SCMAGLEV Project – Fast and Innovative Mode of Transportation in the Northeast Corridor

Vojtech Gall, Sandeep Pyakurel, Nikolaos Syrtariotis
Gall Zeidler Consultants

Cosema Crawford, Liviu Sfintescu
Louis Berger

David J. Henley
Northeast Maglev

ABSTRACT

The Northeast Corridor Superconducting Maglev Project (SCMAGLEV) entails construction of a high-speed train system between Washington, D.C. and New York City, with the first leg between Washington and Baltimore, MD. The system operates using an electromagnetic levitation system developed and deployed in Japan that achieves an operating speed of 500km/h (311 mph).

SCMAGLEV is a technically challenging but innovative project that will shorten travel times between Washington D.C. and Baltimore to 15 minutes, and eventually cover Washington to New York City in an hour. The project will enhance mobility along the Northeast Corridor (NEC) and spur development and economic growth in the region.

This paper provides an overview of the SCMAGLEV project and discusses construction of the tunnel and elevated sections.

INTRODUCTION

The SCMAGLEV Project is proposing a high speed train system between Washington, D.C. and the City of Baltimore, approximately 60 km (37 mi) in length. This is the first leg of an envisioned route from Washington, D.C. to New York City. The SCMAGLEV system operates using a combination of electromagnetic levitation (support), propulsion and lateral guidance, rather than flanged wheels, axles and bearings as in conventional high-speed railways. The train system will cross several transportation corridors including interstate highways (I-95, I-195, MD295 Baltimore Washington Parkway, I-595, I-695, I-895), several state, city and local routes, and railroad lines, as well as the BWI Airport. All crossings will be grade separated. The project owner is the Northeast Maglev / Baltimore Washington Rapid Rail (TNEM / BWWR), with Louis Berger as the prime consultant and Gall Zeidler Consultants as the tunneling sub-consultant.

The project is in the preliminary engineering phase. An independent environmental review process was initiated in the fall of 2016 in accordance with the National Environmental Policy Act (NEPA), with a Record of Decision (ROD) anticipated in mid 2019. Construction is envisioned to commence in 2020 with an estimated total cost of over $10 billion.

Figure 1: Conceptual rendering of the SCMAGLEV

TECHNOLOGY

The SCMAGLEV Project will provide new infrastructure, stations and facilities for the new high speed train system. The project will build on the safety practices and culture of system developer Central Japan Railway Company (JRC), which has operated the Tokaido Shinkansen bullet train between Tokyo and Osaka without a single fatality since 1964. JRC applied a similar safety approach to the development of the SCMAGLEV system. SCMAGLEV technology was fully evaluated by the Japanese government, and the system is currently operating on an approximately 27 mile long segment that is being extended to connect Tokyo and Nagoya. Safety systems for the Baltimore-Washington Maglev project will be developed through a collaborative process with the FRA Office of Safety and local emergency response forces.
The primary elements of the project include superconducting magnetic levitation rolling stock and systems using a proprietary technology developed by JRC and two guideways, one in each direction, borne by tunnel and viaduct structures. The system deploys technologies that are new to the U.S. or of previously limited application, including most notably an electromagnetic propulsion system. This technology is capable of accelerating trains to a top cruising speed of 500 km/h (311mph) in two minutes and allows for a driverless train operation. The total trip time from Washington D.C. to New York will be one hour, while a Washington to Baltimore trip will take 15 minutes with a stop at BWI Airport.

ALIGNMENT ALTERNATIVES

The project is located in Washington, DC and Maryland, traversing a distance of approximately 60 km (37 mi) with three underground stations in Washington D.C., at BWI Airport and in Baltimore.

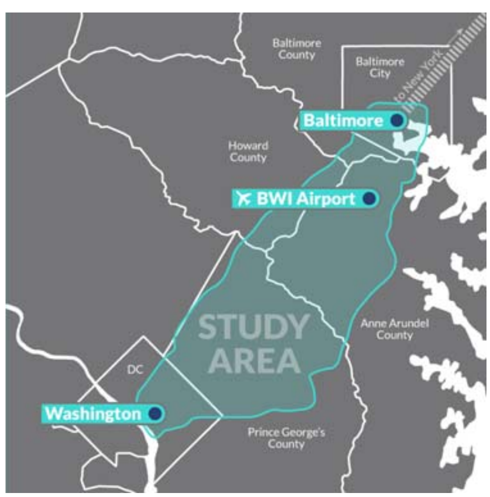

Figure 2: General map of the project area

The SCMAGLEV system runs on an independent grade-separated right-of-way. The ultra high speeds require relatively straight geometry with limited horizontal and vertical curvature. To accommodate the range of topographical and surface features, existing dense urban areas, utility mains, and existing structures, the proposed construction is expected to consist of below-ground (tunnel) for at over half of the route, and elevated structures (viaduct) for the remainder. The train system incorporates two main guideways, three stations, one rolling stock depot, electrical substations, tunnel ventilation plants and emergency egress facilities.

