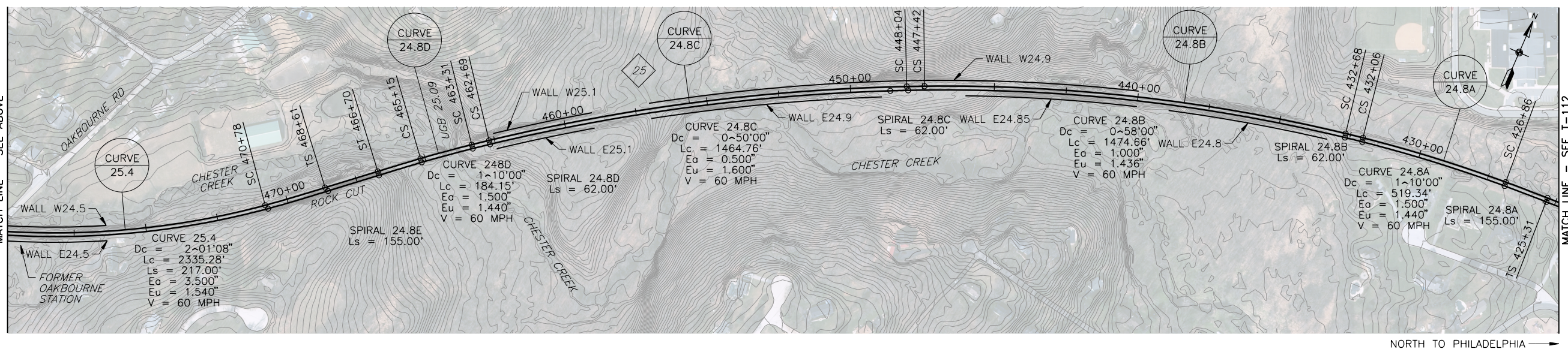
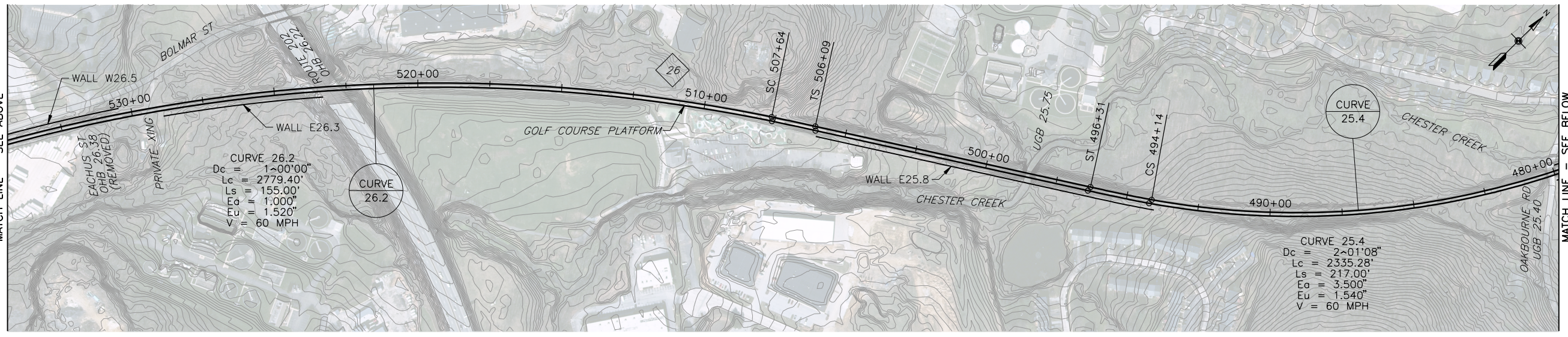
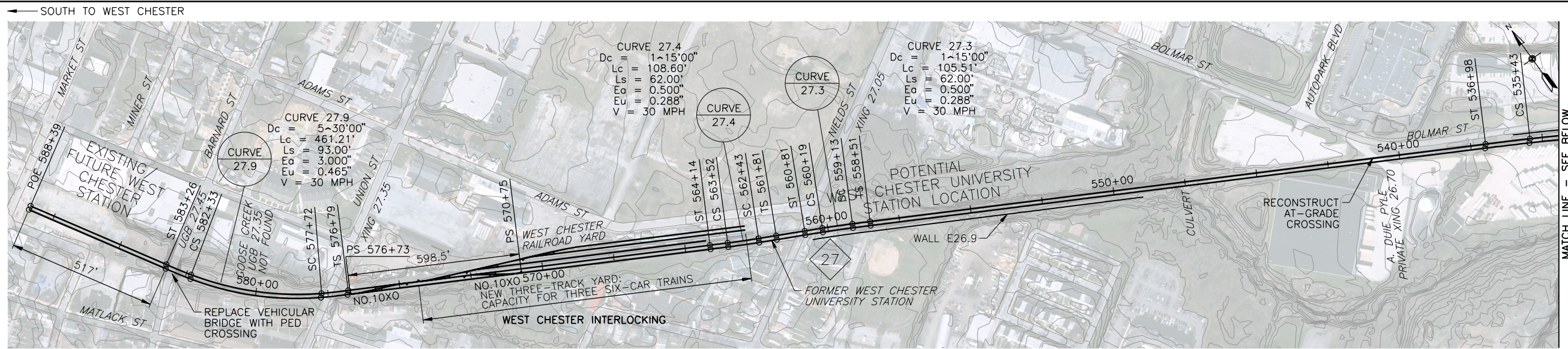


