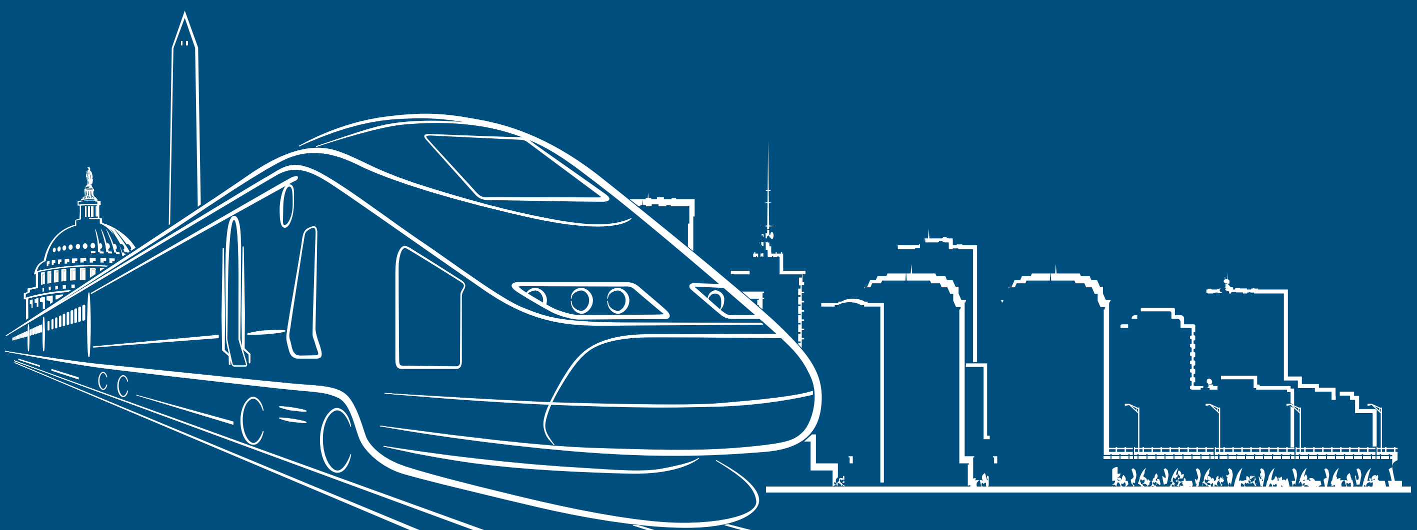
DC TO RICHMOND
SOUTHEAST HIGH SPEED RAIL

L CONSTRUCTABILITY



D.C. TO RICHMOND SOUTHEAST HIGH SPEED RAIL

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1 INTRODUCTION

1.1 PROJECT INTRODUCTION

This report describes the potential construction types, means and methods, sequencing of construction, staging areas, haul routes, and construction interferences that would likely be required for constructing Washington, D.C. to Richmond, Va. corridor and is developed for the Tier II Environmental Impact Statement (EIS) for the 123-mile DC to RVA corridor, based on the Concept Engineering Plans.

1.2 PROJECT DESCRIPTION

The DC to RVA corridor covers a large and diverse geographical area that includes dense urban land use. The general intent is to add a parallel third track to the existing rail network and increase speeds to the extent practical and consistent with corridor service objectives. A 90 mph maximum allowable speed, MAS, for passenger trains for which the corridor will be designed, may not be achievable everywhere within the corridor due to environmental, existing facilities, or operation constraints.

The third track between Washington and Richmond would not be constructed as a completely separate track and would not be solely dedicated to passenger service. Rather, the track would be designed and operated as a third mainline track along with the other two mainline tracks as a completely integrated three-track system. In some areas the new track would be built on the east side of the existing two-track system and in other locations on the west side or, where space permits, between the two existing tracks. Control points with crossovers between tracks would be located at key locations to assure maximum fluidity of train operations. Both passenger and freight trains would have access to the new third track throughout the day depending on train dispatching requirements and negotiated priorities. Passenger trains would have access to all three tracks. Also, under study is a fourth main track from Alexandria to Long Bridge and the operations will be consistent with the third track concept.

1.3 PROJECT SEGMENTS

Refer to Chapter 2, Article 2.4.1 Alternatives Screening area and Segment Descriptions for a description of the three screening areas; Northern, Central, and Richmond. The three areas are further subdivided into 22 project segments within corridors.

1.4 PROJECT BUILD ALTERNATIVES

Refer to Chapter 2, Alternatives, Article 2.5.2 Build Alternatives for a description of the project build screening alternatives and maps.

2 CONSTRUCTION PACKAGING

The DC to RVA corridor alternatives consist of approximately 123-miles of high speed rail on CSX Transportation, (CSXT) rights-of-way. The additional mainline tracks includes improvement to civil rail infrastructure, train control, passenger station infrastructure, and various improvements to the local and Virginia Department of Transportation, VDOT, roadway network.

Construction and maintenance of railway infrastructure within CSX rights-of-way are applicable to National and CSX labor agreements. The construction elements of the project covered by the Labor Agreements will be performed by workers of the railway unions, and for this report CSX labor forces are considered a contractor. Construction work not covered by the labor agreements shall be bid for construction contracts.

All work within CSX rights-of-way will be performed under CSX "Contractors Handbook for CSX Roadway Worker Protection".

It is anticipated the construction packages will be divided into project segments, the packages will be divided as to the types infrastructure improvements; and will be let to meet project schedules as developed during the progressives phases of the project.

Right-of-way acquisition would be a major factor in determining the overall segment construction packaging. This section is being written with the assumption that all rights-of-way have been acquired before construction activities commence.

2.1. CONSTRUCTION TYPES

The potential construction types are based on available conceptual information for the DC to RVA corridor.

The following are characterizations of each of the construction types defined for the DC to RVA corridor:

- **Passenger Station Infrastructure:** Construction of new stations and improvements to existing stations for platforms, pedestrian access, parking, and roadway network connectivity.
- **Rail Bridge:** Construction of railway structures over water crossings, other railways, and highways.
- **Highway Bridge and Underpasses:** Construction of structures to elevate roadways over or under the rail infrastructure.
- **Earthwork:** Construction of roadbed for highways and trackbed for railways with an earthen embankment, cuts, or retained slopes of varying height to meet the existing

grade. The earthwork construction would generally be applied to the corridor prior roadway and trackwork or in unison with a bridge structure construction. Earthwork will be a common activity to all alternatives.

- **Drainage:** The installation of new culverts, the extension of existing culverts, and the installation of drainage ditches in support of the rail and associated roadway infrastructure improvements.
- **Retaining Walls:** Construction of vertical walls to support earthen fills, retain cuts for roadbed and trackbed. Retaining walls minimize rights-of-way impacts by reducing slope width requirements in urban areas, along waterways, wetlands, or where topographic constraints require the support roadways and railway infrastructures.
- **Track Construction:** Construction of new track, shifting of track, track structure upgrades, track retirement, track highway at-grade crossings, special trackwork consisting of turnouts, crossovers and crossing diamonds on a ballasted trackbed or on a bridge structure.
- **Train Control Systems:** Construction of a network of systems elements to provide a safe and reliable control of train operations on tracks through control points, and the advance highway warnings of approaching trains.
- **Utility Relocations:** Construction and relocation of existing water, gas, electric, cables, fiber optics, and pipeline that occupy or cross the rights-of-way impacted by the rail infrastructure improvements.

2.2 CORRIDOR ALTERNATIVES AND CONSTRUCTION ELEMENTS

Table 2-1 is a listing of the major elements in comparison with the screening alternatives. It is not a full compiled list of every construction type or items common to each alternative, rather it provides a relative comparison of the alternatives and a magnitude of the major construction elements. The table is based on the concept plans and additional element quantities will be based of designs developed during the progression of designs.

TABLE 2-1: Segment Major Construction Elements

Screening Areas & Project Segments	Passenger Station	Rail Bridge (Water)	Rail Bridge	Highway Bridge OH / UP	Retaining Walls (SY)	At-Grade Crossing	Track New (TM)	Track Upgrades (TM)	Track Shifts (TM)	Special Trackwork New - (Remove)
AREA 1 – Arlington (CFP-110 to CFP 109.3)										
RO East			1EA 60 BF		3820		1.0		1.3	13 (6)
RO West			1EA 60 BF		1366		0.8		1.3	11 (4)

TABLE 2-1: Segment Major Construction Elements

Screening Areas & Project Segments	Passenger Station	Rail Bridge (Water)	Rail Bridge	Highway Bridge OH / UP	Retaining Walls (SY)	At-Grade Crossing	Track New (TM)	Track Upgrades (TM)	Track Shifts (TM)	Special Trackwork New - (Remove)
RO East / West			1 EA 120 BF		1623		0.7		1.6	6 (1)
AREA 2 – Northern Virginia (CFP 109.3 to CFP 62)										
Northern Virginia	11	5 EA 4600 BF	914 BF	5 EA 812 BF	123168	2 EA 250 TF	45.6	29.2	4.5	50 (13)
AREA 3 – Fredericksburg (CFP 62 to CFP 48)										
Fredericksburg	1	1 EA 800 BF	1 EA 789 BF	1 EA	42006		8.7	2.3	6.0	13 (4)
NOV - Minor	1				18413	2 EA 40 TF	4.2	3.0	8.8	12
Fredericksburg Bypass	1	2 EA 1245 BF	1 EA 100 BF	7 EA	68981	8 EA 400 TF	26.9		2.9	33 (6)
AREA 4 – Central Virginia (CFP 48 to CFP 19)										
NOV to CFP 48					5125		5.8	1.0	2.6	8
CEN (CFP 48 to 19)		4 EA 868 BF			63787		29	42		9 – 1X (2)
AREA 5 – Ashland Area (CFP 19 to CFP 9)										
CEN (In Progress)	1									
Ashland Bypass (In Progress)										
CEN Minor (In Progress)	1									
CEN (MP 19 to 6)					28550	1 EA 40 TF	3.0	4.7	1.3	1 (1)
AREA 6 – Richmond (CFP 9 to A 11)										
RIC 1A (A Line) Mani Street Station / Staples Mill Station (Split Service)	2	1 EA 325 BF	2 EA	3 OH 1 UP	287798	247 TF	20.8	62.3	7.2	60 – 1X (6)
RIC 1B (A Line) Staples Mill Station	1	1 EA 325 BF	2 EA	3 OH 1 UP	257817	247 TF	17.0	39.8	6.4	45 – 1X (6)
RIC 1C (A Line) Boulevard Station	1	1 EA 325 BF	3 EA 2777 BF	6 OH 1 UP	307661	247 TF	28.6	39.8	7.9	94 – 1X (6)

TABLE 2-1: Segment Major Construction Elements

Screening Areas & Project Segments	Passenger Station	Rail Bridge (Water)	Rail Bridge	Highway Bridge OH / UP	Retaining Walls (SY)	At-Grade Crossing	Track New (TM)	Track Upgrades (TM)	Track Shifts (TM)	Special Trackwork New - (Remove)
RIC 1D (A Line) Broad Street Station	1	1 EA 325 BF	2 EA	3 OH 1 UP	342638	1191 TF	28.9	39.3	8.0	106 – 1X (28)
RIC 2A (S Line) Main street Station / Staples Mill Station (Full Service)	2	1 EA 2242 BF		5 UP	181911	1076 TF	32.3	27.2	3.0	103 – 3X (29)
RIC 2B (S Line) Main Street Station	1	1 EA 2242 BF		5 UP	238958	1076 TF	31.5	27.9	3.0	97 – 3X (29)
RIC 3 (A Line / S Line) Main Street Station / Staples Mill Station (Shared Service)	2	1 EA 2242 BF		5 UP	236653	1076 TF	32.7	56.2	3.0	112 -3X (32)

3 GENERAL CONSTRUCTION MEANS AND METHODS

This section summarizes the general construction sequencing, construction methods and staging which may be used by the Contractors.

