Los Angeles County
Metropolitan Transportation Authority

CONSTRUCTION APPROACH REPORT

K LINE NORTHERN EXTENSION

Metro

JULY 2024

K LINE NORTHERN EXTENSION TRANSIT CORRIDOR PROJECT

Construction Approach Report

Prepared for:

Metro

Los Angeles County
Metropolitan Transportation Authority

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ABBREVIATIONS/ACRONYMS

ACRONYM	DEFINITION
Cal/OSHA	California Occupational Safety and Health Administration
cy	cubic yard
EIR	environmental impact report
EPB	earth pressure balance
KNE	K Line Northern Extension
LAX	Los Angeles International Airport
LRT	light rail transit
LRV	light rail vehicle
Metro	Los Angeles County Metropolitan Transportation Authority
MRDC	Metro Rail Design Criteria
MSF	maintenance and storage facility
OCS	overhead contact system
Project	K Line Northern Extension Project
ROW	right-of-way
SEM	sequential excavation method
TBM	tunnel boring machine

SECTION 1: INTRODUCTION

1.1 PROJECT OVERVIEW

The Los Angeles County Metropolitan Transportation Authority (Metro) is preparing a Draft Environmental Impact Report (EIR) for the K Line Northern Extension (KNE) Transit Corridor Project (the project) (Figure 2-1). The project would provide a northern extension of the Metro light rail transit (LRT) K Line from the Metro E Line (Expo) to the Metro D Line (Purple) and B Line (Red) heavy rail transit lines. The project would serve as a critical regional connection, linking the South Bay, the Los Angeles International Airport (LAX) area, South Los Angeles, Inglewood, and Crenshaw corridor to Mid-City, Central Los Angeles, West Hollywood, and Hollywood, allowing for further connections to points north in the San Fernando Valley via the Metro B Line. The project would also connect major activity centers and areas of high population and employment density within the project area itself.

1.2 TECHNICAL REPORT SUMMARY

This report summarizes the construction approach for the project at the Advanced Conceptual Engineering phase. The report describes the construction approaches and the construction issues to be considered in the project development and environmental process. The construction approach could change as the project advances; however, the construction approach defined in this report will be the basis of the analysis in the EIR for the project.

The design and construction of tunnels and project elements discussed in this report are based on the Metro Rail Design Criteria (MRDC). The design considers current design and construction practices in Los Angeles and comparable projects elsewhere. The construction approaches and issues are based on today's available technology and project information. This report does not make assumptions regarding future technological developments or currently uncertain site conditions that will be clarified in future studies.

In addition, project measures are design features, best management practices, or other commitments that Metro would implement as part of all proposed alignments and stations, the design option, and the maintenance and storage facility (MSF) to reduce or avoid environmental effects associated with project construction and operation. These project measures are identified in Chapter 3 of the Draft EIR. A full list of project measures is available in Appendix 2-C, Project Measures.

This report is organized into two main sections:

- Construction Activities (Section 3:) – Provides a high-level overview of the construction approach and timing of activities
- Construction Methods and Techniques (Section 4:) – Provides a more detailed discussion of the construction activities and approaches

SECTION 2: **PROJECT DESCRIPTION**

This section provides information pertinent to the components of the project as evaluated in the technical report. Reference Chapter 2, Project Description, in the KNE Draft EIR for additional details about the project. The project components for evaluation in this technical report include three light rail alignments with stations, one design option, and one MSF.

2.1 ALIGNMENTS

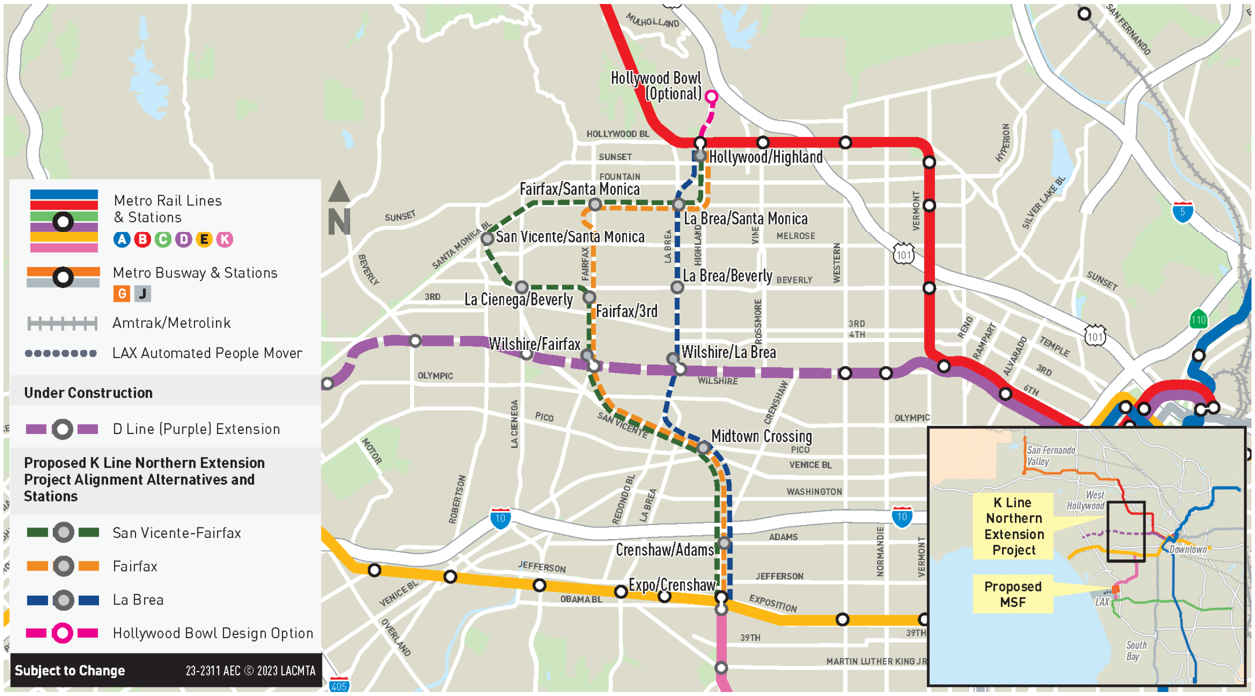
As shown in Figure 2-1, each of the three alignments would provide a northern extension of the Metro K Line from its current terminus at the Expo/Crenshaw Station to the Metro B Line Hollywood/Highland Station. All three alignments would operate entirely underground in parallel twin-bore tunnels with some station elements at the surface, including the station entrance and ventilation structures. Due to the project's length and pending funding availability, the alignments would be constructed sequentially in sections.

The alignments are as follows:

- San Vicente–Fairfax. This alignment would travel north from the existing Metro K Line Expo/Crenshaw Station before heading northwest under San Vicente Boulevard, with a connection to the future Metro D Line Wilshire/Fairfax Station. It would continue north under Fairfax Avenue before turning west under Beverly Boulevard to rejoin San Vicente Boulevard. The alignment would then turn east under Santa Monica Boulevard, and then turn north just east of La Brea Avenue to follow Highland Avenue north to connect to the Metro B Line at the Hollywood/Highland Station.
- Fairfax. This alignment would travel north from the existing Metro K Line Expo/Crenshaw Station before heading northwest under San Vicente Boulevard and north under Fairfax Avenue, where it would connect with the future Metro D Line Wilshire/Fairfax Station. It would continue north under Fairfax Avenue and turn east under Santa Monica Boulevard. The alignment would then turn north just east of La Brea Avenue to follow Highland Avenue north to connect to the Metro B Line at the Hollywood/Highland Station.
- La Brea. This alignment alternative would travel north from the existing Metro K Line Expo/Crenshaw Station before heading northwest under San Vicente Boulevard and north under La Brea Avenue, where it would connect with the future Metro D Line Wilshire/La Brea Station. From there, it would continue north under La Brea Avenue and turn northeast north of Fountain Avenue to follow Highland Avenue to connect with the Metro B Line at the Hollywood/Highland Station.

Table 2-1 summarizes the characteristics of each alignment, and Table 2-2 identifies which stations would be constructed under each alignment. In total, 12 station areas are identified, including the option to extend to the Hollywood Bowl.

FIGURE 2-1. K LINE NORTHERN EXTENSION ALIGNMENTS



Source: Connect Los Angeles Partners 2024

TABLE 2-1. CHARACTERISTICS OF THE ALIGNMENTS AND DESIGN OPTION

PROJECT COMPONENTS	ALIGNMENTS			DESIGN OPTION
	SAN VICENTE–FAIRFAX	FAIRFAX	LA BREA	HOLLYWOOD BOWL EXTENSION
Alignment length	9.7 miles underground	7.9 miles Underground	6.2 miles underground	+ 0.8 mile underground
Stations	9 underground	7 Underground	6 underground	+1 underground
Travel time from Expo/Crenshaw to Hollywood/Highland	19 minutes	15 minutes	12 minutes	+2 minutes (from Hollywood/Highland)

Source: Connect Los Angeles Partners 2024

TABLE 2-2. STATIONS BY ALIGNMENT

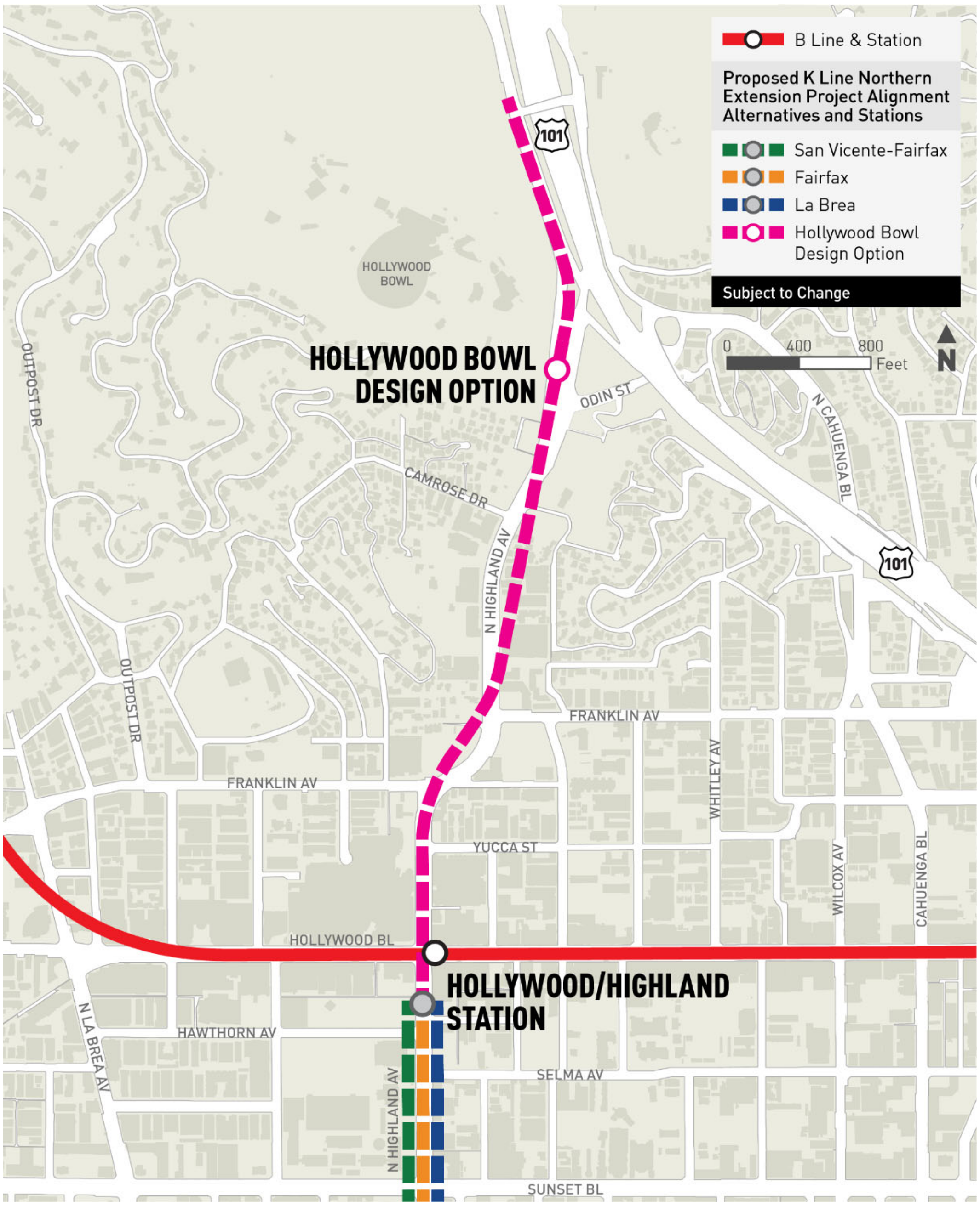
STATION	SAN VICENTE–FAIRFAX	FAIRFAX	LA BREA
Crenshaw/Adams (City of Los Angeles)	●	●	●
Midtown Crossing (City of Los Angeles)	●	●	●
Wilshire/Fairfax (City of Los Angeles)	●	●	
Fairfax/3rd (City of Los Angeles)	●	●	
La Cienega/Beverly (City of Los Angeles)	●		
San Vicente/Santa Monica (City of West Hollywood)	●		
Fairfax/Santa Monica (City of West Hollywood)	●	●	
La Brea/Santa Monica (City of West Hollywood)	●	●	●
Hollywood/Highland (City of Los Angeles)	●	●	●
Wilshire/La Brea (City of Los Angeles)			●
La Brea/Beverly (City of Los Angeles)			●
Hollywood Bowl (City of Los Angeles)	●	●	●

Source: Connect Los Angeles Partners 2024

2.2 HOLLYWOOD BOWL DESIGN OPTION

For every alignment, there is one design option under consideration. The Hollywood Bowl Design Option includes an alternate terminus station at the Hollywood Bowl, north of the proposed Hollywood/Highland Station, as shown in Figure 2-2.