- NOTES:**
- UNDERGRADE BRIDGES (UGB), OVERHEAD BRIDGES (OHB) AND GRADE CROSSINGS (XING) SHOWN ARE BASED ON THE SEPTA TRACK CHARTS.

**ALTERNATIVE 1A/1B CONCEPTUAL PLAN
SINGLE-TRACK WITH PASSING SIDINGS**

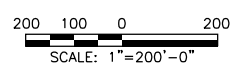


6136317-rs-rp103.dgn DATE PRINTED: 12/29/2017 STATUS



NOTES:
 1. UNDERGRADE BRIDGES (UGB), OVERHEAD BRIDGES (OHB) AND GRADE CROSSINGS (XING) SHOWN ARE BASED ON THE SEPTA TRACK CHARTS.

ALTERNATIVE 2A/2B CONCEPTUAL PLAN
FULL DOUBLE-TRACK



SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY
 ENRC DIVISION
 1234 MARKET ST, 13TH FL.
 PHILADELPHIA, PA 19107

CHIEF ENGINEER - ENRC
 CHIEF ENGINEERING OFFICER - ENRC
 CHIEF RAIL TRAVEL OFFICER
 SYSTEM SAFETY
 DIRECTOR OF ENGINEERING - ENRC
 MANAGER - ARCHITECTURE/ENGINEERING
 PROJECT MANAGER

HNTB
 HNTB Corporation
 1650 Arch Street
 Suite 1700
 Philadelphia, PA 19103
 215-568-6500

REV	DATE	DESCRIPTION	BY	CKD	APD

WEST CHESTER TO WAWA, PA
 WEST CHESTER LINE
RESTORATION
 FEASIBILITY STUDY
 ALTERNATIVE 2A/2B - FULL DOUBLE-TRACK
 CONCEPTUAL PLAN (1 OF 3)

SCALE: AS NOTED	SCALE FACTOR: 1:1
DATE: 12/29/2017	DRAWN BY: FAM CHECKED BY: DP
WORK ORDER NO.: 3137 WO#17	
SHEET NUMBER: T-111	
DWG. NO.: 1 OF 3	
SHT. NO.: 1 OF 3	
ARCHIVE NO.: ARCHIVE NO	
COMPUTER FILE NO.: COMPUTER FILE NO	REV. NO.: 0