The Contractors shall be governed at all times to comply with CSX Safety procedures, and all work within the CSX operating corridor will be performed under the protection of a CSX flagman.

3.1 CONSTRUCTION PHASING

Within the DC to RVA corridor the construction of the third track, infrastructure additions and modification to control points, station infrastructure with additional platforms, and speed increases require a phased construction. At all times there will be at least two main tracks in operation and one track out of service or under construction. Station improvement for platform additions and pedestrian access will be advance early to support the new track when placed in operation. Additional early construction activities will include major bridges having an extended lead time; and earthwork and retaining walls due to estimated length. Final phasing will be developed during the design phase for the corridor.

3.2 SEQUENCE OF CONSTRUCTION ACTIVITIES

Within each construction package the Contractor will begin construction in discrete areas to maximize flexibility in the use of crews and equipment. Should there be delay in one area, crews would likely move to advance construction in another area. The Contractor may choose to advance construction activities depending on the contract terms.

TABLE 3-1: Construction Activities

Activity	Tasks
Pre-Construction Survey	▪ Perform Geotechnical Activities ▪ Utilities Location ▪ Survey Rights−of−Way, Survey Control, & Alignment Centerlines
Site Preparation	▪ Relocate Utilities ▪ Demolition, Clear and Grub ▪ Establish Erosion Control and Sediment Control ▪ Establish Detours and Haul Routes ▪ Erect Safety Devices, and Mobilize Special Construction Equipment ▪ Prepare Staging Areas, Construction Equipment Yards, and Stockpile Materials ▪ Establish Maintenance of Traffic
Heavy Construction	▪ Construct Aerial Railway and Highway Structures ▪ Construct Surface Trackway

TABLE 3-1: Construction Activities

Activity	Tasks
	▪ Construct Roadway ▪ Construct Station Platforms, Pedestrian Bridges, Parking and Roadways
Medium Construction	▪ Construct Passenger Station Facilities ▪ Drainage Installations ▪ Perform Minor Earthwork and Pave Roadways ▪ Construct Trackwork ▪ Construct and Install Special Trackwork
Light Construction	▪ Finish Track Alignment and Surface ▪ Install Train Control and Communications Systems ▪ Install Street Lighting ▪ Landscaping ▪ Install Signage and Striping ▪ Close Detours ▪ Clean−up
Placement In Service	▪ Test Systems & Communications ▪ Implement Signaling Systems

Source: HDR, 2016.

3.3 CONSTRUCTION ACTIVITIES

3.3.1 Preconstruction Surveys

The DC to RVA corridor requires advance information for the development of designs and layout of the design prior to commencement of the construction activities and during the construction.

Geological requirements necessitate collecting of soil borings and soil samples which requires access the rights-of-way.

Utility location services will require access to the rights-of-way to determine type of utility and determine the underground elevations.

Field surveys are required to accurately locate existing features, property and easement lines, establish survey controls and benchmarks, and for layout or alignments and construction lines.

3.3.2 Site Preparation

Site preparation applies to rail and roadway projects and demolition is the first stage of construction. Demolition consists of removing buildings and other large features that conflict with the planned construction. Different methods of demolition could be employed depending on resources available.

Clearing & Grubbing

Clearing and grubbing typically follows the demolition stage of construction. Clearing and grubbing consists of the removal of top soil, trees, minor physical objects and other vegetation from the construction site with the use of specialized equipment for raking, cutting and grubbing. The entire area encompassed by the temporary construction easement would be cleared and grubbed with the exception of areas that have been deemed environmentally sensitive. The clearing and grubbing operations would use mechanical equipment such as loaders, dump trucks, and scrapers.

Preliminary earthwork consists of stripping topsoil from an area and either removing earth or placing and compacting earth for roadbed construction or slope construction.

Erosion Control & Sediment Control

A variety of temporary construction Best Management Practices (BMPs) are used for Erosion Control and Sediment Control (ECSC), including silt fences, berms, storm drain inlet protection, straw bale barriers, check dams, and detention or siltation ponds. Erosion control measures are to be installed and operational before commencement of any ground-disturbing activities. Areas where vegetation should be preserved are clearly marked or fenced. If work is conducted at night, temporary lighting is utilized.

Utilities

The alignments traverse municipalities, urban areas, and suburban agricultural areas, existing utilities such as water supply, sanitary sewer, power, communication, etc., will need to be relocated or adjusted to provide the required clearance for the corridor. Utility relocation and adjustment should be conducted prior to earthworks for the corridor project. New utility connections for corridor facilities (stations, etc.) are anticipated to be constructed during the site preparation stage. During the construction process, coordination between the Contractor and the utility companies will be essential to ensure that all utilities that are in conflict with the corridor are relocated in a timely manner. All utilities relocations are subject to CSXT and local permitting.

Temporary Haul Roads

Temporary road construction is often necessary for equipment access and involves similar site preparation activities as conducted for permanent roads. However, these roads are often unpaved, either constructed by grading, laying fabric and quarry spalls, or construction mats. Compaction is minimized so the materials can be removed and the site restored and replanted following construction.

3.3.3 Heavy Construction

Earthwork

The earth may be moved from or to another section on the same project, or it may come from or be disposed off-site. Excavation is the removal of soils by use of mechanical equipment. Embankment is the placing and compaction of soils for the construction process by means of mechanical equipment. Mechanical equipment such as dump trucks would be used to transport soils to and from the construction site. Excavators, scrapers, and graders would excavate cuts and place fill embankments. Rollers would be used to compact soils to the required compaction limits.

Presently, no blasting for excavation has been identified on the corridor.

Completed cuts or fills may then be covered by any number of treatments, such as rock base and pavement, rock stabilization and rip-rap, or mulch and seeding.

Drainage Structures

Drainage work often accompanies excavation and embankment. Impacts to wetlands and other sensitive areas are first avoided and minimized as much as possible, then mitigated when unavoidable.

Culverts include small concrete pipes and boxes that do not qualify as bridges due to their size. Typically bridges less than 20 feet wide are referred to as either culverts or structures. Conventional culverts include, but are not limited to, concrete, corrugated metal, and PVC piping. Proper culvert sizing is determined by consulting hydraulics manuals. Average culvert lengths range between 18 and 200 feet. Culvert replacements typically require less than one month to complete. Typical culvert replacements involve removing vegetation at the outlet and inlet areas, placing the new culvert, backfilling, installing headwalls, re-vegetating if necessary, and if flow is present, dewatering the work area and establishing a flow bypass prior to initiating work. In-water construction typically occurs during low-flow months, or work occurs during dry periods.

Culverts may be required to be extended for trackbed widening, repaired to full functionality, or new installations to meet local conditions.. Repair or replacement of worn or damaged culverts prevents damage to the roadbed from water saturating the roadbed fill material. Culverts require maintenance when at least 25 percent of their capacity is restricted by debris, sediment, or vegetation.

Drainage will involve both permanent and temporary systems for track and road construction. Temporary systems will be developed to allow for the construction of activities that must be performed in dry conditions. Means and methods for temporary dewatering could include well point systems, sock drains and bypass pumping from one retention area to another. Ground water considerations will need to be taken into account for all operations involving dewatering. Permanent drainage features are anticipated to include closed pipe systems, open channels, swales, box culverts, inlets, and manholes. Production rates for installing permanent drainage will vary depending on depth of cut, soil conditions, installation methods, and type of structures.

Major Bridge Structures

Railway structures include structures over waterways, other railways, and roadways. The existing major railroad structures are scheduled to remain in service with new construction located adjacent to the existing with similar horizontal alignments, and vertical profiles. Drainage structures may require the extension of the existing structures in situ.

There are multiple types of bridges including but not limited to concrete slab, concrete arch, concrete box girder, concrete T beam, steel beam, pre-tensioned concrete beam, post-tensioned concrete beam, steel truss, and timber trestle. The structure construction proposed varies according to function, and design requirements at each respected location. The major multiple span structures will be a typical ballasted deck plate girder superstructure construction. The multiple span substructures shall be driven precast concrete piles with caps and concrete abutments. Thru girders may be required where clearance is critical under the spans and will be reviewed during the design phase. Foundation will vary from spread footings to deep foundation with pipe piles, prestressed concrete piles, or drilled shafts.

Bridges can span wetlands, streams, and other water bodies as well as roadway and other transportation infrastructure. Some bridges span the stream systems they are crossing, while others have piers in the channel. The number of piers in the channel varies by bridge. Most new bridges are designed to span as much of the river as possible, and to provide the least amount of constriction that is practicable on the system. Many bridge piers are now drilled shafts, eliminating shallow footings that are susceptible to scour.

Major bridge construction activities often include:

- Clearing and grading for roadbed widening
- Clearing and grubbing of existing streamside vegetation
- Excavation for new bridge abutments
- Construction of bridge abutments, piers, and retaining walls
- Placement of bridge girders and beams
- Pouring concrete
- Riprap placement

Pile driving is required for the deep foundations and driving rates will vary according to the geological conditions, depth, and number of piles. All pile driving operations shall be performed as to not interfere or foul the existing railroad operations. Local ordinances may restrict pile driving within cities and suburban areas may limit work activities to avoid night time work.

Piles are installed using several different methods. Pile driving involves the use of an impact pile driving hammer, which is a large piston-like device that is usually attached to a crane. The power source for impact hammers may be mechanical, "air steam," diesel, or hydraulic. In most impact drivers, a vertical support holds the pile in place while a heavy weight or ram moves up and down, striking an anvil which transmits the blow of the ram to the pile. In hydraulic hammers, the ram is lifted by fluid, and gravity alone acts on the down stroke. A diesel hammer, or internal combustion hammer, carries its own power source, and can be open-end or closed-end. An open-end diesel hammer falls just under the action of gravity. A closed-end diesel hammer (double acting) compresses air on its upward stroke and can therefore run faster than open-end hammers. Impact hammers can drive at a rate of approximately 40 strikes per minute.