FIGURE 2-2. HOLLYWOOD BOWL DESIGN OPTION



Source: Connect Los Angeles Partners 2024

2.3 MAINTENANCE AND STORAGE FACILITY

A MSF would be constructed that would expand the Division 16 Maintenance Yard (Division 16), the existing MSF for the Metro K Line near LAX, as shown in Figure 2-3. The MSF would provide equipment and facilities to accommodate daily servicing and cleaning, inspection and repairs, and storage of light rail vehicles (LRVs) not in service. The MSF would be the primary physical employment center for rail operation employees, including train operators, maintenance workers, supervisors, administrators, and security personnel. If the project is opened in sections, operation of the extended K Line from the Expo/Crenshaw Station to the Metro D Line could be accommodated within the existing Division 16 site with four new storage tracks.

FIGURE 2-3. MAINTENANCE AND STORAGE FACILITY

Source: Connect Los Angeles Partners 2024

SECTION 3: CONSTRUCTION ACTIVITIES

3.1 SUMMARY

An alignment would be constructed in two or three sections: three sections for the San Vicente–Fairfax Alignment and two sections for the Fairfax and La Brea Alignments. Construction would use similar construction methods as recently built Metro projects, such as the D Line Extension. The stations would primarily be constructed by cut-and-cover method and tunnels would be bored in-between stations.

Project construction activities would involve the following:

- Survey, pre-construction, and site preparation, including limited excavation and right-of-way acquisition
- Tunnel construction, including soft ground tunnel boring machine (TBM) excavation with segmental lining and conventional mining in rock with cast-in-place lining
- Locate, move, and/or support underground utilities
- Station, crossover, and connection box construction by cut-and-cover
- MSF construction
- Ventilation and emergency egress construction with vertical shafts
- Systems installation and facilities, including installation of trackbed, rails, overhead contact system (OCS); conduits for systems installations; electrical substations; and communications and signaling
- Street/site restorations, including paving and sidewalks
- Systems integration, testing, and pre-revenue operations

In addition, the optional Hollywood Bowl segment and station would require:

- Hard rock tunnel and cavern excavations by conventional mining using roadheaders and occasional controlled blasting
- Shaft and cut-and-cover excavations in rock

A generalized sequence of activities that would occur during construction of a section is presented in Table 3-1. The time necessary for each activity would vary depending on such factors as the nature of the subsurface conditions encountered at station sites and during tunneling, work-hours and traffic restrictions, and contractor’s means and methods. Other factors would include the number and type of utilities requiring relocation and the location and condition of nearby surface and subsurface structures. The following sections provide a high-level summary of the construction process for the major project elements—the stations and tunnels. More detailed descriptions of construction methods and techniques are provided in Section 4: .

TABLE 3-1. GENERALIZED SEQUENCE OF CONSTRUCTION ACTIVITIES FOR A CONSTRUCTION SECTION

ACTIVITY	DESCRIPTION	TYPICAL DURATION (MONTHS) PER CONSTRUCTION SECTION
Survey and pre-construction	Locate existing utilities; establish ROW and project control points and centerlines; establish/relocate survey monuments; oil well detection and decommission; and TBM procurement	24 to 36
Site preparation	Relocate utilities and clear ROW (demolition); modify streets at station sites to facilitate traffic flow during construction; establish detours and haul routes; erect safety devices and mobilize special construction equipment; prepare construction equipment yards and stockpile materials	12 to 24
Heavy construction	Construction of stations and station services (waste, domestic water, and fire water), entrances, tunnels and associated structures, and major systems facilities; disposal of excess material; SEM construction	72 to 84
Medium construction	Lay track, construct surface facilities (including aboveground structures), drainage, and station backfill; and reinstate streets	42 to 54
Light construction	Install all system elements (electrical, mechanical, signals, and communication), landscaping, signing, and striping; close detours	6 to 18
System integration, testing, and pre-revenue service	Test power, communications, signaling, and ventilation systems; train operators and maintenance personnel.	24 to 30

Source: Connect Los Angeles Partners 2024
Note: Construction activities would overlap and, therefore, the total construction duration would be shorter
ROW = right-of-way; SEM = sequential excavation method; TBM = tunnel boring machine

3.2 STATION AND CROSSOVER CONSTRUCTION

The underground stations and crossovers would be constructed using the cut-and-cover construction technique (except for the Hollywood Bowl Station). This technique generally begins by installing a system of temporary shoring to support the excavation in which the permanent station structure would be constructed and the temporary street decking above the excavation. The temporary shoring is also designed to support loads from adjacent building foundations. Once the temporary shoring has been constructed, excavation begins inside the area closed by shoring. During a series of street closures, typically occurring on weekends, the street is excavated down to about eight feet to install the steel beams and precast concrete decking panels that allow traffic and pedestrian movements to continue overhead while excavation proceeds beneath the decking down to the final depth. Utilities not relocated in advance of station excavation, are supported in place below the temporary decking by steel beams hangers as the soil is excavated around them. The concrete station box structure is then built within the excavated space. The rest of the space is backfilled up to street level, utility hangers are removed, and the surface is restored. Refer to Section 4.3 for more descriptions and an illustration of cut-and-cover construction.

The optional Hollywood Bowl Station and its crossover(s) would be constructed via the sequential excavation method (SEM), which entails conventional mining techniques and equipment for hard rock excavation. Generally, roadheaders would be used for the excavations. Controlled blasting would be used for locally encountered, extremely strong rocks. Details of the station construction process are provided in Section 4.3, Cut-and-Cover Construction, and Section 4.4, SEM Construction.

3.3 TUNNEL CONSTRUCTION

Most tunneling is expected to be performed in soft ground and would use pressurized-face TBMs. Pressurized-face TBMs control the potential for ground settlement resulting from tunneling and prevents the ingress of ground water and gas into the tunnel. The optional Hollywood Bowl segment would be tunneled via conventional mining through the hard rock formations north of the Hollywood fault using roadheaders and localized controlled blast.

As an alternative, the use of pressurized-face TBMs could be extended through the Hollywood Bowl Design Option segment in hard rock formations. In this case, the actual TBMs used would be custom designed for a particular section and would reflect the varying site-specific requirements, including geologic conditions. Generally, two distinct modes of TBMs would be required for hard rock and soft ground if TBM tunneling is continued in the Hollywood Bowl Design Option segment. The soft ground TBM mode would be used for the majority of the project south of the Hollywood fault. North of the Hollywood fault where hard rock conditions would be encountered, the hard rock TBM mode would be used for this limited tunnel segment. A TBM that crosses the Hollywood fault would have to be modified from one mode to the other or equipped to perform in both modes.

The project would generally consist of twin tunnels with approximately 20 feet of inside diameter, bored side-by-side and separated by a pillar of ground in-between. Bore tunnel excavation generally would take four to six months for the typical one-mile length between stations but would vary depending on the ground conditions, site and work area constraints, length of tunnel, and the number of TBMs used. The two TBMs would be launched in the same direction with a staggered start, in which the second TBM would be launched approximately one month after the first TBM launches. The conventionally mined tunnel section for the Hollywood Bowl Design Option segment would be of similar size except for an enlarged section to accommodate the fault-rupture offset and the TBM walkthrough.

3.4 CONSTRUCTION STAGING AREAS

Construction staging (or laydown) areas would be necessary for construction of stations, tunnels, station entrances, crossovers, and ventilation or emergency exit shafts for the project. Staging areas are used principally for equipment operation, material storage, workshops, site offices, parking, and access to underground construction. A typical station requires approximately one to two acres to support construction activities. At TBM sites, a larger staging area of approximately three to four acres would be required to accommodate more logistics for tunneling activities. Typically, these TBM staging areas would be at station excavation sites to facilitate access to the tunnel. For MSF construction, the construction staging would be confined within the identified MSF site without requiring additional acreages.

Temporary easements and a portion of the sidewalk, traffic lanes, and parking spaces may be acquired at various locations for staging. Construction staging solely within the public right-of-way (ROW) would occur at the connection box site with the Expo/Crenshaw Station where no off-street staging has been identified.

In addition, contractors and construction managers would establish field offices in existing office spaces near work areas or in temporary jobsite trailers at the staging areas. Often these offices are operational 24 hours a day, consistent with construction activities. To the extent feasible, parking for construction workers will be provided within the construction staging areas. However, at some of the more constrained sites this may not be feasible, and parking would be consolidated at larger staging sites or off-site.

Appendix A, Construction Laydown Areas, provides a summary of anticipated construction activities at the proposed construction staging areas identified for the project. Appendix B, Haul Routes, provides the haul routes identified to and from each construction area.

3.5 CONSTRUCTION SECTIONS

Each alignment would be constructed in two or three sections, depending on the selected alignment, to break down the larger project into manageable construction sections. These sections would be built sequentially without an overlap of tunneling activities. The goal for the first construction section is to extend the existing K Line to the D Line at either the Wilshire/Fairfax or Wilshire/La Brea Stations. Subsequent construction section(s) would establish passenger connections between the existing K Line at the Expo/Crenshaw Station and the B Line at the Hollywood/Highland Station with an option to extend to the Hollywood Bowl. Each construction section is expected to take eight to 12 years to complete. Details of each construction section are presented in Table 3-2, and the overall construction section map is shown in Figure 3-1.

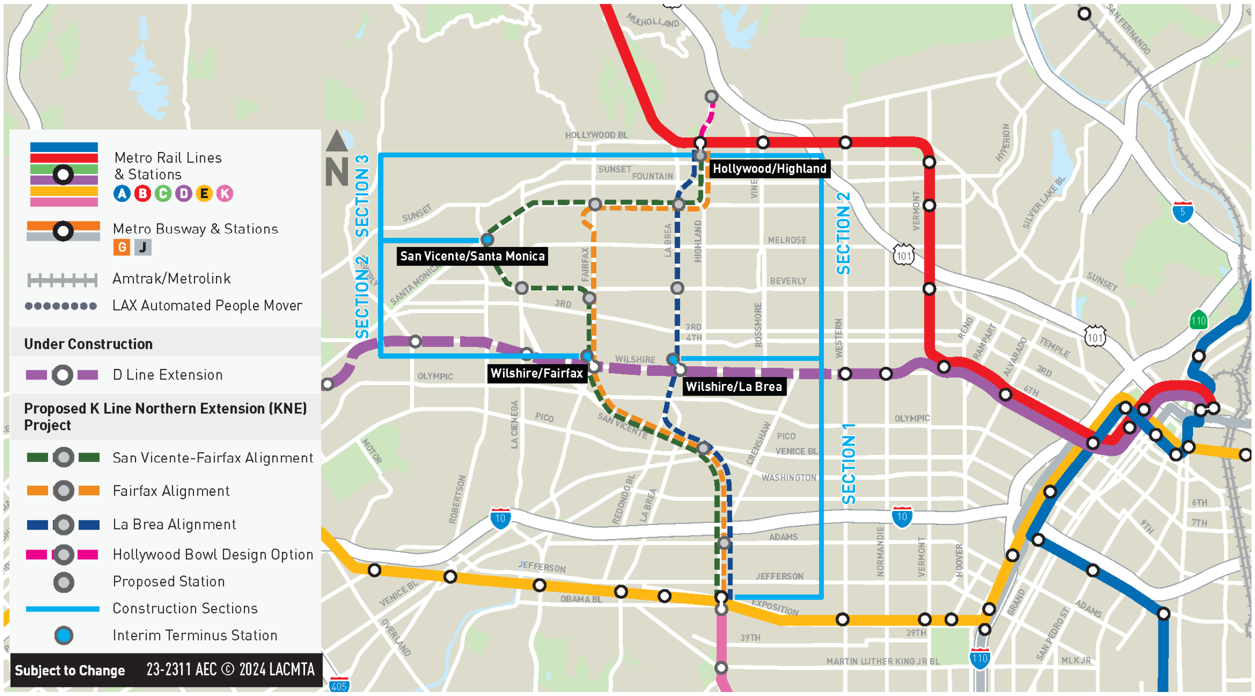
TABLE 3-2. CONSTRUCTION DURATIONS BY SECTION

CONSTRUCTION SECTION	SECTION EXTENTS	MILES/ NUMBER OF STATIONS	APPROXIMATE TOTAL CONSTRUCTION DURATION	TBM LAUNCH SITE	TBM RETRIEVAL SITE
San Vicente–Fairfax Section 1	Expo/Crenshaw Station to Wilshire/Fairfax Station	3.9 miles/ 3 stations	10 to 12 years	Midtown Crossing Station	Northbound: Wilshire/Fairfax Station Southbound: Expo/Crenshaw Station
San Vicente–Fairfax Section 2	Wilshire/Fairfax Station to San Vicente/Santa Monica Station	2.6 miles/ 3 stations	10 to 12 years	San Vicente/Santa Monica Station	Southbound Only: Wilshire/Fairfax Station
San Vicente–Fairfax Section 3	San Vicente/Santa Monica Station to Hollywood/Highland Station	3.2 miles/ 3 stations	9 to 10 years	La Brea/Santa Monica Station	Northbound: Hollywood/Highland Station Southbound: San Vicente/Santa Monica Station
	San Vicente/Santa Monica Station to Hollywood Bowl Station	4.0 miles/ 4 stations	10 to 11 years	La Brea/Santa Monica Station	Northbound: Hollywood Bowl Station Southbound: San Vicente/Santa Monica Station
Fairfax Section 1	Expo/Crenshaw Station to Wilshire/Fairfax Station	3.9 miles/ 3 stations	10 to 12 years	Midtown Crossing Station	Northbound: Wilshire/Fairfax Station Southbound: Expo/Crenshaw Station
Fairfax Section 2	Wilshire/Fairfax Station to Hollywood/Highland Station	3.9 miles/ 4 stations	9 to 10 years	La Brea/Santa Monica Station	Northbound: Hollywood/Highland Station Southbound: Wilshire/Fairfax Station
	Wilshire/Fairfax Station to Hollywood Bowl Station	4.7 miles/ 4 stations	10 to 11 years	La Brea/Santa Monica Station	Northbound: Hollywood Bowl Station Southbound: Wilshire/Fairfax Station
La Brea Section 1	Expo/Crenshaw Station to Wilshire/La Brea Station	3.4 miles/ 3 stations	10 to 11 years	Midtown Crossing Station	Northbound: Wilshire/La Brea Station Southbound: Expo/Crenshaw Station