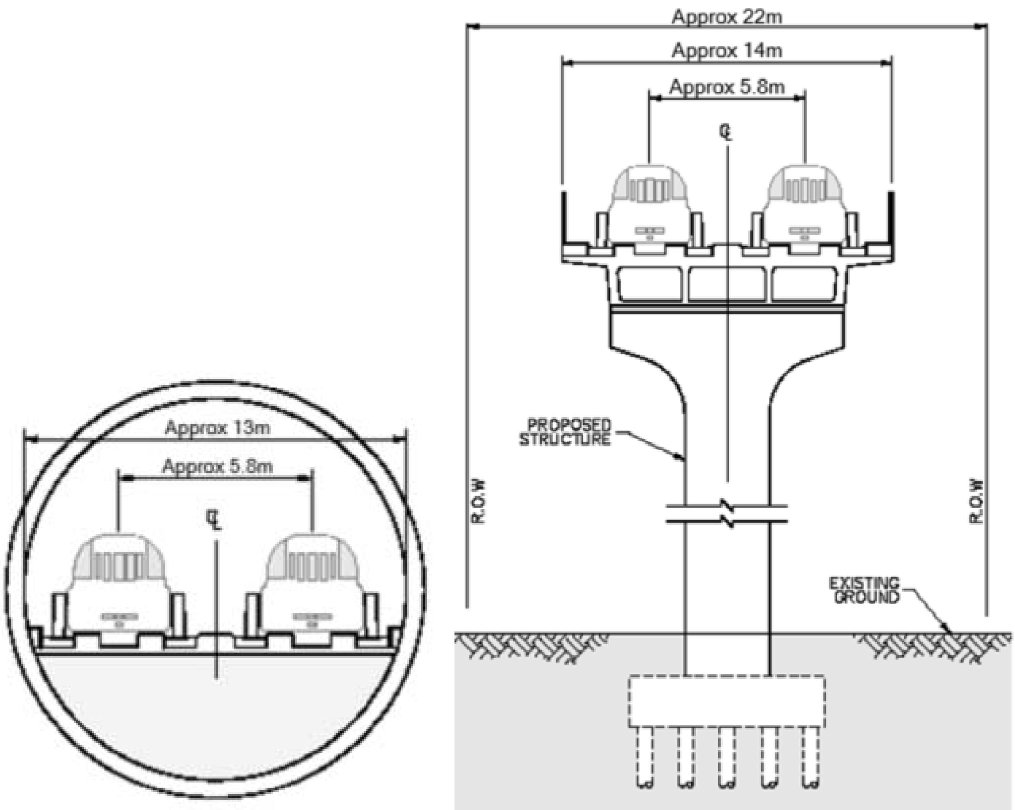

Figure 3: SCMAGLEV in tunnel (left) and viaduct (right) sections

The environmental review process initially identified several possible alignment alternatives which generally follow existing transportation corridors such as Baltimore Washington Parkway (MD 295), Amtrak Northeast Corridor, Washington, Baltimore and Annapolis Trail or a combination thereof, as shown in Figure 4. Alignment alternatives have since been further screened to two, which traverse the eastern and western sides of the BW Parkway. A preferred alternative will be identified in the Draft Environmental Impact Statement in late 2018.
Overall, approximately 75% of the alignment is anticipated to be in tunnel and the remaining 25% is on elevated viaduct.
Underground station locations in Washington and Baltimore are being assessed. The BWI Airport station will be located under the terminal building with direct access to the terminal and parking facilities. Stations will have a platform length of approximately 300 m (980 ft.), and total cavern length of up to 900 m (2,950 ft.) including switch chambers and other ancillary facilities. Stations will accommodate four guideways and two platforms, with a total width of up to 45 m (150 ft.).

