



MEMORANDUM

Project: Front Range Passenger Rail Service Development Plan and National Environmental Policy Act (NEPA)

Memo Date: Monday, November 30, 2020

To: FRPR Project Management Team

From: FRPR Project Development Team

Subject: FRPR Level 2A CapEx and OpEx Analysis (Rev 2)

DISCLAIMER: The cost assessment presented in this memorandum is based on the best information available to-date on the current alternative alignments identified from the Level 1/Level 2A alternative analysis process for the Front Range Passenger Rail. This conceptual cost assessment provides rough-order-magnitude (ROM) costs as a basis to conceptually evaluate major cost drivers and differentiators between alignments. Given the nature of the project development stage at which this assessment was completed, and because AECOM has no control over market conditions or bidding procedures, any projected costs are at a preliminary analysis and AECOM cannot and does not warrant or guarantee that bids, project economics, and/or the actual project costs of a FRPR system will not vary materially from the conceptual cost estimates presented.

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LEVEL 2A CAPEX AND OPEX ASSESSMENT

The purpose of this memorandum is to document the Level 2A cost estimating methodology and initial cost assessment of the Front Range Passenger Rail (FRPR) Project Alignments for preliminary Capital Expenditures (CapEx) and Operational Expenditures (OpEx). This focuses on three alignments that were advanced from the Level 1 alternative analysis process, namely: Alignments 3, 4, and 6. An Alignment refers to the track layout and ancillary facilities while an Alternative is a combination of the track layout, ancillary facilities and operations plan.

The rough order of magnitude (ROM) CapEx estimates presented demonstrate that a FRPR system is cost competitive to other rail transportation systems that have been evaluated along the front range region in the past, primarily the Interregional Connectivity Study (ICS 2014, 2017). The results of this analysis are high-level and demonstrate how each alignment compare to each other. The estimated **CapEx** to construct a full build out of the FRPR from Fort Collins to Pueblo, with a dedicated double track system, is presented below in Table 1 for Alignment 3, 4, and 6. In addition, Table 1 also shows potential phased implementation Scenarios for Alignment 3 that are further described later in the report.

Table 1. CapEx & OpEx Estimate Range

Cost Results Range

2020\$ Total CapEx Cost
2020\$ Annual OpEx Cost

Alignment 3		Alignment 4		Alignment 6	
Low	High	Low	High	Low	High
\$8.0 B	\$13.4 B	\$8.5 B	\$14.2 B	\$7.8 B	\$13.1 B
\$125 M	\$187 M	\$120 M	\$180 M	\$125 M	\$188 M
Potential Phased Implementation Scenarios for Alignment 3					
Scenario 2		Scenario 3		Scenario 4	
Low	High	Low	High	Low	High
\$1.7 B	\$2.8 B	\$5.6 B	\$9.3 B	More information needed.	
More information needed to estimate.					

Cost Results Range

2020\$ Total CapEx Cost
2020\$ Annual OpEx Cost

Next levels of analysis would continue to provide more research and complexity in the topics of terrain challenges, right-of-way acquisition, operational analysis, community input and more detail on station area planning, considerations for track and structure sharing with freight and/or RTD corridors, and potential hybrid alignment combinations that could be assembled by combining specific segments from each alignment.

OVERVIEW OF LEVEL 2A ALIGNMENTS

The three alignments are divided into North, Central, and South Segments for the Level 2A CapEx analysis. For the North segment, each of the alignments begin in Fort Collins and end at either Denver Union Station (Alignments 3 and 4) or the Denver Airport station (alignment 6). Four stations were included in the cost estimate for the North Segment. For the Central segment, each of the alignments begin in at the Denver Union Station (alignments 3 and 4) or Denver Airport station (alignment 6) and end at end at the Castle Rock station. Two stations were included in the cost estimate for the Central Segment. Last, the South segment for each of the three alignments starts at the Castle Rock station and ends at the Pueblo station, and it includes three stations for the cost estimate, including the Colorado Springs station.

Note that only primary stations have been included in this Level 2A assessment, and no secondary stations are considered. The South and Central segments for Alignments 3 and 4 are the same. The North Segment for Alignments 3 and 4 are the same North of Longmont.

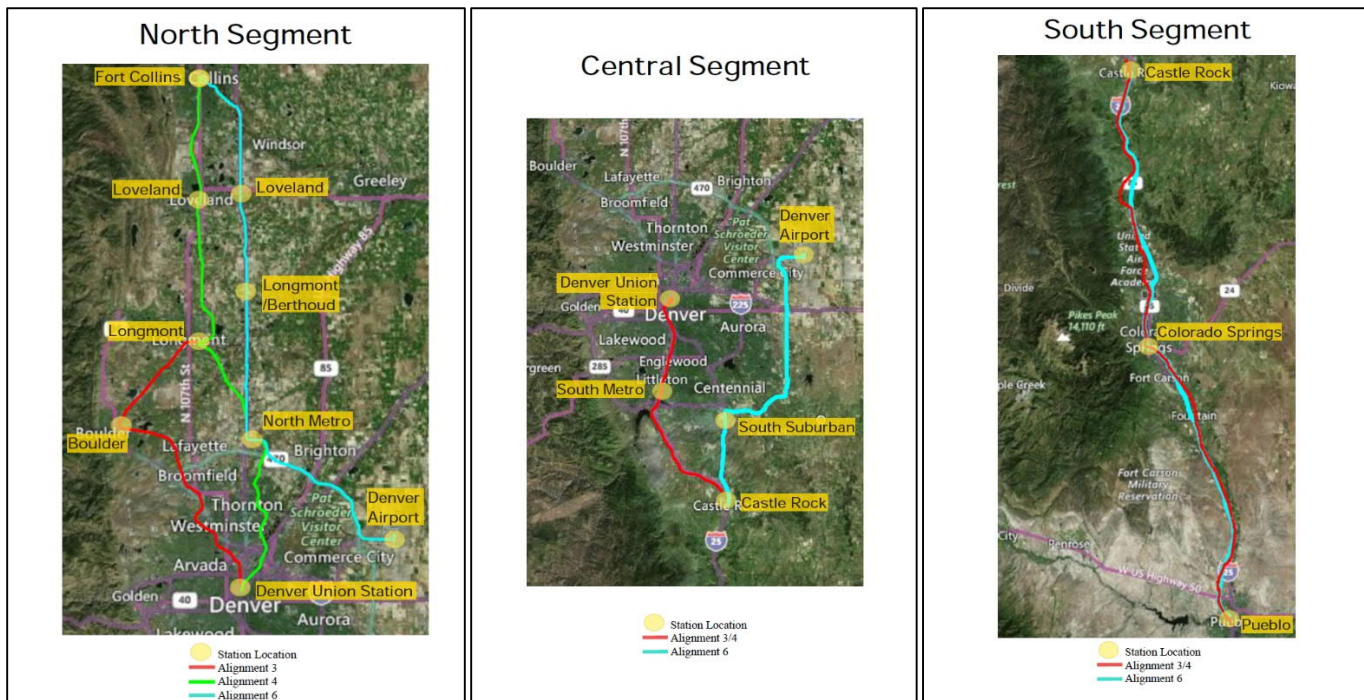


Figure 1. FRPR Level 2A Alternative Alignments Segments & Stations

CAPEX ESTIMATE

The capital cost estimates include the cost to construct the passenger rail civil and structural elements, tracks, stations and support facilities, purchase and installation of system control components, procure vehicles, professional services, and make any other needed infrastructure improvements. In general, capital costs in the estimate assume that the FRPR system would be constructed to follow alongside existing transportation corridors (public roadways, freight and RTD commuter/light rail) where possible with a dedicated double track system.

The estimated CapEx to construct a full build out of the FRPR from Fort Collins to Pueblo is between \$10.5B to \$11.3B (mid-point estimate), approximately \$55M to \$62M per mile including contingencies for the 3 alignments. Below is a comparative overview of the Level 2A CapEx results for the 3 alignments:

Table 2. FRPR CapEx Estimate Comparison between Alignments¹

SCC	Description	Alignment 3	Alignment 4	Alignment 6
10	GUIDEWAY & TRACK ELEMENTS	\$3,745 M	\$4,078 M	\$3,623 M
20	STATIONS	\$390 M	\$350 M	\$380 M
30	SUPPORT FACILITIES	\$260 M	\$260 M	\$260 M
40	SITWORK & SPECIAL CONDITIONS	\$657 M	\$701 M	\$637 M
50	SYSTEMS	\$348 M	\$332 M	\$307 M
51	Construction Subtotal (10 - 50)	\$5,401 M	\$5,721 M	\$5,207 M
60	ROW, LAND, EXISTING IMPROVEMENTS	\$939 M	\$1,007 M	\$1,001 M
70	VEHICLES	\$498 M	\$498 M	\$498 M
80	PROFESSIONAL SERVICES	\$1,728 M	\$1,831 M	\$1,666 M
81	Subtotal (10 - 80)	\$8,566 M	\$9,056 M	\$8,372 M
90	UNALLOCATED CONTINGENCY	\$2,141 M	\$2,264 M	\$2,093 M
91	2020\$ Total Project Cost (10 - 90)	\$10,707 M	\$11,320 M	\$10,465 M
Alignment Length (miles)		190.6 mi	183.6 mi	191.9 mi
2020\$ Construction Cost per Mile (SCC 10 to 50)		\$28.3 M	\$31.2 M	\$27.1 M
2020\$ Total Project Cost per Mile (w/o Vehicles)		\$52.9 M	\$58.3 M	\$51.3 M
2020\$ Total Project Cost per Mile		\$56.2 M	\$61.6 M	\$54.5 M

For the purpose of contingency management following FRA's guidelines, contingency is divided into two major categories: allocated and unallocated contingency. Allocated contingencies are added to each individual line item, based on the level of design development and information, and complexity. For the Level 2A CapEx estimate, a standard 10% allocated contingency has been applied to each line item. As the project progresses and more detailed design information is available, the allocated contingency amounts will be adjusted to reflect a risk level that is commensurate to each individual line item.

Unallocated contingency is applied to the project cost subtotal, and it is used to address uncertainties that are more global in nature, not associated with individual line items. For this estimate, a 25% unallocated contingency was applied to the project subtotal (SCC 81). The total project cost estimate (SCC 91) is the mid-point (most likely) project cost estimate, considered *the moderate scenario*. At this level of accuracy, a cost ranging approach is applied to the total project cost (SCC 91) and a range within +/- 25% off SCC 91 is developed. The *optimistic scenario* is the low range (- 25%), whereas *the conservative scenario* is the high range (+25%) as shown in Figure 2 below. As the project evolves, the cost range will become more specific with a narrower range.

¹ Refer to Appendix E for the Detailed CapEx Summary per Alignment

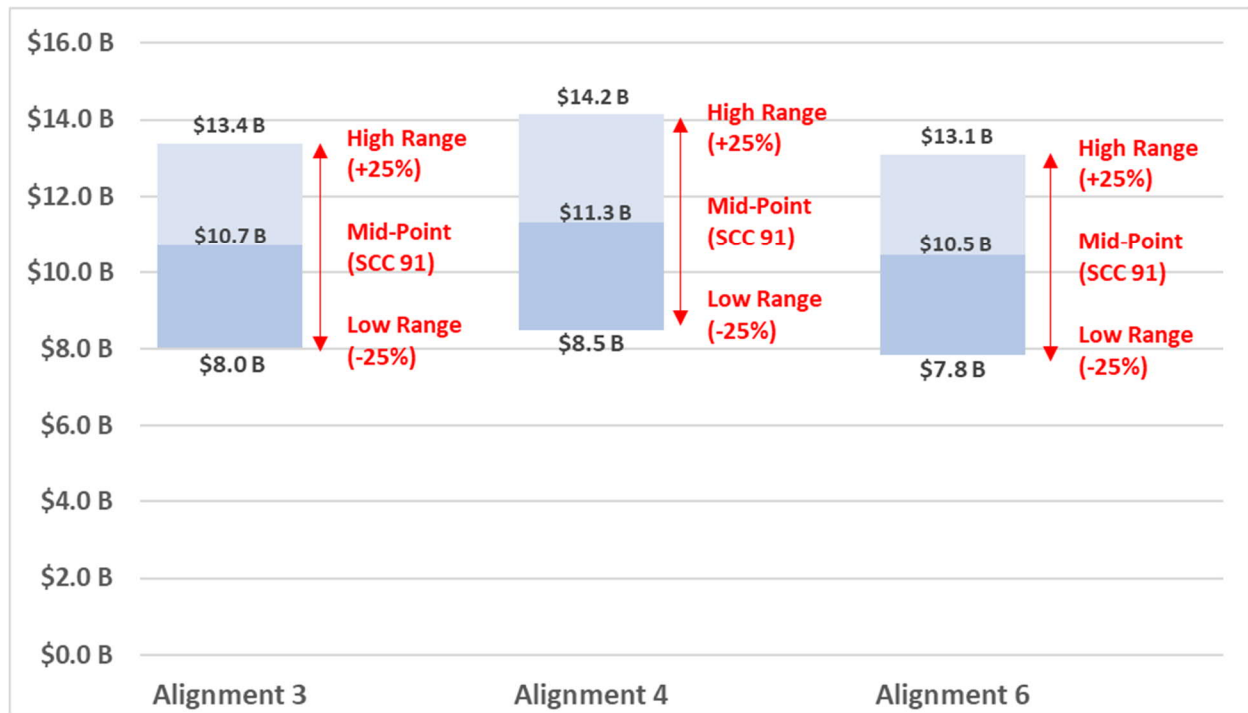


Figure 2. FRPR CapEx Cost Range Results

METHODOLOGY

The CapEx estimate structure has been prepared using the Federal Railroad Administration (FRA) Standard Cost Categories (SCC) format², which serves as both a structure and a summary for the capital cost estimate. This format also facilitates comparison to other intercity passenger rail systems that have used the SCC format (or equivalent), and thus makes it easy to track and control changes over time as the estimate evolves. The SCC format consists of 10 categories:

- 10. Guideway & Track Elements
- 20. Stations
- 30. Support Facilities
- 40. Sitework & Special Conditions
- 50. Systems
- 60. Right-of-Way (ROW), Land & Existing Improvements
- 70. Vehicles
- 80. Professional Services
- 90. Unallocated Contingency
- 100. Finance Charges (not evaluated in this study)

The CapEx estimates developed are presented are for a Project Definition/Advanced Planning level of detail and accuracy. As with other studies for major linear infrastructure projects, the level of accuracy associated with this level of estimating is within +/- 25% or worse accuracy.

² Federal Railroad Administration - Capital Cost Estimating Guidance for Project Sponsors (August 30, 2016)

Table 3: Level of CapEx Estimating Accuracy

Design Development Phase	Approx. Engineering Design Level	Approx. Level of Accuracy
Feasibility Study	0%	+/- 30% or worse
Project Definition / Advanced Planning	1-2%	+/- 25%
Conceptual Engineering	10%	+/- 20%
Preliminary Engineering	30%	+/- 15%
Pre-Final Engineering	65%	+/- 15%
Final Design / Construction Documents	100%	+/- 10% or better

Source: ICS Report (2013), Appendix B.

The Level 2A screening process identifies the major required improvements for each alignment by identifying primary quantities for each SCC. Unit costs are then applied to each identified cost component.

QUANTITIES

Using the Level 2A alignment information captured to date, quantity estimates for each of the applicable 10 SCC were completed. At this level of assessment, the quantity measurements completed are high level using best engineering judgement. They focused on capturing the relative terrain and alignment complexity of each alignment. For example, potential long span (Major Viaduct) structures were quantified in areas with multiple crossings in close succession whereas overpass structures were prescribed for short span crossings like a river or roadway. The type of quantity information captured at this level is considered appropriate to perform a screening process enough to make comparisons between each alignment's anticipated cost drivers and challenges. Below is a summary of the primary quantities captured to perform the CapEx estimates:

Table 4. CapEx Primary Quantities

Level 2A Primary Quantities	Alignment 3	Alignment 4	Alignment 6
Alignment Length	190.6 mi	183.6 mi	191.9 mi
Alignment Elevation Profile (by length)			
At-Grade (with cut & fill)	170.4 mi	159.6 mi	171.4 mi
Overpass	3.1 mi	3.1 mi	2.9 mi
Underpass	2.0 mi	1.5 mi	0.5 mi
Major Viaduct	13.8 mi	18.2 mi	16.6 mi
Tunnel	1.3 mi	1.3 mi	0.6 mi
Alignment Crossings (count)			
Highway	37	32	33
Major Roads	122	106	65
Local Roads	84	82	65
Stream Crossings	158	235	131
Alignment Corridor Type (by length)			
Greenfield/Brownfield Conditions	29.1 mi	39.0 mi	17.9 mi
Existing Roadway Corridor	2.5 mi	6.5 mi	143.1 mi
Existing RTD Corridor	17.7 mi	30.2 mi	7.2 mi
Existing Freight Rail Corridor	141.3 mi	107.9 mi	23.8 mi
Right Of Way (Alignment Acreage)			
Rural - Double Track (assumed 75' width)	1,141 acres	884 acres	1,011 acres
Urban - Double Track (assumed 60' width)	473 acres	629 acres	588 acres
Stations (count)			
Primary (New built)	8 Stations	8 Stations	8 Stations
Primary (Existing Upgrades)	1 Station	1 Station	1 Station
Support Facilities (count)			
Heavy Maintenance Facilities (HMF)	1	1	1
Layover Facilities	3	3	3

UNIT PRICING

Unit prices were compiled from previous Colorado-based passenger rail studies and other locations, including the Midwest Regional Rail Initiative (MWRRI), the California High Speed Rail Association (CHSRA), the Interregional Connectivity Study (ICS), and the North I-25 Commuter Rail Study. The unit prices were studied to determine appropriate conservative averages applicable to each of the primary quantities identified above. Since unit prices were outdated (going back to 2010\$), the CWCCIS for “Roads, Railroads, and Bridges” historical cost indices were applied to adjust all unit pricing to 2020\$. Refer to Appendix E and the respective notes and assumptions indicating the rationale, chosen unit pricing for each cost component, and allocated contingency assumptions. All cost line items are assumed to include embedded allocated contingencies within each unit price, and it is not broken up at this level of assessment. Only the unallocated contingency (SCC 90) of 25% is applied separately.