CONSTRUCTION SECTION	SECTION EXTENTS	MILES/ NUMBER OF STATIONS	APPROXIMATE TOTAL CONSTRUCTION DURATION	TBM LAUNCH SITE	TBM RETRIEVAL SITE
La Brea Section 2	Wilshire/La Brea Station to Hollywood/Highland Station	2.8 miles/ 3 stations	8 to 10 years	La Brea/Santa Monica Station	Northbound: Hollywood/Highland Station Southbound: Wilshire/La Brea Station
	Wilshire/La Brea Station to Hollywood Bowl Station	3.6 miles/ 4 stations	10 to 11 years	La Brea/Santa Monica Station	Northbound: Hollywood Bowl Station Southbound: Wilshire/La Brea Station
MSF	Expansion of Division 16	N/A	4 to 5 years*	N/A	N/A

Source: Connect Los Angeles Partners 2024
*MSF construction would overlap with Section 2 construction activities for all three alignments.
Notes: Section 1 of the San Vicente–Fairfax Alignment and the Fairfax Alignment would be identical in length, number of stations, and northern and southern extents.
Due to its length, the San Vicente–Fairfax Alignment would be constructed in three sections.
MSF = maintenance and storage facility; N/A = not applicable; TBM = tunnel boring machine

FIGURE 3-1. OVERALL CONSTRUCTION SECTION MAP



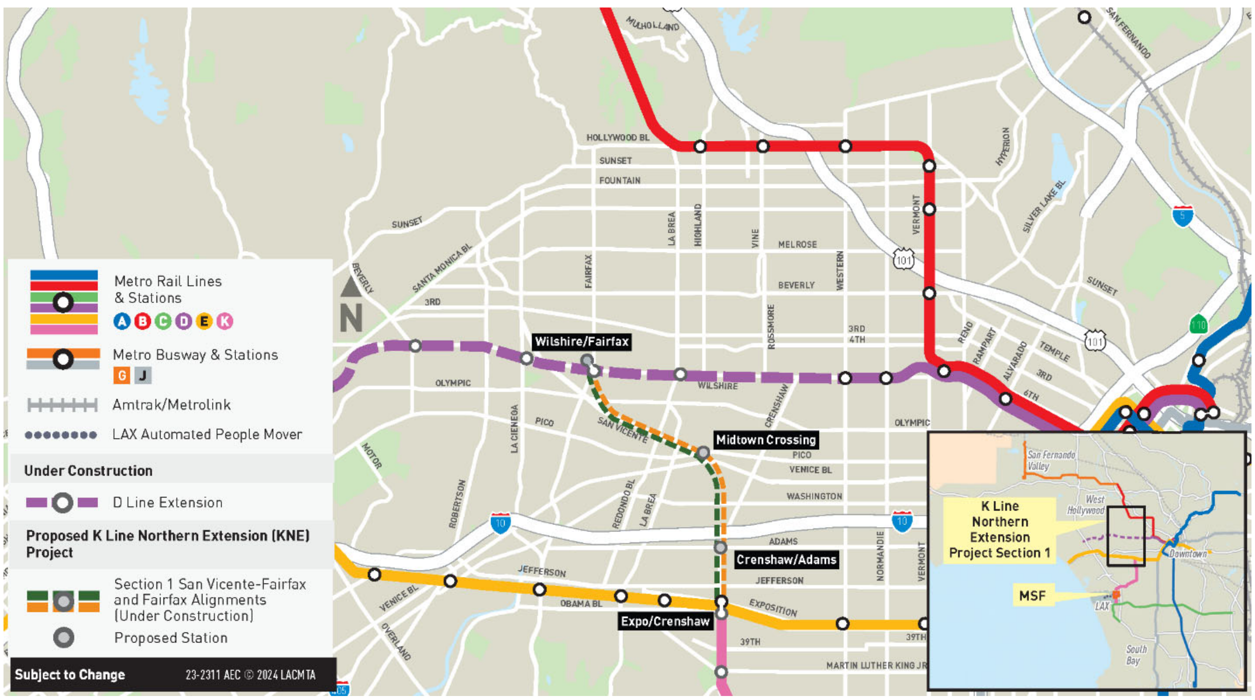
Source: Connect Los Angeles Partners 2024
Note: The Hollywood Bowl Design Option would be included in Section 3 of the San Vicente–Fairfax Alignment or Section 2 of the Fairfax Alignment and La Brea Alignment Alternatives.

The following sections describe the construction section limits for each alignment and also identify the TBM launch site for each construction section, which are discussed in more detail in Appendix A, Construction Laydown Areas.

3.5.1 SAN VICENTE–FAIRFAX ALIGNMENT

The San Vicente–Fairfax Alignment would be constructed in three sections. Section 1 would be 3.9 miles long, would include three stations, and would extend from the current Metro K Line terminus at the Expo/Crenshaw Station to the proposed Wilshire/Fairfax Station, providing a connection to the D Line (Figure 3-2). Two TBMs would be launched from the Midtown Crossing Station, boring toward the south first. They would be extracted at the Expo/Crenshaw Station, transferred to the Midtown Crossing Station via surface streets, and relaunched to the north. They would be partially extracted with the shields abandoned in place at the end of tail track tunnels at the Wilshire/Fairfax Station.

FIGURE 3-2. SAN VICENTE–FAIRFAX AND FAIRFAX ALIGNMENTS– SECTION 1



Source: Connect Los Angeles Partners 2024

Section 2 would extend 2.6 miles from the Section 1 terminus at the Wilshire/Fairfax Station to the proposed San Vicente/Santa Monica Station in West Hollywood and would include three new stations (Figure 3-3). Two TBMs would be launched from the San Vicente/Santa Monica Station and would bore south toward the Wilshire/Fairfax Station. The TBMs would then be partially retrieved with the TBM shields abandoned in place at the Wilshire/Fairfax Station.

FIGURE 3-3. SAN VICENTE–FAIRFAX ALIGNMENTS– SECTION 2

Source: Connect Los Angeles Partners 2024

Section 3 would extend 3.2 miles from the Section 2 terminus at the San Vicente/Santa Monica Station to the northern terminus at the Hollywood/Highland Station or the optional Hollywood Bowl Station and would include three new stations (Figure 3-4). If the Hollywood Bowl Design Option is constructed, it would be incorporated into Section 3. Two TBMs would be launched from the La Brea/Santa Monica Station and would bore toward the south first, then would be extracted at the San Vicente/Santa Monica Station. The TBMs would then be transferred to the La Brea/Santa Monica Station via surface streets, relaunched to the north, and extracted at either the Hollywood/Highland Station or south of the optional Hollywood Bowl Station.

FIGURE 3-4. SAN VICENTE–FAIRFAX ALIGNMENT– SECTION 3

Source: Connect Los Angeles Partners 2024

Table 3-3 summarizes construction activities, including types of construction equipment to be used, volumes of soil and concrete, haul truck trips per day, and approximate range of workers required per day for the San Vicente–Fairfax Alignment.

TABLE 3-3. CONSTRUCTION ACTIVITY SUMMARY FOR SAN VICENTE–FAIRFAX ALIGNMENT

SECTION	ACTIVITY	HAUL TRUCK	CONCRETE TRUCK	DOZER	EXCAVATOR	CRANE	DRILL RIG	FLATBED	MUCK (CY)	CONCRETE (CY)	HAUL TRUCK TRIPS PER DAY	WORKERS PER DAY
Section 1	Pre-construction (per typical station site)						✓	✓	N/A	N/A	5	10-20
	Site preparation (per typical station site)	✓	✓	✓	✓	✓		✓	4,000	1,000	10-20	20-30
	TBM tunnel from Midtown Crossing to Expo/Crenshaw	✓	✓	✓	✓	✓		✓	350,000	Precast	90-100	70-90
	TBM tunnel from Midtown Crossing to Wilshire/Fairfax	✓	✓	✓	✓	✓		✓	324,000	Precast	70-80	70-90
	Retrieval Shaft at Expo/Crenshaw (cut-and-cover)	✓	✓	✓	✓	✓	✓	✓	14,000	2,000	10-20	30-40
	Crenshaw/Adams Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	266,000	48,000	90-100	50-70
	Midtown Crossing Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	296,000	48,000	60-70	50-70
	Wilshire/Fairfax Station (cut-and-cover with crossover, tail tracks)	✓	✓	✓	✓	✓	✓	✓	544,000	54,000	180-190	70-100
	Operating systems installation	✓				✓		✓	N/A	N/A	2	20-30
Section 2	Pre-construction (per typical station site)						✓	✓	N/A	N/A	5	10-20
	Site preparation (per typical station site)	✓	✓	✓	✓	✓		✓	4,000	1,000	10-20	20-30
	TBM tunnel from San Vicente/Santa Monica to Wilshire/Fairfax	✓	✓	✓	✓	✓		✓	461,000	Precast	80-90	70-90
	Fairfax/3rd Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	284,000	48,000	90-100	50-70
	La Cienega/Beverly Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	270,000	48,000	90-100	50-70
	San Vicente/Santa Monica Station (cut-and-cover with crossover, tail tracks)	✓	✓	✓	✓	✓	✓	✓	268,000	48,000	70-80	70-90
	Operating systems installation	✓				✓		✓	N/A	N/A	2	20-30

SECTION	ACTIVITY	HAUL TRUCK	CONCRETE TRUCK	DOZER	EXCAVATOR	CRANE	DRILL RIG	FLATBED	MUCK (CY)	CONCRETE (CY)	HAUL TRUCK TRIPS PER DAY	WORKERS PER DAY
Section 3	Pre-construction (per typical station site)						✓	✓	N/A	N/A	5	10-20
	Site preparation (per typical station site)	✓	✓	✓	✓	✓		✓	4,000	1,000	10-20	20-30
	TBM tunnel from La Brea/Santa Monica to San Vicente/Santa Monica	✓	✓	✓	✓	✓		✓	353,000	Precast	100-110	70-90
	TBM tunnel from La Brea/Santa Monica to Hollywood/Highland	✓	✓	✓	✓	✓		✓	132,000	Precast	70-80	70-90
	Fairfax/Santa Monica Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	312,000	48,000	100-110	50-70
	La Brea/Santa Monica Station (cut-and-cover)	✓	✓	✓	✓	✓	✓	✓	131,000	22,000	30-40	50-70
	Hollywood/Highland Station (cut-and-cover with crossover, tail tracks, and retrieval shaft)	✓	✓	✓	✓	✓	✓	✓	932,000	105,000	140-150	70-100
	Hollywood Bowl Design Option – Tunnels from Franklin Ave	✓	✓	✓	✓	✓	✓	✓	123,000	13,000	20-30	50-70
	Hollywood Bowl Design Option – station, crossovers, tunnels, and end shafts	✓	✓	✓	✓	✓	✓	✓	514,500	51,000	40-50	150-200
	Operating systems installation	✓				✓		✓	N/A	N/A	2	20-30

Source: Connect Los Angeles Partners 2024
CY = cubic yards; N/A = not applicable; TBM = tunnel boring machine

3.5.2 FAIRFAX ALIGNMENT

The Fairfax Alignment would be constructed in two sections. Section 1, similar to the San Vicente–Fairfax Alignment, would extend 3.9 miles from the current K Line terminus at the Expo/Crenshaw Station to the proposed Wilshire/Fairfax Station, providing a connection to the D Line and would include three new stations (Figure 3-2). Two TBMs would be launched from the Midtown Crossing Station, boring toward the south first, and extracted at the Expo/Crenshaw Station. They would be transferred to the Midtown Crossing Station via surface streets, relaunched to the north, and then partially extracted with the shields abandoned in place at the end of tail track tunnels at the Wilshire/Fairfax Station.

Section 2 would extend 3.9 miles from the Section 1 terminus at the Wilshire/Fairfax Station to the northern terminus at the Hollywood/Highland Station and would include four new stations (Figure 3-5). If the Hollywood Bowl Design Option is constructed, it would be incorporated into Section 2. Two TBMs would be launched from the La Brea/Santa Monica Station and would bore toward the south first, then would be extracted at the Wilshire/Fairfax Station. The TBMs would then be transferred to the La Brea/Santa Monica Station via surface streets, relaunched to the north, and extracted at either the Hollywood/Highland Station or south of the optional Hollywood Bowl Station.

FIGURE 3-5. FAIRFAX ALIGNMENT– SECTION 2

Source: Connect Los Angeles Partners 2024

Table 3-4 summarizes construction activities, including types of construction equipment to be used, volumes of soil and concrete, haul truck trips per day, and approximate range of workers required per day for the Fairfax Alignment.