Vibratory hammers can also be used to both install and remove piling. A vibratory hammer is a large, mechanical device, mostly constructed of steel (weighing 5 to l6 tons) that is suspended from a crane by a cable. A vibratory pile driving hammer has a set of jaws that clamp onto the top of the pile. The pile is held steady while the hammer vibrates the pile to the desired depth. Because vibratory hammers are not impact tools, noise levels are not as high as with impact pile drivers. However, piles that are installed with a vibratory hammer must often be "proofed." Proofing involves striking the pile with an impact hammer to determine the load bearing capacity of the pile and may involve multiple impacts. If this is the case, noise will be elevated to that associated with impact pile driving – but for a shorter duration. To remove piles, the hammer is engaged and slowly lifted with the aid of a crane, extracting the piling from the sediment.

Piles may be driven from embankment for many single span installations. For piles driven in channels and waterway may require barges staged in the channels with cranes for driving the piles and placement of superstructures elements.

The driven piles are cut to length and pile cap are constructed to support the superstructure. Construction of concrete substructures requires the placement of steel reinforcement and concrete.

Superstructure is expected to be deck plate girder type to support ballasted track structures. The girders will be manufactured and delivered to the site by truck or rail. The unloading and placement of the girders, beams, and framing will require cranes. The decking is expected to be concrete with curbs, and will be framed and poured. Placement and staging of the cranes shall be scheduled as to not foul the tracks or interfere with train operations.

Temporary shoring and/or bracing will be required during the construction phase as well as temporary supports and falsework.

Minor single span structures will be either ballast deck plate girder or a standard CSXT concrete box structure and are site specific.

Refer to Appendix C for Rail Structures List.

Aerial Structures Construction over Roadways

Aerial structure construction over roadways will need to be coordinated with the local roadway agency, since minor closures may be necessary to allow the Contractor the ability to erect and disassemble falsework. During such operations, the roadway would be temporarily closed to allow the Contractor the exclusive use of the travelled way to position falsework beams in place above the roadway. Traffic would be detoured around the construction area following the requirements of and with the approval of the local agency.

Retaining Walls

Retaining wall construction is a major component of the DC2RVA project. Retaining walls are used to minimize the footprint width of the trackway or roadway cut or fill. Because retaining walls can be virtually vertical, they create a much smaller footprint than an earth slope. They can be used to support the roadway when the roadway is higher than the surrounding ground. Retaining walls can also be used in situations where the road is lower than the surrounding ground. In this case, the retaining wall supports the adjacent soils and prevent them from slumping onto the roadway. Retaining walls are also used in areas where there is a high possibility of erosion, such as near a bridge abutment or water. The walls must have an area of free drainage between the retained soil and the back of the retaining wall to prevent water pressure from developing and adding to the soil loads. The drainage is usually provided by placing a layer of clean gravel and drainage pipes against the back of the retaining wall. Cast–in-place (CIP) type retaining walls are anticipated on the corridor.

3.3.4 Medium Construction

Trackwork Construction

The third main track provides the ability for train operations on two tracks with trackwork progressing on the new construction, track shift, or track improvement on adjacent tracks not in-service.

The proposed track structure shall be ballasted track to be constructed on a prepared trackbed. As the earthwork is completed and approved a subballast layer is constructed with aggregates hauled from the local quarries and from contractor’s stockpiles. The subballast is graded to established lines and rolled and compacted. All underground construction of utilities, and cabling should be completed prior to final placement of the subgrade. If the subballast layer is disturbed after installation it shall be restored and compacted.

With the completion of the installation of the subballast layer it is expected to pre-ballast the roadbed with an 8-inch minimum layer of ballast. The placement of ballast shall be by dump trucks from ballast storage area or directly from the ballast quarries. The ballast is then graded and compacted to accept the track structure.

New Track Construction

Track construction for the new mainline shall consist of continuous welded rail, CWR, on either timber or concrete ties with resilient fasteners according to CSXT track standards. Mainline Class IV for passenger speeds less than 80 mph shall be constructed with timber ties. Mainline Class V track for passenger speeds between 80 and 90 mph, the track shall be constructed with concrete ties.

Railroad track materials are delivered via rail and unloaded on-site or at material storage areas and delivered by truck to the site. Continuous welded rail is delivered via rail train to the site in 1600 foot lengths and unloaded on the roadbed. Ties and Other Track Material (OTM) are typically delivered by rail car and either unloaded on the roadbed or the storage area. Granite ballast is available from several producers in close proximity to the DC to RVA corridor, which either allows for trucking directly to the site or delivery by rail car for unloading on the pre-assembled tracks.

Typical conventional method of track construction includes the laying of ties, placing previously unloaded CWR on the ties, installation of fasteners and anchoring systems, ballasting of track, tamping and lining track, adjustment of rail for neutral rail temperature, welding and final dressing of ballast. These tasks are performed by specialized on-track equipment.

Track construction methods may include the placement of pre-constructed track panels in relative short distances where conditions require short interval for construction windows.

The track construction may be performed with modern track laying machine that can achieve three times the production rates over conventional track construction. The track laying machine requires the CWR to be placed on the roadbed prior to the construction. The track laying machine is capable of constructing track using either timber pre-plated ties or concrete ties. Ties are supplied via a gantry system forward of the work area where the rail is threaded on to the ties and the rail fasteners installed and the assembled track placed on the alignment. The work can be performed safely while operating trains on the adjacent track, the operator are in work areas confined to the track laying equipment and no workers are outside the controlled work areas. Ballast will be unloaded, the track stabilized, the rail will be thermally adjusted and welded for final surfacing.

Track Shifts and Mainline Relocations

In addition to mainline and siding construction, there is also a subcategory for shifting the existing track alignment, where new track materials other than additional ballast will not be required. Such track realignment would be required in locations where the proposed third track shifts from the east side of the existing two-track main to the west side (or vice versa), to improve curve geometrics for speed increase, at certain overhead bridges to improve clearance, and at existing passenger stations. Track shifts and shoefly tracks are an option for control point installations and for the construction of structures below the track grade. The track shifts will be placed on a prepared trackbed and will require dozers and loaders for the track shift, track stabilizer, work trains for unloading of ballast; and tampers and ballast regulators for surfacing the tracks.

Track Upgrades for Mainline Speed Increase

The existing mainline track is presently generally maintained to FRA Class 4 (passenger speeds less than 80 mph, although speeds are currently limited to 70 mph) Track Standards. The increase in speeds on the corridor requires the existing track within the limits of speed increase to 90 mph allowable speed. The increase in speed warrants track upgrades to FRA Class 5 track standards. The present upgrades are expected to change the track structure from existing timber ties to concrete ties with the associated OTM. These upgrades typically are performed in situ while maintaining rail operations; though the upgrades on the corridor may be performed on tracks that are out of service to avoid operational impacts. All track related work shall be performed by mechanized railway equipment.

Control Points & Special Trackwork

The addition of the third main track, speed improvements, and increases in capacity mandates the upgrades and reconfiguration of the existing control points, and the addition of new control points on the DC to RVA corridor. The existing crossovers and universal crossovers will be renewed with new No. 20 standard special trackwork installations.

The new installation requires a roadbed pad to be graded and subballast installed for the assembly and construction staging of the special trackwork. The special trackwork may be assembled on site or delivered from the manufacturer in segmental panels via specialized railcars and unloaded at the site on the graded pads. The panels will be assembled and welded for scheduled installation. The installation will require cranes or specialized heavy equipment to perform the removals and installation.

Control point cut-ins and sequence of trackwork will be unique to each location and special coordination is required between the rail operations, trackwork, train control, and other contractors to sequence and stage the work. Track, bridge, train control, central dispatch centers and other tasks under progress in adjacent Direct Traffic Control (DTC) blocks may have direct impacts to schedules and the corridor will demand the scheduled for control points changes to be properly sequenced.

Staging of the trackwork at a control point will require a clear area and a construction pad to support delivery, setup of pre-assembled special trackwork units, and installation requirements for equipment and roadway worker safety. Consideration for the staging of the special trackwork shall include train control requirements stage construction of signal houses and other facilities.

The staging may allow for the special trackwork to be built entirely or partially on alignment and grade. The pre-constructed tracks will be either be pre-connected to the special trackwork or require minor shifts to connect to special trackwork at the time of placement in-service.

There will also be areas where the special trackwork will be built off line and placed on alignment when placing the tracks in-service. Methods of off-line installation may include cranes, dozers, excavator, or specialized rail equipment to set the special trackwork in place. The connection to existing track will be completed.

A typical installation of special trackwork can be achieved during an 8 to 56 hour period depending on the size and configurations of special trackwork, local constraints, and related tasks to be performed during the installations.

Trackwork At-Grade Crossings

The DC to RVA corridor has many existing roadways that traverse the track at-grade. These roadways are state highway, Municipal Street, or private. The existing crossing to be rebuilt and constructed during the third track addition will be built with CSX standard concrete track panels and the roadway will improved for vehicular safety for pavement, markings, drainage, and the train warning protection. Closures and detouring for major roadways may require work to be performed at night or during weekend to minimize the impacts traffic. One and two lane roadways are typically reconstructed in a normal workday and will require complete closure to install track and panels; with final finishes completed with minor or single lane closures. Equipment for this task includes track hoes, excavator, bump trucks, loader, and paving machinery.

Trackwork Construction Phasing

Typical phasing sequence of trackwork within a segment, between control points, or within defined limits can be performed in a typical sequence.

- The infrastructure, station platform, rail bridges, highway bridges, earthwork and drainage have been completed to support railroad track construction.
- Third main, e.g. track 1, will be constructed completely and finished in advance of the placement in service. The limits of track 1 will be established by a construction schedule for predecessor and successor activities.
- Track 2 will be removed from service, the rail cut on each end of segment, and shifted to align with newly constructed track 1, rails connected, stabilized, ballasted and surfaced.
- Rail operations will then be limited to the existing main track 3 and main track 1 will serve as the second main track.
- Track 2 will be shifted to a new alignment on fifteen foot track centers relative to track 1. Track 2 will be surfaced to the new alignment and superelevated to accommodate the increased speeds.
- Track 3 will be removed from service and track 1 will remain in service.
- Track 3 and track 2 will be shifted, connected, track ballasted, aligned and surfaced. Track 3 mainline operations will be shifted to track 2 and track 3 will remain out of service.
- Track 3 will be shifted to a new alignment on fifteen foot track centers relative to track 2. Track 3 will be surfaced to the new alignment and superelevated to accommodate the increased speeds.
- Track 3 will be connected either to temporary alignment or to special trackwork at control points and placed in service.
- Rail operations are to full capacity on main tracks 1, 2 and 3.