At this level of concept screening, many cost items are calculated using a percentage-based approach, including SCC 30 SITEWORK & SPECIAL CONDITIONS and SCC 80 PROFESSIONAL SERVICES. Appropriate percentage ranges are applied using applicable guidance based on historically derived data for heavy rail and passenger rail projects completed in the US.³

RESULTS

The CapEx results from the Level 2A assessment show comparable costs to previous passenger rail system studies along the front range in Colorado. At a cost of \$55M to \$62M per mile (\$2020) for the full build out of a FRPR from Fort Collins to Pueblo, using conventional rail technology and including stations, the costs are reasonable.⁴ Below are a few observations to consider for the next level of analysis per CapEx category evaluated:

- **SCC 10: Guideway and Track Elements**
 - A more detailed level of engineering effort to classify the infrastructure improvements required for each alignment will provide a deeper comparison between alignments to further define guideway and track elements and identify critical infrastructure bottlenecks or opportunities. Of consideration, the opportunity for freight and RTD rail structure sharing could plan a major role in cost saving options if track sharing is viable.
 - Crossings were assumed to be at-grade for local roadways and any existing at-grade freight rail crossings. Overpasses, major viaducts, or underpasses were also quantified based on existing conditions or nearby existing rail profile.
 - This more detailed level of engineering analysis is particularly applicable to the major guideway improvement crossings identified that include tunneling, major viaducts and many smaller crossings, all assumed to be similar for this level of assessment.
- **SCC 20: Stations**
 - Unit pricing for the primary stations applied the following conservative approach for each 4 station categories defined as:
 - \$60M per **new build major station** where total daily passenger volume >15% of total boardings and alightings

³ TCRP Report 138: Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects: <http://www.trb.org/Publications/Blurbs/163381.aspx>

⁴ This is based primarily on the ICS (2014, 2017) cost results for a similar alignment; however, ICS results are based on high speed rail technology.

- \$50M per **new build moderate station** where total daily passenger volume is between 10% to 15% of total boardings and alightings
- \$40M per **new build minor station** where total daily passenger volume <10% of total boardings and alightings
- \$30M for **existing station improvements** (DUS and Denver Airport).⁵
- Each station was evaluated using the daily passenger volume results (total boardings and alightings relative to total daily system volumes) from the Level 2 Ridership results.

Table 5. Level 2A CapEx Station Classifications used for Pricing

Station	Alignment 3		Alignment 4		Alignment 6	
	Volume*	Classification	Volume*	Classification	Volume*	Classification
Fort Collins	1,145	Minor	1,098	Minor	1,145	Minor
Loveland	1,169	Minor	1,101	Minor	1,336	Moderate
Longmont / Berthoud	1,832	Moderate	763	Minor	555	Minor
Boulder / North Metro	2,717	Major	1,058	Minor	1,048	Minor
Downtown Denver / DIA	4,776	Major Upgrade	3,579	Major Upgrade	5,395	Major Upgrade
South Metro / S. Suburban	1,164	Minor	1,090	Minor	2,475	Major
Castle Rock	348	Minor	309	Minor	612	Minor
Colorado Springs	426	Minor	439	Minor	795	Minor
Pueblo	185	Minor	220	Minor	238	Minor

* Total Daily Passenger Volume = Total Boardings + Alightings from Level 2 Ridership Results

- The next level of assessment should identify station locations and characteristics and provide a refined definition each of what each station might require.
- Funding sources for stations may fall on local municipalities and counties, in addition to potential state and federal Funding sources⁶.
- **SCC 30: Support Facilities**
 - Similar to SCC 20 above, heavy and light maintenance facilities will require further definition, quantification, and more specific location considerations.
 - A heavy maintenance facility is assumed per alignment, as well as 1 light (layover) facility per segment for each alignment. The layover facilities in each segment allow for trains to be stored overnight, cleaned, and with light maintenance services to allow them to return to service the following day.
- **SCC 40: Sitework and Special Conditions.**
 - Given the nature of the level of design development, SCC 40 items have been estimated using a percentage-based approach. It is anticipated that each segment will be adjusted per segment as more information becomes available, and proper quantification can be performed for items like utility relocations, environmental mitigations, and site-specific conditions.
- **SCC 50 and SCC 70: Systems and Vehicles**
 - These two categories are dependent on the rail technology considered and procurement options for pricing with respective original equipment manufacturers (OEMs).
 - Pricing for systems has been applied to capture catch-all categories that will be refined as an alignment is defined further. This assumes wayside components only, and does not

⁵ This unit price is based on the ICS assumptions using 2013\$ adjusted to 2020\$ scaled back for each station classification shown.

⁶ Refer to the *FRPR Funding and Finance Options Memo* dated August 29, 2020 for further details on potential funding sources.

include on-board system components, assumed to be included in the locomotive procurement. It includes:

- 50.01 Wayside train controls and signaling equipment (w/PTC)
- 50.02 Traffic signals and crossing protection
- 50.03 Communications (w/Fiber Optic Backbone)
- Vehicle pricing and rolling stock has assumed pricing of a Siemens Charger diesel-electric locomotive and coaches with recent sources (refer to detailed CapEx results, Appendix E).
- **SCC 60: Right-of-Way**
 - Similar to SCC 10, a more detailed level of engineering effort is required to further classify and determine more appropriate quantification of the necessary ROW acquisition. Also warranting future consideration is leasing portions of the Class I freight railroad ROW, like agreements on the Northeast Corridor between Amtrak and the freight railroad owners.
 - This is particularly important as the interplay and potential partial sharing of public and quasi-public ROW (i.e. I-25 corridor alignment, E-470 alignment) and potential partial sharing of Class I freight and RTD rail ROW, can ultimately become differentiating characteristics of alignments that can significantly change the cost estimates and risk.
 - Unit pricing for ROW acquisition is also highly simplified, with future anticipated refined pricing that further breaks down the estimated cost of ROW acquisition into more categories and site-specific assessments. Unit pricing for Urban vs Rural⁷ areas were differentiated between the three segments (North, Central, South) for each alignment.
 - In addition, any relocation costs of businesses or residents as part of the alignments are not expressly estimated separately and are assumed to be included in the current format.
 - As a rule of thumb, it is assumed that the required ROW width for rural locations is 75-ft width, whereas urban locations is 60-ft width.
- **SCC 80: Professional Services**
 - For this level of assessment, professional services estimated costs are developed using historically based soft costs percentage ranges experienced by previous completed major public transportation fixed guideway projects.⁸
 - As more information becomes available, these percentages can be refined with known alignment characteristics by segment and alignment.
- **SCC 90: Unallocated Contingency**
 - The FRA Capital Cost Estimating guidance recommends a rule-of-thumb *total* contingency ranging between 35% to 55% to be carried for projects in the early preliminary stage of development.
 - *Allocated* contingencies are built into the unit pricing chosen for each line item described above using a standard 10% allocated contingency.
 - *Unallocated* contingency of 25% is applied to the project subtotal (SCC 81).
 - As the project advances, the range-based contingency estimate currently captured (+/- 25% from the mid-point estimate) will become more specific. It is recommended to consider a top-down program cost risk assessment in the early phases of development of the project, in order to establish a mature risk management culture that manages cost and schedule risk

⁷ Rural areas refer to those with the lowest density, few houses or structures (widely dispersed or no residential, commercial and industrial uses); Urban refers to areas with high density, mixed land uses and prominent destinations.

⁸ TCRP Report 138: Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects: <http://www.trb.org/Publications/Blurbs/163381.aspx>

exposure in a sophisticated manner. Mega infrastructure projects of this scale benefit greatly from a proactive risk management approach, ultimately establishing a systematic and transparent process that avoids significant cost and schedule overruns. Delivery of large passenger rail systems is no exception to the high-risk, unpredictable nature given the long planning horizon and complex interfaces anticipated in the process.

NEXT STEPS & SCENARIO CAPEX ESTIMATING

The CapEx analysis presented up to this point in this memo is for the full build out scenario of a FRPR system from Fort Collins to Pueblo, using conventional rail technology, including all major stations, and with a dedicated double track system. This is the long-term vision for the FRPR system. The next step is to develop incremental, or phased, cost estimate scenarios to pursue near-term implementation of a FRPR system.

This analysis is based on alignment 3 because use of existing freight rail track, and use of existing freight rail infrastructure, is a requirement of the initial implementation steps we have identified. Other alignments still under consideration do not have this characteristic. Having established the Full Build Out scenario, other scenarios are then scaled using the Alignment 3 base estimate as a cost estimating framework. The table below shows the potential scenarios that are considered based on Alignment 3.

Table 6. FRPR CapEx Analysis Scenarios

Cost Analysis Criteria	Full Build Out New Dedicated Double Track	Shared Freight Track + Track Improvements + Sidings	New Dedicated Single Track on Shared ROW Corridor	Consolidated Class I Freight + Track Improvements on Remaining Single Track
	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Single / Double-Track	Double	Single	Single	Single ¹
Dedicated / Shared Track	Dedicated	Shared	Dedicated	Dedicated
ROW	Acquired ²	Sidings Acquired ²	Acquired ²	Acquired ²
Sidings	N/A	Yes ³	Yes ⁴	Yes ⁴
Alignments	3,4,6	3	3 and 4 ⁵	3 and 4 ⁵
Capacity Roundtrip Trains/Day ⁸	24+	2-6 ⁶	12-24 max	12-24 max
Crossing Structures	New structures for double track	Utilize existing structures, some replaced or improved	New structures for single track	Utilize existing structures, some replaced or improved
Runtime & Ridership Modeling	RAILSIM / CDOT Travel Demand Modeling Completed	RTC Modeling Needed	RAILSIM / CDOT Travel Demand Modeling Completed ⁷	Further Modeling Needed
CapEx Estimate Range ^{9, 10}	\$8.0 B to \$13.4B	\$1.7B to \$2.8B	\$5.6B to \$9.3B	Further information required and not estimated at this time.

1. Capacity available if FRPR owns ROW – FRPR double-track could be constructed in the future.

2. Estimates assume acquisition of necessary ROW as the base assumption of capital cost estimating, however other models could include leasing ROW/track usage which could be treated as an annual O&M cost, thereby reducing the upfront capital cost but increasing the annual O&M cost..

3. Sidings assumed to be 10,000 ft placed every 12 miles and primarily used by freight equipment so FRPR NB or SB can bypass on mainline. These siding lengths and ratios are preliminary and subject to change based on capacity requirements/ridership demand.

4. FRPR dedicated single-track sidings are assumed to be 1 mile placed every 6 miles and used for NB and SB FRPR trains to bypass each other along the route. These siding lengths and ratios are preliminary and subject to change based on capacity requirements/ridership demand.

5. Alignment 4 North Segment from North Metro to Longmont would be excluded from any shared freight corridor cost considerations.

6. 6 northbound and 2 southbound roundtrips assumed for preliminary service plan while sharing track. RTC modeling required to find capacity limits with this scenario. A range of trains/day and service plans should be evaluated further in addition to the siding ratio, which dictates capacity. Additional capacity could be possible depending on more detailed operational analysis and physical layout of sidings.

7. Full Buildout runtimes can be recycled for this scenario.

8. Based on operational capacity estimates from the Association of American Railroads, National Rail Freight Infrastructure Capacity and Investment Study.

9. Refer to Appendix B for breakdown of each individual Scenario and Alignment CapEx Estimate.

10. Rough order of magnitude capital cost estimate does not include costs of operating on existing freight rail corridor, such as operating lease payments over time which could be structured in various ways such as an annual O&M cost.

Methodology of Scenario Cost Estimating

Scenario 1: This serves as the base estimate that is used to generate rough order of magnitude estimates for the other scenarios. The methodology for the Alignment 3 base cost estimate is detailed in previous sections of this report.

Scenario 2 and 3 are estimated by factoring the Scenario 1 base cost estimate, and are not estimated at the same level of rigor in quantifying various aspects of the physical project definition. A more detailed estimate can be accomplished by developing more specific conceptual design for the phasing scenarios that would allow quantities to be derived specific to each scenario.

Cost Results Range
2020\$ Total CapEx Cost

Scenario 1 Base Estimate: Alignment 3	
Low	High
\$8.0 B	\$13.4 B

Scenario 2: This scenario involves an assumed construction of track improvements and sidings along the existing freight rail corridor in a shared track operating system, except as noted below. To accommodate longer freight trains using the sidings, 10,000 LF of siding is assumed at a spacing of every 12 miles. Scenario 1 as the base reference, estimated a new dedicated double track system, therefore Scenario 2 significantly factors down the amount of track work and infrastructure necessary to reflect only adding new construction of sidings along the existing corridor. This reduction is taken in both Category 10 and 60 FRA Standard Cost Categories (SCC). Since the consolidated mainline from DUS south to C470 is very high freight traffic, it is assumed that FRPR will need to build new dedicated single track in this section. Also, the Scenario 1 route miles were factored to an alignment mirroring the existing freight rail corridor. Tunnel and Major Viaduct segments from Scenario 1 were eliminated and replaced with a proportional ratio of at-grade, overpass, and underpass segments that may occur where sidings are introduced or upgrades to the existing freight corridor are needed. Category 50 was factored to assume Positive Train Control and Communication already exists on the south segment of the freight rail corridor. Other elements such as stations and maintenance facilities were held consistent, while reducing the number of passenger rail vehicles for the lower number of trains per day assumed in this Scenario 2. This methodology results in a rough order of magnitude of cost, and would require more scenario specific design, operational analysis, and coordination with the freight railroad.

CapEx Results Range
2020\$ Total Project Cost

Scenario 2: Alignment 3	
Low	High
\$1.7 B	\$2.8 B

Scenario 3: This scenario involves an assumed construction of a new single track and sidings along the existing freight rail corridor. The length of sidings are shorter at one mile of siding length spaced at every six miles. This length and spacing of sidings is assumed to be used by the passenger rail vehicles only, and accommodates the higher trains per day that are assumed for this Scenario. Scenario 1 as the base reference, estimated a new dedicated double track system, therefore Scenario 3 significantly factors down the amount of track work and infrastructure necessary to reflect only adding a new singletrack and sidings along the existing corridor. This reduction is taken in both Category 10 and 60 FRA Standard Cost Categories (SCC). Scenario 3

route miles are the same as Scenario 1. Category 50 was factored to assume Positive Train Control and Communication upgrades along the entire length of new single track. Other elements such as stations and maintenance facilities were held consistent. The number of passenger rail vehicles was assumed to be equal to Scenario 1. This methodology results in a rough order of magnitude of cost, and would require more scenario specific design, operational analysis, and coordination with the freight railroad.

CapEx Results Range
2020\$ Total Project Cost

Scenario 3: Alignment 3	
Low	High
\$5.6 B	\$9.3 B

Scenario 4: Estimating this scenario would require more information on potential freight rail realignments from Fort Collins to Pueblo. Assuming FRPR purchased/leased BNSF right-of-way from Fort Collins to DUS, to be used exclusively for FRPR, the BNSF would need to shift their operation to another corridor starting either in Fort Collins or Cheyenne (see Figure 3 below). The preferred route and length of new track and right-of-way for the BNSF is an unknown, and thus, this report does not provide an estimate of cost.

Because the consolidated mainline from DUS south to C470 is very high traffic, it is assumed that FRPR would need to build new dedicated single track in this section. For the Central and South Segments, BNSF and UP tracks run roughly parallel. Assuming FRPR assumes exclusive operation on one of the existing freight tracks from C-470 to Pueblo, the estimate would need to capture the cost of exclusive access to the existing freight track plus a newly constructed single track and consolidated freight alignment and right-of-way from C-470 to Pueblo. Cost of sidings for the single track passenger rail would also need to be included to accommodate the operating plan and number of round trip trains per day for the Scenario.

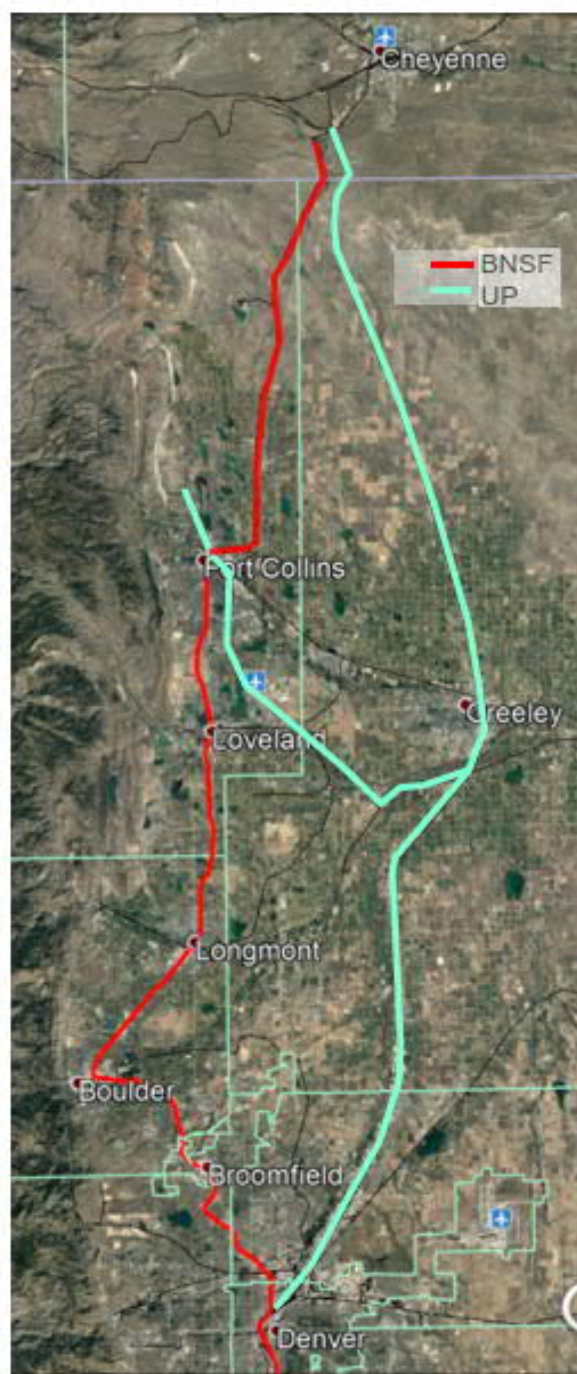


Figure 3. BNSF and UP tracks from Cheyenne to Denver

OPEX ESTIMATE

METHODOLOGY

In order to determine conceptual operating and maintenance (O&M) cost estimates, the O&M expenses of 12 Amtrak services were researched. These Amtrak operated services included state-sponsored corridor trains having more than one round trip per day.