TABLE 3-4. CONSTRUCTION ACTIVITY SUMMARY FOR FAIRFAX ALIGNMENT

SECTION	ACTIVITY	HAUL TRUCK	CONCRETE TRUCK	DOZER	EXCAVATOR	CRANE	DRILL RIG	FLATBED	MUCK (CY)	CONCRETE (CY)	HAUL TRUCK TRIPS PER Day	WORKERS PER DAY
Section 1	Pre-construction (per typical station site)						✓	✓	N/A	N/A	5	10-20
	Site preparation (per typical station site)	✓	✓	✓	✓	✓		✓	4,000	1,000	10-20	20-30
	TBM tunnel from Midtown Crossing to Expo/Crenshaw	✓	✓	✓	✓	✓		✓	350,000	Precast	90-100	70-90
	TBM tunnel from Midtown Crossing to Wilshire/Fairfax	✓	✓	✓	✓	✓		✓	324,000	Precast	70-80	70-90
	Retrieval shaft at Expo/Crenshaw (cut-and-cover)	✓	✓	✓	✓	✓	✓	✓	14,000	2,000	10-20	30-40
	Crenshaw/Adams Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	266,000	48,000	90-100	50-70
	Midtown Crossing Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	296,000	48,000	60-70	50-70
	Wilshire/Fairfax Station (cut-and-cover with crossover, tail tracks)	✓	✓	✓	✓	✓	✓	✓	544,000	54,000	180-190	70-100
	Operating systems installation	✓				✓		✓	N/A	N/A	2	20-30
Section 2	Pre-construction (per typical station site)						✓	✓	N/A	N/A	5	10-20
	Site preparation (per typical station site)	✓	✓	✓	✓	✓		✓	4,000	1,000	10-20	20-30
	TBM tunnel from La Brea/Santa Monica to Wilshire/Fairfax	✓	✓	✓	✓	✓		✓	351,000	Precast	120-130	70-90
	TBM tunnel from La Brea/Santa Monica to Hollywood/Highland	✓	✓	✓	✓	✓		✓	132,000	Precast	70-80	70-90
	Fairfax/3rd Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	284,000	48,000	90-100	50-70
	Fairfax/Santa Monica Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	312,000	48,000	100-110	50-70
	La Brea/Santa Monica Station (cut-and-cover)	✓	✓	✓	✓	✓	✓	✓	131,000	22,000	30-40	50-70
	Hollywood/Highland Station (cut-and-cover with crossover, tail tracks, and retrieval shaft)	✓	✓	✓	✓	✓	✓	✓	932,000	105,000	140-150	70-100
	Hollywood Bowl Design Option – tunnels from Franklin Ave	✓	✓	✓	✓	✓	✓	✓	123,000	13,000	20-30	50-70

SECTION	ACTIVITY	HAUL TRUCK	CONCRETE TRUCK	DOZER	EXCAVATOR	CRANE	DRILL RIG	FLATBED	MUCK (CY)	CONCRETE (CY)	HAUL TRUCK TRIPS PER Day	WORKERS PER DAY
	Hollywood Bowl Design Option – station, crossovers, tunnels, and end shafts	✓	✓	✓	✓	✓	✓	✓	514,500	51,000	40-50	150-200
	Operating systems installation	✓				✓		✓	N/A	N/A	2	20-30

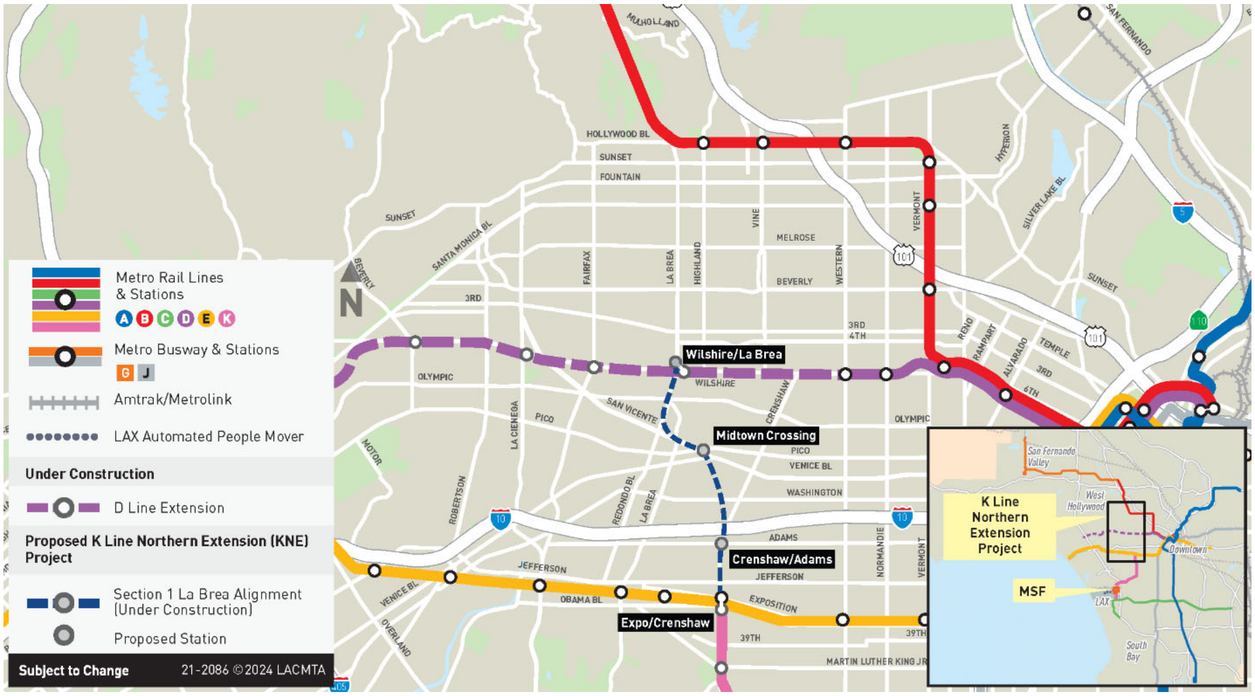
Source: Connect Los Angeles Partners 2024
CY = cubic yards; N/A = not applicable; TBM = tunnel boring machine

3.5.3 LA BREA ALIGNMENT

The La Brea Alignment would be constructed in two sections. Section 1 would extend 3.4 miles from the current K Line terminus at the Expo/Crenshaw Station to the proposed Wilshire/La Brea Station, providing a connection to the D Line and would include three new stations (Figure 3-6). Two TBMs would be launched from the Midtown Crossing Station boring toward the north first and extracted at the Expo/Crenshaw Station. It would be transferred to the Midtown Crossing Station on the streets, relaunched to the south, and then partially extracted with the shields abandoned in place at the end of tail track tunnels at the Wilshire/La Brea Station.

Section 2 would extend 2.8-miles from the Section 1 terminus at the Wilshire/La Brea Station to the northern terminus at the Hollywood/Highland Station and would include three new stations (Figure 3-7). If the Hollywood Bowl Design Option is constructed, it would be incorporated into Section 2. Two TBMs would be launched from the La Brea/Santa Monica Station and would bore toward the south first and would be extracted at the Wilshire/La Brea Station. The TBMs would then be transferred to the La Brea/Santa Monica Station via surface streets, relaunched to the north, and then extracted at either the Hollywood/Highland Station or south of the optional Hollywood Bowl Station.

FIGURE 3-6. LA BREA ALIGNMENT– SECTION 1



Source: Connect Los Angeles Partners 2024

FIGURE 3-7. LA BREA ALIGNMENT– SECTION 2

Source: Connect Los Angeles Partners 2024

Table 3-5 summarizes construction activities, including types of construction equipment to be used, volumes of soil and concrete, haul truck trips per day, and approximate range of workers required per day for the La Brea Alignment.

TABLE 3-5. CONSTRUCTION ACTIVITY SUMMARY FOR LA BREA ALIGNMENT

SECTION	ACTIVITY	HAUL TRUCK	CONCRETE TRUCK	DOZER	EXCAVATOR	CRANE	DRILL RIG	FLATBED	MUCK (CY)	CONCRETE (CY)	HAUL TRUCK TRIPS PER Day	WORKERS PER DAY
Section 1	Pre-construction (per typical station site)						✓	✓	N/A	N/A	5	10-20
	Site preparation (per typical station site)	✓	✓	✓	✓	✓		✓	4,000	1,000	10-20	20-30
	TBM tunnel from Midtown Crossing to Expo/Crenshaw	✓	✓	✓	✓	✓		✓	350,000	Precast	90-100	70-90
	TBM tunnel from Midtown Crossing to Wilshire/La Brea	✓	✓	✓	✓	✓		✓	245,000	Precast	70-80	70-90
	Retrieval shaft at Expo/Crenshaw (cut-and-cover)	✓	✓	✓	✓	✓	✓	✓	14,000	2,000	10-20	30-40
	Crenshaw/Adams Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	266,000	48,000	90-100	50-70
	Midtown Crossing Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	296,000	48,000	60-70	50-70
	Wilshire/La Brea Station (cut-and-cover with crossover, tail tracks)	✓	✓	✓	✓	✓	✓	✓	488,000	48,000	150-160	70-100
	Operating systems installation	✓				✓		✓	N/A	N/A	2	20-30
Section 2	Pre-construction (per typical station site)						✓	✓	N/A	N/A	5	10-20
	Site preparation (per typical station site)	✓	✓	✓	✓	✓		✓	4,000	1,000	10-20	20-30
	TBM tunnel from La Brea/Santa Monica to Wilshire/La Brea	✓	✓	✓	✓	✓		✓	341,000	Precast	110-120	70-90
	TBM tunnel from La Brea/Santa Monica to Hollywood/Highland	✓	✓	✓	✓	✓		✓	184,000	Precast	70-80	70-90
	La Brea/Beverly Station (cut-and-cover with crossover)	✓	✓	✓	✓	✓	✓	✓	299,000	48,000	90-100	50-70
	La Brea/Santa Monica Station (cut-and-cover)	✓	✓	✓	✓	✓	✓	✓	170,000	26,000	40-50	50-70
	Hollywood/Highland Station (cut-and-cover with crossover, tail tracks, and retrieval shaft)	✓	✓	✓	✓	✓	✓	✓	932,000	105,000	140-150	70-100

SECTION	ACTIVITY	HAUL TRUCK	CONCRETE TRUCK	DOZER	EXCAVATOR	CRANE	DRILL RIG	FLATBED	MUCK (CY)	CONCRETE (CY)	HAUL TRUCK TRIPS PER Day	WORKERS PER DAY
	Hollywood Bowl Design Option – tunnels from Franklin Ave	✓	✓	✓	✓	✓	✓	✓	123,000	13,000	20-30	50-70
	Hollywood Bowl Design Option – station, crossovers, tunnels, and end shafts	✓	✓	✓	✓	✓	✓	✓	514,500	51,000	40-50	150-200
	Operating systems installation	✓				✓		✓	N/A	N/A	2	20-30

Source: Connect Los Angeles Partners 2024
CY = cubic yards; N/A = not applicable; TBM = tunnel boring machine

3.5.4 HOLLYWOOD BOWL DESIGN OPTION

Construction of the Hollywood Bowl Design Option could be included in the last construction section (Section 2 or 3) of the respective alignments. The Hollywood Bowl Design Option would extend 0.8 mile north from the northern end of the final section (Section 2 or 3) near Franklin Avenue to a Hollywood Bowl Station and north under Cahuenga Boulevard with the emergency ventilation and egress shaft. As the Hollywood Bowl Design Option would be constructed concurrently with Section 2 or 3 of the project, the overall construction duration of Section 2 or 3 would be similar with or without the Hollywood Bowl Design Option. The Hollywood Bowl Design Option would involve cut-and-cover excavation, underground cavern excavation, and conventionally mined tunnel excavation in hard rock. Refer to 4.7Appendix A, Construction Laydown Areas, for more descriptions and site plans of the Hollywood Bowl Design Option.

3.6 MSF CONSTRUCTION

A new MSF site would be required to maintain and store the project's LRVs). Due to the dense urban environment along the KNE corridor, a suitable site with compatible land uses could not be identified in the immediate vicinity of the project. Instead, the MSF site was identified farther south on the existing K Line in the vicinity of LAX and the K Line's existing Division 16 MSF, as shown in Figure 3-8.

FIGURE 3-8. PROPOSED MSF SITE MAP

Source: Connect Los Angeles Partners 2024

The capacity of the existing K Line MSF (Division 16), located on the southwest corner of Arbor Vitae Street and Aviation Boulevard, would be exceeded with the additional vehicles required for the operation of the full project. Therefore, the proposed MSF site is positioned adjacent to the existing Division 16 yard and proposes to expand the existing Division 16 MSF to provide additional capacity. Expanding the existing site would maintain connection with the existing tracks and would not require additional ROW for track connections, street crossings, or permanent closure of streets. Refer to Table 3-6 for more information on the MSF, including acreages, storage track capacity, estimated construction durations, and major buildings to be constructed.

TABLE 3-6. MSF SITE EXPANSION

ACREAGE	STORAGE TRACK CAPACITY	CONSTRUCTION DURATION	MAJOR BUILDINGS TO BE CONSTRUCTED
19 acres	54 LRVs	3 to 4 years	Service and Inspection Shop, Maintenance-of-Way Facility, Cleaning Platform

Source: Connect Los Angeles Partners 2024
LRV = light rail vehicle

Construction of the expanded MSF would involve construction of trackwork, buildings, and fences. Initially, demolition, site preparation, and grading would be conducted, followed by utility installation and building construction as trackwork progresses. MSF construction would be finished by the addition of fencing, paving, and landscaping. The duration of MSF construction would be three to four years.

Table 3-7 summarizes construction activities, including types of construction equipment to be used, volumes of soil and concrete, haul truck trips per day, and approximate range of workers required per day for MSF construction.

TABLE 3-7. CONSTRUCTION ACTIVITY SUMMARY FOR MSF CONSTRUCTION

ACTIVITY	HAUL TRUCK	CONCRETE TRUCK	DOZER	EXCAVATOR	CRANE	DRILL RIG	FLATBED	MUCK (CY)	CONCRETE (CY)	HAUL TRUCK TRIPS PER Day	WORKERS PER DAY
Pre-construction						✓	✓	N/A	N/A	5	10-20
Site preparation	✓	✓	✓	✓	✓		✓	80,000	1,000	40-50	30-40
Track and building construction	✓	✓	✓	✓	✓	✓	✓	N/A	31,000	20-30	50-70
Operating systems installation	✓				✓		✓	N/A	N/A	2	20-30

Source: Connect Los Angeles Partners 2024
CY = cubic yard; MSF = maintenance and storage facility; N/A = not applicable

SECTION 4: CONSTRUCTION METHODS AND TECHNIQUES

4.1 PRE-CONSTRUCTION AND SITE PREPARATION

During final design and prior to any construction, pre-construction surveys and investigations would be completed to determine existing conditions that could affect construction methods and timing, as described in the following sections. In addition, refined traffic control plans would be prepared for stations and tunnel construction where street closures and excessive truck traffic would disrupt normal street operations.

