



Dulles Corridor Metrorail Expansion

*Providing Safe Transportation
for Northern Virginia*



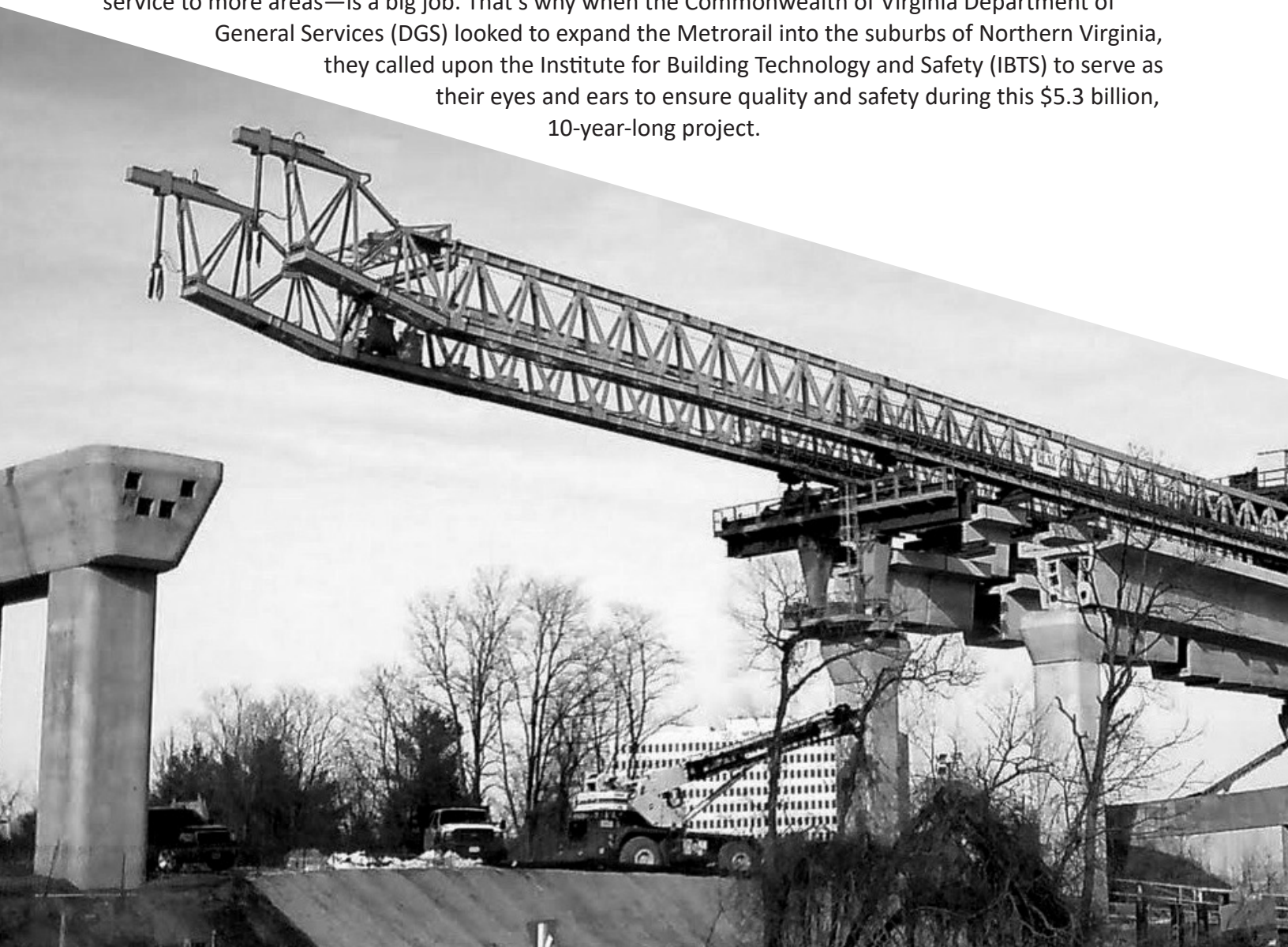
Overview

The Washington D.C. Metrorail is the second busiest rail transit network in the United States, with an average weekday rail ridership of 713,000 passengers. Serving a population of roughly 4 million, it's been one of the most efficient public transportation systems in the country for decades.

Thriving mass transit does more than get people from Point A to Point B. These systems can have significant impact on enhancing economic development, improving quality of life, and reducing environmental burdens.