Annual O&M expenses for the researched corridor trains were taken from Amtrak's September 2018 Monthly Performance Report, which includes annual totals. (Amtrak's fiscal year begins on October 1 and ends on September 30). Amtrak O&M expenses include the recurring expenses for revenue service: labor, fuel and electrical power, consumables, insurance, marketing and other general and administrative services, but exclude some non-cash items like depreciation and income tax expenses. For some trains, they include the lease of equipment, if a state leases locomotives and railcars from Amtrak. They would exclude payments to a host railroads if these are paid outside of Amtrak, that is, directly by one state to a host railroad. The reimbursable Amtrak O&M expenses are subject of negotiations between Amtrak and the individual states that contract with Amtrak for passenger train service.

The O&M expenses for each service were then divided by each service's annual revenue train miles. A train mile is one train traveling one mile. One train traveling a route of 100 miles and returning the same day generates 200 train miles per day. If the train is a daily train, it generates 73,000 train miles per year. Annual train miles for the corridor trains were calculated from the 2018 Amtrak System Timetable (updated in January and again in June of that year; 2018 was the last year that Amtrak published a System Timetable with the schedules of all trains appearing in one document).

The resulting cost per train mile for the 12 researched Amtrak services were then averaged to identify an overall cost per train mile factor, as shown in **Table 7**. One service, the Keystone Service, is electric powered. The remaining 11 services are diesel powered.

Because Amtrak O&M expenses vary per service, the resulting costs per train mile shown in the table below also vary. Some factors to consider: the O&M expenses for the Keystone Service are lower than average in part because of a large percentage of its train miles are generated on Amtrak's Northeast Corridor (NEC) between Philadelphia and New York, and thereby benefit from lower maintenance-of-way (MOW) expenses (the NEC hosts many other trains in addition to the Keystone trains, and thus maintenance costs per train are diluted). Also, the state of Illinois pays MOW costs for the Lincoln Service directly to the host railroad, Union Pacific Railroad, rather than through Amtrak; accordingly, its O&M expense payments to Amtrak do not include maintenance payments to UP (consequently, its total O&M cost is higher than shown). The state of California leases equipment for the Pacific Surfliner from Amtrak, while it runs its own equipment on the Capitol Corridor and San Joaquins services, which consequently have lower costs per train mile.

Table 7. Amtrak O&M Expenses for Selected State-sponsored Corridor Services in 2018

State-sponsored Corridor Service	2018 O&M Cost in \$Millions	2018 Train miles in Millions	O&M Cost per Train Mile
Keystone	\$55.9	1.47	\$38.07
San Joaquins	\$95.1	1.54	\$61.57
Capitol Corridor	\$70.4	1.16	\$60.94
Pacific Surfliner	\$128.9	1.69	\$76.05
Hiawatha	\$21.7	0.43	\$50.40
Cascades	\$68.5	0.96	\$71.55
Lincoln	\$32.3	0.83	\$38.95
Downeaster	\$17.3	0.48	\$35.79
Empire	\$65.2	2.07	\$31.49
Piedmont	\$7.2	0.38	\$19.00
River Runner	\$14.3	0.41	\$34.61
Wolverine	\$32.0	0.67	\$48.07
Average Cost			\$47.21

RESULTS

Escalating the average cost per train mile to 2020 dollars results in a \$50.28 per train mile factor. This factor was then multiplied by the annual train miles for each of the three FRPR alignments to estimate conceptual O&M costs, as shown in **Table 8**. This estimate reflects the mid-point estimate for annual O&M costs. Like the CapEx cost ranging approach, a +/- 25% range from the mid-point estimate is provided.

Table 8. Annual O&M Cost Estimates for FRPR Alignments

FRPR Alignments	Route Miles	Annual Train Miles in Millions	Cost per Train Mile Factor	Annual O&M Cost Range (\$2020M)		
				Low	Mid-Point	High
Alignment 3	190.6	3.10	\$50.28	\$124.8	\$155.9	\$187.1
Alignment 4	183.6	2.99	\$50.28	\$120.2	\$150.2	\$180.3
Alignment 6	191.9	3.11	\$50.28	\$125.1	\$156.3	\$187.6

As the alignments become more refined, assumptions can be made about detailed operating plans, crewing, support staff (maintenance of way and maintenance of equipment), administrative staffing, fuel or power, operators, and governance. With these identified, more detailed O&M costing can begin.

Unit costs can be applied to do a cost build-up for each alignment. For example, salaries and estimated overhead for train crews and organizational staffing, costs for diesel fuel or electrical power for locomotives, insurance, marketing, and legal costs, etc., will be calculated. The result will be a refined estimated annual O&M cost per each alignment, with itemization of specific cost components.

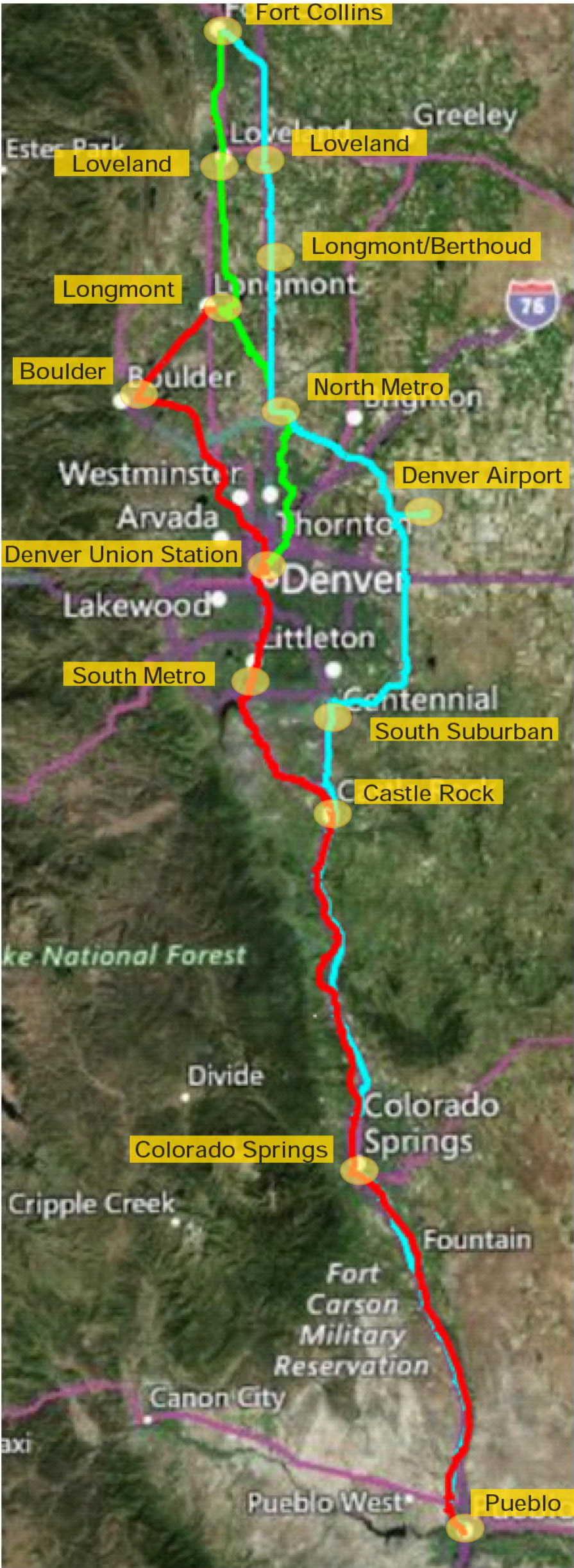
NEXT STEPS & SCENARIO O&M ESTIMATING

This report does not estimate O&M for Scenarios. In order to determine conceptual operating and maintenance (O&M) cost estimates for the Scenario 2, 3, and 4, various considerations would need to be explored in more detail including defined operating plan, number of round trip trains per day, and other ongoing yearly costs specific to the Scenario. For example, the costs of operating on freight railroad tracks or ROW could be operating lease payments over time which could be structured in various ways such as an annual O&M cost.

MEMORANDUM

APPENDICES

APPENDIX A – LEVEL 2A ALIGNMENTS MAP

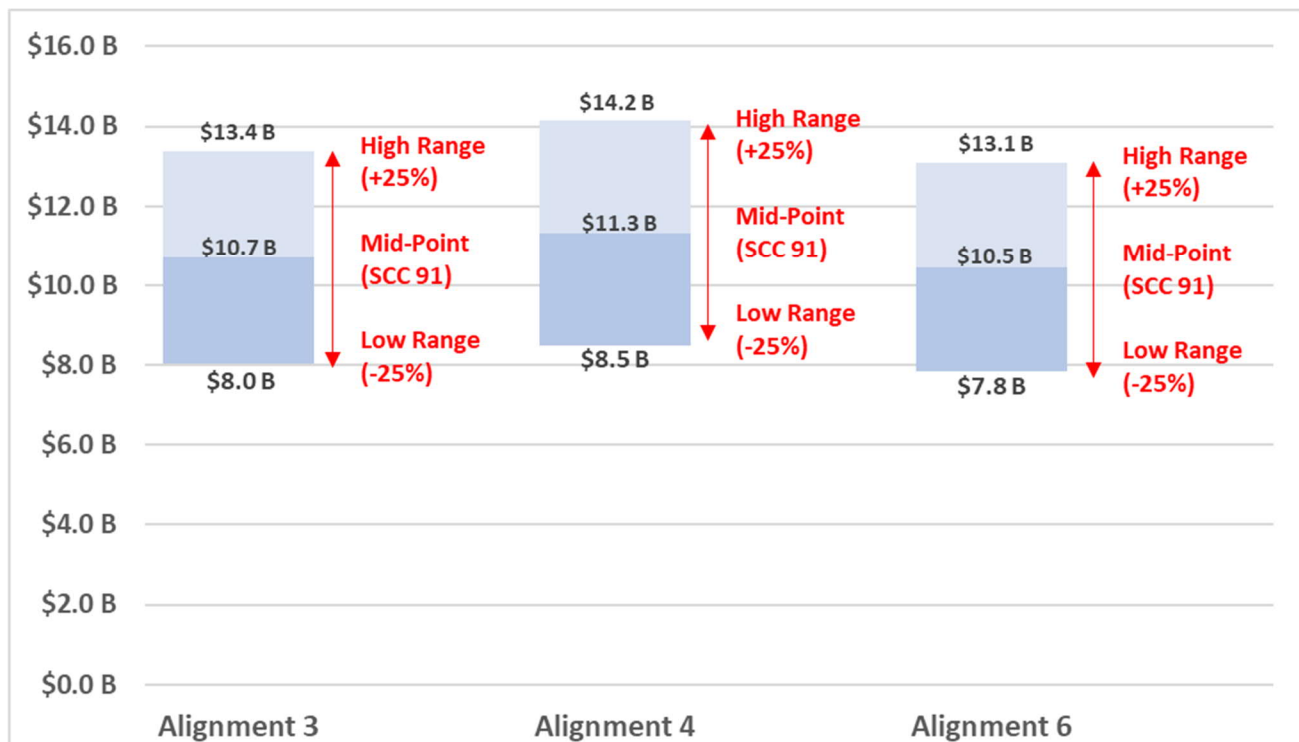


MEMORANDUM

APPENDIX B – CAPEX RESULTS

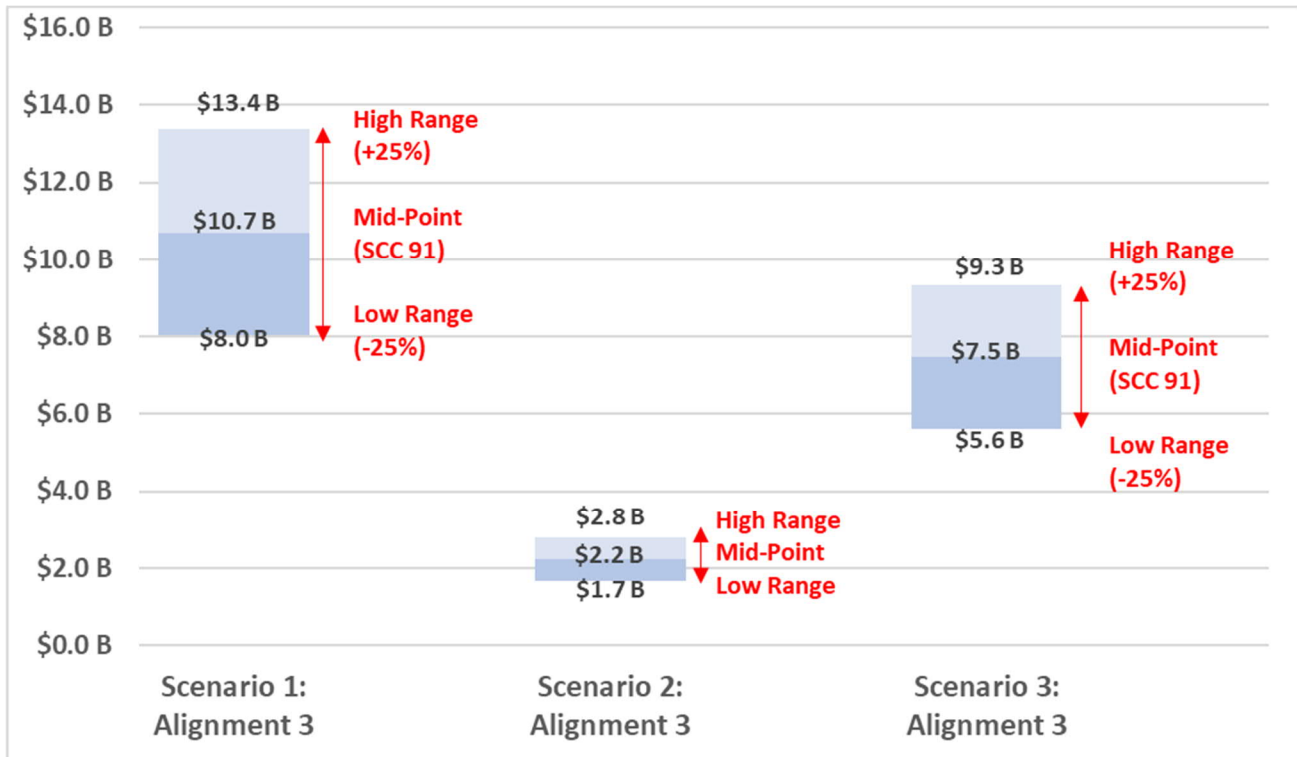
CapEx Results - Alignments Comparison - SCENARIO 1

FRA SCC	Description	Alignment 3		Alignment 4		Alignment 6	
		Total Cost	% of Total Project Cost	Total Cost	% of Total Project Cost	Total Cost	% of Total Project Cost
10	GUIDEWAY & TRACK ELEMENTS	\$3,745 M	35%	\$4,078 M	36%	\$3,623 M	35%
20	STATIONS	\$390 M	4%	\$350 M	3%	\$380 M	4%
30	SUPPORT FACILITIES	\$260 M	2%	\$260 M	2%	\$260 M	2%
40	SITework & SPECIAL CONDITIONS	\$657 M	6%	\$701 M	6%	\$637 M	6%
50	SYSTEMS	\$348 M	3%	\$332 M	3%	\$307 M	3%
51	Construction Subtotal (10 - 50)	\$5,401 M	50%	\$5,721 M	51%	\$5,207 M	50%
60	ROW, LAND, EXISTING IMPROVEMENTS	\$939 M	9%	\$1,007 M	9%	\$1,001 M	10%
70	VEHICLES	\$498 M	5%	\$498 M	4%	\$498 M	5%
80	PROFESSIONAL SERVICES	\$1,728 M	16%	\$1,831 M	16%	\$1,666 M	16%
81	Subtotal (10 - 80)	\$8,566 M	80%	\$9,056 M	80%	\$8,372 M	80%
90	UNALLOCATED CONTINGENCY	\$2,141 M	20%	\$2,264 M	20%	\$2,093 M	20%
91	2020\$ Total Project Cost (10 - 90)	\$10,707 M	100%	\$11,320 M	100%	\$10,465 M	100%
Total CapEx Results Range 2020\$ Total Project Cost		Low \$8.0 B	High \$13.4 B	Low \$8.5 B	High \$14.2 B	Low \$7.8 B	High \$13.1 B



CapEx Results - Scenario Comparison

FRA SCC	Description	SCENARIO 1		SCENARIO 2		SCENARIO 3	
		Alignment 3		Alignment 3		Alignment 3	
		Total Cost	% of Total Project Cost	Total Cost	% of Total Project Cost	Total Cost	% of Total Project Cost
10	GUIDEWAY & TRACK ELEMENTS	\$3,745 M	33%	\$252 M	10%	\$2,369 M	31%
20	STATIONS	\$390 M	3%	\$390 M	16%	\$390 M	5%
30	SUPPORT FACILITIES	\$260 M	2%	\$260 M	11%	\$260 M	3%
40	SITWORK & SPECIAL CONDITIONS	\$657 M	6%	\$135 M	6%	\$451 M	6%
50	SYSTEMS	\$348 M	6%	\$102 M	9%	\$174 M	4%
51	Construction Subtotal (10 - 50)	\$5,401 M	51%	\$1,140 M	52%	\$3,645 M	49%
60	ROW, LAND, EXISTING IMPROVEMENTS	\$939 M	8%	\$58 M	2%	\$670 M	9%
70	VEHICLES	\$498 M	4%	\$221 M	9%	\$498 M	6%
80	PROFESSIONAL SERVICES	\$1,728 M	16%	\$365 M	17%	\$1,166 M	16%
81	Subtotal (10 - 80)	\$8,566 M	80%	\$1,783 M	80%	\$5,978 M	80%
90	UNALLOCATED CONTINGENCY	\$2,141 M	20%	\$446 M	20%	\$1,495 M	20%
91	2020\$ Total Project Cost (10 - 90)	\$10,707 M	100%	\$2,229 M	100%	\$7,473 M	100%
Total CapEx Results Range 2020\$ Total Project Cost		Low \$8.0 B	High \$13.4 B	Low \$1.7 B	High \$2.8 B	Low \$5.6 B	High \$9.3 B