Passenger Station Improvements

The existing railway passenger stations on the DC to RVA corridor require facilities infrastructure improvements for the additional third track, projected ridership, and connectivity. The individual stations site requirements will be developed in Preliminary Engineering.

Station Site Preparation

The site preparation may include demolition of existing facilities to be determined. The site will include clearing and grubbing; grading for the platform and third track; utility service installation and relocations; and drainage installations. Additional site work will be required for access, connectivity, parking, and subsequent work task during the project.

Station Passenger Platforms

The additional third track requires the construction of a new platform at all stations. The platform shall be constructed in advance and shall completed ready for service when the third track is placed in-service for operations. The platform work shall consist of a poured concrete structure with, MEP, communications systems, elevators, and pedestrian overpasses for ingress and egress to the station. Contractor shall stage construction for material delivery and handling, construction equipment, and work zones to not interfere with the existing train and station operations during construction.

Station Overhead Pedestrian Crossing

The new platforms for the additional third track require the construction of a pedestrian crossing over existing tracks and/or the new track under construction. The truss will require concrete foundations and piers to be framed, reinforced, and poured. The aerial truss construction placement will require cranes for setting the trusses over the tracks; and to erect and disassemble falsework. These activities require advanced coordination with the railroads. Ancillary work that can be performed without fouling the track includes framing, decking, MEP, finishes, and support systems. These tasks will require construction material handlers, welding equipment, concrete placement, and finishes to be installed. The overhead pedestrian structures include stairways and elevators to be constructed on the platforms and station for access.

Other Station Infrastructure

Other infrastructure improvements at stations are being developed. Each station is being reviewed for existing and projected demands. Construction additions or modification may include intermodal connectivity for local transit, passenger pickup and drop offs, parking (either parking decks or paved parking areas), and internal connectivity.

Roadway

Roadway reconstruction is a major component of the DC to RVA corridor project. Due to the alignment of the corridor, roads are proposed to be lowered, elevated, realigned, or reconstructed. The proposed alignment may retain the existing roadway at-grade or either replaced as overpasses or underpasses. At-grade crossing may need to be closed, and new grade separations may be warranted by traffic demands and the addition of the third track. The roadway and highways shall be designed and constructed to Virginia Department of Transportation standards.

After the earthwork operations and utilities relocations have been constructed the roadway subgrade, base and final pavement sections will be constructed.

Since roadway closures and detours during the construction process are anticipated, close coordination between the Contractor and the relevant local agencies is essential to scheduling temporary road closures and obtaining approval of detour routes.

Roadway Structures over Railways

Structures over railways require horizontal and vertical clearances to be maintained during construction and in post construction operations.

The structure type for grade separations will be determined during the planning and design phase and are dependent on factors such as alignment, topography, and geological conditions.

The location of abutments and piers are typically 25 feet horizontally from the center of the nearest track which allow access with excavators, pile drivers, and concrete trucks to the site. Aerial structure construction over railroads requires the contractor to place AASHTO prestressed concrete type girders, in lengths ranging from 100 to 120 feet, with cranes over the operating tracks; and to erect and disassemble falsework. These activities require advanced coordination with the railroads. The framing and concrete decks can be constructed with accomplished with material loaders, welding activities and the placement of concrete and paving without interference to railroad operations.

Construction Staging at Roadway Grade Separations

The following conditions may require detailed site-specific construction staging plans:

- Locations involving corridor structures passing under existing railroads or major highways that can tolerate only very short traffic interruptions.
- Locations involving multiple roadway grade separations and/or realignments of busy highways that can tolerate only minimal impact to roadway traffic. These situations also frequently require temporary railroad shoofly or detour tracks as well as possibly also requiring multiple roadway detour routes and/or temporary detour roads.

Detours

Locations involving multiple grade separations and/or alignments of busy highways that can tolerate only minimal impact to roadway traffic typically require detailed site-specific construction staging plans. These situations also frequently require multiple detour routes and/or temporary detour roads.

At proposed grade separation sites, where the existing roadway has low traffic counts, where convenient non-circuitous detour routes are available, and where minimal adjacent properties or businesses would be adversely affected, the use of more complex and expensive staged construction procedures cannot be justified. Many of the grade separation structures on the corridor are in a rural setting and meet these conditions, the closure of these roads during the construction of the grade separation combined with the use of detour routes is proposed.

Temporary Roads at Grade Separations

On-site construction of temporary detour roads, either in place of or in addition to existing road detours, is proposed at grade separation sites where there would be excessive impact on roadway traffic or on adjacent properties or businesses with the use of existing roads only as detour routes. Excessive traffic impacts could result if there are high traffic counts on the road to be separated or on potential detour routes and where there are circuitous or no detour routes available.

The use of temporary detour roads usually requires staged construction with the following construction sequencing typically followed:

- Construct temporary detour roadway around and outside the permanent roadway construction work zone.
- Shift roadway traffic to the temporary detour roadway and close existing road.
- Remove existing roadway and construct the grade separation structure and new roadway.
- Shift roadway traffic to the new permanent grade separated road and close temporary detour road.
- Remove temporary detour roadway and restore temporary road right-of-way to original use.

The closure of roads during grade separation construction with the use of site-specific temporary detour roads and staged construction is delineated in the Civil and Grade Separation Plan Set.

3.3.5 Light Construction

Train Control & Systems Facilities

Train control and communications infrastructure will have additions and upgrades to support the control point, interlockings, and the speed improvements on the DC to RVA corridor.

The new and revised control points and interlockings, and the additions of No. 20 turnouts and crossovers will require new signal installation with signal control houses and cabling. Wayside signals will be replaced with overhead signal trusses for spanning the additional main tracks. The truss systems will require new foundations installations. The cabling will be installed underground linking the new trackwork, overhead signals, and signal houses. Cranes will be required to set the trusses and signal houses.

Wayside intermediate signals will be relocated along the corridor for train operations between control points and interlockings.

Defect Detectors along the corridor will be relocated and upgraded for the additional main line installation.

At-Grade crossing protections will be relocated and upgraded for the additional main line track installation. Train detection will be relocated for the speed increases. Relocation of signal mast and crossing arms require new signal foundations, cabling, and truck mounted equipment for setting signals.

3.3.6 Placement In-Service

Placement in service includes the inspections, testing and training.

Construction inspections are complete to ensure that items constructed meet specifications and conform to design drawing.

All systems including train control, communications, and station facilities are tested for full compliance to specifications and all operations are fully functional.

The operators and maintainers of the system are fully trained on the operating rules, safety functions and procedures, and the operation of the systems.

4 CONSTRUCTION EQUIPMENT

The DC to RVA corridor construction will involve many trades and utilize various type of construction equipment. The contractor is responsible for selection of methods and means, crew sizes, and equipment to meet construction schedule timelines and specific for the segment under contract.

Refer to list of equipment utilization to work activities and typical production rates for work activities. The equipment listed include a generic makes and models for the assign activity. The project specific requirements and availability may supplement the equipment list for actual equipment on the site.

The classification of work is by:

- Civil: Demolition, Clearing & Grubbing
- Civil: Grading and Excavation
- Civil: Paving
- Civil: Milling
- Civil: Concrete Work
- Civil: Miscellaneous
- Trackwork
- Train Control
- Stations: Platform
- Stations: Facilities
- Structures: Rail
- Structures: Highway
- Structures: Retaining Walls
- Structures: Drainage
- Utilities

4.1 CONSTRUCTION STAGING AND HAUL ROUTES

4.1.1 Staging Areas

Staging Areas – Staging areas are used for delivery and storage of construction materials and equipment, contractor office and storage trailers, and employee parking. They would be similar for road and rail projects and are typically contractor-selected and permitted. These areas are often fenced and located in proximity to project construction. Temporary fencing prevents machinery and equipment, materials storage, and construction activity from intruding into adjacent properties, wetland and stream buffers, and shoreline areas. Office trailers, placed on temporary foundations, are often connected to available utilities including power, telephone, water, and sewer as needed. Connecting to these utilities may include installing poles for power lines and excavating trenches to place water and sewer pipelines. After construction is complete, staging areas are restored, if appropriate, and disconnected from any utilities.

General requirements for construction staging areas shall include:

- Each segment shall have at least one designated storage area.
- Relatively flat and is either graded or paved.
- Rail and or highway networks access.
- Located within the existing rights-of-way.
- Located in close proximity to the construction activities.
- In relative size to support the construction activities.
- Each passenger stations shall have a designated staging area.
- Each major structure shall have a designated staging area.
- Each control point shall have a permanent pad constructed to support local staging.
- Staging and Storage areas shall be shown on the final construction plans.

Depending on site conditions, construction staging areas vary in size and may require vegetation clearing, grubbing, and grading or excavation to level the site and install drainage improvements. Extensive alterations to establish a staging area, such as blasting, are extremely unlikely. Cleared vegetation is often hauled offsite, mulched and redistributed, or less commonly piled and burned onsite. Excess material (e.g., soil, rock, and debris) is disposed of at offsite facilities or reused as appropriate in construction.

Conveyance systems for the movement of storm water from a collection point to an outfall can consist of drainage pipes and storm water facilities (such as ponds, vaults, and catch basins), using gravity or pumps to move the storm water. Temporary driveways and access roads may be established from staging areas to the existing roadway network. Some staging areas may also be equipped with wheel washes that clean truck tires to reduce tracking dirt and dust offsite. Additional dust control is provided via water trucks and street sweepers.

Staging, fueling, and storage areas are typically located in areas that minimize potential effects to sensitive areas. Specialized best management practices (BMPs) are employed around concrete-handling areas to prevent water contamination from uncured cement entering water bodies or storm water facilities. Temporary erosion and sediment control measures are implemented prior to ground disturbance on these sites. Examples include marking clearing limits, establishing construction access, controlling runoff flow rates (sediment ponds, check dams, etc.), installing sediment controls and soil stabilization (silt fence, coir blankets, temporary seeding), protecting slopes, protecting drain inlets, and preventing/containing contaminant spills.

Offsite Use Areas – Offsite use areas are necessary for rail and roadway projects and mainly consist of borrow material and non-hazardous waste disposal sites. Depending on the project, they can be owned by public or private entity. They are typically permitted separately from the project and are contractor-selected. Common activities associated with material sites include vegetation removal, excavation, and rock crushing, and blasting.

4.1.2 Haul Routes

The 123-mile DC to RVA corridor will requires the hauling of construction materials and equipment to and from or within the project rights-of-way. The transport of these items may be by rail, by waterways or by the roadway network and are designated as haul routes.