6/13/2017 10:41:11 AM
 DATE PRINTED: 12/29/2017
 STATUS

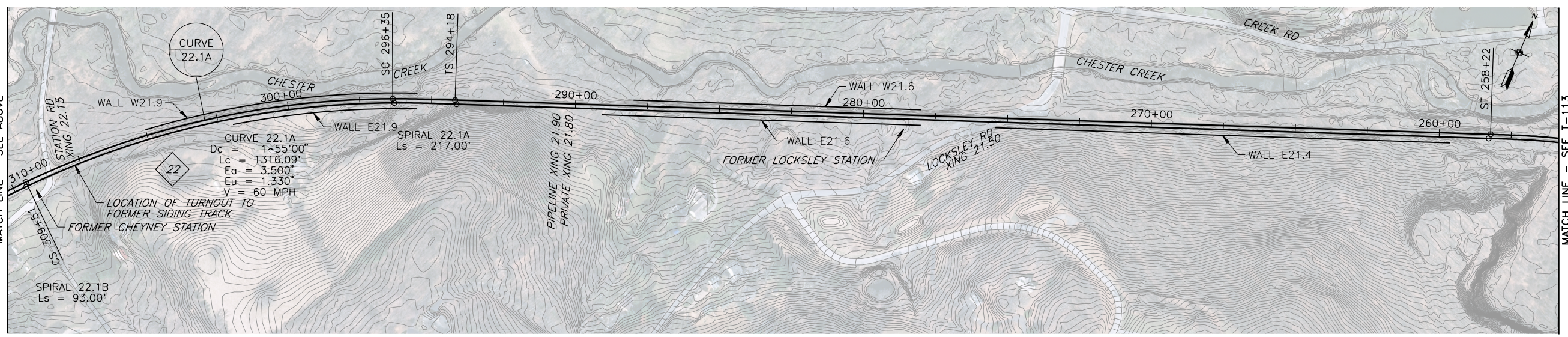
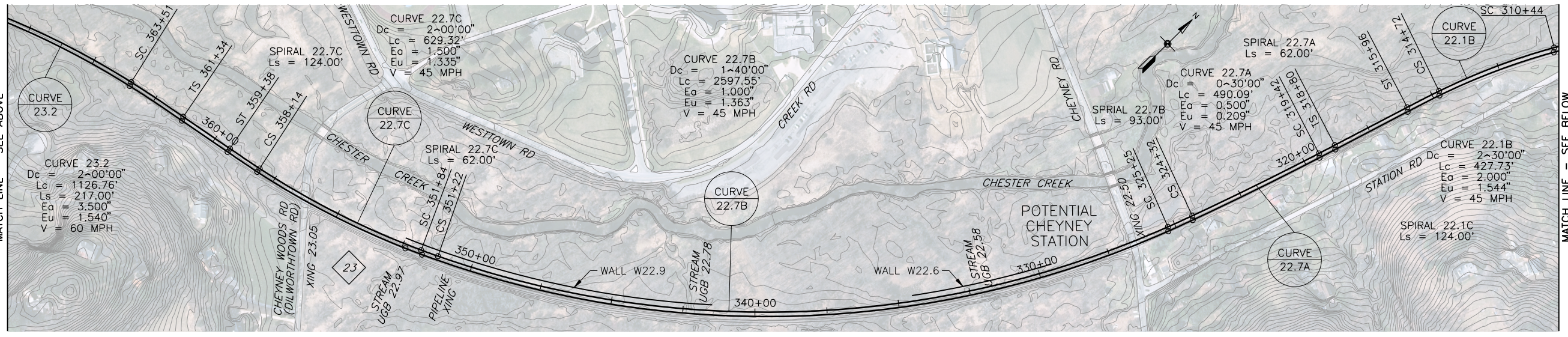
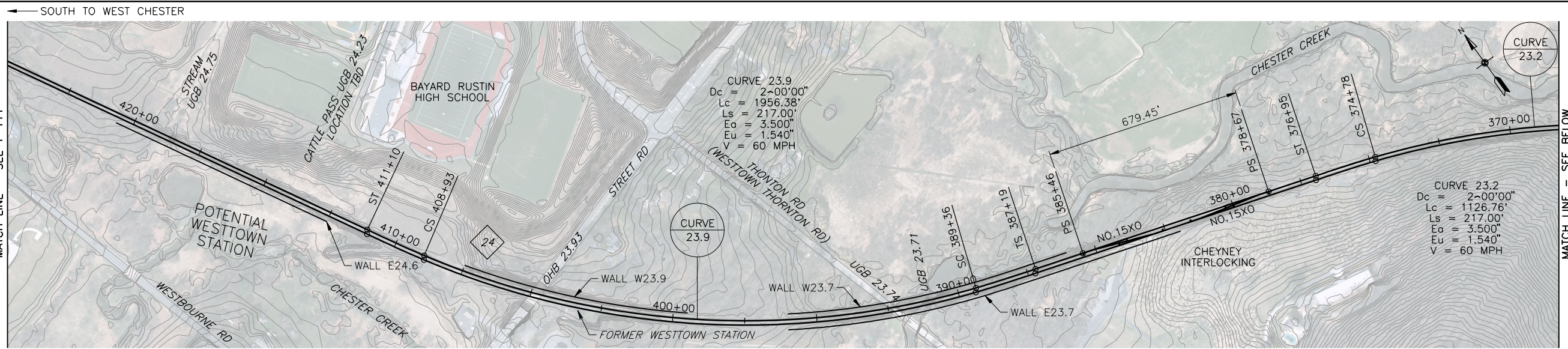
CHIEF ENGINEER - ENR
CHIEF ENGINEERING OFFICER - BAB
CHIEF RAIL TRAVEL OFFICER
SYSTEM SAFETY
DIRECTOR OF ENGINEERING - BAB
MANAGER - ARCH/ENGINEERING
PROJECT MANAGER