APPENDIX C – TRAINSET CALCULATIONS

Alignment 3 Level 2A Trainset Calculations Table:

Alternative 3 Weekday AM Peak Trainset Calculations						
# of Trainsets		From	Depart at	To	Arrive at	Notes
1	Train 100 (NB)	Pueblo	6:00	DUS	7:35	+8 min turnaround time before ready for next departure (engineer moves to cab coach / locomotive vice versa)
2	Train 101 (NB)	DUS	6:00	Ft Collins	7:09	See above.
3	Train 102 (SB)	Ft Collins	6:00	DUS	7:09	See above.
4	Train 103 (SB)	DUS	6:00	Pueblo	7:34	See above.
5	Train 104 (NB)	Pueblo	6:30	DUS	8:05	See above.
6	Train 105 (NB)	DUS	6:30	Ft Collins	7:39	See above.
7	Train 106 (SB)	Ft Collins	6:30	DUS	7:39	See above.
8	Train 107 (SB)	DUS	6:30	Pueblo	8:04	See above.
9	Train 108 (NB)	Pueblo	7:00	DUS	8:35	See above.
10	Train 109 (NB)	DUS	7:00	Ft Collins	8:09	See above.
11	Train 110 (SB)	Ft Collins	7:00	DUS	8:09	See above.
12	Train 111 (SB)	DUS	7:00	Pueblo	8:34	See above.
13	Train 112 (NB)	Pueblo	7:30	DUS	9:05	See above.
14	Train 113 (NB)	DUS	7:30	Ft Collins	8:39	See above.
-	Train 101 (SB)	Ft Collins	7:30	DUS	8:39	See above.
-	Train 102 (SB)	DUS	7:30	Pueblo	9:04	See above.
-	Train 103 (NB)	Pueblo	8:00	DUS	9:35	See above.
-	Train 100 (NB)	DUS	8:00	Ft Collins	9:09	See above.
-	Train 105 (SB)	Ft Collins	8:00	DUS	9:09	See above.
-	Train 106 (SB)	DUS	8:00	Pueblo	9:34	See above.
-	Train 107 (NB)	Pueblo	8:30	DUS	10:05	See above.
-	Train 104 (NB)	DUS	8:30	Ft Collins	9:39	See above.
-	Train 109 (SB)	Ft Collins	8:30	DUS	9:39	See above.
-	Train 110 (SB)	DUS	8:30	Pueblo	10:04	See above.
-	Train 111 (NB)	Pueblo	9:00	DUS	10:35	See above.
-	Train 108 (NB)	DUS	9:00	Ft Collins	10:09	See above.
-	Train 113 (SB)	Ft Collins	9:00	DUS	10:09	See above.
15	Train 114 (SB)	DUS	9:00	Pueblo	10:34	See above.
15 Peak Trainsets + 20% Spares = 18 Total Trainsets						

Alignment 4 Level 2A Trainset Calculations Table:

Alternative 4 Weekday AM Peak Trainset Calculations						
# of Trainsets		From	Depart at	To	Arrive at	Notes
1	Train 100 (NB)	Pueblo	6:00	DUS	7:35	+8 min turnaround time before ready for next departure (engineer moves to cab coach / locomotive vice versa)
2	Train 101 (NB)	DUS	6:00	Ft Collins	7:07	See above.
3	Train 102 (SB)	Ft Collins	6:00	DUS	7:05	See above.
4	Train 103 (SB)	DUS	6:00	Pueblo	7:34	See above.
5	Train 104 (NB)	Pueblo	6:30	DUS	8:05	See above.
6	Train 105 (NB)	DUS	6:30	Ft Collins	7:37	See above.
7	Train 106 (SB)	Ft Collins	6:30	DUS	7:35	See above.
8	Train 107 (SB)	DUS	6:30	Pueblo	8:04	See above.
9	Train 108 (NB)	Pueblo	7:00	DUS	8:35	See above.
10	Train 109 (NB)	DUS	7:00	Ft Collins	8:07	See above.
11	Train 110 (SB)	Ft Collins	7:00	DUS	8:05	See above.
12	Train 111 (SB)	DUS	7:00	Pueblo	8:34	See above.
13	Train 112 (NB)	Pueblo	7:30	DUS	9:05	See above.
14	Train 113 (NB)	DUS	7:30	Ft Collins	8:37	See above.
-	Train 101 (SB)	Ft Collins	7:30	DUS	8:35	See above.
-	Train 102 (SB)	DUS	7:30	Pueblo	9:04	See above.
-	Train 103 (NB)	Pueblo	8:00	DUS	9:35	See above.
-	Train 100 (NB)	DUS	8:00	Ft Collins	9:07	See above.
-	Train 105 (SB)	Ft Collins	8:00	DUS	9:05	See above.
-	Train 106 (SB)	DUS	8:00	Pueblo	9:34	See above.
-	Train 107 (NB)	Pueblo	8:30	DUS	10:05	See above.
-	Train 104 (NB)	DUS	8:30	Ft Collins	10:37	See above.
-	Train 109 (SB)	Ft Collins	8:30	DUS	10:35	See above.
-	Train 110 (SB)	DUS	8:30	Pueblo	10:04	See above.
-	Train 111 (NB)	Pueblo	9:00	DUS	10:35	See above.
-	Train 108 (NB)	DUS	9:00	Ft Collins	10:07	See above.
-	Train 113 (SB)	Ft Collins	9:00	DUS	10:05	See above.
15	Train 114 (SB)	DUS	9:00	Pueblo	10:34	See above.
15 Peak Trainsets + 20% Spares = 18 Total Trainsets						

Alignment 6 Level 2A Trainset Calculations Table:

Alternative 6 Weekday AM Peak Trainset Calculations						
# of Trainsets		From	Depart at	To	Arrive at	Notes
1	Train 100 (NB)	Pueblo	6:00	DEN Airport	7:30	+8 min turnaround time before ready for next departure (engineer moves to cab coach / locomotive vice versa)
2	Train 101 (NB)	DEN Airport	6:00	Ft Collins	6:53	See above.
3	Train 102 (SB)	Ft Collins	6:00	DEN Airport	6:53	See above.
4	Train 103 (SB)	DEN Airport	6:00	Pueblo	7:30	See above.
5	Train 104 (NB)	Pueblo	6:30	DEN Airport	8:00	See above.
6	Train 105 (NB)	DEN Airport	6:30	Ft Collins	7:23	See above.
7	Train 106 (SB)	Ft Collins	6:30	DEN Airport	7:23	See above.
8	Train 107 (SB)	DEN Airport	6:30	Pueblo	8:00	See above.
9	Train 108 (NB)	Pueblo	7:00	DEN Airport	8:30	See above.
10	Train 109 (NB)	DEN Airport	7:00	Ft Collins	7:53	See above.
11	Train 110 (SB)	Ft Collins	7:00	DEN Airport	7:53	See above.
12	Train 111 (SB)	DEN Airport	7:00	Pueblo	8:30	See above.
13	Train 112 (NB)	Pueblo	7:30	DEN Airport	9:00	See above.
14	Train 113 (NB)	DEN Airport	7:30	Ft Collins	8:23	See above.
-	Train 101 (SB)	Ft Collins	7:30	DEN Airport	8:23	See above.
-	Train 102 (SB)	DEN Airport	7:30	Pueblo	9:00	See above.
-	Train 103 (NB)	Pueblo	8:00	DEN Airport	9:30	See above.
-	Train 100 (NB)	DEN Airport	8:00	Ft Collins	8:53	See above.
-	Train 105 (SB)	Ft Collins	8:00	DEN Airport	8:53	See above.
-	Train 106 (SB)	DEN Airport	8:00	Pueblo	9:30	See above.
-	Train 107 (NB)	Pueblo	8:30	DEN Airport	10:00	See above.
-	Train 104 (NB)	DEN Airport	8:30	Ft Collins	9:23	See above.
-	Train 109 (SB)	Ft Collins	8:30	DEN Airport	9:23	See above.
-	Train 110 (SB)	DEN Airport	8:30	Pueblo	10:00	See above.
-	Train 111 (NB)	Pueblo	9:00	DEN Airport	10:30	See above.
-	Train 108 (NB)	DEN Airport	9:00	Ft Collins	9:53	See above.
-	Train 113 (SB)	Ft Collins	9:00	DEN Airport	9:53	See above.
15	Train 114 (SB)	DEN Airport	9:00	Pueblo	10:30	See above.
15 Peak Trainsets + 20% Spares = 18 Total Trainsets						

APPENDIX D – LEVEL 2 RIDERSHIP RESULTS

Alignment 3 Level 2 Ridership Results:

Stop (Total of both directions of travel)	Total Boardings	Total Alightings	Access Mode						Egress Mode			
			Walk	Drive	Transfer	Walk	Drive	Transfer	Walk	Transfer	Walk	Transfer
Total	6,881	6,881	2,067	2,279	2,535	30%	33%	37%	3,498	3,383	51%	49%
Fort Collins	495	650	103	81	311	21%	16%	63%	172	478	27%	73%
Loveland	677	492	83	417	177	12%	62%	26%	333	159	68%	32%
Longmont	985	847	104	650	232	11%	66%	24%	516	331	61%	39%
Boulder	1,180	1,537	463	408	308	39%	35%	26%	803	734	52%	48%
Downtown Denver(DUS)	2,359	2,417	1,261	0	1,098	53%	0%	47%	1,086	1,331	45%	55%
South Metro(Mineral)	666	498	17	391	258	3%	59%	39%	276	222	56%	44%
Castle Rock	213	135	6	206	1	3%	97%	0%	132	3	98%	2%
Colorado Springs	205	220	17	99	89	8%	48%	43%	132	88	60%	40%
Pueblo	101	84	13	28	60	13%	28%	59%	46	38	55%	45%

Alignment 4 Level 2 Ridership Results:

Stop (Total of both directions of travel)	Total Boardings	Total Alighting	Access Mode						Egress Mode			
			Walk	Drive	Transfer	Walk	Drive	Transfer	Walk	Transfer	Walk	Transfer
Total	4,828	4,828	1,278	2,079	1,470	26%	43%	30%	2,969	1,859	61%	39%
Fort Collins	493	604	85	94	314	17%	19%	64%	157	447	26%	74%
Loveland	623	478	102	385	136	16%	62%	22%	355	123	74%	26%
Longmont	382	381	0	382	0	0%	100%	0%	381	0	100%	0%
North Metro	572	485	19	553	0	3%	97%	0%	485	0	100%	0%
Downtown Denver(DUS)	1,593	1,986	1,012	0	581	64%	0%	36%	1,019	967	51%	49%
South Metro(Mineral)	648	442	26	354	268	4%	55%	41%	239	204	54%	46%
Castle Rock	187	122	5	175	7	3%	94%	4%	121	1	99%	1%
Colorado Springs	216	223	12	108	96	6%	50%	45%	156	67	70%	30%
Pueblo	114	106	17	29	68	15%	25%	60%	56	50	53%	47%

Alignment 6 Level 2 Ridership Results:

Stop (Total of both directions of travel)	Total Boarding	Total Alighting	Access Mode						Egress Mode			
			Walk	Drive	Transfer	Walk	Drive	Transfer	Walk	Transfer	Walk	Transfer
Total	6,800	6,800	2,919	2,449	1,432	43%	36%	21%	5,100	1,700	75%	25%
Fort Collins	530	616	51	269	210	10%	51%	40%	319	296	52%	48%
Loveland	678	659	49	557	72	7%	82%	11%	610	49	93%	7%
Longmont/Berthoud	299	256	0	299	0	0%	100%	0%	256	0	100%	0%
North Metro	518	529	13	505	0	3%	97%	0%	529	0	100%	0%
DIA	2,806	2,589	2,752	0	55	98%	0%	2%	2,521	68	97%	3%
SouthSuburban	1,134	1,341	0	182	952	0%	16%	84%	164	1,177	12%	88%
Castle Rock	341	271	14	327	0	4%	96%	0%	271	0	100%	0%
Colorado Springs	374	421	10	278	86	3%	74%	23%	345	76	82%	18%
Pueblo	120	118	30	32	58	25%	27%	48%	84	34	71%	29%

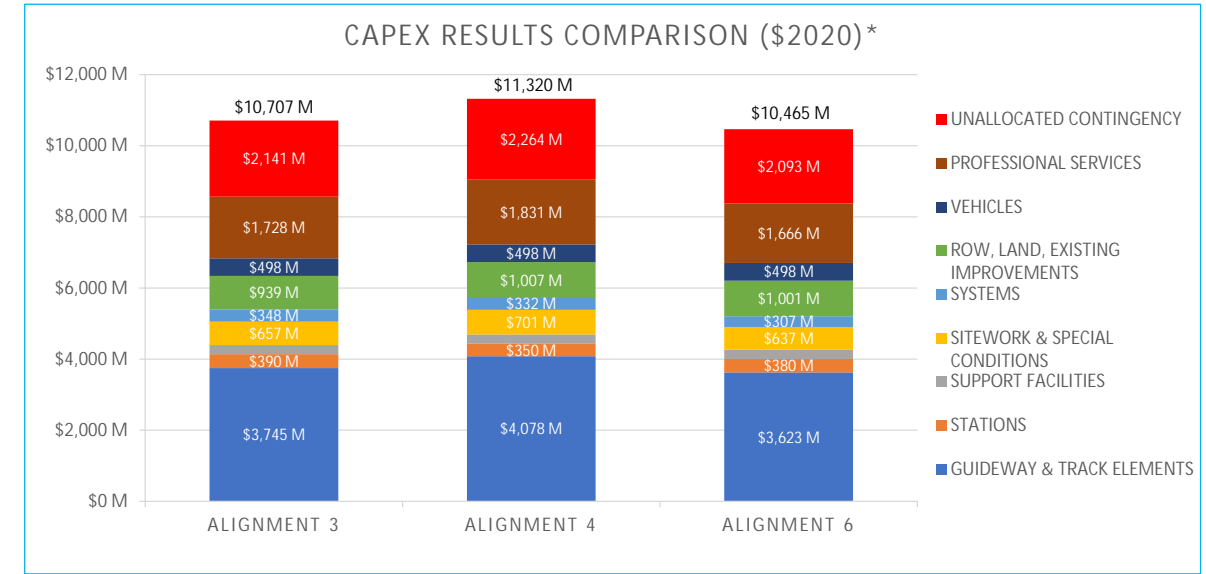
APPENDIX E – DETAILED CAPEX RESULTS

CapEx Results - Alignments Comparison - SCENARIO 1

FRA SCC	Description	Alignment 3		Alignment 4		Alignment 6	
		Total Cost	% of Total Project Cost	Total Cost	% of Total Project Cost	Total Cost	% of Total Project Cost
10	GUIDEWAY & TRACK ELEMENTS	\$3,745 M	35%	\$4,078 M	36%	\$3,623 M	35%
20	STATIONS	\$390 M	4%	\$350 M	3%	\$380 M	4%
30	SUPPORT FACILITIES	\$260 M	2%	\$260 M	2%	\$260 M	2%
40	SITEWORK & SPECIAL CONDITIONS	\$657 M	6%	\$701 M	6%	\$637 M	6%
50	SYSTEMS	\$348 M	3%	\$332 M	3%	\$307 M	3%
51	Construction Subtotal (10 - 50)	\$5,401 M	50%	\$5,721 M	51%	\$5,207 M	50%
60	ROW, LAND, EXISTING IMPROVEMENTS	\$939 M	9%	\$1,007 M	9%	\$1,001 M	10%
70	VEHICLES	\$498 M	5%	\$498 M	4%	\$498 M	5%
80	PROFESSIONAL SERVICES	\$1,728 M	16%	\$1,831 M	16%	\$1,666 M	16%
81	Subtotal (10 - 80)	\$8,566 M	80%	\$9,056 M	80%	\$8,372 M	80%
90	UNALLOCATED CONTINGENCY	\$2,141 M	20%	\$2,264 M	20%	\$2,093 M	20%
91	2020\$ Total Project Cost (10 - 90)	\$10,707 M	100%	\$11,320 M	100%	\$10,465 M	100%
Total CapEx Results Range 2020\$ Total Project Cost		Low \$8.0 B	High \$13.4 B	Low \$8.5 B	High \$14.2 B	Low \$7.8 B	High \$13.1 B

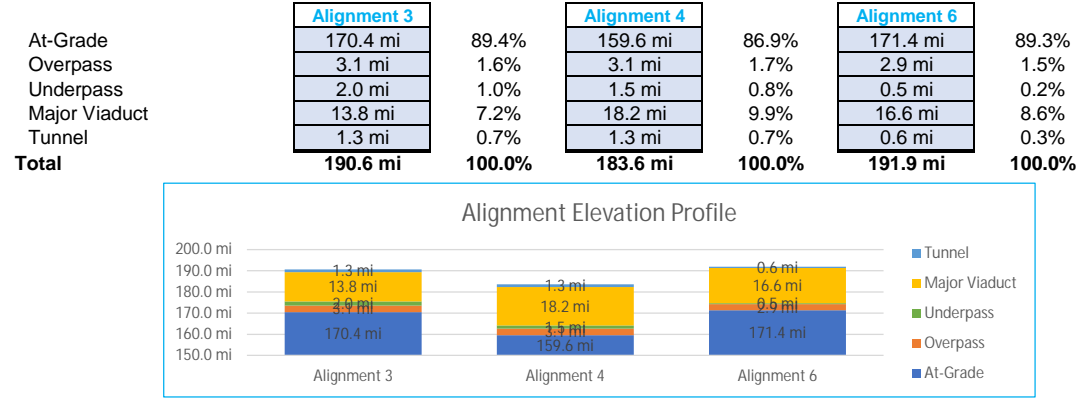
Cost / Mile Analysis:

Total Route Miles	190.6 mi	183.6 mi	191.9 mi
2020\$ Construction Cost per Mile (SCC 10 to 50)	\$28.3 M	\$31.2 M	\$27.1 M
2020\$ Total Project Cost per Mile (w/o Vehicles)	\$52.9 M	\$58.3 M	\$51.3 M
2020\$ Total Project Cost per Mile	\$56.2 M	\$61.6 M	\$54.5 M

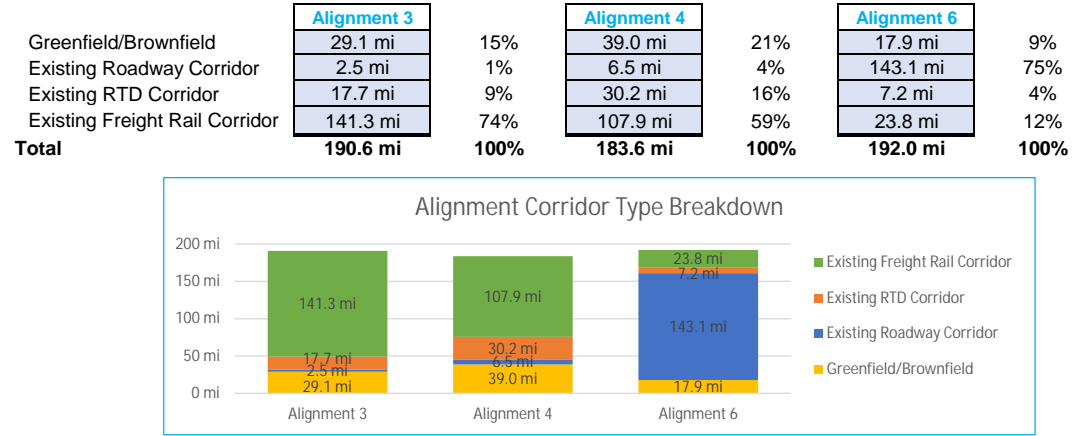


*Total Mid-point Estimates shown (SCC 91).