4.1.1 LOCAL BUSINESS SURVEYS

Individual businesses would be surveyed and interviewed to identify business usage, delivery, shipping patterns, and critical times of the day or year for business activities. This information would be used by Metro to develop construction requirements and worksite traffic control plans and to identify alternative access routes and requirements to maintain critical business activities.

4.1.2 GEOTECHNICAL INVESTIGATIONS

Subsurface (geotechnical) investigations would further evaluate geology, groundwater, seismic, and environmental conditions along the alignment. These investigations would be spaced along the alignment to evaluate soil, rock, groundwater, seismic, and geoenvironmental conditions, particularly to note locations where hydrocarbon or other contaminant deposits may be encountered. The results of these investigations would influence final design and construction methods for stations, tunnels, other underground structures, and foundations.

4.1.3 NOISE AND VIBRATION ASSESSMENT

Prior to any construction, the sensitive receptors for noise and vibration would be identified and assessed for the anticipated noise and vibration impacts during construction and operation. The assessment would include measurements of ambient noise and vibration to set the criteria for potential mitigation approaches at the receptor sites. The construction requirements and site plans will be developed based on the assessment with respect to the noise and vibration induced by the project.

4.1.4 CULTURAL RESOURCE INVESTIGATIONS

PALEONTOLOGICAL PROPERTIES

Areas surrounding the Wilshire/Fairfax and Wilshire/La Brea Stations are known to have tar deposits or tar sands with potential paleontological features that may have to be removed under special conditions. Therefore, preliminary preparation and excavation are likely to occur early on to remove the identified resources and prepare the ground for excavation. Where paleontological resources are found, this could affect the cut-and-cover operations to allow sufficient time to evaluate and recover the resources without complete suspension of construction activities. It may be necessary to employ raised decking with ramps, which would allow traffic to be restored without disturbing the underlying resources.

HISTORIC PROPERTIES AND ARCHAEOLOGICAL RESOURCES

If historic properties are identified above tunnels or adjacent to tunnels, stations, or cut-and-cover construction areas or within areas proposed for acquisition, Metro would develop appropriate measures to avoid or minimize impacts during construction and as identified in the EIR. Cultural resources pertaining to intact archaeological deposits could also be affected, and appropriate measures would be developed and identified in the EIR.

4.1.5 BUILDING/UTILITY/OTHER STRUCTURE ASSESSMENT

The condition of existing buildings, utilities, and other structures (such as multi-level parking garages) in proximity to stations, tunnels, and other underground structures would be evaluated with respect to excavation for underground stations and tunnels. This evaluation would determine whether additional protection work, such as special excavation support systems, underpinning, or ground improvement, is necessary to mitigate settlement. The integrity of adjacent structures would influence the method of excavation, type of support systems, and the monitoring program that would be used.

4.1.6 UTILITY RELOCATION AND STREET CLOSURES

Underground utilities are researched and noted on drawings as part of the conceptual design phase. During pre-construction, existing utilities may be more closely inspected and evaluated, including depth, condition, material, and exact location. An operation called potholing is typically done to physically locate certain utilities, which can then be appropriately marked or protected. It would be necessary to either relocate, modify, or protect-in-place all utilities and underground structures that would conflict with excavations.

Protection-in-place is the method of choice, as this is less disruptive to streets and less costly. Where in-place protection is insufficient, relocation is required. Utility relocations can be done prior to or during construction, depending on the sensitivity of the utility and scope of relocation. Utilities that would interfere with the installation of shoring or deck beams would have to be relocated during advance work ahead of construction. Affected utilities are expected to include storm drains, sanitary sewers, water lines, power lines, gas pipelines, oil pipelines, electrical duct banks and transmission lines, lighting, irrigation lines, and communications, such as phone, data, and cable TV.

Utility relocations would be coordinated with the utility owner. Relocation and protection of underground utilities would require excavation to the depth of the existing utility line and installation of a replacement utility in a new location if protection-in-place is not feasible. This would occur within the affected ROW and on nearby streets, as required. Access hatches may also be included for utility provider access after construction. Utility relocations often entail some form of temporary service interruptions. These are typically planned for periods of minimum use (such as nights or weekends), so that outages have the least impact on users. If longer outages are anticipated, sidelining services will be considered.

Utilities within the construction area, such as high-pressure water mains and gas lines, would be relocated around the construction area or supported in place by hanging from deck beams. The contractor would determine whether to relocate utility lines that do not conflict with temporary decking but cross or parallel open excavation.

In addition to utility relocations, various new utilities would be installed to accommodate construction and station service needs. These include, but are not limited to, communications cables (including fiber optic lines), electrical duct banks, drainage facilities, waste lines, water and fire supply lines, and lighting.

Relocation of utilities that would conflict with the construction of shoring and decking would occur before excavation and would require closure of traffic lanes. In some instances, block-long sections of streets might be closed temporarily. Major cross streets would require partial closure while relocating utilities.

4.1.7 SITE PREPARATION AND DEMOLITION

Prior to construction, contractors would prepare work sites to accept workers, equipment, and materials. This would include clearing, grubbing, and grading, followed by mobilization of initial equipment and materials.

At most sites, building demolition would be required to provide space for construction or construction work areas. Demolition necessitates strict controls to ensure that adjacent buildings and infrastructure are not damaged or otherwise affected. These controls include fencing and barricades, environmental monitoring, and limits on the types of equipment and demolition procedures. Demolition equipment typically includes bulldozers and front-end loaders, which are often specially developed or modified to allow for precise and controlled dismantling. Prior to demolition, the contractor would remove any hazardous materials and may also salvage items, such as fixtures, mechanical equipment, and lumber. Where economical, materials such as steel and concrete may be recycled.

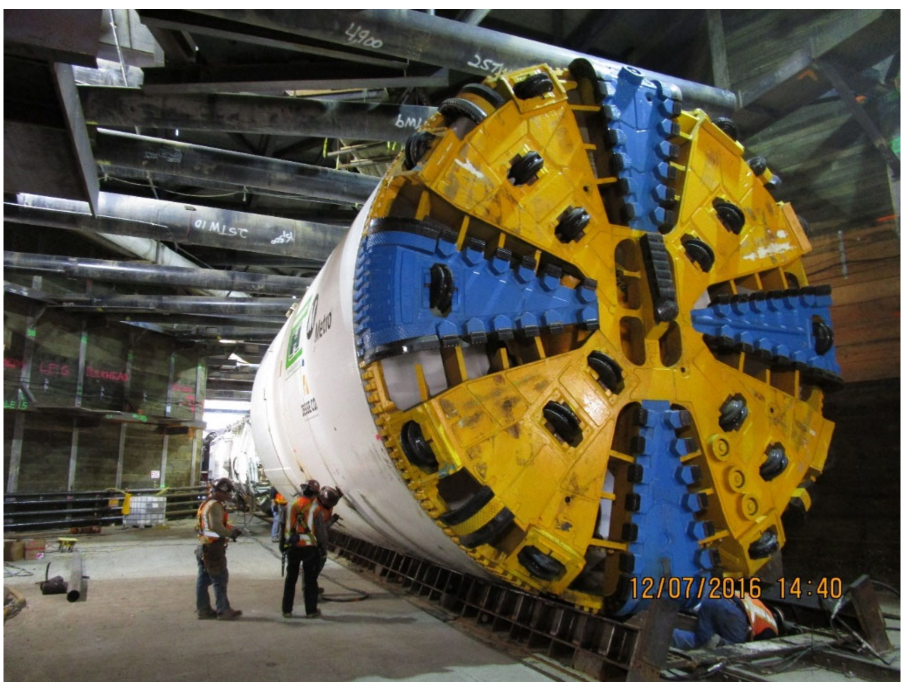
4.2 TUNNEL CONSTRUCTION

The guideway tunnels for the project would be constructed as twin-bore tunnels similar to those employed by Metro for many previous underground transit projects. Pressurized-face TBMs, which maintain an equilibrium of ground pressure at the face, would be primarily used to construct the tunnels. They have been commonly used by Metro since the 1990s and were recently used to construct the Regional Connector and D Line Extension projects.

The guideway tunnels in the Hollywood Bowl Design Option segment (north of the Hollywood fault) would be constructed via conventional mining for hard rock formations. In such case, the TBMs would enter the conventionally mined tunnels which would be sized to accommodate the TBM walking up to a retrieval site. The conventional mining would be performed using roadheaders and localized controlled blast as ground conditions require. In addition, conventional mining techniques could be used to construct an enlarged tunnel section at the Hollywood Fault to accommodate fault-rupture displacement. However, depending on the future site investigation and advanced fault characterization, TBM tunneling could be extended farther eliminating conventionally mined tunneling within the Hollywood Bowl area. In this case, the TBMs crossing the Hollywood fault would have to be able to switch modes between soft ground and hard rock operations or equipped for dual modes, and the segmental lining through the Hollywood fault would have to be specially designed to accommodate the anticipated fault offset. Figure 4-1, Figure 4-2, and Figure 4-3 depict TBM, roadheader, and drill-and-blast operation, respectively.

As described earlier, the project would be constructed in sections depending on the length and complexity of the selected alignment. For each section, the TBMs would be launched from designated TBM launch sites. These sites are used to support tunneling activities throughout the duration of the tunneling process, and most tunneling construction activities and impacts would be concentrated at the TBM launch sites. At the end of each tunneling segment, the TBMs would be removed via a retrieval shaft or partially retrieved through the tunnel with a portion of the TBM shield to be abandoned in place.

FIGURE 4-1. TUNNEL BORING MACHINE PRIOR TO LAUNCH



Source: WSP, Metro Regional Connector Transit Corridor Project, 2016

FIGURE 4-2. ROADHEADER

Source: Website https://www.rocktechnology.sandvik/

FIGURE 4-3. DRILL-AND-BLAST OPERATION

Source: Website https://www.robitgroup.com/

4.2.1 BORED TUNNELS

4.2.1.1 TBM TRANSPORT AND DELIVERY

TBM components would be shipped to the tunnel construction staging sites by self-propelled modular trailer, which is a platform heavy hauler with a large array of wheels typically operated using hydraulic power (Figure 4-4). These trailers are used to transport massive objects such as TBMs that are too big or heavy for trucks. Several oversize deliveries would be made, typically during nights and weekends. However, this activity would occur only during the initial setup and removal period for the TBM. As a TBM is to be re-used to excavate a subsequent tunnel, the entire machine may be transported by road from one site to the next. This would require slow-speed oversized truck loads on streets, typically at night.

FIGURE 4-4. TUNNEL BORING MACHINE DELIVERY

Source: https://i.ytimg.com/vi/CXOs_EsttQ0/maxresdefault.jpg

4.2.1.2 TBM LAUNCH AND RETRIEVAL SITES

The construction staging area for launching a TBM and supporting a TBM operation would include the working shaft (supporting air/water/electricity supplies and spoil hoisting); crane pad; storage and preparation of precast concrete segments; temporary spoil storage; truck wash; mechanical and electrical shops; ventilation fans and lines; grout plant; soil conditioning plant; slurry separation plant (for slurry TBM) which would include filters, centrifuges, and vibrator equipment; cooling tower; compressed air plant; construction driveways; temporary power substation with emergency generator; and field offices.

A Metro tunnel construction staging area typical for twin-bore operation would require a minimum of three acres.

Generally, the location of a Metro tunneling construction staging area is selected based on tunneling direction, access roads and haulage routes available for the construction traffic volumes, available acreages, and environmental justice. In addition, at the selected TBM construction staging area, a temporary construction power supply with a minimum of approximately 10 megawatts must be available, and the noise, vibration, erosion, and dust caused by construction activities must be manageable.

Considering the minimum requirement of three acres, construction in multiple sections, stakeholder considerations, and future development opportunities, four sites have been identified as potential tunneling sites: three TBM launching sites and one conventionally mined tunneling site that also can be considered for a TBM launching site in the future. Because of limited space available in the urban environment, the tunneling contractor would be most likely constrained to launch TBM(s) at these four sites. The four TBM launch sites are described below. 4.7Appendix A, Construction Laydown Areas, includes additional descriptions and site plans of the TBM launch sites.

MIDTOWN CROSSING

The Midtown Crossing Station site (Figure A-4 in Appendix A, Construction Laydown Areas) has been identified as the TBM launch site for Section 1 construction of all three alignments. About six acres would be used for tunnel/station construction. Two segments of TBM tunnel would be constructed from this site: one segment to the south about 2.0 miles ending at the existing Expo/Crenshaw Station, and the other to the north about 1.4 miles for the La Brea Alignment and 1.9 miles for the San Vicente–Fairfax and Farifax Alignment ending with a new station at Wilshire Boulevard. The TBM launched from this site to the south would be retrieved from the connection box excavation (70 feet wide and 60 feet long) at the northern end of the existing Expo/Crenshaw Station, and the other to the north would be partially retrieved from the proposed station excavation at Wilshire Boulevard, leaving abandoned TBM shields in the stub tunnel at the end of the tail tracks.