4.1.2.1 Temporary Hauls Routes

The temporary haul routes are typically used for earthwork, drainage, utility, trackwork, and continual access for railroad maintenance activities. Temporary haul routes localized to the project rights-of-way will be maintained by the contractor during the construction project will be used for material and equipment movements without departing from the rights-of-way. The haul routes will at all times allow for the safe movements, and will construct to avoid potential interference of train operations. The temporary haul routes shall not be constructed within wetlands or areas requiring environmental mitigation.

Temporary haul routes may be required to access the rights-of-way from the local roadway networks on land that are either owned by the VDOT, local municipalities or may be privately owned. The contractor shall secure the necessary permits and rights-of-entry and restore the property to the preconstruction condition upon demobilization and completion of the construction activities.

4.2.1.2 Rail Haul Routes

CSXT provides rail service along the corridor for delivery of material and equipment to yard tracks and team tracks. The rail connections allow for material to be routed to and from the CSXT network and connect with the Norfolk Southern Railway (NSRR). The CSXT regionally and locally provides service to suppliers of ballast, aggregates, and concrete products within the corridor and allows benefits of delivery, staging, and storage of materials.

4.2.1.3 Waterway Haul Routes

The DC to RVA corridor has available access to the Potomac River waterway and the Port of Richmond on the James River for the delivery of materials.

The northern segment from Alexandria, Va. to north of the City of Fredericksburg, Va. parallels the Potomac River which will allow for barge access to the major bridges construction projects. Local barge loading and unloading as determined by the contractor will be secured by the contractor as the construction commences for each location.

The alternatives under review in the City of Richmond, Va. propose bridge crossings of the James River. The Richmond Marine Terminal is central Virginia's domestic and international multi-modal freight and distribution gateway on the James River with waterborne, rail, and shipper access.

4.2.1.4 Roadway Haul Routes

The roadway haul routes on the corridor for material deliveries for suppliers, staging areas, and storage sites are expected to be inclusive of the Virginia state highway network. The contractor shall secure the necessary permits for the hauling of material and equipment with the Virginia Department of Motor Vehicles.

Project Haul Routes in Virginia:

- Interstate Highways
  - I-95 from Alexandria to Richmond
  - I-395 in Alexandria
  - I-495 in Alexandria
  - I-295 and I-64 in Richmond
- Primary Highways:
  - U.S. Routes
  - Virginia Highway, route number under 600
- Virginia Secondary Highways, route number greater than 600
- County, City and Municipal Street

4.2.1.5 Material Suppliers

The materials resourced locally for the construction include but not limited to selected aggregates from quarries, railroad ballast, concrete ready mix, precast prestressed concrete products, and asphalt materials. Additional material may be required include steel for structures, rail, ties and other track material, specialized material and prefabricated assemblies and these sources are not available for this report.

Material suppliers list is a compilation of CSX Ballast Producers in Virginia; and Virginia Transportation Construction Alliance members. It is not intended as a full complete list of all suppliers of material in the area nor a list of approved suppliers, rather a list to determine haul routes and availability of materials.

Material Suppliers

Name of Supplier	Location	Materials					Haul Type	
		Ballast	Aggregates	Asphalt	Concrete	Prestressed	Rail	Roadway
Luck Stone Boscobel Plant	Sabot, VA	X					X	X
Martin Marietta Aggregates	Doswell, VA	X					X	X
Vulcan Materials Company	Skippers, VA	X					X	X
Aggregate Industires	Ashland, VA		X		X			X
American Pipe Company	Ashland, VA				X			X
American Stone	Ruther Glen, VA				X	X		X
Americast	Ashland, VA					X		X
Beasley Concrete	Milford, VA				X			X
Branscome Powhatan Asphalt	Doswell, VA			X	X			X
Green Rock Material, LLC	Richmond, VA				X			X
Hanson Concret Product	Ashland, VA			X		X		X
Hanson Pipe & Precast	Manassas, VA					X		X
Luck Stone	Chantilly, VA		X					X
Luck Stone	Richmond, VA		X	X				X
Luck Stone Quarry	Fredericksburg, VA		X					X
Oldcastle Precast Inc	Fredericksburg, VA					X		X
Powhatan Ready Mix	Richmond, VA				X			X
Roanakoe Cement Co.	Richmond, VA				X			X
Rotondo Precast	Fredericksburg, VA					X		X
S B Cox Ready Mis	Doswell, VA			X	X			X
S B Cox Ready Mis	Henrico, VA		X		X			X
Seaborad Concrete	Richmond, VA				X	X		X
Spotsyvannia Concrete Plant	Fredericksburg, VA				X			X
Surperior Paving Corp	Fredericksburg, VA				X			X
Virginia Paving Co.	Alexandria, VA		X	X	X			X
Virginia Paving Co.	Fredericksburg, VA		X	X			X	X
Virginia Paving Co.	Lorton, VA			X				X
Vulcan Materials	Alexandria, VA		X				X	X
Vulcan Materials	Arlington, VA							X
Vulcan Materials	Dufries		X		X			X
Vulcan Materials	Fredericksburg, VA			X				X
Vulcan Materials	Henrico, VA							X
Vulcan Materials	Lorton, VA		X					X
Vulcan Materials	Richmond, VA		X					X
Vulcan Materials	Rockwille, VA		X					X
Vulcan Materials	Springfield, VA		X				X	X
Vulcan Materials	Stafford, VA		X					X
Vulcan Materials	Stafford, VA		X					X
Vulcan Materials	Woodbridge, VA				X			X

5 CONSTRUCTION HOURS

The DC2RVA corridor has high volumes of train traffic operating 24 hours a day with minimal windows for construction activities to be performed on or over the operating tracks. Construction work is typically progressed weekdays, during daylight, and with single shifts performing the work.

Construction schedules are flexible but at the same time there are work windows for performing specific tasks that are constrained by local impacts, material deliveries, traffic congestions, or railroad operations. This will require work to be performed at night or during the weekends. The contractor shall not be restrained from working during these periods unless prohibited by local regulations or permitting requirement.

5.1 NIGHTTIME AND WEEKEND CONSTRUCTION

When night time work is required, it requires work place safety which should be reviewed to protect the worker and to provide protection to the travelling public. Illumination must be provided, extra work-zone markings and flagmen are required due to visibility, impaired drivers, and higher speeds on roadways.

Because of increased traffic congestion during the day, road construction activities are proposed to be conducted during nighttime hours or during the weekends when traffic volumes are lower.

Roadway task performed during the night may include milling and paving installations.

Bridge construction over highways requires the placement of girders and beams across traffic lanes. Night times are often selected for this work activities when lanes can be closed completely and detouring of traffic does not add significantly to the current congestion. The closures allow for the delivery of long girders to the site, the staging of cranes to pick the and place the girders and the setting of false work.

Bridges and trusses over the railroad also require scheduling of construction tasks over active tracks. The windows available are determined by railroad operations and can occur anytime during the day or night when available.

Bridge over waterways may require extra shifts to work nights for specific tasks such as girder placement of the pouring of concrete foundation that cannot be interrupted once the task starts. Many bridges have schedules that require more than one shift for project completion.

Trackwork for the phasing of the third track and modifications of the existing track require track operations to be suspended for limited time periods. This requires the work not to be interrupted and the railroad operations restored by a given time. Work expected during these outages will include removal of existing track, excavation, grading, placement of special trackwork by cranes or heavy machinery, track welding, ballast unloading, train control systems installations, and the lining and surfacing of track.

Trackwork interfacing with roadway may require road closures. Multiple lanes roadways often require full closures of roadways for extended periods to allow for removals, excavations, placement of subgrade and drainage, track installations and surfacing, installation of the crossing structures and paving.

Station infrastructure improvements may require work to be performed at night when operations are less frequent and the impact to public safety is less. These activities may include platform work, placement of pedestrian crossing over track, parking deck construction and the paving of roadway within the site.

6 RAILROAD OPERATION IMPACTS

6.1 RAIL OPERATIONS AND ASSUMPTIONS

The DC2RVA corridor supports the operation of freight, passenger, and commuter rail operations. CSXT is the host railroad on the corridor. CSX interchanges with the Buckingham Branch Railroad (BBRR) in Doswell and Richmond; Norfolk Southern (NS) in Northern Virginia; and Amtrak in Washington, D.C. and to the south. CSXT has primary control of trackage or infrastructure within the study area. Operators on the corridor include CSXT, Amtrak, the Virginia Railway Express (VRE), NS, and BBRR. The maximum authorized passenger rail speed (MAS) is 70 mph. Lower speeds are in effect in many sections due to the physical characteristics of the line.

The general intent is to add a parallel track to the existing rail network and increase speeds to the extent practical (MAS of 90 mph) consistent with corridor service objectives. The third track between Washington and Richmond would not be constructed as a completely separate track and would not be solely dedicated to passenger service. Rather, the track would be designed and operated as a mainline track along with the other two mainline tracks as a completely integrated three-track system. In some areas the new track would be built on the east side of the existing two-track system and in other locations on the west side or, where space permits, between the two existing tracks. Crossovers between tracks would be located at key locations to assure maximum fluidity of train operations. Both passenger and freight trains would have access to the new third track throughout the day depending on train dispatching requirements and negotiated priorities. Passenger trains would have access to all three mainline tracks. Under study is a fourth main track from Alexandria to Long Bridge and the operations will be consistent with the third track concept.

Track construction will be performed while maintaining train operations at the present level of service, and existing authorized speeds. Two main tracks shall be in service during normal operations and one operational main track during limited outages for trackwork installation, track shifts, and track maintenance activities. The speed increases will be initiated as track construction and control points are placed in service and with operational prerequisites accepted for service.

Train operations are presently centrally control via a Direct Traffic Control, Centralized Traffic Control block signal system with limits defined by control points. The preferred track construction shall be performed within blocks and between control points to minimize impact to operations. Construction tasks may be underway in multiple blocks along the corridor at any time, and may be subject to limits imposed for rail safety and operations. For new control points to be placed in service the train control systems will be impacted within the control point and the adjacent blocks signals. The design of the train control system for the corridor will be performed during the final design phase, and phasing of construction shall be coordinated at that time for the implementation of the new system.

The train operations will be impacted during installations, track shifts and special trackwork installations. The operational impacts will typically be localized to one operating main, for short intervals and allowing for one main track in full service operation. The closure of tracks requires suspension of train operations for varying durations either in the form of Operating Rule 704, Rule 707, curfews during weekends and holidays when operations are reduce. This will provide for the maximum track time and minimize the impacts to train operations. The contractor shall be responsible for scheduling, phasing of construction, and shall coordinate with the owner and the rail operators on the corridor.

The major infrastructure improvements for bridges, structures, walls, drainage, utilities relocated, roadbed, cabling duct banks and station platforms are anticipated to be complete or progressed to a stage that allows for track construction. Train Control and systems modification shall be complete or in a temporary phase to support track shifts and special trackwork installations.

