Introduction

Increased volumes of domestic and international freight, and the need for improved service and reliability, have prompted U.S. railroads to accommodate double-stack, containerized intermodal service. Changes in the transportation marketplace are allowing railroads to capture business along routes which only a few years ago were deemed too short to be efficient and economical. The highly anticipated completion of the Panama Canal expansion is expected to further increase container traffic flow through east coast ports and to inland consumer markets. With this dramatic growth in intermodal traffic and to remain competitive, CSX recognized the need to double-stack clear its mainline route connecting Mid-Atlantic region ports with the large consumer markets in the Midwest and beyond.

National Gateway Initiative

The National Gateway Initiative (NGI) is a public-private-partnership (PPP) undertaken jointly by public agencies and CSX to clear a route for double-stacks between the east coast and Greenwich, Ohio. This $183M project is a jointly funded PPP, in recognition of the substantial public and private benefits expected from clearing the route for double-stacks. The initiative is a phased program designed to open service between terminals incrementally.

Although many double-stack clearance projects have been undertaken by U.S. railroads, this project is unique and very complex. The first phase of NGI involved forty (40) obstructions and presented many challenges due to sensitive areas and infrastructure including dense urban areas, rugged mountainous terrain, numerous overhead highway bridges and multiple intersecting railroads. Perhaps the greatest challenge has been completing the project while accommodating 25 to 30 time-sensitive freight trains and two Amtrak trains on a daily basis. That challenge impacted virtually all planning, design and construction decisions for the project. Technical engineering associated with the project ranged from simple bridge removals to complex structural analysis for the ten mountain tunnels with unstable geological conditions.

CSX has a very direct route between the Mid-Atlantic region and western destinations. Because some of the segments along this route were constructed as far back as the 1830’s, urban areas with urban infrastructure have “grown up” around the railroad over the last 180 years. The route also passes through remote and rugged mountains in some areas. Initial "scoping" of the project was conducted by CSX with the assistance of several consulting firms. Each obstruction site was visited, clearances spot checked, and an initial assessment made as to the most practical method to achieve clearance. To align project scope with the level of public and private (CSX) funding available at the time, NGI was divided into three programs, each having independent utility. The scope of the first phase, and subject of this paper, was to achieve clearance between new Northwest Ohio and Chambersburg intermodal terminals.

The vertical clearance CSX specifies to accommodate double-stack clearance is dependent on the type of structure involved. Newly constructed overhead highway bridges are to have a 23 feet minimum vertical clearance above top-of-rail, which is consistent with FHWA guidance. However, inside tunnels, or beneath existing overhead bridges where it was not feasible from an
engineering perspective to raise spans or lower track to achieve 23 feet, a 21-foot clearance was specified. This provides 10-inches of “cushion” above the industry-standard 20’-2” height of a loaded double-stack railroad car.

Project Scope

A total of forty (40) individual obstructions were required to be cleared in the states of Ohio, Pennsylvania, West Virginia, and Maryland to create double-stack clearance between the intermodal terminals in northwest Ohio and Chambersburg, PA. The general types, approach to clear and number of obstructions were:

- Remove abandoned overhead bridges: 8
- Modify railroad thru-trusses: 2
- Remove/replace overhead highway bridges: 8
- Lower tracks beneath bridges: 8
- Raise active overhead bridges: 3
- Urban tunnels (J&L Tunnel): 1
- Mountain tunnels: 10 (Totaling 15,595 LF)

Each obstruction presented a unique set of challenges including technical engineering, maintenance-of-traffic, environmental permitting, community impacts, and in most cases, a combination of more than one. The projects were managed in their entirety by CSX from the initial planning and design through permitting and construction. This included addressing the CSXT-owned railroad infrastructure, as well as various highway and 3rd party infrastructure. This, in turn, required negotiations and coordination with numerous state and local agencies.

As previously mentioned, CSX managed the design and construction of the overhead highway bridges and other public infrastructure. Although not necessarily complex from a technical civil engineering perspective, achieving consensus from communities and public agencies was certainly a challenge.

The ten mountain tunnels presented the greatest engineering challenge: (1) limited track time available to perform the work inside the tunnels, (2) highly variable geology above the tunnels, and (3) the aggressive deadlines for achieving clearance. The tunnels totaled 15,595 linear feet in the Appalachian Mountains. Geology in the Appalachian Mountains is highly variable, folded strata of sedimentary rock. Strata of competent rock intermixed with layers and pockets of weak soil and rock was quite common. Removal of existing tunnel linings and stabilization of the overburden proved to be particularly challenging.