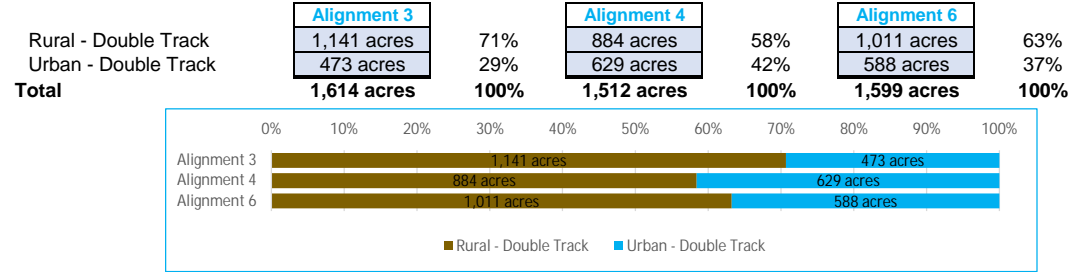
Alignment Elevation Profiles (by length)



Alignment Corridor Types Summary (by length)



ROW Classifications Summary (by Area)



Level 2 Alignments Map



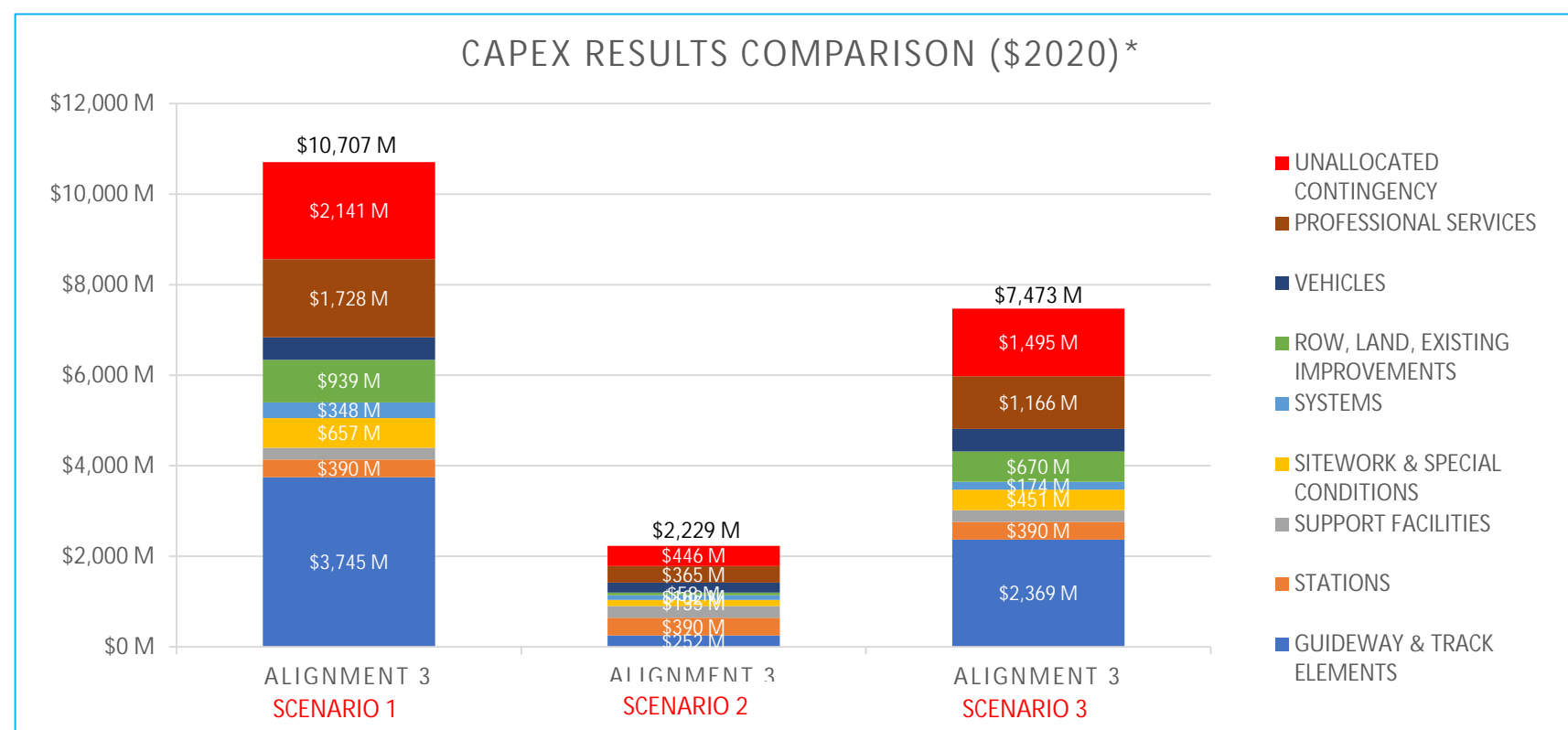
Station Location
Alignment 3 (3&4 share Central and South Segment)
Alignment 4
Alignment 6

CapEx Results - Scenario Comparison

FRA SCC	Description	SCENARIO 1		SCENARIO 2		SCENARIO 3	
		Alignment 3		Alignment 3		Alignment 3	
		Total Cost	% of Total Project Cost	Total Cost	% of Total Project Cost	Total Cost	% of Total Project Cost
10	GUIDEWAY & TRACK ELEMENTS	\$3,745 M	33%	\$252 M	10%	\$2,369 M	31%
20	STATIONS	\$390 M	3%	\$390 M	16%	\$390 M	5%
30	SUPPORT FACILITIES	\$260 M	2%	\$260 M	11%	\$260 M	3%
40	SITework & SPECIAL CONDITIONS	\$657 M	6%	\$135 M	6%	\$451 M	6%
50	SYSTEMS	\$348 M	6%	\$102 M	9%	\$174 M	4%
51	Construction Subtotal (10 - 50)	\$5,401 M	51%	\$1,140 M	52%	\$3,645 M	49%
60	ROW, LAND, EXISTING IMPROVEMENTS	\$939 M	8%	\$58 M	2%	\$670 M	9%
70	VEHICLES	\$498 M	4%	\$221 M	9%	\$498 M	6%
80	PROFESSIONAL SERVICES	\$1,728 M	16%	\$365 M	17%	\$1,166 M	16%
81	Subtotal (10 - 80)	\$8,566 M	80%	\$1,783 M	80%	\$5,978 M	80%
90	UNALLOCATED CONTINGENCY	\$2,141 M	20%	\$446 M	20%	\$1,495 M	20%
91	2020\$ Total Project Cost (10 - 90)	\$10,707 M	100%	\$2,229 M	100%	\$7,473 M	100%
Total CapEx Results Range 2020\$ Total Project Cost		Low \$8.0 B	High \$13.4 B	Low \$1.7 B	High \$2.8 B	Low \$5.6 B	High \$9.3 B

Cost / Mile Analysis:

Total Route Miles	190.6 mi	190.1 mi	190.6 mi
2020\$ Construction Cost per Mile (SCC 10 to 50)	\$28.3 M	\$6.0 M	\$19.1 M
2020\$ Total Project Cost per Mile (w/o Vehicles)	\$52.9 M	\$10.3 M	\$35.9 M
2020\$ Total Project Cost per Mile	\$56.2 M	\$11.7 M	\$39.2 M



*Total Mid-point Estimates shown (SCC 91).

Alignment 3 Map (Scenario 2 & 3 assumed to follow the same alignment)



North	Central	South	Total
Fort Collins Station to Downtown Denver Station	Downtown Denver Station to Castle Rock Station	Castle Rock Station to Pueblo Station	Fort Collins Station to Pueblo Station
71.4	32.6	86.6	190.6

FRA SCC	Description	Unit	Unit Cost (2020\$)	Quantity	Total Segment Cost	Quantity	Total Segment Cost	Quantity	Total Segment Cost	Quantity	Total Cost	% of Const. Cost	% of Total Project Cost	Notes & Assumptions
10	GUIDEWAY & TRACK ELEMENTS			71.4	\$917,929,000	32.6	\$617,204,000	86.6	\$2,210,336,000	190.6	\$3,745,469,000	69%	35%	Unit prices escalated to 2020\$ from CHSRA (2010) and MWRRI (2010)Unit Pricing catalogs, also presented in ICS Appendix (2014). All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
10.01	At-Grade	Route Mile	\$5,000,000	68.5	\$342,700,000	28.9	\$144,500,000	73.0	\$365,000,000	170.4	\$852,200,000			Unit Price Assumption: Cut and Fill Track Structure (> 4' height/depth), \$5M/mi (high conservative range)
10.02	Overpass	Route Mile	\$100,000,000	0.8	\$76,000,000	1.1	\$112,000,000	1.2	\$124,000,000	3.1	\$312,000,000			Unit Price Assumption: Overpass (Railway, Roadway, Stream/River) Average (Double Track) Cost / Mile
10.03	Underpass	Route Mile	\$69,700,000	0.8	\$53,669,000	0.7	\$50,184,000	0.5	\$33,456,000	2.0	\$137,309,000			Unit Price Assumption: Underpass (Roadway / Railroad) Average (Double Track) Cost / Mile
10.04	Major Viaduct	Route Mile	\$84,000,000	1.3	\$110,040,000	1.9	\$157,080,000	10.6	\$890,400,000	13.8	\$1,157,520,000			Double Track on Flyover/Elevated Structure
10.05	Tunnel	Route Mile	\$300,000,000	0.0	\$0	0.0	\$0	1.3	\$390,000,000	1.3	\$390,000,000			TBM Double Track, 40 to 50ft ID in soft ground
10.06	Minor Stream Crossing	Each	\$1,000,000	50.0	\$50,000,000	23.0	\$23,000,000	61.0	\$61,000,000	134.0	\$134,000,000			Total Stream Crossings identified minus Major Stream Crossings count. Unit price ~ \$1M each.
10.07	Track: Ballasted	Route Mile	\$4,000,000	71.4	\$285,520,000	32.6	\$130,440,000	86.6	\$346,480,000	190.6	\$762,440,000			Assumed Track New Construction throughout: Conventional Ballasted 2 Track unit cost.
20	STATIONS			4.0	\$190,000,000	2.0	\$80,000,000	3.0	\$120,000,000	9.0	\$390,000,000	7%	4%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
20.01	Fort Collins	Stations	\$40,000,000	1.0	\$40,000,000		\$0		\$0	1.0	\$40,000,000			Assumed to be a primary minor station cost of \$40M. The unit cost for this item includes the station building and platform, drainage, grading, lighting, landscaping, signage, security, site furnishings, 2,000 space parking facility, vehicle access and circulation, bicycle facilities, and access to other modes of public transit. It assumes a 20 acres of ROW acquisition.
20.02	Loveland	Stations	\$40,000,000	1.0	\$40,000,000		\$0		\$0	1.0	\$40,000,000			Primary minor station , see above.
20.03	Longmont	Stations	\$50,000,000	1.0	\$50,000,000		\$0		\$0	1.0	\$50,000,000			Assumed to be a primary moderate station cost of \$50M. Same characteristics as described above. 20 acres ROW acquisition required.
20.04	Boulder	Stations	\$60,000,000	1.0	\$60,000,000		\$0		\$0	1.0	\$60,000,000			Assumed to be a primary major station cost of \$60M. Same characteristics as described above. 25 acres ROW acquisition required.
20.05	Downtown Denver	Stations	\$30,000,000		\$0	1.0	\$30,000,000		\$0	1.0	\$30,000,000			Assumed to be a primary major upgrade station at a cost of \$30M for upgrades needed to the existing platforms, drainage, grading, lighting, landscaping, signage, security, site furnishings, bicycle facilities, and access to other modes of public transit.
20.06	South Metro	Stations	\$50,000,000		\$0	1.0	\$50,000,000		\$0	1.0	\$50,000,000			Assumed to be a primary moderate station , see above.
20.07	Castle Rock	Stations	\$40,000,000		\$0		\$0	1.0	\$40,000,000	1.0	\$40,000,000			Primary minor station , see above.
20.08	Colorado Springs	Stations	\$40,000,000		\$0		\$0	1.0	\$40,000,000	1.0	\$40,000,000			Primary minor station , see above.
20.09	Pueblo	Stations	\$40,000,000		\$0		\$0	1.0	\$40,000,000	1.0	\$40,000,000			Primary minor station , see above.
30	SUPPORT FACILITIES			1.0	\$20,000,000	2.0	\$220,000,000	1.0	\$20,000,000	4.0	\$260,000,000	5%	2%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
30.02	Light Maintenance Facility (Layover)	Each	\$20,000,000	1.0	\$20,000,000	1.0	\$20,000,000	1.0	\$20,000,000	3.0	\$60,000,000			Assume one LMF at each segment, a 5 acres site required, no specific location assigned yet.
30.03	Heavy Maintenance Facility	Each	\$200,000,000		\$0	1.0	\$200,000,000		\$0	1.0	\$200,000,000			Assumes one HMF located in central segment, a 40 acres site required, considered location at Burnham Yards.
40	SITEWORK & SPECIAL CONDITIONS	% of SCC (10+20+30)	15.0%		\$168,625,386		\$137,121,998		\$351,375,232		\$657,122,616	12%	6%	A per segment evaluation of SCC 40 should be adjusted given known elevation and ROW profile characteristics; however, for Level 2A assessment a % based approach has been implemented.
40.01	Demolition, Clearing, Earthwork		2.0%		\$22,558,580		\$18,344,080		\$47,006,720		\$87,909,380			See above.
40.02	Site Utilities, Utility Relocation		6.0%		\$67,675,740		\$55,032,240		\$141,020,160		\$263,728,140			See above.
40.03	Haz. mat'l, contam'd soil removal/mitigation, ground water treatments		0.7%		\$7,895,503		\$6,420,428		\$16,452,352		\$30,768,283			See above.
40.04	Environmental mitigation, e.g. wetlands, historic/archeologic, parks		0.5%		\$5,639,645		\$4,586,020		\$11,751,680		\$21,977,345			See above.
40.05	Site structures including retaining walls, sound walls		0.3%		\$2,819,823		\$2,293,010		\$5,875,840		\$10,988,673			See above.
40.06	Pedestrian / bike access and accommodation, landscaping		0.3%		\$2,819,823		\$2,293,010		\$5,875,840		\$10,988,673			See above.
40.07	Automobile, bus, van accessways including roads, parking lots		0.3%		\$2,819,823		\$2,293,010		\$5,875,840		\$10,988,673			See above.
40.08	Temporary Facilities and other indirect costs during construction		5.0%		\$56,396,450		\$45,860,200		\$117,516,800		\$219,773,450			Given magnitude of project, this has been kept at 5% (higher %). Assumed to allocate construction "indirect" costs among the construction costs in Categories 10 through 30. Where that is not possible, indirects are included here.
50	SYSTEMS				\$130,192,540		\$59,577,630		\$158,721,460		\$348,491,630	6%	3%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
50.01	Wayside train controls and signaling equipment (w/PTC)	Route Mile	\$ 850,000	71.4	\$60,673,000	32.6	\$27,718,500	86.6	\$73,627,000	190.6	\$162,018,500			Wayside train controls and signalization with PTC for new dedicated double track corridor, includes: Dispatch System Capable of Interfacing to BOS/PTC; BOS; System Command Center; and Implementation Integrator. Exclusions: Onboard Components and Mechanical TCS are assumed to be included in the locomotive procurement (70.01); Grade Crossing Warning Systems listed under 50.02; Communication Costs listed under 50.03.
50.02	Traffic signals and crossing protection	Each	\$ 750,000	61.0	\$45,750,000	28.0	\$21,000,000	75.0	\$56,250,000	164.0	\$123,000,000			Remaining number of roadway crossings from CDOT provided crossing numbers and identified major crossings. Distributed among segments in a % based approach given route lengths for Level 2A assessment.
50.03	Communications (w/Fiber Optic Backbone)	Route Mile	\$ 333,000	71.4	\$23,769,540	32.6	\$10,859,130	86.6	\$28,844,460	190.6	\$63,473,130			It is assumed that Fiber is installed for all communication needs of the corridor under this line item cost. Non-tunnel cost per mile. (Source: ICS Appendix (2014); CHSR Review of 2018 Capital Cost Estimates (May 1, 2019))
51	Construction Subtotal (10 - 50)				\$1,426,746,926		\$1,113,903,628		\$2,860,432,692		\$5,401,083,246	100%	50%	
60	ROW, LAND, EXISTING IMPROVEMENTS			592	\$364,839,552	255	\$400,989,600	767	\$172,941,120	1,614	\$938,770,272		9%	Multiply assumed cost/SF x 43,560 SF/Acre for unit cost shown. All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
60.01	Land Acquisition North Rural - Double Track (assumed 75' width)	ACRE	\$ 348,480	365	\$127,163,520		\$0		\$0	365	\$127,163,520			Assumed \$8/SF for North Rural. (Source: HDR)
60.02	Land Acquisition North Urban - Double Track (assumed 60' width)	ACRE	\$ 1,045,440	227	\$237,676,032		\$0		\$0	227	\$237,676,032			Assumed \$24/SF for North Urban. (Source: HDR)
60.03	Land Acquisition Central Rural - Double Track (assumed 75' width)	ACRE	\$ 871,200		\$0	91	\$79,516,800		\$0	91	\$79,516,800			Assumed \$20/SF for Central Rural. (Source: HDR)
60.04	Land Acquisition Central Urban - Double Track (assumed 60' width)	ACRE	\$ 1,960,200		\$0	164	\$321,472,800		\$0	164	\$321,472,800			Assumed \$45/SF for Central Urban. (Source: HDR)
60.05	Land Acquisition South Rural - Double Track (assumed 75' width)	ACRE	\$ 174,240		\$0		\$0	685	\$119,338,560	685	\$119,338,560			Assumed \$4/SF for South Rural. (Source: HDR)
60.06	Land Acquisition South Urban - Double Track (assumed 60' width)	ACRE	\$ 653,400		\$0		\$0	82	\$53,602,560	82	\$53,602,560			Assumed \$15/SF for South Urban. (Source: HDR)
70	VEHICLES (number)			36	\$165,900,000	36	\$165,900,000	36	\$165,900,000	108	\$497,700,000		5%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
70.01	Locomotive (18 Trainsets x 1 Locomotive/Trainset)	Each	\$ 6,750,000	6	\$40,500,000	6	\$40,500,000	6	\$40,500,000	18	\$121,500,000			Recently priced Siemens Charger Equipment cost for Caltrans Rolling Stock (direct source). Each trainset includes 1 Locomotive + 4 Economy Cars + 1 Coach Cab Car.
70.02	Economy Single Level Car (18 Trainsets x 4 Cars/Trainset)	Each	\$ 4,000,000	24	\$96,000,000	24	\$96,000,000	24	\$96,000,000	72	\$288,000,000			Recently priced Siemens Charger Equipment cost for Caltrans Rolling Stock (direct source). Each trainset includes 1 Locomotive + 4 Economy Cars + 1 Coach Cab Car.
70.03	Coach Cab Car (18 Trainsets x 1 Coach Cab Car/Trainset)	Each	\$ 4,900,000	6	\$29,400,000	6	\$29,400,000	6	\$29,400,000	18	\$88,200,000			Recently priced Siemens Charger Equipment cost for Caltrans Rolling Stock (direct source). Each trainset includes 1 Locomotive + 4 Economy Cars + 1 Coach Cab Car.
80	PROFESSIONAL SERVICES (applies to Cats. 10-50)		32.0%		\$456,559,016		\$356,449,161		\$915,338,461		\$1,728,346,639		16%	Approximate range %'s from TCRP Report 138 (2010) guidance.
80.01	Project Development		3.0%		\$42,802,408		\$33,417,109		\$85,812,981		\$162,032,497			
80.02	Engineering		10.0%		\$142,674,693		\$111,390,363		\$286,043,269		\$540,108,325			
80.03	Project Management for Design and Construction		4.0%		\$57,069,877		\$44,556,145		\$114,417,308		\$216,043,330			
80.04	Construction Administration & Management		10.0%		\$142,674,693		\$111,390,363		\$286,043,269		\$540,108,325			
80.05	Professional Liability and other Non-Construction Insurance		2.0%		\$28,534,939		\$22,278,073		\$57,208,654		\$108,021,665			
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.		1.0%		\$14,267,469		\$11,139,036		\$28,604,327		\$54,010,832			
80.07	Surveys, Testing, Investigation, Inspection		1.0%		\$14,267,469		\$11,139,036		\$28,604,327		\$54,010,832			
80.08	Start up		1.0%		\$14,267,469		\$11,139,036		\$28,604,327		\$54,010,832			
81	Subtotal (10 - 80)				\$2,414,045,494		\$2,037,242,389		\$4,114,612,273		\$8,565,900,156		80%	
90	UNALLOCATED CONTINGENCY	% of Subtotal (10 - 80)	25.0%		\$603,511,373		\$509,310,597		\$1,028,653,068		\$2,141,475,039		20%	Concept screening level of project definition (maturity). Recommended UNALLOCATED contingency to be kept at a minimum of 25%, ALLOCATED contingencies assumed to be included in line items above (SCC 10 to SCC 80).
91	2020\$ Total Project Cost (10 - 90)				\$3,017,556,867		\$2,546,552,986		\$5,143,265,342		\$10,707,375,195		100%	