SAN VICENTE/SANTA MONICA

The San Vicente/Santa Monica Station site (Figure A-9 and Figure A-10 in Appendix A, Construction Laydown Areas) has been identified as the TBM launching site of Section 2 construction for the San Vicente–Fairfax Alignment. About three acres would be used for tunnel and station construction at this location. A single segment would be constructed from this site only to the south for about 2.6 miles with three stations within the segment and ending at the proposed Wilshire/Fairfax Station to be constructed in Section 1. The TBM would be partially retrieved through the tunnel connecting to the stub tunnel at the end of the tail tracks constructed at the northern end of the Wilshire/Fairfax station during Section 1 construction.

LA BREA/SANTA MONICA

The La Brea/Santa Monica Station site (Figure A-13 and Figure A-14 in Appendix A, Construction Laydown Areas) has been identified as the TBM launch site of Section 2 construction for the La Brea and Fairfax Alignments and Section 3 construction of the San Vicente–Fairfax Alignment. This would be the TBM launch site for the last construction section (Section 2 or 3) of each alignment. Even if the Hollywood Bowl Design Option is advanced, this site would have to be available as a TBM launch site if conventionally mined tunneling is employed for the Hollywood Bowl Design Option segment.

About three acres of commercial property could be used for the tunnel and station construction at this location. Two segments of TBM tunnel would be constructed from this site: to the south about 1.7 to 2.8 miles (depending on the alignment), and to the north about 1.1 miles for all alignments with or without the Hollywood Bowl Design Option. The southbound TBM from this site could be partially retrieved through the tunnel with the TBM shield abandoned in place at the northern end of the station or the tail track tunnels constructed in the earlier construction section. The northbound TBM from this site could be retrieved at the Hollywood/Highland Station site or at the optional Hollywood Bowl Station site.

HOLLYWOOD BOWL

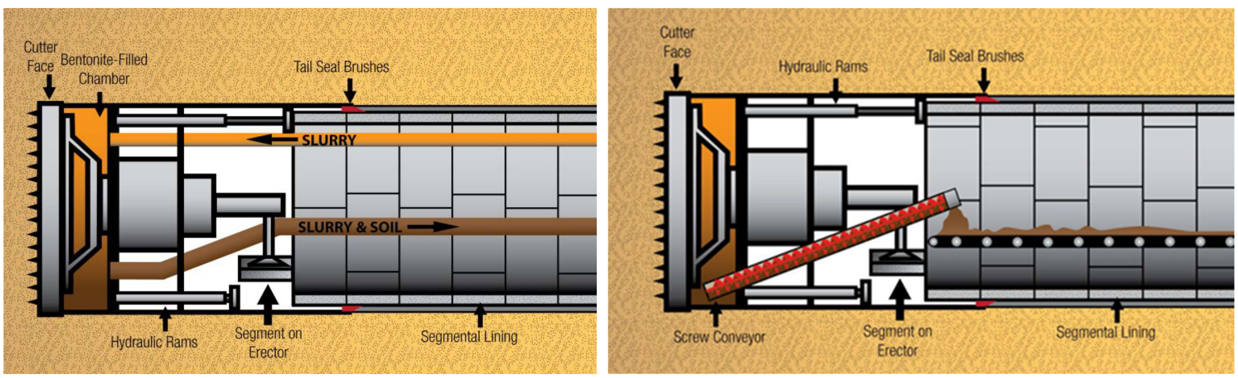
The optional Hollywood Bowl Station site (Figure A-21 and Figure A-22 in Appendix A, Construction Laydown Areas) has been identified as a conventionally mined tunnel/cavern site to construct the Hollywood Bowl Design Option segment. About four acres of the parking lots at the Hollywood Bowl would be used for tunnel and station construction. The twin guideway tunnels, crossover and station caverns located on north of Franklin Avenue would be excavated from this site.

4.2.1.3 TBM OPERATIONS

A TBM continuously bores a large-diameter circular tunnel. Two types of pressurized-face TBMs—earth pressure balance (EPB) and slurry TBM—are commonly used in the Los Angeles region depending on geologic conditions. Both EPB and slurry TBMs apply a balancing pressure to the excavation face to stabilize the ground and balance the groundwater pressure in front of the excavation face. Operating both types of TBMs, the excavated materials are removed through the tunnel using conveyor belts or closed spoil transport pipelines. As the machine advances, the cutterhead chamber pressure responds to the ground pressure in front of the cutterhead, and the exposed ground around the shield is continually supported by the TBM shield with shield gap injection. It is then permanently supported by the precast concrete segmental liner rings that are erected within the TBM shield and pushed in position at the tail of the machine. After the segmental lining is erected, fully bolted, and pushed in, the machine advances and the annular space between the lining and the excavated perimeter is filled with grout through the tail skin. If remedial grouting is later required, grouting can be done through grout holes casted in the segmental lining. A special set of seals or brushes prevents the grout from flowing into the TBM. This method creates a tunnel with little to no disruption at the surface creating a circular opening. The concrete segmental lining would have double gaskets in each joint to prevent water/gas from entering the tunnel.

For tunneling through soft ground, EPB or slurry TBMs work in a "closed-mode." Slurry TBMs (Figure 4-5) introduce bentonite slurry into the excavated muck so that the muck can be pumped to the ground surface where the excavated solids are screened out. Then, variable control of the flow extracted from the excavation chamber allows the regulation of the balancing pressure. EPB TBMs (Figure 4-5) operate by remolding the soil ("mixing-up") and adding conditioners that change the soil into a paste-like material that is then removed through a screw conveyor. This type of tunneling equipment is evolving to the more comprehensive approach of "pressurized tunneling" where the ground around the entire TBM is stabilized by pressurization, not just at the face. To date, only EPB TBMs have been selected over slurry TBMs for Metro tunnel constructions. Using pressurized-face mode, tunneling can be accomplished without affecting groundwater conditions in the project vicinity.

FIGURE 4-5. SLURRY (LEFT) AND EPB (RIGHT) TBM OPERATIONS

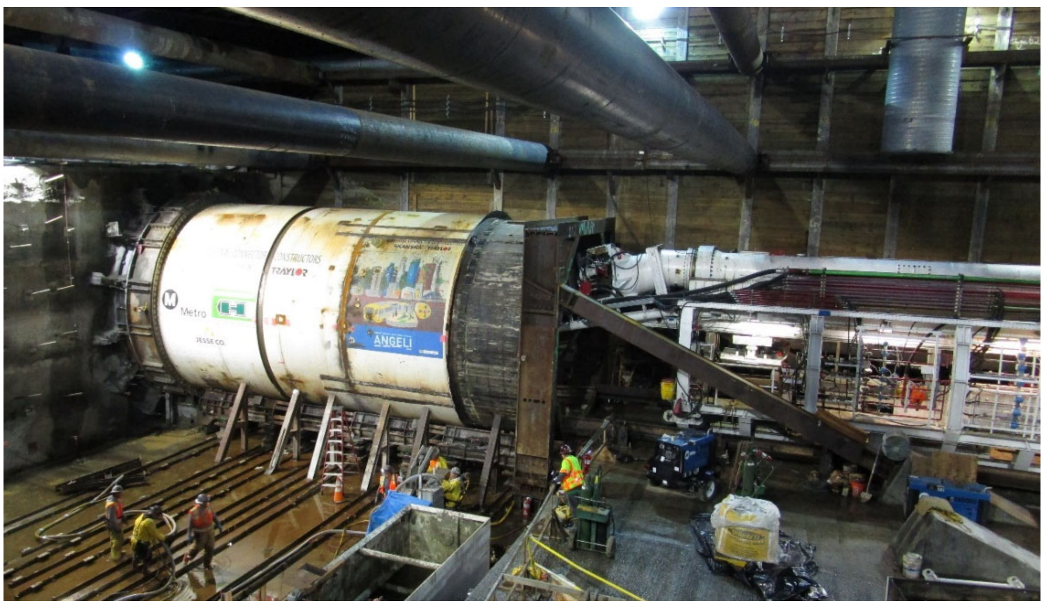


Source: Metro 2012

If used for the rock conditions north of the Hollywood Fault at the base of the Santa Monica Mountains for the Hollywood Bowl Design Option, TBMs would work in "open-mode" at atmospheric pressure. There would be no need to pressurize the face in front of the excavation. TBM in "open-mode" removes the spoil from the cutterhead/excavation chamber through a muck conveyor. However, because of the short tunneling duration in rock conditions, it may not be economical to equip or convert the TBM for "open-mode." Instead, the TBM in "closed-mode" can continue being employed with low- to non-pressurized-face to tunnel through the short segment of hard rocks, although some modifications on the machine and cutterhead would be necessary to adapt the TBM to handle the hard rock condition. The cutterhead modification could be performed when the TBM is parked at the launch site.

A TBM tunnel drive is a cyclic operation. The TBM advances each cycle length (typically four to five feet) as hydraulic jacks push the TBM forward against the previously installed segmental liner ring. Following a complete "push" to advance the TBM, the hydraulic jacks are retracted, and the next liner ring is erected. This process is repeated as the tunnel advances. When starting a tunnel drive from a shaft or station excavation, a heavy steel frame is typically erected to allow for a rigid structure for the TBM to react against so that it can start to push forward (Figure 4-6). As the TBM is pushed into the ground, temporary segmental liner rings are erected between the TBM and the reaction frame. The temporary segmental lining erected within the shaft is later removed once the TBM and several liner rings are fully "buried" in the ground and continuously advanced. Following tunnel excavation, the TBMs may be dismantled underground with the shield (outer shell) left in place. Other parts of the TBM can be retrieved through the tunnel all the way to the launching site. An alternative to dismantling the TBM would be to excavate a separate retrieval shaft at the end of tunnel. However, due to potential surface impacts at the retrieval shaft location, retrieving the TBM from the retrieval shaft may be less desirable than dismantling the TBM and leaving the shield in place. An exception is if the TBM could be re-used immediately or in a reasonable time frame for constructing the next segment of tunnel. In such cases, the disruption caused by retrieval from the street may be justified.

FIGURE 4-6. TBM LAUNCHING



Source: Metro Regional Connector Transit Corridor Project, 2017

The precast concrete segmental lining is fabricated off-site and delivered to the site by truck. Truck loads for segments are estimated to be 10 to 20 per day for the duration of tunneling based on an estimated overall excavation rate of 35 to 55 feet per day. Segments requiring several days of production are generally stored at the work site to allow continuous tunneling. Tunneling operations typically occur six or seven days a week, usually with three, eight-hour shifts per day. A typical TBM tunnel and segmental lining are shown in Figure 4-7.

FIGURE 4-7. TYPICAL TBM TUNNEL AND PRECAST CONCRETE SEGMENTAL LINING WITH DOUBLE GASKETS

Source: Metro Regional Connector Transit Corridor Project, 2018

During tunneling with an EPB machine, excavated material (spoils) is moved to the rear of the TBM by a screw conveyor and deposited on a conveyor belt. The conveyor belt transfers the spoils to the launching area. At the shaft, the conveyor belt would continue to the surface to dump the muck into the muck bin to be temporarily stockpiled. From the muck bin, the material is loaded into trucks for off-site disposal. In the case of slurry TBM operation, closed pipe systems would be used to transport spoils through the tunnel and to the surface. With the use of either pressurized-face TBM, the spoils generally undergo partial treatment, separation, and/or drying processes before being loaded on trucks for off-site disposal.

4.2.1.4 DISPOSAL OF TUNNEL SPOILS

Spoils would be transported off-site for disposal. Using pressurized-face TBMs, the spoils would first undergo some treatment (such as drying or de-sanding) and testing before being loaded onto trucks for off-site disposal. For mostly sandy soils, drying can be accomplished on-site. For soils with higher water and fine contents, an additional temporary off-site storage/drying location may be needed if the volume of such soils is substantial. Based on testing results, the spoils are classified according to California Landfill Classification and transferred to the designated landfill sites. Refer to Appendix B, Haul Routes, for more details about the landfill classification and the available landfill sites.

For a typical tunnel excavation, boring two tunnels at approximately 35 to 55 feet per day depending on conditions, the rate of spoil removal would be approximately 80 to 120 loose cubic yards (CY) per hour, or approximately five to eight trucks per hour, assuming 16 hours of production per day. With temporary stockpiling of spoils on the site, hauling could be partially deferred to nights and weekends.

4.2.2 CONVENTIONALLY MINED TUNNELS

As described earlier, guideway tunnels in the Hollywood Bowl Design Option segment would be constructed by a conventional mining method. Within the Hollywood Bowl area, the conventionally mined guideway tunnels would likely extend from the Hollywood fault near Franklin Avenue to the crossover structure and farther north connecting between the crossover and station/end shaft. The mining operation would be launched and performed from the Hollywood Bowl Station site. The length of the mined tunnel would depend on how far the TBM tunneling is extended. Depending on where the TBM section meets with the conventionally mined section, the cross section of mined tunnels may have to be large enough to have the TBM break into and be “walked” through the tunnel. The TBM approaching from the south would encounter the southern end of the conventionally mined tunnel extended from the Hollywood Bowl site. TBMs would then walk through the mined tunnels to be retrieved at the Hollywood Bowl Station excavation.

In addition, conventionally mined tunnels would be employed for crossing the Hollywood fault. If a large displacement of fault rupture needs to be accommodated by the tunnels, large-sized tunnel sections would be constructed for a certain distance over the fault crossing. The large-sized tunnel section should accommodate the expected fault-rupture displacement across the Hollywood fault and withstand the seismic loads so that the tracks can be inspected, realigned, and reinstated after the seismic event.