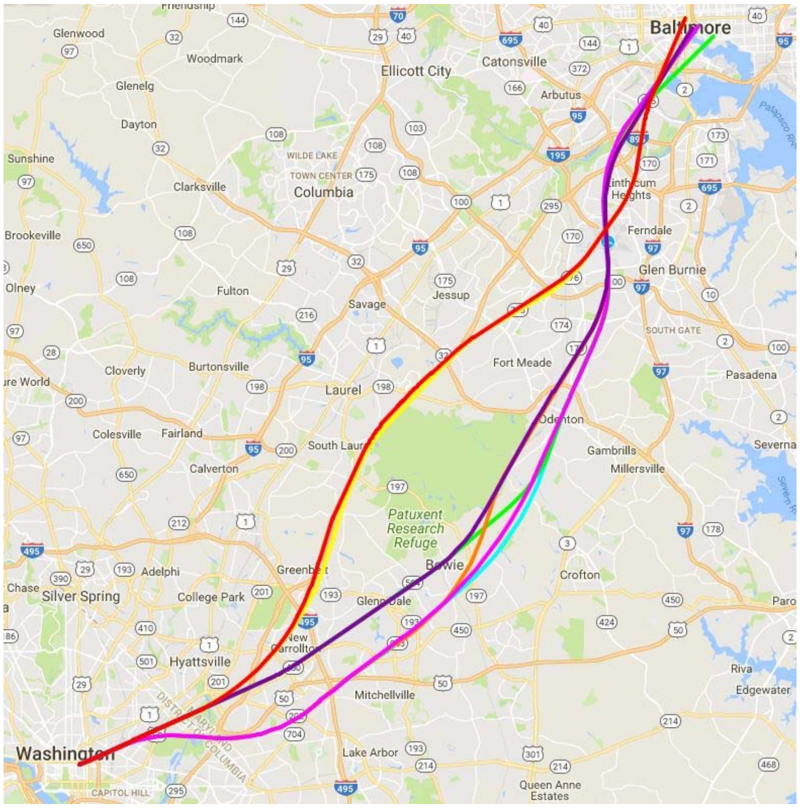

Figure 4: Proposed alignment alternatives

GROUND CONDITIONS

The proposed alignments are located within the Coastal Plain Physiographic Province, consisting of relatively soft strata. These strata lie on top of crystalline bedrock and thicken to the southeast on the order of approximately 150 m (500 ft.) per 8 km (5 mi). These sedimentary deposits include clays, sands, and gravels with younger sediments composed of sand, silts and muds. In general, the soil profile along the alignment consists of fill, residual soils, loose granular soils and clays with interlayering and lenses along the alignment.

Groundwater conditions are expected to vary widely across the alignments, from dry conditions to groundwater levels ranging from relative shallow depths of less than 3 m (10 ft.), to depths in excess of 12 m (40 ft.). Fluctuations in groundwater levels across the alignment will occur seasonally due to variations in rainfall, evaporation, construction activity, surface runoff and proximity to adjacent streams and the Chesapeake Bay shoreline. Localized perched groundwater and isolated water-saturated sediment lenses can also be expected. Connectivity of the aquifers to rivers and creeks has been identified in various locations.

Construction is expected to occur primarily in soft ground for most of the alignment. The bedrock is deeper along the central part of the alignments and is expected to become shallower at the two ends in Washington D.C. and Baltimore, although locally higher sections of the bedrock cannot be excluded.

A preliminary geotechnical exploration program is underway, comprising 24 borings and geotechnical testing. The program intends to investigate the soil formations and delineate the bedrock level, obtain ground properties to assess ground behavior along the alignment corridor and identify areas for further geotechnical investigations.

ELEVATED VIADUCTS

Elevated viaducts are proposed for each alignment in portions where development is less dense. A single viaduct structure approximately 14 m (46 ft.) wide will carry two guideways. The structure will be built with precast concrete superstructure elements supported on concrete piers with pile foundations. The typical span of the viaduct structure will be 30 to 35 m (100 to 115 ft.). Longer spans will be used at locations where the SCMAGLEV crosses waterway features or existing infrastructure.