In the case of the Metrorail, property values within a half-mile of stations are 7-9% higher. Over \$1 billion of time and fuel are saved by commuters every year. 20% of households using the Metrorail system are able to live a car-free lifestyle, saving \$342 million a year in auto expenditures and avoiding 260 tons of volatile organic compounds, 22 tons of particulate matter (PM), and 0.5 million tons of CO₂. 54% of all jobs in the region are within a half-mile radius of Metrorail stations.

Keeping the system running at optimal efficiency with the utmost of passenger safety—while also expanding service to more areas—is a big job. That's why when the Commonwealth of Virginia Department of General Services (DGS) looked to expand the Metrorail into the suburbs of Northern Virginia, they called upon the Institute for Building Technology and Safety (IBTS) to serve as their eyes and ears to ensure quality and safety during this \$5.3 billion, 10-year-long project.



Complexities Abound

Phase 1 of the Dulles Metrorail Expansion extended the track 11.7 miles to the economic hub of Tysons, Virginia, providing convenient transportation and economic development through commercial, residential, and retail growth.

The project was complex, thanks to its multi-jurisdictional, multi-phased nature and scale. The Metrorail and its stations had to be built around existing buildings and major transportation roadways, but IBTS inspectors were available 24/7 to ensure safety and code compliance. Due to that close monitoring and observation, costly construction defects were avoided and system-wide risks were reduced.

Phase 2 of the Dulles Corridor Metrorail Extension will bring the Metrorail from the eastern edge of Reston, VA, west through Washington Dulles International Airport, and to Ashburn, VA, in eastern Loudoun County. IBTS is responsible for all code and environmental review throughout the design and construction.

Despite having never served on a program of this magnitude before, we leveraged our prior experience and took full advantage of the extensive knowledge and flexibility of our plan review and inspection teams to make the Metrorail expansion a success. The techniques and lessons learned from this project could serve as an example for other transportation and infrastructure programs across the country.

The Players



Virginia Department of General Services (DGS)
Authority-having jurisdiction for Phase 1 and 2



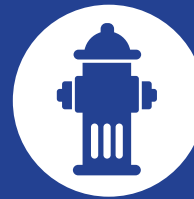
Metropolitan Washington Airport Authority (MWAA)
Owner/ Authority-having jurisdiction for Phase 2



Washington Metropolitan Area Transit Authority (WMATA)
Operator



Federal Transit Administration
Oversees federal safety standards



State Fire Marshall
Ensures compliance with fire and life safety codes



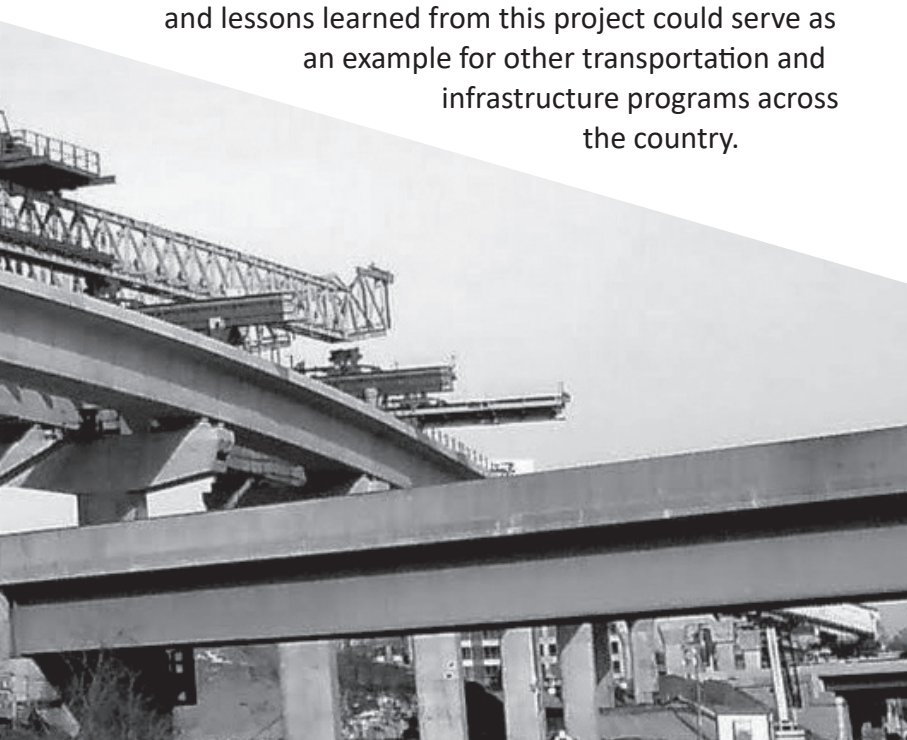
Dulles Transit Partners
Phase 1 Developer