Alingment 3 CapEx Summary - Scenario 1

		Total	
FRA SCC	Description	Total Cost	% of Total Project Cost
10	GUIDEWAY & TRACK ELEMENTS	\$3,745 M	35%
20	STATIONS	\$390 M	4%
30	SUPPORT FACILITIES	\$260 M	2%
40	SITEWORK & SPECIAL CONDITIONS	\$657 M	6%
50	SYSTEMS	\$348 M	3%
51	Construction Subtotal (10 - 50)	\$5,401 M	50%
60	ROW, LAND, EXISTING IMPROVEMENTS	\$939 M	9%
70	VEHICLES	\$498 M	5%
80	PROFESSIONAL SERVICES	\$1,728 M	16%
81	Subtotal (10 - 80)	\$8,566 M	80%
90	UNALLOCATED CONTINGENCY	\$2,141 M	20%
91	2020\$ Total Project Cost (10 - 90)	\$10,707 M	100%

Cost / Mile Analysis:

		Total
Total Route Miles		190.6 mi
2020\$ Construction Cost per Mile (SCC 10 to 50)		\$28.3 M
2020\$ Total Project Cost per Mile Not Including Vehicles		\$52.9 M
2020\$ Total Project Cost per Mile		\$56.2 M
YOE\$ Total Project Cost per Mile (Escalated Cost)		\$64.8 M

Alignment Elevation Profile Summary (by length)

At-Grade	170.4 mi	89.4%
Overpass	3.1 mi	1.6%
Underpass	2.0 mi	1.0%
Major Viaduct	13.8 mi	7.2%
Tunnel	1.3 mi	0.7%
Total	190.6 mi	100.0%

Alignment Corridor Type Summary (by length)

Greenfield or Brownfield Conditions	29.1 mi	15%
Existing Roadway Corridor	2.5 mi	1%
Existing RTD Corridor	17.7 mi	9%
Existing Freight Rail Corridor	141.3 mi	74%
Total	190.6 mi	100%

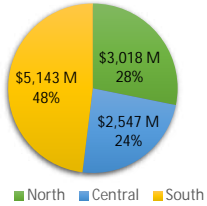
Segments:	North	Central	South
	Cost	Cost	Cost
	\$918 M	\$617 M	\$2,210 M
	\$190 M	\$80 M	\$120 M
	\$20 M	\$220 M	\$20 M
	\$169 M	\$137 M	\$351 M
	\$130 M	\$60 M	\$159 M
	\$1,427 M	\$1,114 M	\$2,860 M
	\$365 M	\$401 M	\$173 M
	\$166 M	\$166 M	\$166 M
	\$457 M	\$356 M	\$915 M
	\$2,414 M	\$2,037 M	\$4,115 M
	\$604 M	\$509 M	\$1,029 M
	\$3,018 M	\$2,547 M	\$5,143 M

Segments:	North	Central	South
	71.4 mi	32.6 mi	86.6 mi
	\$20.0 M	\$34.2 M	\$33.0 M
	\$39.4 M	\$71.7 M	\$57.0 M
	\$42.3 M	\$78.1 M	\$59.4 M
	\$48.7 M	\$90.0 M	\$68.5 M

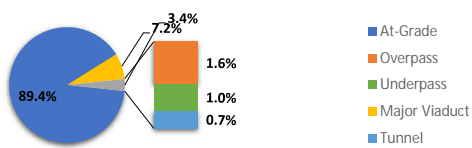
68.5 mi	28.9 mi	73.0 mi
0.8 mi	1.1 mi	1.2 mi
0.8 mi	0.7 mi	0.5 mi
1.3 mi	1.9 mi	10.6 mi
0.0 mi	0.0 mi	1.3 mi
71.4 mi	32.6 mi	86.6 mi

8.9 mi	3.5 mi	16.7 mi
0.0 mi	0.0 mi	2.5 mi
0.0 mi	17.7 mi	0.0 mi
62.5 mi	11.4 mi	67.4 mi
71.4 mi	32.6 mi	86.6 mi

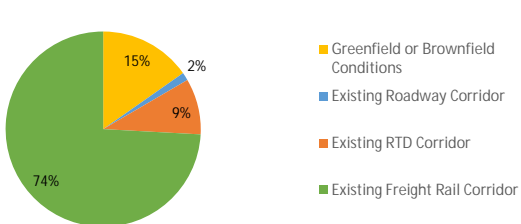
Alignment Cost Split by Segment (2020\$)



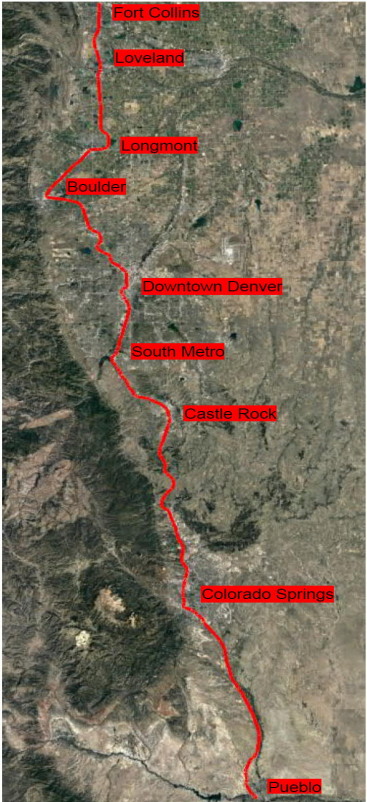
Alignment Elevation Profile (by length)



Alignment Corridor Type Breakdown (by length)



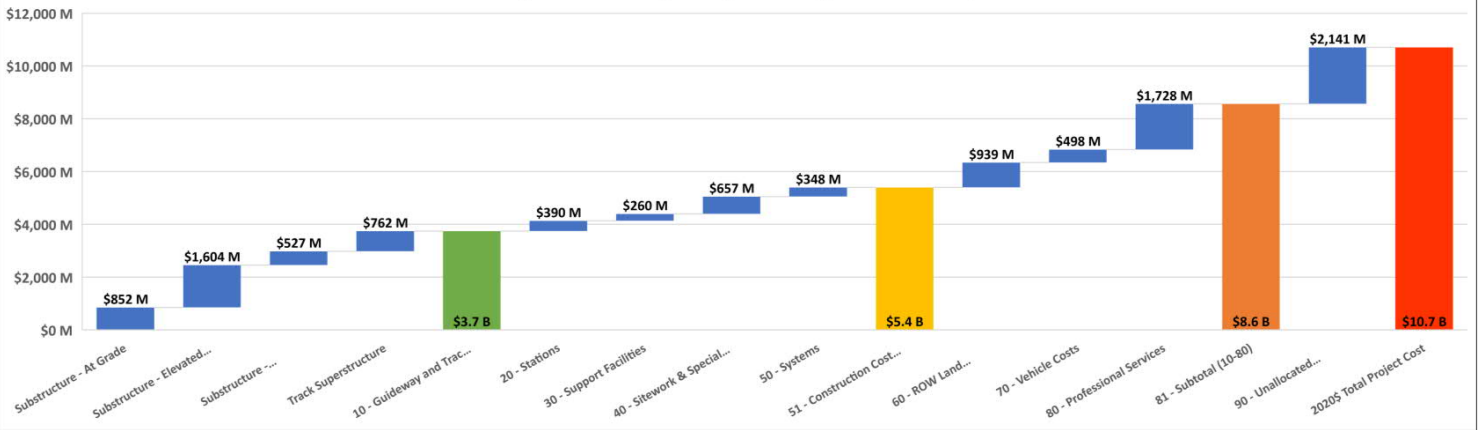
ALTERNATIVE 3 ALIGNMENT MAP



Major Categories Analysis:

Major CapEx Categories Build-Up	Cost Estimate	% of Total
Substructure - At Grade	\$852 M	8.0%
Substructure - Elevated (Overpass / Viaducts / Minor Crossings)	\$1,604 M	15.0%
Substructure - Underground (Underpass / Tunnels)	\$527 M	4.9%
Track Superstructure	\$762 M	7.1%
10 - Guideway and Track Elements	\$3,745 M	35.0%
20 - Stations	\$390 M	3.6%
30 - Support Facilities	\$260 M	2.4%
40 - Sitework & Special Conditions	\$657 M	6.1%
50 - Systems	\$348 M	3.3%
51 - Construction Cost (10-50)	\$5,401 M	50.4%
60 - ROW Land Acquisition Costs	\$939 M	8.8%
70 - Vehicle Costs	\$498 M	4.6%
80 - Professional Services	\$1,728 M	16.1%
81 - Subtotal (10-80)	\$8,566 M	80.0%
90 - Unallocated Contingency	\$2,141 M	20.0%
2020\$ Total Project Cost	\$10,707 M	100.0%