Conventional mining method would be performed within the hard rock formations at the base of the Santa Monica Mountains using roadheader (Figure 4-2) and localized blasting (Figure 4-3). Similar to the SEM excavations for the station or crossover cavern construction, the conventional mining method employs a cyclic excavation technique. The “excavation cycle” consists of excavation, mucking spoils, and installing a ground support. The “excavation cycle” length would be about five feet per cycle for guideway tunnels in the Hollywood Bowl area. An “excavation cycle” or two could be done in three tunnel faces each day assuming three, eight-hour shifts a day. This daily advance rate would be converted to 250 to 500 CY of crushed rock generated per day, requiring about 20 to 30 haul truck trips per day. A typical ground-support system includes rock reinforcement, shotcrete, lattice girder with shotcrete, and forepoling or spiling. The “excavation cycle” would be repeated as the tunnel drive advances. Depending on ground condition, pre-grouting, dewatering, and/or ground freezing may be required. The excavated rock materials would be transferred to the working shaft at the Hollywood Bowl Station site via rubber tire haulers, hoisted to the surface at the working shaft, and crushed to proper fragment sizes by the on-site rock crusher before being hauled out for off-site disposal.

Conventionally mined tunnels would be a two-pass system. The initial ground supports would be installed during excavation cycles, then the final cast-in-place concrete lining would be installed in an approximate rate of 20 linear feet of each tunnel daily. This final lining advance rate would require 48 CY of concrete to be delivered to the site by about four concrete trucks each day.

4.2.3 TUNNELING IN GASSY GROUND

All underground design and construction would require reviews by the Metro Tunnel Advisory Panel and the Metro Fire/Life Safety Committee, which includes members from the Los Angeles City and County Fire Departments, as well as Metro safety specialists. In California, tunnel construction safety is governed by the California Occupational Safety and Health Administration (Cal/OSHA) Tunnel Safety Orders and worker safety training. California Electrical Safety Orders would apply to use of electric equipment. Where methane or hydrogen sulfide gases could be encountered, the regulations are specific and begin with the tunnel classification. The classifications range from "non-gassy" to "gassy" depending on the likelihood of encountering hazardous gases and anticipated concentrations of the gases within the tunnel, and can be reclassified upon actual filed measurements, incidences, and requests during construction.

As a gassy condition is anticipated along the alignments, TBMs would use an enclosed mucking system to prevent spoil and groundwater from releasing gas into the tunnel. In addition, an adequate ventilation system, which dilutes and transports gases out of the tunnel, would be mandated. For gassy tunnels, Cal/OSHA requires monitoring devices to detect gas and trigger an automatic shutdown of electric power to the TBM. TBMs and other equipment used in the tunnel would be sealed and be of explosion-proof design for use in a gassy environment. For tunnels classified as gassy, Cal/OSHA requires a refuge chamber or alternate escape route to be maintained within 5,000 feet of the face of a tunnel. Refuge chambers would be equipped with a compressed air supply, a telephone, and means of isolating the chamber from the tunnel atmosphere. These chambers are typically prefabricated and travel with the TBM.

The tunnel must have adequate ventilation to dilute gases to safe levels. Methane is combustible when mixed with air in the range of between 5 percent and 15 percent by volume; as such, the Lower Explosive Limit of methane is 5 percent by volume. Below the 5 percent Lower Explosive Limit, methane is not explosive. Similarly, hydrogen sulfide levels must be maintained well below the safe worker exposure limit of 10 parts per million. Project tunneling specifications would require excess ventilation capacity. Gas levels would be monitored continuously to ensure maintenance of safe exposure levels. The main ventilation systems would exhaust flammable gas or vapors from the tunnel, be provided with explosion-relief mechanisms, and be constructed of fire-resistant materials.

4.2.4 SETTLEMENT

During TBM excavation, the surrounding ground at the tunnel face relaxes and deforms inward slightly until stabilized by the ground-support system. This is often referred to as "ground loss," the term for the small volume of displacement. Ground loss can produce surface settlement, which can occur during tunneling, or days or weeks after tunneling depending on ground conditions. The use of pressurized-face TBMs minimizes this settlement. Pressure is maintained at the face of the TBM tunnel excavation to reduce the potential for ground loss. In addition to ensuring adequate face pressures using pressurized-face TBMs, the requirement for precast segmental linings with prompt grouting of the annular space between the segmental lining and the surrounding ground as the TBM advances also minimizes settlement potential. The amount of ground surface settlement would also depend on tunnel depth, tunnel size, proximity of adjacent tunnels, ground conditions, TBM performance, and excavation techniques. For tunneling below sensitive structures or utilities, additional measures, including grouting and underpinning, can be employed to control settlement. The measures used would depend on the ground conditions and structure details at specific areas. Prior to construction, settlement monitoring points would be established with baseline readings for ground surface, buildings, utilities, and other structures. During construction, the settlement monitoring data would be collected and reviewed for any contingency actions required and would be broadcasted in real-time to the TBM operator to implement reactions with the TBM.

4.2.4.1 GROUTING

Grouting as a ground improvement program can be considered a preventive measure for settlements due to tunneling. Grouting involves drilling to the targeted area in the ground and injecting cementitious material within the voids of in-situ soils or mixing cementitious material with in-situ soils to create stiffer and stronger soil blocks. The purpose of grouting is to prevent anticipated ground movements due to tunneling or to compensate for the movements detected during or after tunneling. Drilling and placing the cementitious material can be performed from the ground surface, tunnel, or building basement. Surface preparation would be required (traffic controls, removal of landscaping, etc.) to allow space for drilling equipment, installation of grout pipes, and injection of grout. In cases where large structures are over the tunnel, access into the buildings or basements could be required. In such cases, the use of the building could be restricted during grouting operations. After grouting is completed, the area would be restored. These grouting methods can in some cases use directional drilling, which can be done from off-street locations and can allow for horizontal orientation of grout holes along the tunnel alignment.

PERMEATION GROUTING

Permeation grouting is used to improve the ground prior to tunneling in the area. Chemical (sodium silicate) or cement-based grouts are injected into the ground to fill voids between soil particles and provide the soils with greater strength and stand-up time. This grout can be placed through pipes in various orientations from the surface before the TBM arrives at the grouted area, from pits or shafts adjacent to the grouted area, or in some instances from the tunnel face. In the latter case, the tunneling machine must be stopped for a period to drill, install grout pipes, pump grout, and allow the grout to solidify. Permeation grouting is typically used in sandy soils, which are common in the vicinity of the project.

JET GROUTING

Jet grouting is a ground improvement method that consists of injecting fluids at high pressure into the ground to segregate the soil particles and mix the material with a cement grout. The fluids are typically injected into the ground through a rotating string of drill rods with nozzles positioned horizontally or slightly inclined from the horizontal. The high-pressure fluids are used to break-up the in-situ soil fabric and erode a portion of the soil material. The cementing agent, which is typically cement grout, is mixed with the remaining soil particles to form a hardened mixture of grout and soil that has a high strength and low permeability. Jet grouting creates a cylindrical column around the drilling path. A mass of grouted soil can be created by overlapped grouted columns as a panel or discrete block.

COMPACTION GROUTING

Compaction grouting involves consolidating the ground prior to or following tunnel excavation. Compaction grouting entails the controlled injection of a stiff grout (typically sand with a small amount of cement) into soils at and above the planned tunnel excavation. Grout pipes are installed in advance of tunneling, and a thick grout mix is injected to pre-consolidate the ground prior to the TBM or to replace ground lost after tunnel excavation by compacting the surrounding soils. In either case, the grout improves soil integrity and makes the ground more resistant to deformation.

COMPENSATION GROUTING

Compensation grouting can be performed while advancing the tunnel excavation or even after the settlement occurs. This involves controlled injection of grout between underground excavations and structures that require protection from settlement. For tunneling applications, the grout pipes are installed a few feet above the intended tunnel crown, ahead of the TBM. Grout is injected above the tunnel crown as the TBM excavation advances. The grout thickens the soil above the tunnel crown and replaces some of the ground that may be lost during tunneling. This method prevents ground loss from propagating to the surface, thus avoiding settlement. In limited cases, compensation grouting can be used as corrective measures to reverse settlements due to tunneling. A key component in compensation grouting is monitoring both structures and ground movements to optimize the timing and quantities of grout injected.

4.2.4.2 UNDERPINNING

Underpinning involves supporting the foundations of an existing building or structure by carrying its load-bearing element to deeper levels or to newly installed foundation deviating the load path from its original configuration. The new load path can be configured to protect the building from settlement that may be caused by construction near that foundation. Underpinning permanently transfers the foundation loads of the structure to an appropriate location beyond the range of influence of the construction activity. This can be accomplished by providing deeper piles adjacent to or directly under the existing foundation and transferring the building foundation loads onto the new system. If the building is directly above the tunnel alignment imparting additional loads on the tunnel lining, the tunnel lining would have to be designed for the additional loads.

4.2.5 CRITICAL CROSSINGS AND OBSTRUCTIONS

The TBM bore tunnels for the project would cross existing human-made structures and the Hollywood fault. In addition, the bored tunnels would excavate through tar-infused sedimentary layers and encounter several abandoned-in-place oil wells.

4.2.5.1 I-10 CROSSING

The bore tunnels would cross directly below the I-10 freeway. At the crossing location, the tunnel crown would be at least 40 feet below the freeway surface. Therefore, the settlement impacts of bore tunnels under the freeway structures and operation would be minimal. Further analysis should be planned to confirm the minimal impacts, and the settlement monitoring program should be implemented during construction.

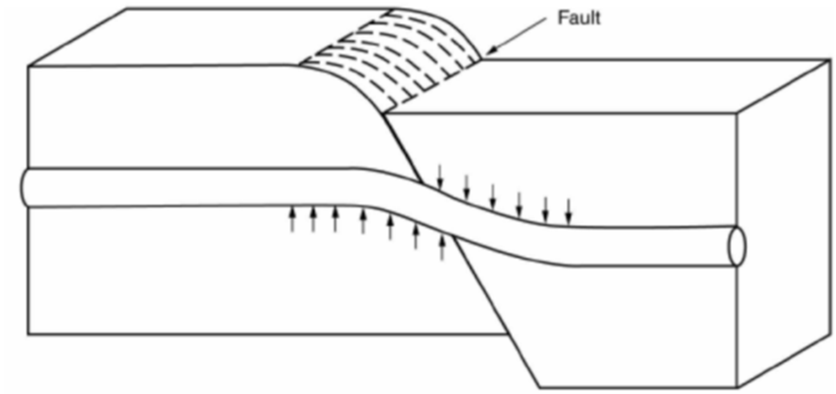
4.2.5.2 METRO D AND B LINES CROSSING

The bore tunnels would cross directly below a newly constructed D Line station along Wilshire Boulevard and an existing B Line station. The La Brea Alignment would cross under the Wilshire/La Brea Station, and the San Vicente–Fairfax and Fairfax Alignments would cross under the Wilshire/Fairfax Station of the D Line. All three alignments would cross under the existing Hollywood/Highland Station of the B Line. At all three crossings, the tunnel crowns for the project would be about eight feet below the bottom of the overlaying stations. The current pressurized TBM technology would be able to make these crossings with such a clearance between the station bottom and the tunnel crown. However, because of the proximity of the tunnels to the bottom of the stations, the proposed bore tunnels would encounter embedded pile sections of the support of excavation that have been abandoned in place during construction of those stations. Since these piles include steel beams that would be troublesome for the TBM to cut through, the pile portions that intrude into the course of the TBM would have to be removed prior to the TBM's arrival at the abandoned pile sites. The existing pile removal would be accomplished by small-sized conventionally mined adits that would begin from a temporary working shaft or a station excavation for the project adjacent to the undercrossing site. After removing the interfering piles, the working shaft and adits would be backfilled with lean concrete that has a similar strength as surrounding soils. Then the TBM would excavate through the ground and backfilled material upon arrival to the site.

4.2.5.3 HOLLYWOOD FAULT

If the Hollywood Bowl Design Option is constructed, the bore tunnel traveling under Highland Avenue would encounter the Hollywood fault in the vicinity of the intersection of Highland and Franklin Avenues near the Hollywood Bowl area. For a tunnel crossing active faults, fault-rupture displacement can be as high as several feet and distributed and dissipated through some distance from the fault (Figure 4-8).

FIGURE 4-8. FAULT-RUPTURE DEFORMATION



Source: MRDC Section 5 – Structural/Geotechnical

During a rupture, the crossing tunnels experience large deformations and changes in external ground and water pressures. In this aspect, a tunnel lining is designed to be flexible to accommodate the fault-rupture displacement and to be strong enough to withstand the external ground and water pressures. At the Hollywood fault crossing, several hundred linear feet of the twin tunnels would be conventionally mined to have an enlarged section to accommodate the anticipated fault-rupture deformation, similar to the B Line tunnels crossing the same fault in the area. Alternatively, depending on the estimated magnitude of the fault-rupture deformation, the TBM could continue tunneling across the fault and install special segmental lining. The special segmental lining could be bolted steel, concrete, or steel/concrete combined segmental linings and designed to provide ground support that is strong enough to resist external (ground and water) pressures induced by earthquake but ductile enough to tolerate seismically imposed movements within the fault zones.

4.2.5.4 TAR SANDS AND OIL WELL CASINGS

The Los Angeles Basin is a prolific petroleum basin that has a long history of petroleum production. Significant oil discoveries in the vicinity of the project include several oil fields: the Las Cienegas, Beverly Hills, Cheviot Hills, San Vicente, Inglewood, and Salt Lake Oil Fields. Within the Salt Lake Oil Field are the La Brea Tar Pits, which are a surficial tar deposit and a valuable fossil site. As such, extensive oil and gas exploration and petroleum extraction (pumping) from proven reserves have occurred within the vicinity of the project. According to the Wildcat Maps and the digital wells database of the California Geologic Energy Management Division (formerly the California Department of Conservation Division of Oil, Gas, and Geothermal Resources), wells within the vicinity of the project are likely idle, abandoned, or dry. Regardless of operating status, the presence of well casings creates a hazard to tunneling. An even greater hazard is the potential for the tunneling to encounter abandoned and undocumented (unknown) well casings.