Capital Rail Constructors and Hensel-Phelps
Phase 2 Developers



IBTS
Contracted by DGS and MWAA to inspect for compliance with applicable codes and standards



1994

Major Investment Study

2000

Environmental Impact Statement & Locally Preferred Option Analysis

2005

Preliminary Engineering

2007

Agreement with Metropolitan Washington Airports Authority (MWAA) and Federal Transit Authority




Finding the Silver Line

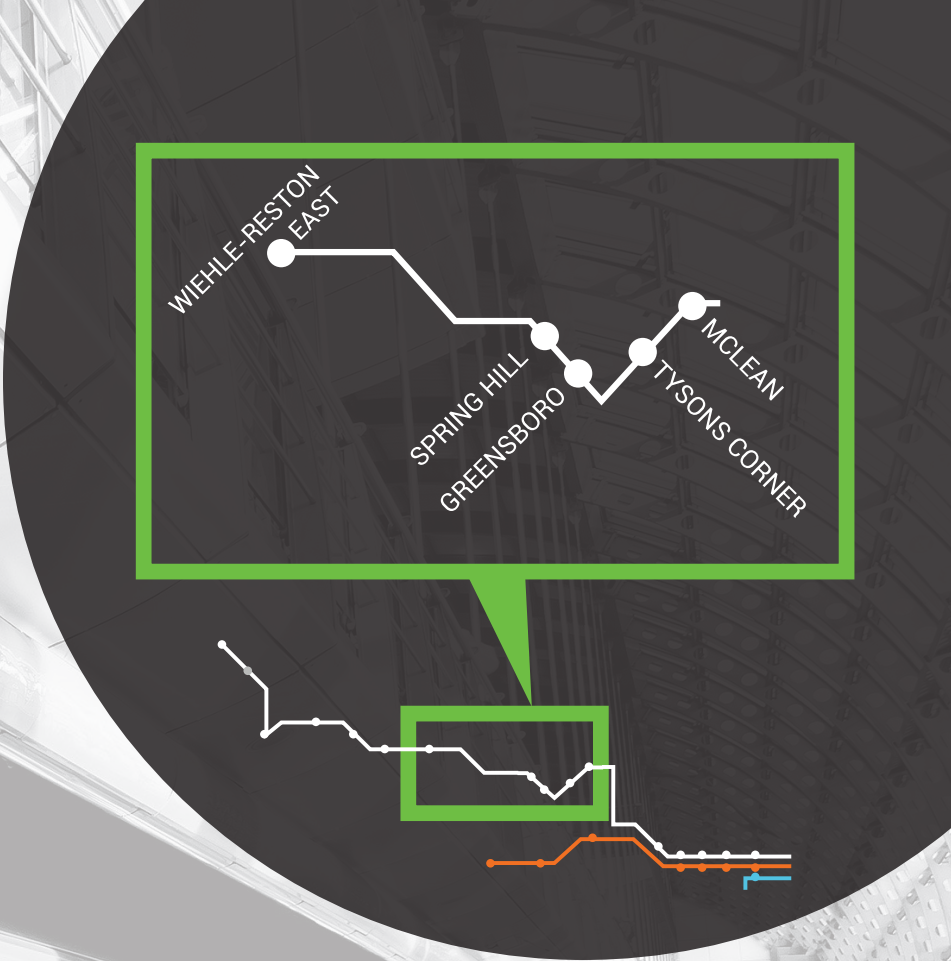
The Silver Line is a 23-mile extension of the existing Metrorail system, built in two phases and operated by the WMATA. Once complete, the line will provide a one-seat, no-transfer ride from Dulles Airport to downtown D.C., connecting the burgeoning economic hub of Northern Virginia with the nation's capital.

Phase 1:

-  **11.7 miles of track**
-  **5 new stations**
-  **Opened July 26, 2014**

Phase 2:

-  **11.4 miles of track**
-  **6 new stations**
-  **Anticipated open in 2020**



2009

Federal grant to MWAA, IBTS begins Phase 1 of construction

2014

MWAA transfers control of the Metro to WMATA in May. Silver Line opens in July. IBTS begins preliminary construction on Phase 2.