6.2 CONSTRUCTION IMPACTS ON TRAIN OPERATIONS

Implementation of multiple infrastructure projects along an active highly congested rail corridor presents challenges. The construction of the various projects must be scheduled to minimize outages or delays to continuous train operations, the resource materials and resources where and when needed, and to optimize the overall project deliverables and completion. The planning and staging of work to minimize adverse impacts continuous rail operations will require a high level of coordination among the various rail operators. Likely adverse impacts could include the following:

- Reduced service during portions of the day or night to lengthen periods of available outages for construction activities
- Longer travel time, resulting from track being taken out of service and slower speeds on infrastructure and around work zones
- Reduced on-time performance and reliability resulting from specific project work, such as constructing infrastructure in between or adjacent to existing live and operating railroad tracks
- Temporary station closures to accommodate work at or around the stations
- Reduced parking at some station during construction
- Frequent changes to train schedules

The chief cause of delays during the capital improvements will be slow orders and the longer travel times. Slow orders are speed restrictions imposed by the host railroad due to infrastructure improvement work. Speed restrictions are classified as:

- Maximum working speed at which a train may pass through the work area
- Stabilizing speed - the greatest speed at which a train may pass over a repaired track to consolidate the roadbed and ballast.

The durations of the slow order speed restriction are dependent of the type of work activity, limits of track disturbance, type of equipment and methodology of construction, weather conditions, and train tonnage require for stabilization of the track.

Activities that require temporary slow orders include:

- Laying of rail
- Tie replacement
- At-grade crossing renewals
- Bridge work
- Surfacing of track
- Special trackwork installation
- Welding of rail

The primary work activities on the DC to RVA corridor generating the outages and slow orders will be the installation of special trackwork at the control points and track shifts which requires the predominate third track construction on the east side to shift to the west side (or vice-versa) either for curve realignment or geometric constraints. These activities will typically be limited to impacting one of the two of the operating tracks with the third track not in service during construction or renewals. Technique selection, equipment utilization, resources, and close coordination of the scheduling of activities shall minimize impact to train operations.

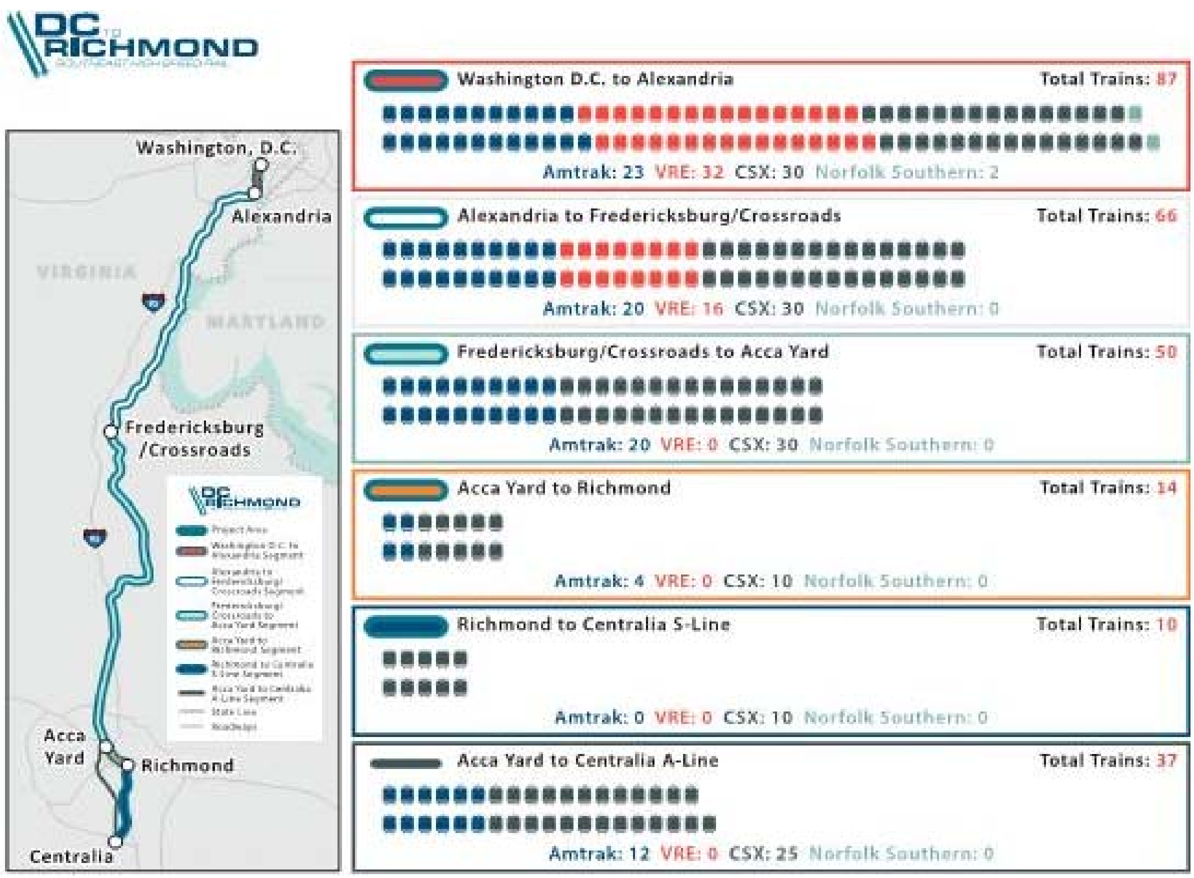
6.3 TRAIN OPERATIONS

CSX owns, operates, and controls the operation for the DC to Richmond corridor. The freight operations are 24 hours a day – 7 days a week with presently approximately 30 daily trains.

AMTRAK operates approximately 20 daily on the corridor with interchanges in the Richmond area; and additional trains interchanging in the Alexandria, Virginia area. Presently, AMTRAK serves 9 stations on the corridor.

Virginia Railway Express, VRE, operates between Washington, D.C. and Fredericksburg, Virginia and serves 11 stations within the corridor. VRE operates 12 daily trains from Fredericksburg to Alexandria and 20 daily trains from Alexandria to Washington.

Norfolk Southern interchanges with the CSX line at Alexandria and operates approximately two daily trains.



6.4 SCHEDULING

Freight and passenger service on the Washington DC to Richmond corridor will be strained during construction of the infrastructure improvements. The benefits derived from the added infrastructure and increase capacity will provide relief, flexibility for routing of trains, and increase in the operational speeds.

The scheduling and phasing of the segmental construction will be essential to project delivery. Scheduling construction will be critical and shall be coordinated with the rail operators and a baseline completed prior to the beginning of the construction phase. An analysis of the present train capacity and operations; the benefits derived from segmental construction including capacity and speed improvements shall be factored into the analysis.

Construction task that can be performed prior to impacting track removal, shifts or temporary outages from service and shall be advanced to early construction items. This shall include utility relocations, roadway relocations and roadway bridges over existing tracks, retaining walls, grading, roadbed construction, offline railway bridges, special trackwork preassembly, and station improvements.

Train operations will require two mainline track to be in service at all times with limited windows for tracks to be removed from service, this will require the major track related activities to be performed on track not in service and minimal windows for temporary shifts and transitions. The scheduling of tasks related to track service issues is critical to maintain train performance requirements.

7 CONSTRUCTION EQUIPMENT LIST

Civil: Demolition, Clearing and Grubbing			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Clearing – Light	**Acre**	**1.4**	**Acre/Day**
Truck 1/2 Ton (1) Dozer D-5 (1)			
Excavator Cat 336 (1)			
Tub Grinder (1)			
Clearing - Medium	**Acre**	**1.2**	**Acre/Day**
Truck 1/2 Ton (1) Dozer D-6 (1)			
Excavator Cat 336 (1)			
Tub Grinder (1)			
Clearing - Heavy	**Acre**	**1**	**Acre/Day**
Truck 1/2 Ton (1) Dozer D-5 (1)			
Dozer D-8 (1)			
Excavator Cat 336 (1)			
Tub Grinder (1)			
Structure Demolition	**Each**	**1**	**Each/Hour**
Truck 1/2 Ton (1) Truck Dump 14 CY (3)			
Loader R/T Cat 980 (1)			
Excavator Cat 336 (1)			
Pipe Removal - All Sizes	**LF**	**24**	**LF/Hour**
Truck 1/2 Ton (1) Truck Dump 14 CY (1)			
Dozer D-3 (1)			
Excavator Cat 336 (1)			
Pavement Removal - Asphalt	**CY**	**50**	**CY/Hour**
Truck 1/2 Ton (1) Truck Dump 14 CY (4)			
Volvo Milling Machine (1) Broom (1)			
Pavement Removal - Concrete	**CY**	**66**	**CY/Hour**
Truck 1/2 Ton (1) Truck Dump 14 CY (3)			
Loader R/T Cat 950 (1) Excavator W/ Hoe ram (1)			

Civil: Grading & Excavation			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Grading - Dirt - Off Road - Short Haul	**CY**	**200**	**CY/Hour**
Truck 1/2 Ton (1) Truck Water (0.5)			
Dozer D-7 (1)			
Haul Truck Articulated 25 Ton (2)			
Excavator Cat 345 (1)			
Motor Grader Cat 12 (0.5)			
Roller 815 Soil Compactor (1)			
Grading - Dirt - On Road - Short Haul	**CY**	**240**	**CY/Hour**
Truck 1/2 Ton (1) Truck Dump 14 CY (6)			
Truck Water (0.5)			
Dozer D-8 (1)			
Excavator Cat 345 (1)			
Motor Grader Cat 12 (0.5)			
Roller 815 Soil Compactor (1)			
Grading - Dirt - Off Road - Long Haul	**CY**	**280**	**CY/Hour**
Truck 1/2 Ton (1) Truck Water (1)			
Dozer D-8 (1)			
Haul Truck Rigid 50 Ton (3)			
Excavator Cat 345 (1)			
Motor Grader Cat 16 (1)			
Roller Cat 825 Soil Compactor (1)			
Grading - Dirt - On Road - Long Haul	**CY**	**240**	**CY/Hour**
Truck 1/2 Ton (1)			
Truck Dump 14 CY (18)			
Truck Water (0.5)			
Dozer D-8 (2)			
Excavator Cat 345 (1)			
Motor Grader Cat 16 (1)			
Roller 815 Soil Compactor (1)			
Grading -Rock - Off Road - Short Haul	**CY**	**210**	**CY/Hour**
Truck 1/2 Ton (1) Truck 1 Ton Powder (1)			
Truck Water (0.5)			
Dozer D-7 (1)			
Haul Truck Articulated 25 Ton (3)			
Loader R/T Cat 980 (1)			
Motor Grader Cat 12 (1)			
Track Drill ECM590 (2006) (1)			
Grading - Rock - On Road - Short Haul	**CY**	**140**	**CY/Hour**
Truck 1/2 Ton (1) Truck 1 Ton Powder (1)			
Truck Dump 14 CY (4)			
Truck Water (0.5)			
Dozer D-7 (1)			
Loader R/T Cat 980 (1)			
Motor Grader Cat 12 (1)			
Track Drill ECM590 (2006) (1)			
Grading - Rock - Off Road - Long Haul	**CY**	**240**	**CY/Hour**
Truck 1/2 Ton (1) Truck 1 Ton Powder (1)			
Truck Water (0.5)			
Dozer D-7 (1)			
Haul Truck Rigid 70 Ton (3)			
Loader R/T Cat 980 (1)			
Motor Grader Cat 12 (1)			