REV	DATE	DESCRIPTION	BY	CHKD	APD

WEST CHESTER TO WAWA, PA
 WEST CHESTER LINE
RESTORATION
 FEASIBILITY STUDY
 ALTERNATIVE 2A/2B - FULL DOUBLE-TRACK
 CONCEPTUAL PLAN (2 OF 3)

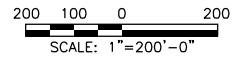
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DATE:	12/29/2017	DRAWN BY:	FAM
WORK ORDER NO.:	3137 WO#17	CHECKED BY:	DP
SHEET NUMBER:	T-112		
DWG. NO.:	2	OF	3
SHT. NO.:	2	OF	3
ARCHIVE NO.:	ARCHIVE NO		
COMPUTER FILE NO.:	COMPUTER FILE NO		
REV. NO.:	0		

6/13/317-rs-rpln112.dgn
 DATE PRINTED: 12/29/2017
 STATUS



- NOTES:**
- UNDERGRADE BRIDGES (UGB), OVERHEAD BRIDGES (OHB) AND GRADE CROSSINGS (XING) SHOWN ARE BASED ON THE SEPTA TRACK CHARTS.

ALTERNATIVE 2A/2B CONCEPTUAL PLAN
 FULL DOUBLE-TRACK



MATCH LINE - SEE T-111

MATCH LINE - SEE BELOW

MATCH LINE - SEE ABOVE

MATCH LINE - SEE BELOW

MATCH LINE - SEE ABOVE

MATCH LINE - SEE T-113

NORTH TO PHILADELPHIA

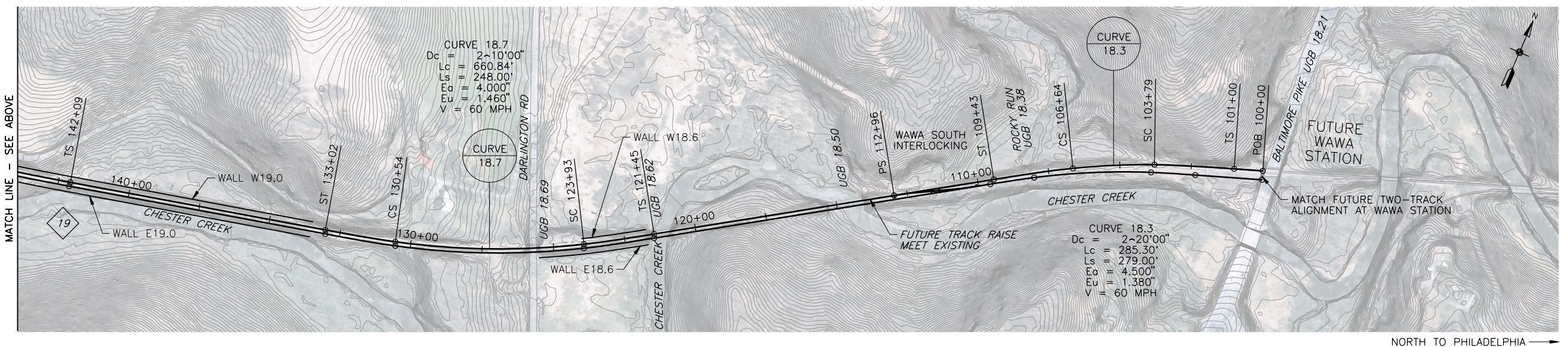