2020

Anticipated opening of the six remaining Silver Line stations



Managing the Expansion

DGS sought an experienced firm to provide 24/7 oversight and inspections due to the complexity of this project. We were chosen to be onsite for observations of special inspection testing of more than 500,000 cubic yards of reinforced concrete and to perform code inspections to ensure quality and safety.

The project involved a variety of overlapping and often conflicting code standards and a large number of stakeholders. IBTS helped interpret codes and bridge the gap between the jurisdictions and players.

After demonstrating our expertise and support capabilities to both the state and airport authority, we were selected to oversee Phase 2 for both DGS and MWAA as the Metrorail extended to the Washington Dulles International Airport and Loudoun County. Phase 2 will see the completion of six metro stations, nine entrance pavilions and pedestrian bridges, aerial guideways through Dulles Airport, 11.4 miles of track, and numerous ancillary buildings.



Cracking the Codes

Metrorail expansion is currently one of the largest infrastructure projects in the United States and is considered an engineering marvel. The expansion involved many elements that each have their own standard set of codes, which included:

- Virginia Uniform Statewide Building Code
- Mechanical Code
- Plumbing Code
- National Electrical Code
- International Fire Code
- NFPA 130: Standard for Fixed Guideway Transit and Passenger Rail Systems
- NFPA 101: Life Safety Code
- ADA Accessibility Guidelines (ADAAG)

“

[IBTS's] code reviewers have demonstrated intimate knowledge of code requirements and they produce insightful, prompt, and thorough reviews. They act as a seamless extension of the Airports Authority's Building Codes Office.

”

Russ Werner
Design Manager
Metropolitan Washington Airports Authority



Bringing Value to the Tracks

We performed all the structural design reviews, including at-grade, below-grade, above-grade and heavy rail plans.

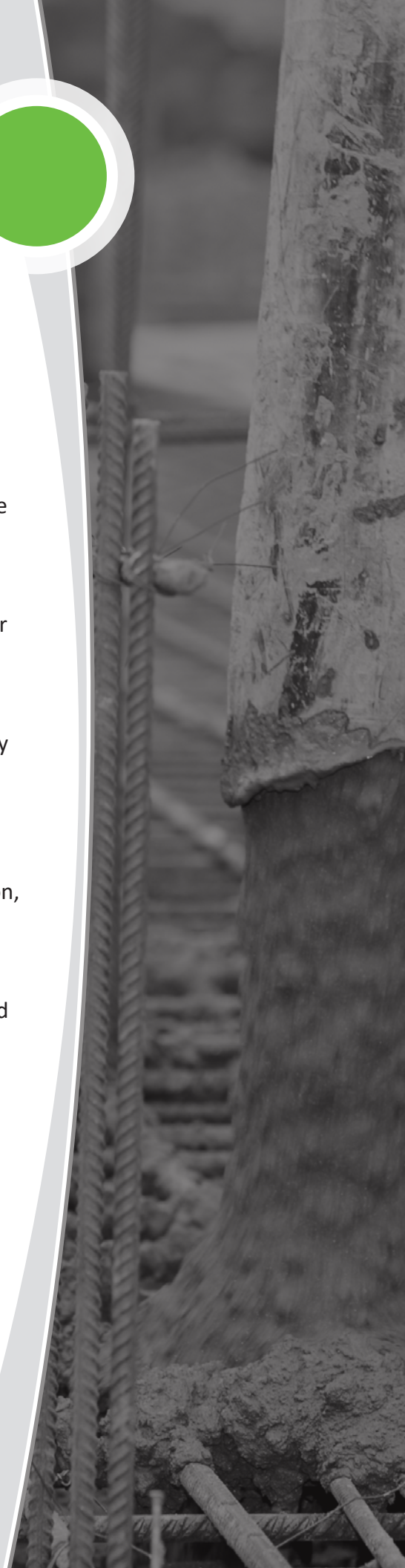
Because the project spanned across multiple jurisdictions, our inspectors' building code knowledge proved a great asset to the Commonwealth of Virginia. Conflicts were identified and remedied early before they became problems. Similarly, their technical knowledge of all project aspects was valuable to stakeholders throughout the process. We were able to streamline processes and avoid delays and overruns.

Phase 1 was a design-build project, and due to its complexity, changes in the field were anticipated and being able to adapt was critical. We were there for code compliance inspections without delaying construction.