CSXT’s former and historic Baltimore & Ohio Railroad between Pittsburgh and Baltimore continues to be a very busy corridor, carrying a variety of intermodal, merchandise, unit coal trains and Amtrak’s “Capitol Limited”. After working closely with customers and Amtrak and coordinating train schedules and connections, uninterrupted track time was limited to 4 to 6 hours daily, 4 to 5 days per week. To minimize impacts to customers and train operations, design details and construction methodologies were specifically employed to allow work to be accomplished “under traffic”. Tunnel projects and other clearance work were planned and executed to return the mainline to service at the end of each shift, allowing the safe passage of 25 to 30 trains through each work site. The design and construction methodology, particularly for the tunnel projects, was implemented to “get in and get out” quickly, maximizing every minute of track time.
Due to the high volume of train traffic at each project location, innovation and creativity in the design and methodology were paramount. New control points with crossovers and signal system upgrades were installed at three locations to allow periodic track outages and provide improved “recoverability” for operations after curfews. Extensive train modeling was completed prior to the start of the project to optimize the availability of work curfews while minimizing adverse impacts to the trains serving CSX’s customers.

As part of its communication plan for NGI, CSX communicated with freight customers and Amtrak well in advance of the project so there was a common understanding of how shipments and schedules may be affected.

**Removal of Retired Overhead Bridges**

The earliest, and certainly most straightforward clearance locations, were the three abandoned overhead bridges on the corridor. An out-of-service pedestrian walkway located at Coraopolis, PA was the very first clearance obstruction on NGI to be cleared. The project was a simple span pick, demolition and site restoration of the site.

Coraopolis, PA – Overhead Walkway

Before

After

A much larger span removed was an abandoned railroad bridge located in Youngstown, OH, as shown here.
Youngstown, OH – Abandoned Railroad Bridge

Before                                                After

Modifications to Railroad Thru-Trusses

Clearing existing, CSXT-owned railroad thru-truss bridges were also completed early. These structures were owned by CSXT and required limited permitting. An example is the Chartiers Creek Bridge in Pittsburgh which required modification of its original corner braces at the portals. The braces were removed and replaced with a brace shaped to accommodate the double-stack clearance template, shown in the before and after photos below. These impressive, heavily built bridges are on CSXT’s former Pittsburgh & Lake Erie Railroad line.

Pittsburgh, PA – Modify Chartiers Creek Bridge

Before                                        After
Overhead Highway Bridges

NGI included a number of pony truss bridges originally constructed in the early 1900's to carry local and private roadways over the railroad. Many of these bridges were built, owned and maintained by CSXT and its predecessor railroads over the years. These spans were not designed to accommodate today's heavier highway vehicles making the ability to raise to achieve clearance requirements from a structural viewpoint was questionable. CSX worked with the local counties and municipalities to replace these spans with modern bridges meeting today's highway standards and the railroad vertical clearance standards. Some counties and municipalities were willing to assume ownership and maintenance of the new structures upon completion. Although the overhead highway bridge projects were not overly challenging from a technical engineering perspective, obtaining agreements to remove and replace a bridge, and agency approvals of designs, were time consuming and complex.

Replace 5th Street Bridge Niles, OH.

Before

After
Creston, OH – Replace Mud Lake Road Bridge

Sullivan, OH – Replace TR 391 Bridge
**Track Lowering**

At eight locations, the tracks were lowered to achieve clearance. CSXT’s preference is to raise or replace overhead structures, in lieu of lowering track due to the disruption to train operations. And depending on the location, constructing a new drainage system for a lowered track bed can be difficult, expensive, and involve permitting challenges.

It was not feasible to raise or replace some of the bridges, such as the Smithfield Street Bridge in Pittsburgh. Due to its size, track lowering was preferred. This was accomplished by building a temporary "shoofly" track, shifting each of the main tracks, and excavating and constructing a new roadbed at the lower elevation. This methodology for lowering track was preferred at most locations in lieu of using on-track undercutting equipment to avoid moving on-track equipment in and out on a busy mainline railroad. Utilizing mostly "off-track" equipment provided quick "clearing" of equipment and personnel to minimize disruptions to revenue train operations and maximize work windows provided. The following photos show this work in progress at Smithfield Street.

**Pittsburgh, PA – Lower Track at Smithfield Street**

![Before](image1.png) ![After](image2.png)

For similar reasons, the track was lowered beneath an enclosed pedestrian walkway where CSXT bisects the University of Akron campus.
CSXT lowered track at several locations with overhead intersecting railroads. Lowerings were preferred to avoid disrupting railroad operations involving Norfolk Southern, and the Pittsburgh & Ohio Central.