Alignment 3 Major CapEx Categories Build-Up



CapEx Model - SCENARIO 1			Segment:	North		Central		South		Total		Full Build Out Scenario 1: New Dedicated Doubletrack			
Alignment 4: Siemens Charger Diesel Electric Locomotive			From - To Length (mi)	Fort Collins Station to Downtown Denver Station 65.1		Downtown Denver Station to Castle Rock Station 31.9		Castle Rock Station to Pueblo Station 86.6		Fort Collins Station to Pueblo Station 183.6					
FRA SCC	Description	Unit	Unit Cost (2020\$)	Quantity	Total Segment Cost	Quantity	Total Segment Cost	Quantity	Total Segment Cost	Quantity	Total Cost	% of Const. Cost	% of Total Project Cost	Notes & Assumptions	
10	GUIDEWAY & TRACK ELEMENTS			65.1	\$1,253,624,000	32.6	\$614,404,000	86.6	\$2,210,336,000	184.3	\$4,078,364,000	71%	36%	Unit prices escalated to 2020\$ from CHSRA (2010) and MWRRI (2010) Unit Pricing catalogs, also presented in ICS Appendix (2014). All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.	
10.01	At-Grade	Route Mile	\$5,000,000	58.4	\$291,800,000	28.9	\$144,500,000	73.0	\$365,000,000	160.3	\$801,300,000			Unit Price Assumption: Cut and Fill Track Structure (> 4' height/depth), \$5M/mi (high conservative range)	
10.02	Overpass	Route Mile	\$100,000,000	0.7	\$74,000,000	1.1	\$112,000,000	1.2	\$124,000,000	3.1	\$310,000,000			Unit Price Assumption: Overpass (Railway, Roadway, Stream/River) Average (Double Track) Cost / Mile	
10.03	Underpass	Route Mile	\$69,700,000	0.3	\$22,304,000	0.7	\$50,184,000	0.5	\$33,456,000	1.5	\$105,944,000			Unit Price Assumption: Underpass (Roadway / Railroad) Average (Double Track) Cost / Mile	
10.04	Major Viaduct	Route Mile	\$84,000,000	5.7	\$477,120,000	1.9	\$157,080,000	10.6	\$890,400,000	18.2	\$1,524,600,000			Double Track on Flyover/Elevated Structure	
10.05	Tunnel	Route Mile	\$300,000,000	0.0	\$0	0.0	\$0	1.3	\$390,000,000	1.3	\$390,000,000			TBM Double Track, 40 to 50ft ID in soft ground	
10.06	Minor Stream Crossing	Each	\$1,000,000	128.0	\$128,000,000	23.0	\$23,000,000	61.0	\$61,000,000	212.0	\$212,000,000			Total Stream Crossings identified minus Major Stream Crossings count. Unit price ~ \$1M each.	
10.07	Track: Ballasted	Route Mile	\$4,000,000	65.1	\$260,400,000	31.9	\$127,640,000	86.6	\$346,480,000	183.6	\$734,520,000			Assumed Track New Construction throughput: Conventional Ballasted 2 Track unit cost.	
20	STATIONS			4.0	\$160,000,000	2.0	\$70,000,000	3.0	\$120,000,000	9.0	\$350,000,000	6%	3%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.	
20.01	Fort Collins	Stations	\$40,000,000	1.0	\$40,000,000		\$0		\$0	1.0	\$40,000,000			Assumed to be a primary minor station cost of \$40M. The unit cost for this item includes the station building and platform, drainage, grading, lighting, landscaping, signage, security, site furnishings, 2,000 space parking facility, vehicle access and circulation, bicycle facilities, and access to other modes of public transit. It assumes a 20 acres of ROW acquisition.	
20.02	Loveland	Stations	\$40,000,000	1.0	\$40,000,000		\$0		\$0	1.0	\$40,000,000			Primary minor station, see above.	
20.03	Longmont	Stations	\$40,000,000	1.0	\$40,000,000		\$0		\$0	1.0	\$40,000,000			Primary minor station, see above.	
20.04	North Metro	Stations	\$40,000,000	1.0	\$40,000,000		\$0		\$0	1.0	\$40,000,000			Primary minor station, see above.	
20.05	Downtown Denver	Stations	\$30,000,000		\$0	1.0	\$30,000,000		\$0	1.0	\$30,000,000			Assumed to be a primary major upgrade station at a cost of \$30M for upgrades needed to the existing platforms, drainage, grading, lighting, landscaping, signage, security, site furnishings, bicycle facilities, and access to other modes of public transit.	
20.06	South Metro	Stations	\$40,000,000		\$0	1.0	\$40,000,000		\$0	1.0	\$40,000,000			Primary minor station, see above.	
20.07	Castle Rock	Stations	\$40,000,000		\$0		\$0	1.0	\$40,000,000	1.0	\$40,000,000			Primary minor station, see above.	
20.08	Colorado Springs	Stations	\$40,000,000		\$0		\$0	1.0	\$40,000,000	1.0	\$40,000,000			Primary minor station, see above.	
20.09	Pueblo	Stations	\$40,000,000		\$0		\$0	1.0	\$40,000,000	1.0	\$40,000,000			Primary minor station, see above.	
30	SUPPORT FACILITIES			1.0	\$20,000,000	2.0	\$220,000,000	1.0	\$20,000,000	4.0	\$260,000,000	5%	2%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.	
30.02	Light Maintenance Facility (Layover)	Each	\$20,000,000	1.0	\$20,000,000	1.0	\$20,000,000	1.0	\$20,000,000	3.0	\$60,000,000			Assume one LMF at each segment, a 5 acres site required, no specific location assigned yet.	
30.03	Heavy Maintenance Facility	Each	\$200,000,000		\$0	1.0	\$200,000,000		\$0	1.0	\$200,000,000			Assumes one HMF located in central segment, a 40 acres site required, considered location at Burnham Yards.	
40	SITEWORK & SPECIAL CONDITIONS		% of SCC (10+20+30)	15.0%	\$214,326,788		\$135,208,398		\$351,375,232		\$700,910,418	12%	6%	A per segment evaluation of SCC 40 should be adjusted given known elevation and ROW profile characteristics; however, for Level 2A assessment a % based approach has been implemented.	
40.01	Demolition, Clearing, Earthwork		2.0%		\$28,672,480		\$18,088,080		\$47,006,720		\$93,767,280			See above.	
40.02	Site Utilities, Utility Relocation		6.0%		\$86,017,440		\$54,264,240		\$141,020,160		\$281,301,840			See above.	
40.03	Haz. mat'l, contam'd soil removal/mitigation, ground water treatments		0.7%		\$10,035,368		\$6,330,828		\$16,452,352		\$32,818,548			See above.	
40.04	Environmental mitigation, e.g. wetlands, historic/archeologic, parks		0.5%		\$7,168,120		\$4,522,020		\$11,751,680		\$23,441,820			See above.	
40.05	Site structures including retaining walls, sound walls		0.3%		\$3,584,060		\$2,261,010		\$5,875,840		\$11,720,910			See above.	
40.06	Pedestrian / bike access and accommodation, landscaping		0.3%		\$3,584,060		\$2,261,010		\$5,875,840		\$11,720,910			See above.	
40.07	Automobile, bus, van accessways including roads, parking lots		0.3%		\$3,584,060		\$2,261,010		\$5,875,840		\$11,720,910			See above.	
40.08	Temporary Facilities and other indirect costs during construction		5.0%		\$71,681,200		\$45,220,200		\$117,516,800		\$234,418,200			Given magnitude of project, this has been kept at 5% (higher %). Assumed to allocate construction "indirect" costs among the construction costs in Categories 10 through 30. Where that is not possible, indirects are included here.	
50	SYSTEMS				\$114,513,300		\$58,749,530		\$158,721,460		\$331,984,290	6%	3%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.	
50.01	Wayside train controls and signaling equipment (w/PTC)	Route Mile	\$ 850,000	65.1	\$55,335,000	31.9	\$27,123,500	86.6	\$73,627,000	183.6	\$156,085,500			Wayside train controls and signalization with PTC for new dedicated double track corridor, includes: Dispatch System Capable of Interfacing to BOS/PTC; BOS; System Command Center, and Implementation Integrator. Exclusions: Onboard Components and Mechanical TCS are assumed to be included in the locomotive procurement (70.01); Grade Crossing Warning Systems listed under 50.02; Communication Costs listed under 50.03.	
50.02	Traffic signals and crossing protection	Each	\$ 750,000	50.0	\$37,500,000	28.0	\$21,000,000	75.0	\$56,250,000	153.0	\$114,750,000			Remaining number of roadway crossings from CDOT provided crossing numbers and identified major crossings. Distributed among segments in a % based approach given route lengths for Level 2A assessment.	
50.03	Communications (w/Fiber Optic Backbone)	Route Mile	\$ 333,000	65.1	\$21,678,300	31.9	\$10,626,030	86.6	\$28,844,460	183.6	\$61,148,790			It is assumed that Fiber is installed for all communication needs of the corridor under this line item cost. Non-tunnel cost per mile. (Source: ICS Appendix (2014); CHSR Review of 2018 Capital Cost Estimates (May 1, 2019))	
51	Construction Subtotal (10 - 50)				\$1,762,464,088		\$1,098,361,928		\$2,860,432,692		\$5,721,258,708	100%	51%		
60	ROW, LAND, EXISTING IMPROVEMENTS			495	\$442,772,352	250	\$390,867,840	767	\$172,941,120	1,512	\$1,006,581,312		9%	Multiply assumed cost/SF x 43,560 SF/Acre for unit cost shown. All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.	
60.01	Land Acquisition North Rural - Double Track (assumed 75' width)	ACRE	\$ 348,480	107	\$37,445,760		\$0		\$0	107	\$37,445,760			Assumed \$8/SF for North Rural. (Source: HDR)	
60.02	Land Acquisition North Urban - Double Track (assumed 60' width)	ACRE	\$ 1,045,440	388	\$405,326,592		\$0		\$0	388	\$405,326,592			Assumed \$24/SF for North Urban. (Source: HDR)	
60.03	Land Acquisition Central Rural - Double Track (assumed 75' width)	ACRE	\$ 871,200		\$0	91	\$79,516,800		\$0	91	\$79,516,800			Assumed \$20/SF for Central Rural. (Source: HDR)	
60.04	Land Acquisition Central Urban - Double Track (assumed 60' width)	ACRE	\$ 1,960,200		\$0	159	\$311,351,040		\$0	159	\$311,351,040			Assumed \$45/SF for Central Urban. (Source: HDR)	
60.05	Land Acquisition South Rural - Double Track (assumed 75' width)	ACRE	\$ 174,240		\$0		\$0	685	\$119,338,560	685	\$119,338,560			Assumed \$4/SF for South Rural. (Source: HDR)	
60.06	Land Acquisition South Urban - Double Track (assumed 60' width)	ACRE	\$ 653,400		\$0		\$0	82	\$53,602,560	82	\$53,602,560			Assumed \$15/SF for South Urban. (Source: HDR)	
70	VEHICLES (number)			36	\$165,900,000	36	\$165,900,000	36	\$165,900,000	108	\$497,700,000		4%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.	
70.01	Locomotive (18 Trainsets x 1 Locomotive/Trainset)	Each	\$ 6,750,000	6	\$40,500,000	6	\$40,500,000	6	\$40,500,000	18	\$121,500,000			Recently priced Siemens Charger Equipment cost for Caltrans Rolling Stock (direct source). Each trainset includes 1 Locomotive + 4 Economy Cars + 1 Coach Cab Car.	
70.02	Economy Single Level Car (18 Trainsets x 4 Cars/Trainset)	Each	\$ 4,000,000	24	\$96,000,000	24	\$96,000,000	24	\$96,000,000	72	\$288,000,000			Recently priced Siemens Charger Equipment cost for Caltrans Rolling Stock (direct source). Each trainset includes 1 Locomotive + 4 Economy Cars + 1 Coach Cab Car.	
70.03	Coach Cab Car (18 Trainsets x 1 Coach Cab Car/Trainset)	Each	\$ 4,900,000	6	\$29,400,000	6	\$29,400,000	6	\$29,400,000	18	\$88,200,000			Recently priced Siemens Charger Equipment cost for Caltrans Rolling Stock (direct source). Each trainset includes 1 Locomotive + 4 Economy Cars + 1 Coach Cab Car.	
80	PROFESSIONAL SERVICES (applies to Cats. 10-50)		32.0%		\$563,988,508		\$351,475,817		\$915,338,461		\$1,830,802,787		16%	Approximate range %'s from TRCP Report 138 (2010) guidance.	
80.01	Project Development		3.0%		\$52,873,923		\$32,950,858		\$85,812,981		\$171,637,761				
80.02	Engineering		10.0%		\$176,246,409		\$109,836,193		\$286,043,269		\$572,125,871				
80.03	Project Management for Design and Construction		4.0%		\$70,498,564		\$43,934,477		\$114,417,308		\$228,850,348				
80.04	Construction Administration & Management		10.0%		\$176,246,409		\$109,836,193		\$286,043,269		\$572,125,871				
80.05	Professional Liability and other Non-Construction Insurance		2.0%		\$35,249,282		\$21,967,239		\$57,208,654		\$114,425,174				
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.		1.0%		\$17,624,641		\$10,983,619		\$28,604,327		\$57,212,587				
80.07	Surveys, Testing, Investigation, Inspection		1.0%		\$17,624,641		\$10,983,619		\$28,604,327		\$57,212,587				
80.08	Start up		1.0%		\$17,624,641		\$10,983,619		\$28,604,327		\$57,212,587				
81	Subtotal (10 - 80)				\$2,935,124,948		\$2,006,605,585		\$4,114,612,273		\$9,056,342,807		80%		
90	UNALLOCATED CONTINGENCY		% of Subtotal (10 - 80)	25.0%		\$733,781,237		\$501,651,396		\$1,028,653,068		\$2,264,085,702		20%	Concept screening level of project definition (maturity). Recommended UNALLOCATED contingency to be kept at a minimum of 25%. ALLOCATED contingencies assumed to be included in line items above (SCC 10 to SCC 80).
91	2020\$ Total Project Cost (10 - 90)					\$3,668,906,185		\$2,508,256,981		\$5,143,265,342		\$11,320,428,508		100%	

Alignment 4 CapEx Summary - Scenario 1

FRA SCC	Description	Total Cost	% of Total Project Cost
10	GUIDEWAY & TRACK ELEMENTS	\$4,078 M	36%
20	STATIONS	\$350 M	3%
30	SUPPORT FACILITIES	\$260 M	2%
40	SITWORK & SPECIAL CONDITIONS	\$701 M	6%
50	SYSTEMS	\$332 M	3%
51	Construction Subtotal (10 - 50)	\$5,721 M	51%
60	ROW, LAND, EXISTING IMPROVEMENTS	\$1,007 M	9%
70	VEHICLES	\$498 M	4%
80	PROFESSIONAL SERVICES	\$1,831 M	16%
81	Subtotal (10 - 80)	\$9,056 M	80%
90	UNALLOCATED CONTINGENCY	\$2,264 M	20%
91	2020\$ Total Project Cost (10 - 90)	\$11,320 M	100%

Cost / Mile Analysis:

	Total
Total Route Miles	183.6 mi
2020\$ Construction Cost per Mile (SCC 10 to 50)	\$31.2 M
2020\$ Total Project Cost per Mile Not Including Vehicles	\$58.3 M
2020\$ Total Project Cost per Mile	\$61.6 M
YOES Total Project Cost per Mile (Escalated Cost)	\$71.1 M

Alignment Elevation Profile Summary (by length)

At-Grade	159.6 mi	86.9%
Overpass	3.1 mi	1.7%
Underpass	1.5 mi	0.8%
Major Viaduct	18.2 mi	9.9%
Tunnel	1.3 mi	0.7%
Total	183.6 mi	100.0%

Alignment Corridor Type Summary (by length)

Greenfield or Brownfield Conditions	39.0 mi	21%
Existing Roadway Corridor	6.5 mi	4%
Existing RTD Corridor	30.2 mi	16%
Existing Freight Rail Corridor	107.9 mi	59%
Total	183.6 mi	100%

Segments:

North	Central	South
Cost	Cost	Cost
\$1,254 M	\$614 M	\$2,210 M
\$160 M	\$70 M	\$120 M
\$20 M	\$220 M	\$20 M
\$214 M	\$135 M	\$351 M
\$115 M	\$59 M	\$159 M
\$1,762 M	\$1,098 M	\$2,860 M
\$443 M	\$391 M	\$173 M
\$166 M	\$166 M	\$166 M
\$564 M	\$351 M	\$915 M
\$2,935 M	\$2,007 M	\$4,115 M
\$734 M	\$502 M	\$1,029 M
\$3,669 M	\$2,508 M	\$5,143 M

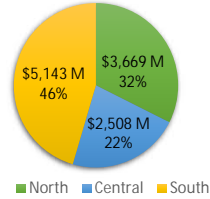
Segments:

North	Central	South
65.1 mi	31.9 mi	86.6 mi
\$27.1 M	\$34.4 M	\$33.0 M
\$53.2 M	\$72.1 M	\$57.0 M
\$56.4 M	\$78.6 M	\$59.4 M
\$65.0 M	\$90.6 M	\$68.5 M

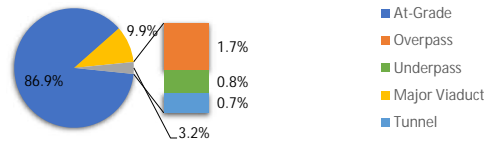
58.4 mi	28.2 mi	73.0 mi
0.7 mi	1.1 mi	1.2 mi
0.3 mi	0.7 mi	0.5 mi
5.7 mi	1.9 mi	10.6 mi
0.0 mi	0.0 mi	1.3 mi
65.1 mi	31.9 mi	86.6 mi

18.8 mi	3.5 mi	16.7 mi
4.0 mi	0.0 mi	2.5 mi
13.3 mi	17.0 mi	0.0 mi
29.1 mi	11.4 mi	67.4 mi
65.1 mi	31.9 mi	86.6 mi

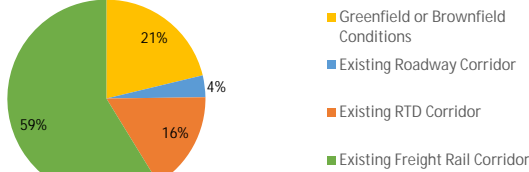
Alignment Cost Split by Segment (2020\$)



Alignment Elevation Profile (by length)



Alignment Corridor Type Breakdown (by length)



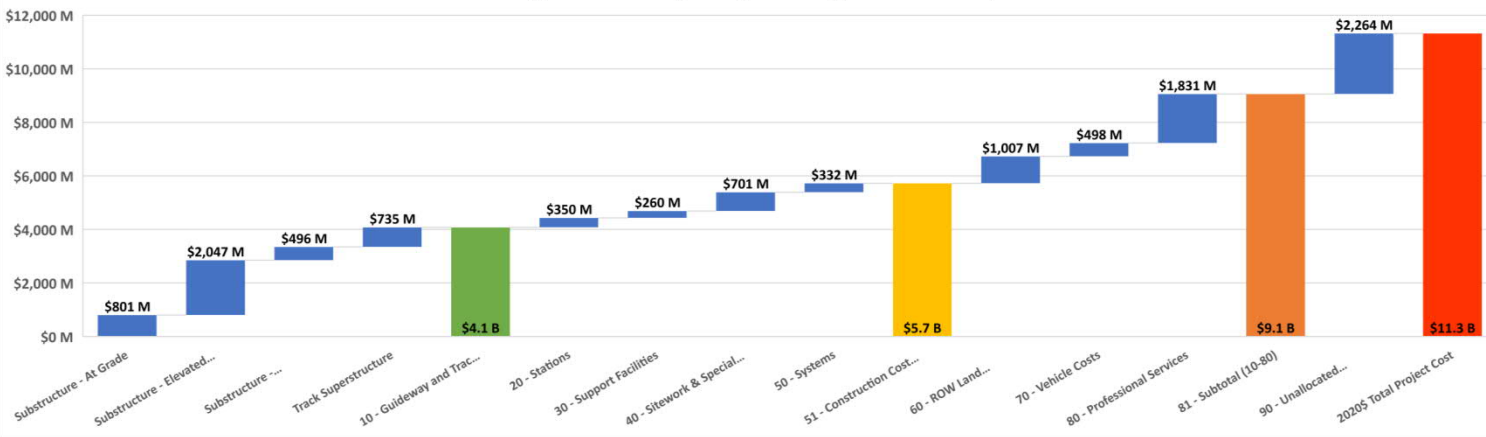
ALTERNATIVE 4 ALIGNMENT MAP



Major Categories Analysis:

Major CapEx Categories Build-Up	Cost Estimate	% of Total
Substructure - At Grade	\$801 M	7.1%
Substructure - Elevated (Overpass / Viaducts / Minor Crossings)	\$2,047 M	18.1%
Substructure - Underground (Underpass / Tunnels)	\$496 M	4.4%
Track Superstructure	\$735 M	6.5%
10 - Guideway and Track Elements	\$4,078 M	36.0%
20 - Stations	\$350 M	3.1%
30 - Support Facilities	\$260 M	2.3%
40 - Sitework & Special Conditions	\$701 M	6.2%
50 - Systems	\$332 M	2.9%
51 - Construction Cost (10-50)	\$5,721 M	50.5%
60 - ROW Land Acquisition Costs	\$1,007 M	8.9%
70 - Vehicle Costs	\$498 M	4.4%
80 - Professional Services	\$1,831 M	16.2%
81 - Subtotal (10-80)	\$9,056 M	80.0%
90 - Unallocated Contingency	\$2,264 M	20.0%
2020\$ Total Project Cost	\$11,320 M	100.0%