Throughout both phases, IBTS has provided its clients with on-demand, on-time-every-time code reviews, project monitoring, and inspections. Flexibility is key in keeping the project moving forward. If an IBTS inspector arrived on site and the work wasn't ready, he would come back later in the day to ensure delays were minimized. In Phase 1, we provided inspections to 11 power substations, eight at locations along the new track and three within passenger stations. Each included underground duct-banks, wiring installation, connections, battery rooms, and terminations. In the current phase, the team helps ensure compliance with building codes, including structural and accessibility factors, electrical, energy, fire, mechanical, and plumbing codes, as well as compliance with environmental, erosion and sediment control, and stormwater management regulations.

To support our clients, we developed and implemented a tool that provides actionable, 7-day and 30-day reports that identify compliance issues or potential errors to be addressed in a timely manner, escalating items when necessary. The reports are intended to reduce the end-of-project "punch list" from thousands to a few known and manageable items, ensuring on-time project completion.

A software platform, aptly named Metrorail, was developed by the IBTS IT department to allow contractors to log in to request and review permitting inspections using a quick and easy user interface. With thousands of permits across multiple jurisdictions and more than 10,000 inspections performed to-date, streamlining this process was essential to success!



Safe, Sound Infrastructure Relies on Concrete

“With an infrastructure project of this magnitude, having IBTS onsite gave the Department of General Services confidence that construction met building code requirements.”


Mike Coppa

Director of Bureau of
Outlay Management
Department of General
Services, Virginia

Phase 1 consisted of 500,000 cubic yards of concrete, weighing more than 1 million tons. IBTS was onsite observing the construction of caissons, piers, and elevated guide ways, built in segments lifted 70 feet by trusses, that cross one of the busiest highways in the country.

There are countless compliance risks at play when pouring concrete: anything from changing weather conditions, the amount of vibration, or the time it takes to transport the concrete can impact quality. We worked around the clock to oversee slurry application and timing. Since concrete conditions require close monitoring, we notified field engineers if the concrete was poured within the appropriate period. If drivers' travel time was more than an hour, our inspectors would make sure the driver had not added water to alter pliability of the concrete. The use of vibrators removed air pockets from the concrete. Slump amounts were measured to ensure that the concrete met safety codes and would be strong enough to carry the 480-ton trains that comprise the Metrorail.

Pre-cast concrete slabs are used throughout Phase 2 to allow for faster construction speeds and greater cost-efficiency. This method is faster and easier to erect, while maintaining the same level of safety and durability. Performing on-site, out-of-state inspections at multiple facilities means these elements arrive on the job site in top-notch quality. IBTS monitored embedment of electrical equipment in the precast panels manufactured at these facilities, one of several aspects of construction only accessible for verification and validation at the precast facility.



IBTS is on the job site to watch all aspects of the concrete process to verify quality of the structures, including proper mixing, temperature, pouring, and placement.

Tunnel Vision

IBTS observed special inspections of two 1,700-foot long tunnels. Safety was top-of-mind, as the tunnels had to be mined without disturbing the heavily trafficked roadway above—often only eight feet above the ongoing construction.

The tunnels consisted of 110 segments. They were stabilized with a shotcrete coating, waterproofed with a liner system, and then concreted using a specially-designed form that created 30-foot long and 27-foot diameter segments that are 12 to 24 inches thick.

The entrance and exit, or east and west vent structures, were built using the cut and cover method. These complex structures contain the fire, train control, communications, and emergency egress from the tunnels. Within these structures, there were two 50 HP motors for the smoke evacuation system that would exhaust tunnel smoke in the event of a fire.

This stage took two years to complete, during which we oversaw the special inspections for concrete testing and placement, as well as code inspections for the mechanical, electrical, and plumbing.



This is My Station

The quality and safety of the passenger experience relies heavily on the quality and safety of stations. IBTS was involved in ten passenger stations between the two phases: McLean, Tysons Corner, Greensboro, Spring Hill, Reston Town Center, Herndon, Innovation Center, Dulles Airport, Loudoun Gateway, and Ashburn. These stations start as 30-foot holes in the ground and are then equipped with sewage, fire, and potable water lines, followed by support columns and I-beams. Each station is constructed with an entrance pavilion, stairs, escalators, and elevators that lead passengers to an aerial walkway attached to the train station. The stations also have public and employee restrooms, which are inspected for ADA compliance.