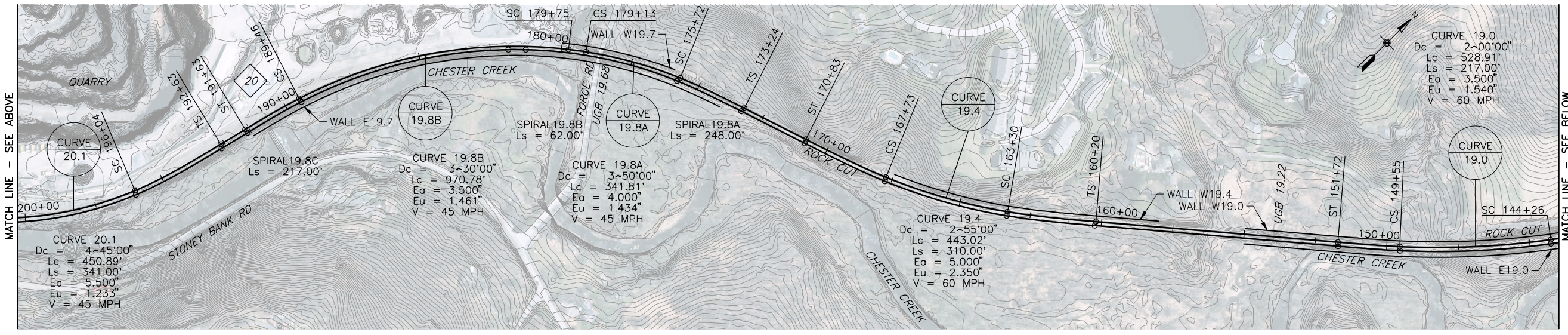
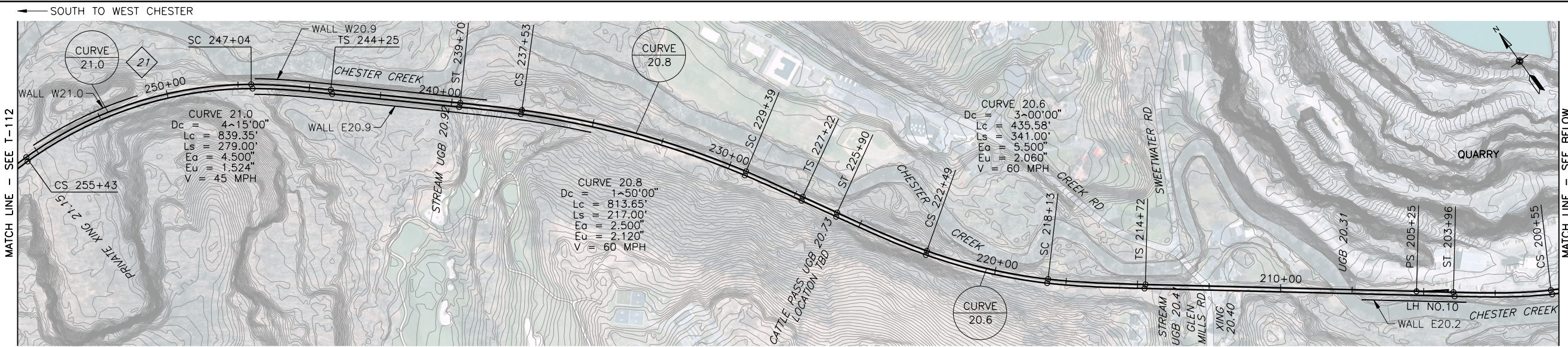
SOUTH TO WEST CHESTER

CHIEF ENGINEER - EM&C
CHIEF ENGINEERING OFFICER - BAB
CHIEF RAIL TRAVEL OFFICER
SYSTEM SAFETY
DIRECTOR OF ENGINEERING - BAB
MANAGER - ARCH. ENGINEERING
PROJECT MANAGER

REV	DATE	DESCRIPTION	BY	CKD	APD

WEST CHESTER TO WAWA, PA
WEST CHESTER LINE
RESTORATION
FEASIBILITY STUDY
ALTERNATIVE 2A/2B - FULL DOUBLE-TRACK
CONCEPTUAL PLAN (3 OF 3)

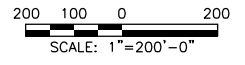
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SHEET NUMBER:	T-113		
DWG. NO.:	3	OF	3
SHT. NO.:	3	OF	3
ARCHIVE NO.:	ARCHIVE NO		
COMPUTER FILE NO.:	COMPUTER FILE NO		
REV. NO.:	0		



NOTES:

- UNDERGRADE BRIDGES (UGB), OVERHEAD BRIDGES (OHB) AND GRADE CROSSINGS (XING) SHOWN ARE BASED ON THE SEPTA TRACK CHARTS.

ALTERNATIVE 2A/2B CONCEPTUAL PLAN
FULL DOUBLE-TRACK



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DATE PRINTED: 12/29/2017

STATUS