TUNNELING

The proposed alignments include up to 48 km (30 mi) of deep tunnel sections. Considering the length of the tunnel sections and the required uniform geometry, it is anticipated that deep mechanized tunneling will be implemented for the majority of the alignment that will need to address the following challenges:

- Mostly tunneling in soft ground
- High groundwater level
- Tunneling across urban areas and under major roadways

Considering the soil types and groundwater conditions expected along the deep tunnel sections, which require an active face support, the use of a closed face Tunnel Boring Machine (TBM) will be required. Based on the available preliminary information on the geological and hydrogeological conditions and the critical impact of groundwater to the tunneling activities, implementation of an Earth Pressure Balance Machine (EPBM) is considered, at this stage, most appropriate for the anticipated subsurface conditions. Alternatively, a Mix Shield TBM could be considered, as the alignment could encounter sections of mixed geology with hard rock potentially shallower at the two ends of the alignment. The information acquired from the additional ground investigation program will be used to evaluate and select the TBM type and refine specifications.

TBM tunnels in soft ground are generally supported by pre-cast segments, which are erected at the tail end of the TBM producing a continuous lining over the tunnel length with a circular, uniform geometry. Segmental linings will be equipped with gaskets in the joints between the segments to inhibit groundwater inflow into the tunnel.

To minimize the construction footprint of the project, reduce surface disturbance and construction impact, and taking into consideration the spatial requirements for the train operation, a single bore TBM tunnel with an outside diameter of approximately 15 m (50 ft.) is being considered as optimal compared to twin bore tunnel configuration. Although tunneling with a large bore TBM is a challenge in itself, the technology and capabilities of present day TBMs allows for unimpeded tunneling and enhanced risk management. Additionally, TBM tunneling will be performed under at least one tunnel diameter of ground cover to minimize surface impact.

Subdivision of the TBM tunnel alignment into sections with a length of 5 to 6 km (3 to 4 mi) is currently considered to enable concurrent boring along various sections and provide flexibility for contracting and packaging of the project. Each TBM requires construction of a launch site, which is typically a cut-and-cover structure. In areas where space restrictions do not allow for construction of launch boxes, launch shafts of adequate size will be considered as an alternative. Ventilation shaft sites are planned to be used as launch shafts where possible to minimize cost and streamline construction. As the launch sites will be also used for stockpiling of the spoils, implementation of multiple launch sites along the alignment will allow efficient storage and transport of the spoils to the areas designated for disposition.

Short sections of cut-and-cover tunneling will be used for the stations, for the transitions between the viaduct and TBM tunnel sections and for TBM launch locations. Implementation of cut-and cover tunneling will involve installation of support of excavation, such as slurry walls, bored pile walls, soldier pile and lagging or shotcrete. Depending on the limits of disturbance, generally tie-back support or internal strutting is expected for deeper excavations. A waterproofing system will be installed to prevent groundwater inflow into the tunnel in the final permanent stage. The dense urban environment in Washington D.C. and Baltimore, coupled with the relatively deep alignment, will necessitate measures for construction of the stations with minimal surface impact and disruption to the city activities. Similarly, construction of the station under the BWI Airport will require significant coordination and phasing to avoid disrupting airport operations.

FIRE AND LIFE SAFETY

Design, construction and operations for the SCMAGLEV will be planned with a safety focus: safety of the traveling public, the construction and operations workforce, and the adjoining communities. These elements will be addressed in the planning and design of the infrastructure, core systems, facilities, and operating and maintenance practices for the SCMAGLEV system.

Fire and life safety will be given full consideration in all aspects of the system design, including linear infrastructure (viaducts and tunnels), passenger stations and operations and maintenance facilities. The fire and life safety considerations include elements and layout of egress and access paths in the tunnel system; definition of design fires for vehicles, cables, etc.

An emergency egress path for passengers to a point of safety will be provided in the underground sections. The proposed tunnel cross section allows the use of the space below the guideways as an emergency evacuation chamber. Additionally, ventilation plants and shafts are envisioned along the underground section of the alignment.

Due to the unique characteristics of the SCMAGLEV system, safety systems and practices researched and developed by JRC specifically for the SCMAGLEV system will be proposed to FRA Office of Safety for incorporation into the SCMAGLEV project in the U.S. to ensure that the highest standards for safety are deployed.

OUTLOOK

The Baltimore-Washington SCMAGLEV project will dramatically transform the region by reducing travel times between the two cities by a factor of two to four times. The proposed extension to New York will add stations in Wilmington and Phladelphia, and connect BWI Airport to the Philadelphia and Newark Airports, enhancing mobility and spurring growth and economic development. Construction is anticipated to start in 2020, with the start of operations later in the decade.