The stations have Alternating Current (AC) switch rooms, which provide 34.5 kV of power to four 1,600-amp switchgears. This powers the station and the rectifiers that convert the AC voltage into 750 VDC for the train power. Three of the stations

had Traction Power Sub Stations (TPSS), Train Control Rooms (TCR), and Communications Rooms built into the structure.

We also inspect the installation of the electrical, water, sanitary, and stormwater in the sub-structure and the electrical, mechanical, plumbing, and fire stopping for the super structure. The biggest challenge in this aspect of the project was the fire stopping. We inspected every corner and wall/floor penetration for UL assembly compliance and worked closely with the State Fire Marshal to ensure proper installation.

The Dulles Airport Station will be unique in that it will mimic the architecture of the airport terminal. This will include a large atrium, parking ramp, and a three-story escalator. The three levels will house a motorized walkway to the airport, a retail center, and the Metrorail station itself. IBTS will oversee the construction of each aspect of this station.



Ensuring High-Performance Infrastructure



At-Grade and Elevated Track Foundations

IBTS verified proper testing and specifications of the Metrorail foundations. Due to variations, we had to make sure the at-grade and elevated track was built to plan and could safely support trains and people.

Elevated Track Piers

There are more than 80 elevated track piers that raise the rail system and support aerial tracking, at points 70 feet above ground. We observed special inspections of these piers with a keen eye to safety and durability.

Ventilation Structures

Ventilation structures exist in the tunnels to provide an exhaust of air that is moved as trains travel through the tunnel. We inspect the construction of the exhaust fans and system to ensure that tunnels had the correct amount of air movement for the health and safety of passengers.

Power Transfer Substations

Pushing the trains along the track is no easy task. The power transfer substations take 34.5 kV and convert it to 750 VDC to move the trains. We inspect the installation of duct banks and electrical equipment after assembly of these substations to ensure optimal performance and safety.

Control Rooms

Trains switching tracks require track signals to keep the trains moving and passengers safe. The control rooms house all of the signals and switches to the tracks and stations, which are controlled from these designated locations. We perform inspections of AC panels and disconnects for the Silver Line control rooms, located at the stations.

Maintenance Yard

Proper servicing of the rail cars happen in the maintenance yard, ensuring safe, clean and reliable rides for passengers. The essential systems – mechanical, electrical, and plumbing – are inspected by IBTS for proper installation.

Staying Ahead of the Learning Curve

Leveraging a talent pool that includes Master Code Professionals, project engineers, civil engineers, electrical engineers, fire protection engineers and certified building officials, IBTS offered a broad array of expertise and the ability to staff up or down based on project requirements at any given time. Bringing key staff from Phase 1 onto Phase 2 also meant much-needed continuity and experience on the second part of the expansion.

Throughout the project, our team has continuously expanded and upgraded knowledge. IBTS inspectors have added International Code Council and other relevant certification to their resumes while working on the Metrorail expansion – gaining experience and certifications before the project required them.

At the request of a developer, members of our staff underwent specialized training for confined space inspections, meeting the safety requirements for performing manhole inspections.

And as always, our office team is prepared to support the field with subject matter expertise, specialized skills and administrative support. The ability to itemize invoices by permit number may sound like a small thing, but when a project includes tens of thousands of permits across multiple jurisdictions, it's more than a minor convenience for our clients.



All Aboard!

Expanding a major mass transit system requires a lot of diligence, collaboration and expertise. Our close monitoring and observation has reduced the number of system-wide risks and could be replicated in similar transportation projects throughout the nation.

For many, the Silver Line will be the first impression of the DC-Metro area for travelers arriving at the Dulles International Airport. For the 100,000 new jobs projected in the Tysons Corner area, many will rely on the Silver Line daily. It is expected to spur even more urban development along the Dulles Corridor and to service 50,000 riders per day. IBTS is proud to have played an integral role in the Silver Line and in ensuring the safety and welfare of its surrounding communities.



Who We Are

We are building resilient communities by reducing risk, enhancing public safety, providing quality assurance measures and improvements to quality of life.

IBTS is a nonprofit organization built on government partnerships with the goal of strengthening communities. Placing people over profits, we provide services to local, state, and federal governments that combine public sector credibility with private sector innovation.



40-year history of public service

Specialize in building services; energy and sustainability; management and consulting services; municipal services; natural disaster management; and quality assurance and quality control

Board of Directors consisting of five national associations representing city, county, and state-level governments





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