Ravenna, OH – Lower Track at NS

Before

After
Bridge Raises

Three overhead bridges were raised, two carrying hiking/bicycle trails, and one carrying an active railroad. In Kent, Ohio, two side-by-side thru-plate girder spans were raised. Both were designed to carry railroad lines over CSXT's predecessor, the B&O, but at the time of the project, only one of the bridges was carrying an active railroad line. The other had been converted to trail use only.

The active railroad bridge carries the Akron Barberton Cluster Railway (AB) over CSXT. Because of AB's frequency of traffic, the bridge could not be out-of-service for a sufficient length of time to raise the span. Therefore, CSXT obtained permission from AB, and the owner of the trail bridge, to temporarily place track on the trail bridge to serve as a "shoofly" while the AB bridge and approaches were raised.

Perhaps the most iconic NGI overhead bridge was the massive, former Western Maryland Railway thru-truss at Blue Lick, Maryland west of Cumberland. This span, no longer serving as a railroad bridge, carries the Great Allegheny Passage Rail Trail. To obtain a permit to raise the bridge, CSXT was required to keep the trail on the bridge in-service to bicycles and pedestrian at all times. Due to deterioration, CSXT rebuilt the abutments to provide sound jacking platforms. The photos below show the work involved in performing substructure repairs, maintenance of trail traffic and the actual raising. Obviously, the considerable advance work and negotiations necessary to obtain approvals for the project from local agencies are not captured in the photos.
Blue Lick Truss Raise

Before                                              After

J&L Tunnel – Urban “Cut & Cover” Tunnel
The J&L Tunnel, located in Pittsburgh, is a single-track, 2,001 foot long tunnel which was originally constructed to allow expansion of the massive Jones & Laughlin Steel Co. Pittsburgh Works over the top of the Pittsburgh & Lake Erie Railroad. The steel mill was razed and the land redeveloped as a high-end, mixed-use community of offices, commercial and residential buildings on both sides and immediately fronting the subsurface tunnel right-of-way. Due to uncertain property rights, a community park and several cross streets were built directly over CSXT’s tunnel.

Because of the tunnel paralleling the Monongahela River, the presence of a high water table, and the high volume of railroad traffic, removing the roof, raising the tunnel sidewalls, and installing a new roof in a “cut & cover” process was the only feasible solution. Obtaining local approvals and permits was difficult and time consuming due to the perceived disruption to the community and businesses fronting the area where the tunnel roof had to be excavated and removed. Approval was required from multiple city agencies and the developer that had property rights in the area.

A further complication was the area being a “brownfield” site resulting from the past steel mill operations directly above and adjacent to the tunnel project site. Soils excavated could only be staged at approved containment areas and returned to the tunnel for backfill and roof cover. This required a very detailed staging and phasing plan, and multiple handling of the excavated soil materials. Precast roof sections were used to expedite replacement of the roof, and ultimate restoration of the park land above the tunnel. Below are a series of photos showing selected aspects of the project, from commencement to completion.
Mountain Tunnels

The ten tunnels in the Appalachian Mountain range in Pennsylvania, West Virginia and Maryland offered the greatest technical and constructability challenges. Working inside the tunnels with very short windows of available track time was particularly difficult. Three different methods were employed to clear the tunnels:

1. Elimination of the tunnel by open cut (“daylighting”)
2. Tunnel liner “notching”
3. Tunnel liner removal and replacement

During the design process geotechnical investigations were conducted at each tunnel to assess the competency of rock and soil conditions. The most appropriate method (or methods) were chosen.

CSXT’s first choice was to eliminate the tunnel entirely by daylighting which eliminates future need for structural maintenance, and tunnel track and drainage maintenance. The second choice is to “notch” the inside of the tunnel by using mechanical rock grinding equipment to accommodate the upper corners of double-stacked containers. This option was only feasible where relatively small amounts of lining removal were required, and where remaining was adequate for structural integrity. The third option, lining removal and replacement, involved removal of most or all of the lining to achieve the required clearance. Depending on the integrity of the in-situ rock and soil, either installation of rock bolts with a new shotcrete lining, or rock bolts and structural steel sets with steel lagging would be installed.

Design engineers were never completely sure of in-situ rock and soil conditions until the tunnel lining had been removed. Even with considerable site investigation in advance of construction (e.g., rock core borings, drilled probe holes, etc.) conditions can vary substantially between borings and probe holes. Therefore, only short sections of lining were removed during each 4 to 6 hour work window to ensure that rock bolts, steel sets, and shotcreting could stabilize the disturbed roof areas prior to the tunnel being placed back in-service for the passage of trains.