Track Drill ECM590 (2006) (1)			
Grading - Rock - On Road - Long Haul	**CY**	**140**	**CY/Hour**
Truck 1/2 Ton (1) Truck 1 Ton Powder (1)			
Truck Dump 14 CY (11)			
Truck Water (0.5)			
Dozer D-7 (1)			
Loader R/T Cat 980 (1)			
Motor Grader Cat 12 (1)			
Track Drill ECM590 (2006) (1)			
Rock Drilling & Blasting (Only) (No Haul)	**CY**	**250**	**CY/Hour**
Truck 1/2 Ton (1) Truck 1 Ton Powder (1)			
Loader/Backhoe Cat 416 (1)			
Track Drill ECM590 (2006) (1)			
Strip Topsoil	**CY**	**120**	**CY./Hour**
Truck 1/2 Ton (1) Dozer D-5 (1)			
Scraper 621 (1)			
Roadbed Finishing	**SY**	**400**	**SY/Hour**
Truck 1/2 Ton (1) Dozer D-5 (1)			
Scraper 621 (1)			
Motor Grader Cat 14 w/GPS (1)			

Civil: Paving			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Base Stone	**Ton**	**217**	**Ton/Hour**
Truck 1/2 Ton (1)			
Truck Dump 14 CY (10)			
Truck Water (1)			
Dozer D-5 w/Spreader Box (1) Motor Grader Cat 14 w/GPS (1)			
Roller Tamper 25-35 Ton (1) Screening/Crushing Plant (Portable) (1)			
Hot Mix Asphalt - Structural Course (0-5 mile haul)	**Ton**	**200**	**Ton/Hour**
Truck 1/2 Ton (1) Truck Distributor (1)			
Truck Dump 14 CY (6)			
Truck Water (1)			
Roller Asphalt (Breakdown) (1) Roller Asphalt (Finish) (1) Roller Asphalt (Rubber Tire) (1)			
BlawKnox PF3200 Asphalt Paver (1) RoadTec Shuttle Buggy (1)			
Asphalt Plant (1)			
Hot Mix Asphalt - Surface Course (0-5 mile haul)	**Ton**	**150**	**Ton/Hour**
Truck 1/2 Ton (1) Truck Distributor (1)			
Truck Dump 14 CY (6)			
Truck Water (1)			
Roller Asphalt (Breakdown) (1) Roller Asphalt (Finish) (1) Roller Asphalt (Rubber Tire) (1)			
BlawKnox PF3200 Asphalt Paver (1) RoadTec Shuttle Buggy (1)			
Asphalt Plant (1)			
Hot Mix Asphalt - Leveling Course (0-5 mile haul)	**Ton**	**130**	**Ton/Hour**
Truck 1/2 Ton (1) Truck Distributor (1)			
Truck Dump 14 CY (6)			
Truck Water (1)			
Roller Asphalt (Breakdown) (1) Roller Asphalt (Finish) (1) Roller Asphalt (Rubber Tire) (1)			

BlawKnox PF3200 Asphalt Paver (1) RoadTec Shuttle Buggy (1)			
Asphalt Plant (1)			
Hot Mix Asphalt - Structural Course (5-15 mile haul)	**Ton**	**200**	**Ton/Hour**
Truck 1/2 Ton (1) Truck Distributor (1)			
Truck Dump 14 CY (11)			
Truck Water (1)			
Roller Asphalt (Breakdown) (1) Roller Asphalt (Finish) (1) Roller Asphalt (Rubber Tire) (1)			
BlawKnox PF3200 Asphalt Paver (1) RoadTec Shuttle Buggy (1)			
Asphalt Plant (1)			
Hot Mix Asphalt - Surface Course (5-15 mile haul)	**Ton**	**150**	**Ton/Hour**
Truck 1/2 Ton (1) Truck Distributor (1)			
Truck Dump 14 CY (8)			
Truck Water (1)			
Roller Asphalt (Breakdown) (1) Roller Asphalt (Finish) (1) Roller Asphalt (Rubber Tire) (1)			
BlawKnox PF3200 Asphalt Paver (1) RoadTec Shuttle Buggy (1)			
Asphalt Plant (1)			
Hot Mix Asphalt - Leveling Course (5-15 mile haul)	**Ton**	**130**	**Ton/Hour**
Truck 1/2 Ton (1) Truck Distributor (1)			
Truck Dump 14 CY (8)			
Truck Water (1)			
Roller Asphalt (Breakdown) (1) Roller Asphalt (Finish) (1) Roller Asphalt (Rubber Tire) (1)			
BlawKnox PF3200 Asphalt Paver (1) RoadTec Shuttle Buggy (1)			
Asphalt Plant (1)			
Hot Mix Asphalt - Structural Course (Over 15 mile haul)	**Ton**	**200**	**Ton/Hour**
Truck 1/2 Ton (1) Truck Distributor (1)			
Truck Dump 14 CY (12)			
Truck Water (1)			
Roller Asphalt (Breakdown) (1) Roller Asphalt (Finish) (1) Roller Asphalt (Rubber Tire) (1)			
BlawKnox PF3200 Asphalt Paver (1) RoadTec Shuttle Buggy (1)			
Asphalt Plant (1)			
Hot Mix Asphalt - Surface Course (Over 15 mile haul)	**Ton**	**150**	**Ton/Hour**
Truck 1/2 Ton (1) Truck Distributor (1)			
Truck Dump 14 CY (12)			
Truck Water (1)			
Roller Asphalt (Breakdown) (1) Roller Asphalt (Finish) (1) Roller Asphalt (Rubber Tire) (1)			
BlawKnox PF3200 Asphalt Paver (1) RoadTec Shuttle Buggy (1)			
Asphalt Plant (1)			
Hot Mix Asphalt - Leveling Course (Over 15 mile haul)	**Ton**	**130**	**Ton/Hour**
Truck 1/2 Ton (1) Truck Distributor (1)			
Truck Dump 14 CY (7)			
Truck Water (1)			
Roller Asphalt (Breakdown) (1) Roller Asphalt (Finish) (1) Roller Asphalt (Rubber Tire) (1)			

BlawKnox PF3200 Asphalt Paver (1) RoadTec Shuttle Buggy (1)			
Asphalt Plant (1)			

Civil: Milling			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Milling (<2") (0 - 5 Mile Haul)	**SY**	**6250**	**SY/Hour**
Truck 1/2 Ton (1) Truck Dump 14 CY (3)			
Truck Water (1)			
Dozer D-5 (1)			
Volvo MT2000 Milling Machine (1) Broom (1)			
Milling (<2") (5 - 15 Mile Haul)	**SY**	**6250**	**SY/Hour**
Truck 1/2 Ton (1) Truck Dump 14 CY (4)			
Truck Water (1)			
Dozer D-5 (1)			
Volvo MT2000 Milling Machine (1) Broom (1)			
Milling (<2") (Over 15 Mile Haul)	**SY**	**6250**	**SY/Hour**
Truck 1/2 Ton (1) Truck Dump 14 CY (7)			
Truck Water (1)			
Dozer D-5 (1)			
Volvo MT2000 Milling Machine (1) Broom (1)			
Milling (2-4") (0 - 5 Mile Haul)	**SY**	**6250**	**SY/Hour**
Truck 1/2 Ton (1) Truck Dump 14 CY (3)			
Truck Water (1)			
Dozer D-5 (1)			
Volvo MT2000 Milling Machine (1) Broom (1)			
Milling (2-4") (5 - 15 Mile Haul)	**SY**	**6250**	**SY/Hour**
Truck 1/2 Ton (1)			
Truck Dump 14 CY (11)			
Truck Water (1)			
Dozer D-5 (1)			
Volvo MT2000 Milling Machine (1) Broom (1)			
Milling (2-4")(Over 15 Mile Haul)	**SY**	**6250**	**SY/Hour**
Truck 1/2 Ton (1)			
Truck Dump 14 CY (20)			
Truck Water (1)			
Dozer D-5 (1)			
Volvo MT2000 Milling Machine (1) Broom (1)			

Civil: Concrete Work			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Concrete Pavement (</= 6 Thick)	**SY**	**60**	**SY/Hour**
Truck 1/2 Ton (1) Ready-Mix Truck (6)			
Loader/Backhoe Cat 416 (1) Concrete Slipform Paver (1)			
Concrete Pavement (>6 Thick)	**SY**	**45**	**SY/Hour**
Truck 1/2 Ton (1) Ready-Mix Truck (6)			
Loader/Backhoe Cat 416 (1) Concrete Slipform Paver (1)			
Curb & Gutter	**LF**	**100**	**LF/Hour**
Truck 1/2 Ton (1) Ready-Mix Truck (1) Loader Skid Steer (1)			
Gomaco Commander GT3200 Curber (1)			
Concrete Median Barrier	**LF**	**70**	**LF/Hour**

Truck 1/2 Ton (1) Ready-Mix Truck (6) Loader Skid Steer (1) Power Curber 5700B (1)			
Sidewalk	**LF**	**100**	**LF/Hour**
Truck 1/2 Ton (1) Ready-Mix Truck (6) Loader Skid Steer (1) Power Curber 5700B (1)			

Civil: Miscellaneous			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Fencing (up to 6' height)	**LF**	**200**	**LF/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1)			
Loader Skid/Steer (1)			
Fencing (over 6' height)	**LF**	**200**	**LF/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1)			
Loader Skid/Steer (1)			
Fence Gates	**Each**	**2**	**Each/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1)			
Loader Skid/Steer (1)			
Steel Guardrail	**LF**	**300**	**LF/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1)			
Truck Guardrail Install (1) Generator Small (1)			
Wire/Cable Guardrail	**LF**	**100**	**LF/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1)			
Truck Guardrail Install (1)			
Guardrail Posts	**Each**	**25**	**Each/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1)			
Guardrail Install Truck (1)			
Solid Sodding	**SY**	**500**	**SY/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1)			
Loader Skid/Steer (1)			
Hydro Seeding	**Acre**	**3**	**Acre/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1)			
Truck Hydroseeder (1)			
Seedbed Preparation	**Acre**	**0.5**	**Acre/Hour**
Truck 1/2 Ton (1) Tractor w/Disk (1)			
Solid Pavement Marking	**LM**	**2**	**LM/Hour**
Truck 1/2 Ton (2)			
Truck, Thermoplastic Paint (1)			
Skip Pavement Marking	**LM**	**2**	**LM/Hour**
Truck 1/2 Ton (2)			
Truck, Thermoplastic Paint (1)			