Alignment 4 Major CapEx Categories Build-Up



CapEx Model - SCENARIO 1			Segment:	North	Central	South	Total	Full Build Out Scenario 1: New Dedicated Doubletrack						
Alignment 6: Siemens Charger Diesel Electric Locomotive			From - To	Fort Collins Station to Denver Airport Station	Denver Airport Station to Castle Rock Station	Castle Rock Station to Pueblo Station	Fort Collins Station to Pueblo Station							
			Length (mi)	65.8	42.9	83.2	191.9							
FRA SCC	Description	Unit	Unit Cost (2020\$)	Quantity	Total Segment Cost	Quantity	Total Segment Cost	Quantity	Total Segment Cost	Quantity	Total Cost	% of Const. Cost	% of Total Project Cost	Notes & Assumptions
10	GUIDEWAY & TRACK ELEMENTS			65.8	\$1,157,110,000	42.9	\$1,088,081,000	83.2	\$1,377,931,000	191.9	\$3,623,122,000	70%	35%	Unit prices escalated to 2020\$ from CHSRA (2010) and MWRRI (2010)Unit Pricing catalogs, also presented in ICS Appendix (2014). All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
10.01	At-Grade	Route Mile	\$5,000,000	59.2	\$295,950,000	36.1	\$180,450,000	76.1	\$380,500,000	171.4	\$856,900,000			Unit Price Assumption: Cut and Fill Track Structure (> 4' height/depth), \$5M/mi (high conservative range)
10.02	Overpass	Route Mile	\$100,000,000	0.4	\$42,000,000	0.9	\$91,000,000	1.5	\$154,000,000	2.9	\$287,000,000			Unit Price Assumption: Overpass (Railway, Roadway, Stream/River) Average (Double Track) Cost / Mile
10.03	Underpass	Route Mile	\$69,700,000	0.0	\$0	0.2	\$16,031,000	0.2	\$16,031,000	0.5	\$32,062,000			Unit Price Assumption: Underpass (Roadway / Railroad) Average (Double Track) Cost / Mile
10.04	Major Viaduct	Route Mile	\$84,000,000	6.2	\$519,960,000	5.1	\$425,040,000	5.3	\$448,560,000	16.6	\$1,393,560,000			Double Track on Flyover/Elevated Structure
10.05	Tunnel	Route Mile	\$300,000,000	0.0	\$0	0.6	\$180,000,000	0.0	\$0	0.6	\$180,000,000			TBM Double Track, 40 to 50ft ID in soft ground
10.06	Minor Stream Crossing	Each	\$1,000,000	36.0	\$36,000,000	24.0	\$24,000,000	46.0	\$46,000,000	106.0	\$106,000,000			Total Stream Crossings identified minus Major Stream Crossings count. Unit price ~ \$1M each.
10.07	Track: Ballasted	Route Mile	\$4,000,000	65.8	\$263,200,000	42.9	\$171,560,000	83.2	\$332,840,000	191.9	\$767,600,000			Assumed Track New Construction throughout: Conventional Ballasted 2 Track unit cost.
20	STATIONS			4.0	\$170,000,000	2.0	\$90,000,000	3.0	\$120,000,000	9.0	\$380,000,000	7%	4%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
20.01	Fort Collins	Stations	\$40,000,000	1.0	\$40,000,000		\$0		\$0	1.0	\$40,000,000			Assumed to be a primary minor station cost of \$40M. The unit cost for this item includes the station building and platform, drainage, grading, lighting, landscaping, signage, security, site furnishings, 2,000 space parking facility, vehicle access and circulation, bicycle facilities, and access to other modes of public transit. It assumes a 20 acres of ROW acquisition.
20.02	Loveland	Stations	\$50,000,000	1.0	\$50,000,000		\$0		\$0	1.0	\$50,000,000			Assumed to be a primary moderate station cost of \$50M. Same characteristics as described above. 20 acres ROW acquisition required.
20.03	Longmont/Berthoud	Stations	\$40,000,000	1.0	\$40,000,000		\$0		\$0	1.0	\$40,000,000			Primary minor station , see above.
20.04	North Metro	Stations	\$40,000,000	1.0	\$40,000,000		\$0		\$0	1.0	\$40,000,000			Primary minor station , see above.
20.05	Denver Airport	Stations	\$30,000,000		\$0	1.0	\$30,000,000		\$0	1.0	\$30,000,000			Assumed to be a primary major upgrade station at a cost of \$30M for upgrades needed to the existing platforms, drainage, grading, lighting, landscaping, signage, security, site furnishings, bicycle facilities, and access to other modes of public transit.
20.06	South Suburban	Stations	\$60,000,000		\$0	1.0	\$60,000,000		\$0	1.0	\$60,000,000			Assumed to be a primary major station cost of \$60M. Same characteristics as described above. 25 acres ROW acquisition required.
20.07	Castle Rock	Stations	\$40,000,000		\$0		\$0	1.0	\$40,000,000	1.0	\$40,000,000			Primary minor station , see above.
20.08	Colorado Springs	Stations	\$40,000,000		\$0		\$0	1.0	\$40,000,000	1.0	\$40,000,000			Primary minor station , see above.
20.09	Pueblo	Stations	\$40,000,000		\$0		\$0	1.0	\$40,000,000	1.0	\$40,000,000			Primary minor station , see above.
30	SUPPORT FACILITIES			1.0	\$20,000,000	2.0	\$220,000,000	1.0	\$20,000,000	4.0	\$260,000,000	5%	2%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
30.02	Light Maintenance Facility (Layover)	Each	\$20,000,000	1.0	\$20,000,000	1.0	\$20,000,000	1.0	\$20,000,000	3.0	\$60,000,000			Assume one LMF at each segment, a 5 acres site required, no specific location assigned yet.
30.03	Heavy Maintenance Facility	Each	\$200,000,000		\$0	1.0	\$200,000,000		\$0	1.0	\$200,000,000			Assumes one HMF located in central segment, a 40 acres site required, considered location at Burnham Yards.
40	SITEWORK & SPECIAL CONDITIONS	% of SCC (10+20+30)	15.0%		\$201,392,945		\$209,013,110		\$226,930,685		\$637,336,739	12%	6%	A per segment evaluation of SCC 40 should be adjusted given known elevation and ROW profile characteristics; however, for Level 2A assessment a % based approach has been implemented.
40.01	Demolition, Clearing, Earthwork		2.0%		\$26,942,200		\$27,961,620		\$30,358,620		\$85,262,440			See above.
40.02	Site Utilities, Utility Relocation		6.0%		\$80,826,600		\$83,884,860		\$91,075,860		\$255,787,320			See above.
40.03	Haz. mat'l, contam'd soil removal/mitigation, ground water treatments		0.7%		\$9,429,770		\$9,786,567		\$10,625,517		\$29,841,854			See above.
40.04	Environmental mitigation, e.g. wetlands, historic/archeologic, parks		0.5%		\$6,735,550		\$6,990,405		\$7,589,655		\$21,315,610			See above.
40.05	Site structures including retaining walls, sound walls		0.3%		\$3,367,775		\$3,495,203		\$3,794,828		\$10,657,805			See above.
40.06	Pedestrian / bike access and accommodation, landscaping		0.3%		\$3,367,775		\$3,495,203		\$3,794,828		\$10,657,805			See above.
40.07	Automobile, bus, van accessways including roads, parking lots		0.3%		\$3,367,775		\$3,495,203		\$3,794,828		\$10,657,805			See above.
40.08	Temporary Facilities and other indirect costs during construction		5.0%		\$67,355,500		\$69,904,050		\$75,896,550		\$213,156,100			Given magnitude of project, this has been kept at 5% (higher %). Assumed to allocate construction "indirect" costs among the construction costs in Categories 10 through 30. Where that is not possible, indirects are included here.
50	SYSTEMS				\$104,841,400		\$68,738,870		\$132,937,430		\$306,517,700	6%	3%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
50.01	Wayside train controls and signaling equipment (w/PTC)	Route Mile	\$ 850,000	65.8	\$55,930,000	42.9	\$36,456,500	83.2	\$70,728,500	191.9	\$163,115,000			Wayside train controls and signalization with PTC for new dedicated double track corridor, includes: Dispatch System Capable of Interfacing to BOS/PTC; BOS; System Command Center; and Implementation Integrator. Exclusions: Onboard Components and Mechanical TCS are assumed to be included in the locomotive procurement (70.01); Grade Crossing Warning Systems listed under 50.02; Communication Costs listed under 50.03.
50.02	Traffic signals and crossing protection	Each	\$ 750,000	36.0	\$27,000,000	24.0	\$18,000,000	46.0	\$34,500,000	106.0	\$79,500,000			Remaining number of roadway crossings from CDOT provided crossing numbers and identified major crossings. Distributed among segments in a % based approach given route lengths for Level 2A assessment.
50.03	Communications (w/Fiber Optic Backbone)	Route Mile	\$ 333,000	65.8	\$21,911,400	42.9	\$14,282,370	83.2	\$27,708,930	191.9	\$63,902,700			It is assumed that Fiber is installed for all communication needs of the corridor under this line item cost. Non-tunnel cost per mile. (Source: ICS Appendix (2014); CHSR Review of 2018 Capital Cost Estimates (May 1, 2019))
51	Construction Subtotal (10 - 50)				\$1,653,344,345		\$1,675,832,980		\$1,877,799,115		\$5,206,976,439	100%	50%	
60	ROW, LAND, EXISTING IMPROVEMENTS			541	\$347,561,280	377	\$389,093,760	680	\$264,385,440	1,599	\$1,001,040,480		10%	Multiply assumed cost/SF x 43,560 SF/Acre for unit cost shown. All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
60.01	Land Acquisition North Rural - Double Track (assumed 75' width)	ACRE	\$ 348,480	313	\$109,200,960		\$0		\$0	313	\$109,200,960			Assumed \$8/SF for North Rural. (Source: HDR)
60.02	Land Acquisition North Urban - Double Track (assumed 60' width)	ACRE	\$ 1,045,440	228	\$238,360,320		\$0		\$0	228	\$238,360,320			Assumed \$24/SF for North Urban. (Source: HDR)
60.03	Land Acquisition Central Rural - Double Track (assumed 75' width)	ACRE	\$ 871,200		\$0	322	\$280,605,600		\$0	322	\$280,605,600			Assumed \$20/SF for Central Rural. (Source: HDR)
60.04	Land Acquisition Central Urban - Double Track (assumed 60' width)	ACRE	\$ 1,960,200		\$0	55	\$108,488,160		\$0	55	\$108,488,160			Assumed \$45/SF for Central Urban. (Source: HDR)
60.05	Land Acquisition South Rural - Double Track (assumed 75' width)	ACRE	\$ 174,240		\$0		\$0	375	\$65,419,200	375	\$65,419,200			Assumed \$4/SF for South Rural. (Source: HDR)
60.06	Land Acquisition South Urban - Double Track (assumed 60' width)	ACRE	\$ 653,400		\$0		\$0	305	\$198,966,240	305	\$198,966,240			Assumed \$15/SF for South Urban. (Source: HDR)
70	VEHICLES (number)			36	\$165,900,000	36	\$165,900,000	36	\$165,900,000	108	\$497,700,000		5%	All costs include allocated contingencies, approximate unit cost assumed to include ~10% allocated contingency.
70.01	Locomotive (18 Trainsets x 1 Locomotive/Trainset)	Each	\$ 6,750,000	6	\$40,500,000	6	\$40,500,000	6	\$40,500,000	18	\$121,500,000			Recently priced Siemens Charger Equipment cost for Caltrans Rolling Stock (direct source). Each trainset includes 1 Locomotive + 4 Economy Cars + 1 Coach Cab Car.
70.02	Economy Single Level Car (18 Trainsets x 4 Cars/Trainset)	Each	\$ 4,000,000	24	\$96,000,000	24	\$96,000,000	24	\$96,000,000	72	\$288,000,000			Recently priced Siemens Charger Equipment cost for Caltrans Rolling Stock (direct source). Each trainset includes 1 Locomotive + 4 Economy Cars + 1 Coach Cab Car.
70.03	Coach Cab Car (18 Trainsets x 1 Coach Cab Car/Trainset)	Each	\$ 4,900,000	6	\$29,400,000	6	\$29,400,000	6	\$29,400,000	18	\$88,200,000			Recently priced Siemens Charger Equipment cost for Caltrans Rolling Stock (direct source). Each trainset includes 1 Locomotive + 4 Economy Cars + 1 Coach Cab Car.
80	PROFESSIONAL SERVICES (applies to Cats. 10-50)		32.0%		\$529,070,190		\$536,266,553		\$600,895,717		\$1,666,232,460		16%	Approximate range %'s from TCRP Report 138 (2010) guidance.
80.01	Project Development		3.0%		\$49,600,330		\$50,274,989		\$56,333,973		\$156,209,293			
80.02	Engineering		10.0%		\$165,334,435		\$167,583,298		\$187,779,911		\$520,697,644			
80.03	Project Management for Design and Construction		4.0%		\$66,133,774		\$67,033,319		\$75,111,965		\$208,279,058			
80.04	Construction Administration & Management		10.0%		\$165,334,435		\$167,583,298		\$187,779,911		\$520,697,644			
80.05	Professional Liability and other Non-Construction Insurance		2.0%		\$33,066,887		\$33,516,660		\$37,555,982		\$104,139,529			
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.		1.0%		\$16,533,443		\$16,758,330		\$18,777,991		\$52,069,764			
80.07	Surveys, Testing, Investigation, Inspection		1.0%		\$16,533,443		\$16,758,330		\$18,777,991		\$52,069,764			
80.08	Start up		1.0%		\$16,533,443		\$16,758,330		\$18,777,991		\$52,069,764			
81	Subtotal (10 - 80)				\$2,695,875,815		\$2,767,093,293		\$2,908,980,271		\$8,371,949,379		80%	
90	UNALLOCATED CONTINGENCY	% of Subtotal (10 - 80)	25.0%		\$673,968,954		\$691,773,323		\$727,245,068		\$2,092,987,345		20%	Concept screening level of project definition (maturity). Recommended UNALLOCATED contingency to be kept at a minimum of 25%. ALLOCATED contingencies assumed to be included in line items above (SCC 10 to SCC 80).
91	2020\$ Total Project Cost (10 - 90)				\$3,369,844,769		\$3,458,866,616		\$3,636,225,339		\$10,464,936,724		100%	

Alingment 6 CapEx Summary - Scenario 1

		Total	
FRA SCC	Description	Total Cost	% of Total Project Cost
10	GUIDEWAY & TRACK ELEMENTS	\$3,623 M	35%
20	STATIONS	\$380 M	4%
30	SUPPORT FACILITIES	\$260 M	2%
40	SITEWORK & SPECIAL CONDITIONS	\$637 M	6%
50	SYSTEMS	\$307 M	3%
51	Construction Subtotal (10 - 50)	\$5,207 M	50%
60	ROW, LAND, EXISTING IMPROVEMENTS	\$1,001 M	10%
70	VEHICLES	\$498 M	5%
80	PROFESSIONAL SERVICES	\$1,666 M	16%
81	Subtotal (10 - 80)	\$8,372 M	80%
90	UNALLOCATED CONTINGENCY	\$2,093 M	20%
91	2020\$ Total Project Cost (10 - 90)	\$10,465 M	100%

Cost / Mile Analysis:

	Total
Total Route Miles	191.9 mi
2020\$ Construction Cost per Mile (SCC 10 to 50)	\$27.1 M
2020\$ Total Project Cost per Mile Not Including Vehicles	\$51.3 M
2020\$ Total Project Cost per Mile	\$54.5 M
YOE\$ Total Project Cost per Mile (Escalated Cost)	\$62.9 M

Alignment Elevation Profile Summary (by length)

At-Grade	171.4 mi	89.3%
Overpass	2.9 mi	1.5%
Underpass	0.5 mi	0.2%
Major Viaduct	16.6 mi	8.6%
Tunnel	0.6 mi	0.3%
Total	191.9 mi	100.0%

Alignment Corridor Type Summary (by length)

Greenfield or Brownfield Conditions	17.9 mi	9%
Existing Roadway Corridor	143.1 mi	75%
Existing RTD Corridor	7.2 mi	4%
Existing Freight Rail Corridor	23.8 mi	12%
Total	192.0 mi	100%

Segments:

North	Central	South
Cost	Cost	Cost
\$1,157 M	\$1,088 M	\$1,378 M
\$170 M	\$90 M	\$120 M
\$20 M	\$220 M	\$20 M
\$201 M	\$209 M	\$227 M
\$105 M	\$69 M	\$133 M
\$1,653 M	\$1,676 M	\$1,878 M
\$348 M	\$389 M	\$264 M
\$166 M	\$166 M	\$166 M
\$529 M	\$536 M	\$601 M
\$2,696 M	\$2,767 M	\$2,909 M
\$674 M	\$692 M	\$727 M
\$3,370 M	\$3,459 M	\$3,636 M

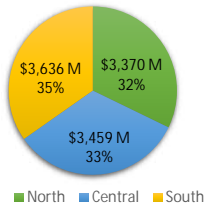
Segments:

North	Central	South
65.8 mi	42.9 mi	83.2 mi
\$25.1 M	\$39.1 M	\$22.6 M
\$48.1 M	\$75.8 M	\$41.2 M
\$51.2 M	\$80.6 M	\$43.7 M
\$59.0 M	\$93.0 M	\$50.4 M

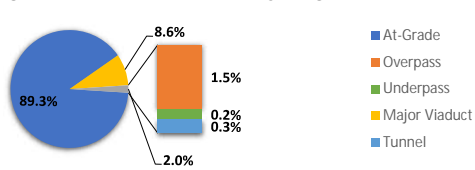
59.2 mi	36.1 mi	76.1 mi
0.4 mi	0.9 mi	1.5 mi
0.0 mi	0.2 mi	0.2 mi
6.2 mi	5.1 mi	5.3 mi
0.0 mi	0.6 mi	0.0 mi
65.8 mi	42.9 mi	83.2 mi

3.5 mi	8.8 mi	5.7 mi
53.2 mi	30.3 mi	59.6 mi
3.3 mi	4.0 mi	0.0 mi
6.0 mi	0.0 mi	17.9 mi
65.8 mi	43.0 mi	83.2 mi

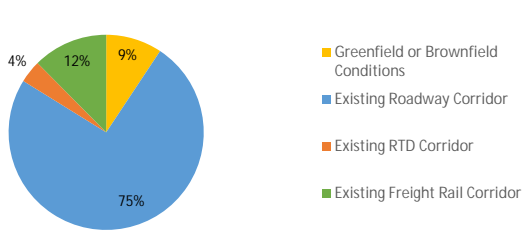
Alignment Cost Split by Segment (2020\$)



Alignment Elevation Profile (by length)



Alignment Corridor Type Breakdown (by length)



ALTERNATIVE 6 ALIGNMENT MAP



Major Categories Analysis:

Major CapEx Categories Build-Up	Cost Estimate	% of Total
Substructure - At Grade	\$857 M	8.2%
Substructure - Elevated (Overpass / Viaducts / Minor Crossings)	\$1,787 M	17.1%
Substructure - Underground (Underpass / Tunnels)	\$212 M	2.0%
Track Superstructure	\$768 M	7.3%
10 - Guideway and Track Elements	\$3,623 M	34.6%
20 - Stations	\$380 M	3.6%
30 - Support Facilities	\$260 M	2.5%
40 - Sitework & Special Conditions	\$637 M	6.1%
50 - Systems	\$307 M	2.9%
51 - Construction Cost (10-50)	\$5,207 M	49.8%
60 - ROW Land Acquisition Costs	\$1,001 M	9.6%
70 - Vehicle Costs	\$498 M	4.8%
80 - Professional Services	\$1,666 M	15.9%
81 - Subtotal (10-80)	\$8,372 M	80.0%
90 - Unallocated Contingency	\$2,093 M	20.0%
2020\$ Total Project Cost	\$10,465 M	100.0%

Alignment 6 Major CapEx Categories Build-Up