Tunnels Daylighting
Daylighting worked for three of the ten tunnels; including Benford (406 feet), Shoo Fly (307 feet), and Pinkerton (1,081 feet), all located in Pennsylvania. Daylighting Benford and Shoo Fly consisted of very straightforward heavy excavation. Excavation work was performed under the protection of CSXT flagmen between trains. Before and after photos are shown below.
The daylighting of Pinkerton Tunnel proved to be a significant challenge. Although the initial engineering analysis indicated that clearance could be achieved at a lower construction cost, track time became the real challenge. Pinkerton is located on the only section of single-track mainline on CSXT between Pittsburgh and Baltimore. Due to train schedules, reasonable work windows could not be established for removal and replacement of the lining. And this tunnel, which was built in 1884, had an extensive history of instability.
Therefore, CSXT elected to daylighting Pinkerton because (1) the vast majority of the work could be performed while maintaining train operations, (2) daylighting would eliminate future maintenance of the tunnel, and (3) the proposed open-cut would accommodate construction of a second main track in the future.

The cut through rock and soil strata was as deep as 300 feet at its midpoint. Seams of coal and other weak layers were encountered. As excavation neared the elevation of the top of the existing tunnel, groundwater seepage through the tunnel lining increased dramatically. As the flow of seepage increased, the existing brick lining began to delaminate and collapse.

Efforts made to intercept the groundwater failed. For rock excavation work to continue, steel sets were installed along nearly the entire length of the tunnel to maintain safe operation of trains. Photos below show the massive rock excavation at various stages and the temporary work performed to stabilize the tunnel.

Pinkerton Tunnel
Tunnel Notching
Two tunnels were cleared by notching. One is the well-known Sand Patch Tunnel, located near the summit of CSXT’s crossing of the Appalachian Mountain range.

Notching Operation in Stuart Tunnel

Tunnel Lining Removal and Replacement
Due to track time availability, tunnels requiring lining removal and replacement became the critical-path projects for the entire first phase of NGI. Limited lining removal and replacement could take place during 4 to 6 hour daily work windows. Photos of typical work activities:

Sidewall Rockbolts, Pre-Grouting  Rockbolt Installation
Section of Brick Lining Removed, Shotcreting In-Progress

Portal Treatments at Carothers Tunnel

Before

After
Brook Tunnel

Before

In-Progress

Graham Tunnel

Before

After
Conclusion

The first phase of the National Gateway Initiative Clearance Improvement Project was extremely successful. There were diverse challenges for CSXT’s engineers to find solutions to minimize impacts on neighboring communities while keeping a busy mainline railroad operating safely and in-service for its customers. Safety was always the first consideration in all decision making on the NGI project, including design, development of “safety action plans” and follow-up with on-site safety job briefings. CSXT, teamed with its contractor and consultant partners, worked together to ensure safety of the public, project workers, and freight and passenger trains moving through each project area.

In addition to clearing an historic route through the eastern United States for modern, double-stack intermodal service, completing the project while safely operating 25 to 30 trains daily exemplifies the unique demands upon engineers in the railroad industry. This project is a prime example of a cross-functional project team working together to successfully complete a project while maintaining operations to provide reliable service to railroad customers.

C. E. Gullakson
CSX Transportation
June 3, 2013
National Gateway Clearance Improvement Project
Greenwich, OH – Chambersburg, PA

Charles E. Gullakson, PE – Assistant Chief Engineer
Michael W. Hoey, PE – Director Project Management
**Freight rail enables Intermodal success**

- Increased need for supply chain flexibility
  - Shifting global supply chains
  - Globalization, Panama Canal expansion favor diversification to East Coast ports
- Intermodal freight transport increasingly critical to meeting nation’s transportation needs
  - Combined efficiency of freight rail and flexibility of highway transportation

**Congestion is getting worse**

- Track Volume Scale
  - 60,000 to 20,000 to 12,000

**National Gateway Initiative**

- **Phase I – Completed**
  - 40 locations to clear in 4 states
  - 8 abandoned bridge removals
  - 2 railroad through-truss modifications
  - 8 remove/replace overhead highway bridges
  - 8 track lowerings beneath bridges
  - 3 bridge raises
  - 1 urban tunnel (J&L)
  - 10 mountain tunnels (15,595 LF total)

- **Phase II – Under Construction**

- **CSXT Double-Stack Routes**
  - New York / New Jersey
  - Baltimore
  - Portsmouth
  - Chicago
  - St. Louis
  - Memphis
  - Wilmington
  - Cleveland
  - Northwest Ohio
  - ICTF
  - Columbus
  - Cincinnati
  - Toledo
  - Chambersburg
  - Intermodal Terminal