Trackwork			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Material Loading & Unloading			
CWR Unload	**LF**	**8400**	**LF/Day**
DMU Work Train			
Speed Swing			
CWR Load	**LF**	**4200**	**LF/Day**
DMU Work Train			
Speed Swing			
Tie Unload	**EA**	**15**	**EA/HR**
DMU Work Train			

Loader/Backhoe Cat 416 (1)			
OTM Unload		**TBD**	
4.5 CY Loader 966			
Ballasted Track - New			
Distribute CWR	**LF**	**300**	**LF/HR**
Speed Swing (1)			
Load / Haul / Distribute Ties	**EA**	**20**	**EA/HR**
Truck & Flatbed			
4.5 CY Loader 966			
Loader/Backhoe Cat 416 (1)			
Lay / Clip / Concrete Ties	**TF**	**50**	**TF/HR**
Speed Swing			
Clip applicator			
Lay / Spike / Anchor / Timber Ties	**TF**	**30**	**TF/HR**
Speed Swing			
Track Spiker			
Track Anchor Applicator			
Track Screw Spike Applicator			
Hy Rail Truck			
Final Ballast	**Tons**	**70**	**Tons/HR**
DMU Work Train			
4.5 CY Loader 966			
Surface Track	**TF**		
Tamper	**TF**	**60**	**TF/HR**
Ballast Regulator	**TF**	**80**	**TF/HR**
Saw Cut / Distress Track	**TF**	**200**	**TF/HR**
Rail Heater (1)			
Rail Vibrator (1)			
Rail Saw			
Ballasted Track - Curve Shift (0-15')			
Shift Track	**TF**	**TBD**	
DMU Work Train			
Dozer D-5 (2)			
Hy Rail Welder Truck (1)			
Loader/Backhoe Cat 416 (1)			
Backhoe (1)			
4.5 CY Loader 966 (1)			
Ballast Compactor (1)			
Tamper (1)			
Ballast Regulator (1)			
Insulated Joints	**EA**	**2**	**EA / Day**
Speed Swing			
Backhoe (1)			
Hy Rail Welder Truck (1)			
Special Trackwork			
#20 Turnout - Panel Unload	**Turnout**	**1**	**Turnout / Day**
DMU Work Train			
Crane 100 Ton Crawler (2)			
Loader/Backhoe Cat 416 (1)			
4.5 CY Loader 966			
#20 Turnout - Assemble Panels	**Turnout**	**0.2**	**Turnout / Day**
Loader/Backhoe Cat 416 (1)			
4.5 CY Loader 966			
Backhoe (1)			
Hy Rail Welder Truck			
#20 Turnout - Install	**Turnout**	**1**	**Turnout / Day**

Crane 100 Ton Crawler (2)			
Loader/Backhoe Cat 416 (1)			
4.5 CY Loader 966			
Dozer D-5 (2)			
Backhoe (1)			
Hy Rail Welder Truck			
#20 Turnout - Ballast & Tamp & Surface	**Turnout**	**0.5**	**Turnout / Day**
DMU Work Train			
Tamper			
Ballast Regulator			
Grade Crossing			
Grade Crossing - Unload Panels	**LD**	**4**	**LD / HR**
4.5 CY Loader 966			
Speed Swing			
Grade Crossing - Remove Existing	**TF**	**10**	**TF/HR**
Backhoe (1)			
4.5 CY Loader 966			
Loader/Backhoe Cat 416 (1)			
Truck Dump 14 CY (11)			
Hy Rail Welder Truck			
Grade Crossing - Install & Surface	**TF**	**5**	**TF/HR**
4.5 CY Loader 966			
Speed Swing			
Backhoe (1)			
Hy Rail Welder Truck			
Tamper			
Ballast Regulator			
Welding			
Field Weld	**EA**	**2**	**EA/Day**
Hy Rail Welder Truck (1)			
Rail Saw (1)			
Rail Grinder (1)			
Rail Grinding (Production)			
Rail Grinder - 32 Stone (1)	**TF**	**3000**	**TF/Day**

Train Control			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Install Underground Cabling		**TBD**	
Cable Truck			
Ditcher			
Boom Truck			
Install Above Ground Power Line		**TBD**	
Cable Truck			
Bucket Truck			
Install Signals		**TBD**	
Boom Truck			
Backhoe (1)			
Install Control Instrument House		**TBD**	
Boom Truck 50 ton (1)			
Backhoe (1)			
Install Rail Crossing Signals		**TBD**	
Boom Truck (1)			

Backhoe (1)			

Structures: Rail			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Coffer Dam	**SF**	**80**	**SF / Day**
Pile Driver (1)			
Sheet Pile Vibrator (1)			
Compressor 85-185 (1)			
Pump 4 (1)"			
Superstructure Piling	**LF**	**60**	**LF / HR**
Pile Driver (1)			
Compressor 85-185 (1)			
Pump 4 (1)"			
Generator Small (1)			
Substructure Concrete	**CY**	**5**	**CY / Hour**
Truck 1/2 Ton (1) Ready-Mix Truck (6)			
Loader/Backhoe Cat 430 (1)			
Excavator R/T Cat 316 (1)			
Crane 100 Ton Crawler (1)			
Pump 4 (1)"			
Generator Small (1)			
Superstructure Concrete	**CY**	**10**	**CY / Hour**
Truck 1/2 Ton (1) Ready-Mix Truck (5)			
Loader/Backhoe Cat 416 (1)			
Crane 100 Ton Crawler (1)			
Compressor 85-185 (1)			
Generator Small (1)			
Concrete Bridge Deck Finisher (1)			
Reinforcing Steel	**LB.**	**2,000**	**LB. / Hour**
Truck 1/2 Ton (1)			
Crane 30 Ton Hydraulic (1)			
Steel Beams	**LF**	**60**	**LF / Hour**
Truck 1/2 Ton (1)			
Truck Tractor & Lowboy Trailer (1) Crane 100 Ton Crawler (1)			

Structures: Highways			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Substructure Concrete	**CY**	**10**	**CY / Hour**
Truck 1/2 Ton (1) Ready-Mix Truck (6)			
Loader/Backhoe Cat 430 (1)			
Excavator R/T Cat 316 (1)			
Crane 100 Ton Crawler (1)			
Pump 4 (1)"			
Generator Small (1)			
Superstructure Concrete	**CY**	**10**	**CY / Hour**
Truck 1/2 Ton (1) Ready-Mix Truck (5)			
Loader/Backhoe Cat 416 (1)			
Crane 100 Ton Crawler (1)			
Compressor 85-185 (1)			
Generator Small (1)			
Concrete Bridge Deck Finisher (1)			

Reinforcing Steel	**LB.**	**2,000**	**LB./Hour**
Truck 1/2 Ton (1)			
Crane 30 Ton Hydraulic (1)			
Steel Beams	**LF**	**100**	**LF/Hour**
Truck 1/2 Ton (1)			
Truck Tractor & Lowboy Trailer (1) Crane 100 Ton Crawler (1)			

Structures: Retaining Walls			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Retaining Wall	**SF**	**20**	**SF/Hour**
Truck 1/2 Ton (1) Ready-Mix Truck (1)			
Loader Backhoe Cat 430 (1)			
Crane 30 Ton Hydraulic (1)			

Structures: Drainage			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Small Pipe Crew (</= 18" Pipe)	**LF**	**24**	**LF/Hour**
Truck 1/2 Ton (1) Dozer D-3 (1)			
Loader R/T 938 (1)			
Excavator Cat 336 (1)			
Roller Vibrating Plate Compact (1) Roller Ram Max Trench (1)			
Medium Pipe Crew (>18" to 36" Pipe)	**LF**	**16**	**LF/Hour**
Truck 1/2 Ton (1) Dozer D-3 (1)			
Loader R/T 938 (1)			
Excavator Cat 336 (1)			
Roller Vibrating Plate Compact (1) Roller Ram Max Trench (1)			
Large Pipe Crew (> 36" Pipe)	**LF**	**8**	**LF/Hour**
Truck 1/2 Ton (1) Dozer D-6 (1)			
Loader R/T 938 (1)			
Excavator Cat 345 (1) Roller 815 Soil Compactor			
Roller Vibrating Plate Compact (1) Roller Ram Max Trench (1)			
Drainage Structures	**Each**	**2**	**Each/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1) Ready Mix Truck (0.1)			
Loader/Backhoe Cat 416 (1)			
Excavator Cat 324 (1) Roller Ram Max Trench (1)			

Utilities			
Work Task	**Unit of Measure**	**Production Rates**	**Production Rate Unit of Measure**
Water Line (up to 4' depth)	**LF**	**20**	**LF/Hour**
Truck 1/2 Ton (1) Dozer D-3 (1)			
Loader R/T 938 (1)			
Excavator Cat 336 (1)			
Roller Vibrating Plate Compact (1) Roller Ram Max Trench			
Roller Ram Max Trench (1)			

Water Line (over 4' depth)	**LF**	**10**	**LF/Hour**
Truck 1/2 Ton (1) Dozer D-3 (1)			
Loader R/T 938 (1)			
Excavator Cat 336 (1)			
Roller Vibrating Plate Compact (1) Roller Ram Max Trench (1)			
Sewer Line (up to 4' depth)	**LF**	**20**	**LF/Hour**
Truck 1/2 Ton (1) Dozer D-3 (1)			
Loader R/T 938 (1)			
Excavator Cat 336 (1)			
Roller Vibrating Plate Compact (1) Roller Ram Max Trench (1)			
Sewer Line (over 4' depth)	**LF**	**10**	**LF/Hour**
Truck 1/2 Ton (1) Dozer D-3 (1)			
Loader R/T 938 (1)			
Excavator Cat 336 (1)			
Roller Vibrating Plate Compact (1) Roller Ram Max Trench (1)			
Water/Sewer Manholes	**Each**	**2**	**Each/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1)			
Loader/Backhoe Cat 416 (1) Roller Ram Max Trench			
Intersection Signalization (2 Lane)	**Each**	**0.5**	**Each/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1)			
Crane 12 Ton Truck (1)			
Intersection Signalization (4 Lane)	**Each**	**0.25**	**Each/Hour**
Truck 1/2 Ton (1) Truck 2 Ton Flatbed (1)			
Crane 12 Ton Truck (1)			