- **Other CSXT Routes**
  - Detroit
  - Greenwich
  - Pittsburgh
  - Washington

**Phase I Scope**

- Connects Mid-Atlantic Region to the Midwest and beyond
- Supports long-term growth of Mid-Atlantic ports
- Expedites traffic through Chicago and St Louis

**Challenges**

- Limited track-time / maintaining rail service
  - 4 to 6 hours per day, 4 to 5 days per week
  - 25 to 30 revenue freight trains through the project daily
  - Amtrak’s “Capitol Limited”

- Reaching a consensus amongst stakeholders
  - Communities
  - Highway agencies

- Geology at mountain tunnels
  - Highly variable

**Removal of Retired Overhead Bridges**

- **Coraopolis, PA – Overhead Walkway**

  Before

  After
Removal of Retired Overhead Bridges

**Youngstown, OH – Abandoned Railroad Bridge**

Before  
After

Modifications to Railroad Thru-Trusses

**Pittsburgh, PA – Chartiers Creek Bridge**

Before  
After

Overhead Highway Bridges

**Niles, OH – 5th Street**

Before  
After

**Creston, OH – Mud Lake Road**

Before  
After

Overhead Highway Bridges

**Sullivan, OH – TR 391**

Before  
After

Track Lowerings

**Pittsburgh, PA – Smithfield Street**

Before  
After
Track Lowerings

Akron, OH – University of Akron

Before

After

Ravenna, OH – Norfolk Southern overhead bridge

Before

After

Bridge Raises

Blue Lick, PA – Great Allegheny Passage Rail Trail

(Former Western Maryland Railway bridge)

Before

After

Approach work for trail

Pier work to provide needed raise

Steel work to accommodate jacking
Bridge Raises

*Blue Lick, PA – Great Allegheny Passage Rail Trail*

Jacking in-progress

J&L Tunnel - Urban “Cut & Cover”

*Tunnel Length: 1,646’*

Track level prior to construction

Spans formerly used for “hot-metal” and intra-plant railroad

J&L Tunnel – Urban “Cut & Cover”

Excavation to expose existing roof

Removal of roof sections

J&L Tunnel

Completed West Portal

Landscaping In-Progress

Mountain Tunnels

- 10 mountain tunnels
- 15,595 LF total
- Brick, masonry, and concrete liners
- Existing tunnel liners were built between 1880’s to 1910’s
- Methods to achieve clearance:
  - Elimination by open-cut (“daylighting”)
  - Liner “notching”
  - Liner removal and replacement

Carothers Tunnel near Paw Paw, WV

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**Tunnel Liner “Notching”**

*Paw Paw, WV – Stuart Tunnel*

- Taking measurements for setting proper notching location
- Retrofitted air-dump beneath notching work

**Tunnel Liner Removal / Replacement**

*Confluence, PA - Brook Tunnel*

- Drilling for installation of rockbolts

**Tunnel Liner Removal / Replacement**

*Indianapolis, IN*

**Tunnel Liner Removal / Replacement**

*Structural Steel Set and Lagging Installation*

**Tunnel Liner Removal / Replacement**

*Magnolia, MD - Graham Tunnel*

**Historical Aspects**

*Date Keystone from Brook Tunnel*
**Tunnels Daylighted**

**Confluence, PA – Benford Tunnel**

Before

After

Length: 406’

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**Confluence, PA – Shoo Fly Tunnel**

Before

After

Length: 307’

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**Confluence, PA – Shoo Fly Tunnel**

Before

After

Length: 307’

Overburden removed to liner

Final liner removal

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**Pinkerton, PA – Pinkerton Tunnel**

- Length: 1,081’
- Originally bored 1870’s
- Brick lined in 1884
- 200’+ overburden
- Various strata layers - sandstones, shales, coal

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**Shoo Fly Tunnel**

Daylighting selected to minimize impacts on revenue train traffic

1 million+ cubic yards excavated

30 months construction

Completion September, 2013

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Pinkerton Tunnel

West to Pittsburgh  East to Baltimore

September 29 – October 2, 2013
Indianapolis, IN

Pinkerton Tunnel

Temporary Stabilization Work During Rock Excavation

Shotcrete “Ribs”  Steel sets being installed

September 29 – October 2, 2013
Indianapolis, IN

Pinkerton Tunnel

1st train

September 29 – October 2, 2013
Indianapolis, IN

Summary

- Construction duration: 32 months (March, 2011 - September, 2013)
- First double-stack train: August 15, 2013
- Phase I total cost: $183M

September 29 - October 2, 2013
Indianapolis, IN

Questions?