When the bore tunnels and stations are excavated within the oil fields, tar-infused soils would be encountered and the oil/gas well casings would present, especially along La Brea and Fairfax Avenues and Beverly and San Vicente Boulevards. The oil/gas casings that are present within the course of tunneling would have to be identified and removed prior to tunneling. For those wells, many sources can be searched for information regarding the location, configuration, quantity, and status of wells along or in the vicinity of the alignments. Local geophysical survey/measurements combined with horizontal directional drilling also can be employed to locate and quantify the oil wells. The seismic reflection/ refraction survey and downhole magnetometer techniques are typically used. Once the field surveys and tests provide the locations of the oil wells, the well casings would be decommissioned and recapped outside the TBM zone of influence from the surface prior to advancing the TBM. Decommissioning oil wells from the tunnel face has fewer impacts on the surface. However, a potential fresh inflow of oil/gas/water/slurry mixture into the tunnel face would occur while removing the oil wells at the tunnel face, risking the safety of people who work at the tunnel face; therefore, it would be best to avoid decommissioning oil wells at the TBM face to the extent feasible.

4.2.5.5 EXISTING TIEBACKS

Abandoned tiebacks could project into the planned tunnel excavation and be problematic because the TBMs generally cannot excavate through steel tie-back cables or rods. In such cases, the tie-back cables or rods must be cut and removed so the TBM cutterhead is not damaged. Tiebacks are anticipated at areas adjacent to deep basements or underground parking garages in buildings generally constructed after 1965.

Where the locations of tiebacks can be reasonably well established, it is possible to mine up to the tie-back and stop. The forward chamber of the TBM can then be pressurized with compressed air, and workers can enter ahead of the machine to cut and remove the tiebacks. Alternatively, a preferred and safer procedure would be to excavate a small-diameter shaft from the ground surface and advance a small-sized mined adit in which the tiebacks are cut and removed prior to tunneling. For any of the situations above, the ground in the tie-back areas may need to be improved or strengthened by grouting prior to cutting the tie-back to minimize ground losses and associated settlement. In addition, depending on the number of tiebacks to be removed and the depth of the tunnel, a short section of cut-and-cover excavation may be advanced in the tie-back zone. The TBM would “walk through” the open excavation and erect the precast tunnel segments. Once the TBM had progressed completely through the area, backfill would be placed and compacted around the precast segments and up to the ground surface, which would then be restored.

4.2.6 TUNNELING DURATION

With the tunnel launching sites identified for the multiple construction sections, tunneling durations have been estimated assuming the Hollywood Bowl Design Option is built by conventional mining using roadheaders. The estimated tunneling duration for each construction section would be about two to four years, which fits an eight- to twelve-year range for each section completion. For the tunneling duration analysis, TBM advance rates of 55 feet per day in regular sediments and 35 feet per day in tar-infused sediments are assumed, as all tunnel grounds within any known oil field boundaries are assumed to be tar-infused. A roughly estimated conventional rock tunneling rate of five feet per day by roadheader is assumed. The estimated tunneling durations for the three alignments are summarized below. Tunneling operations are assumed continuous, including intermediate TBM mobilization, occurring six or seven days a week and consisting of two, eight-hour production shifts and one, eight-hour maintenance shift per day.

SAN VICENTE–FAIRFAX ALIGNMENT

- Section 1: 27 months by two TBMs launched from the Midtown Crossing Station site
- Section 2: 17 months by two TBMs launched from the San Vicente/Santa Monica Station site
- Section 3:
  - To Hollywood/Highland: 22 months by two TBMs launched from the La Brea/Santa Monica Station site
  - With Hollywood Bowl Design Option: 41 months by two TBMs launched from the La Brea/Santa Monica Station site and at least four roadheaders launched for conventionally mined tunnels from the Hollywood Bowl Station site

FAIRFAX ALIGNMENT

- Section 1: 27 months by two TBMs launched from the Midtown Crossing Station site
- Section 2:
  - To Hollywood/Highland: 24 months by two TBMs launched from the La Brea/Santa Monica Station site
  - With Hollywood Bowl Design Option: 42 months by two TBMs launched from the La Brea/Santa Monica Station site and at least four roadheaders launched for conventionally mined tunnels from the Hollywood Bowl Station site

LA BREA ALIGNMENT

- Section 1: 24 months by two TBMs launched from the Midtown Crossing Station site
- Section 2:
  - To Hollywood/Highland: 20 months by two TBMs launched from the La Brea/Santa Monica Station site
  - With Hollywood Bowl Design Option: 34 months by two TBMs launched from the La Brea/Santa Monica Station site and at least four roadheaders launched for conventionally mined tunnels from the Hollywood Bowl Station site

4.2.7 CROSS-PASSAGE CONSTRUCTION

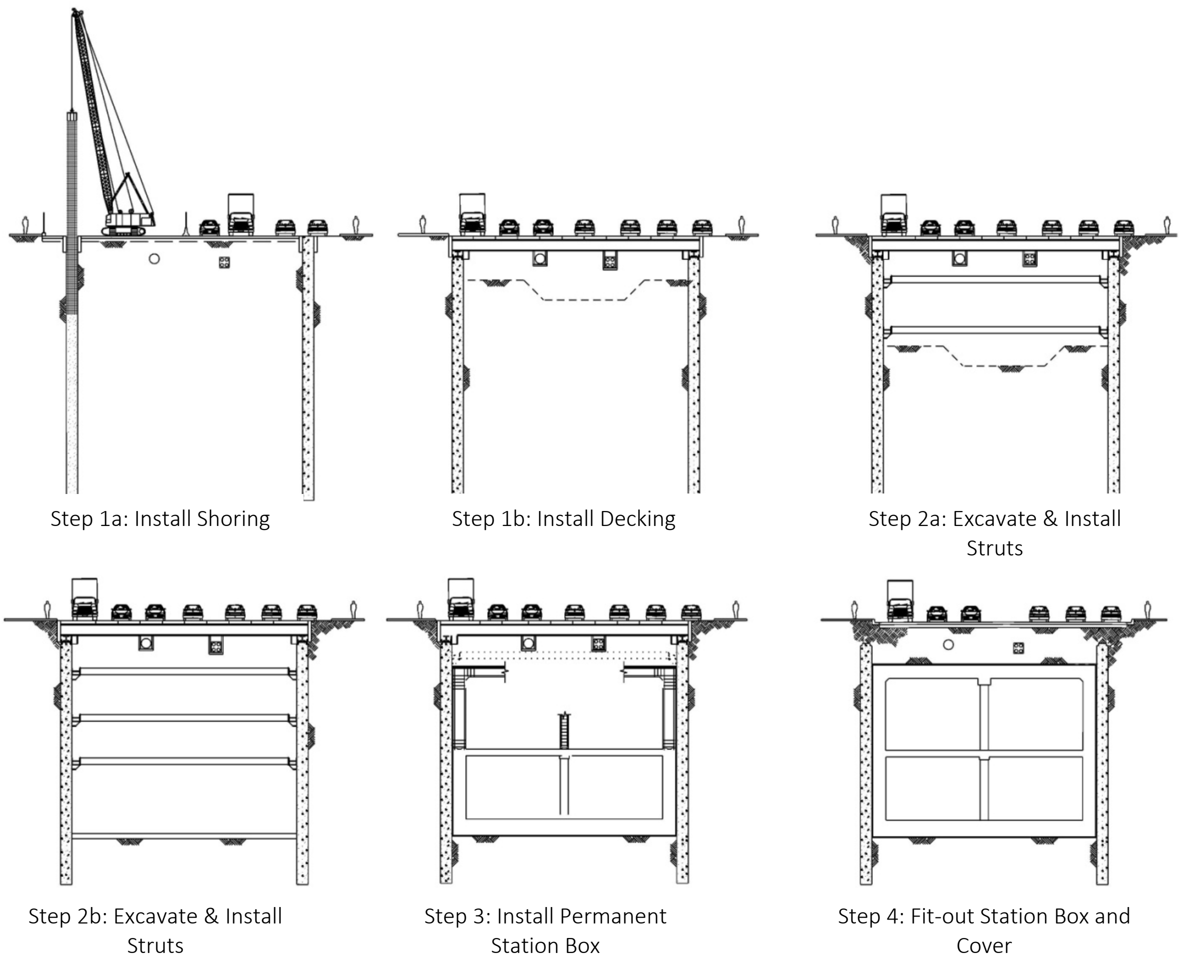
Per National Fire Protection Association 130 and MRDC, cross-passages are required at no less than 800-foot intervals along the tunnel alignment. Each alignment would include 31 to 55 cross-passages depending on the alignments and the design option. The primary purpose of cross-passages is to provide passenger egress to a point of safety in the event of a fire emergency and to provide access paths between inbound and outbound tunnels for maintenance. Cross-passages also provide space for mechanical and electrical equipment and a location to provide fire protection plumbing crossovers from one tunnel to the other. Cross-passages would be excavated typically by SEM after the completion of the twin tunnels. Depending on the ground conditions, ground improvements such as permeation grouting, jet grouting, or ground freezing may be required prior to cross-passage excavation. These ground improvement programs may be performed from tunnels or from the surface, which would impact the surface. The ground improvement program would require a partial street closure for one to two weeks at each site.

Cross-passages would have a final lining of cast-in-place reinforced concrete that would be placed after completion of the excavation of each cross-passage. Typical cross-passage opening sizes for twin-bore tunnels would be about 19 feet high by 19 feet wide, and the finished entryway would be about 11 feet by 11 feet after installation of waterproofing and cast-in-place reinforced concrete lining. The length of the cross-passage could vary, depending on the distance between the two tunnels.

4.3 CUT-AND-COVER CONSTRUCTION

Metro’s underground stations, crossovers, and box tunnels have been traditionally constructed by the cut-and-cover construction method where the site is fully excavated with proper shoring, the final structure is built, the excavation is backfilled, and the surface is restored. Figure 4-9 illustrates a typical cut-and-cover construction sequence. For this project, the cut-and-cover construction method would be used for stations, crossovers, connection boxes, and end shafts, with the exception of the Hollywood Bowl Design Option.

FIGURE 4-9. TYPICAL CUT-AND-COVER CONSTRUCTION SEQUENCE



Source: Choi et al., 2014

4.3.1 SUPPORT OF EXCAVATION SYSTEM

The primary purpose of the excavation support system is to provide temporary support for the adjacent ground and minimize ground movement that can damage adjacent buildings, utilities, or pavements. The excavation support system is generally a combination of support wall and lateral bracing. Support walls could be soldier piles and lagging, tangent piles, secant piles, deep soil cement mixing walls, and slurry walls. Lateral bracing elements could be cross lot struts, rakers, corner braces, and tiebacks regardless of the support wall type.

For past Metro projects, a soldier piles and lagging system has been typically used. However, the most probable method of excavation support for each cut-and-cover site for the project could vary depending on excavation depths, groundwater levels, and ground conditions. For ground conditions throughout the Los Angeles Basin, soldier piles and lagging, tangent piles, and secant piles would be used for an excavation depth of up to about 80 feet; and deep soil cement mixing walls and slurry walls would be used for excavations deeper than 80 feet. The excavation depths would exceed 80 feet and require deep soil cement mixing walls or slurry walls at three locations: the Wilshire/La Brea, Wilshire/Fairfax, and Hollywood/Highland Station sites. As the project could be extended to the base of the Santa Monica Mountains where it would encounter hard rock formations, rock anchors or dowels combined with shotcrete lining could be used in rock excavation for the optional Hollywood Bowl Station.

4.3.1.1 SOLDIER PILES AND LAGGING

Excavation support systems for most cut-and-cover construction on the Metro Rail system uses soldier piles with lagging. The soldier piles are structural steel members placed in a drilled hole with concrete fill. The soldier piles would be about three feet in diameter and placed six to 12 feet on centers. The treated wood lagging with thicknesses ranging from three to six inches would be placed between the soldier piles, either behind the pile flanges or in front of the flanges. At some locations where soil conditions allow, shotcrete lagging could be placed with welded wire fabric as reinforcement in lieu of timber laggings.

Deflections and resulting ground movements would be minimized by careful selection of the bracings and installation of such braces in a timely manner. In design of the bracing system, the configuration of the final structure must be considered along with the constructability, such as head room for the equipment for the excavation and utilities that are supported in place. The wall movements must be controlled and closely monitored during construction.

The current criteria for the design of the excavation support system that dictates the vertical spacing of the walers and struts, the control of the open face prior to installation of the lagging, the requirements for the embedment below the depth of the excavation, and the empirical formulas for the design of the various elements of the system have served well for many years. The locations and spacing of walers and cross lot bracings should be selected to meet these criteria. However, where underground easements are available, tiebacks could be used in lieu of cross lot struts. The tie-back system provides opened clear space during construction and has performed well in many other transit projects.

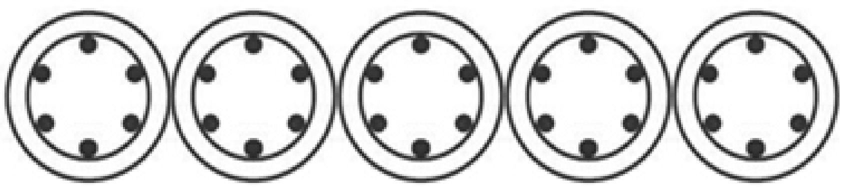
The soldier pile and lagging system is cost effective, requires relatively simple equipment setup, has low impact on streets, accommodates utilities and traffic control requirements well, and can be revised to adapt to circumstances encountered during construction.

Soldier pile and lagging walls are classified as pervious systems. Measures are required to handle water and gas infiltration into the excavation. These measures typically include dewatering or grouting to reduce groundwater inflow into the excavation and providing ventilation that generates air movements to dilute gas concentration in the excavation.

4.3.1.2 TANGENT AND SECANT PILES

Tangent piles are soldier piles placed next to each other with a center space such that the circumference of the adjacent piles barely touch each other (Figure 4-10). This arrangement can minimize the pile diameter and ground loss. They could be used where limited space is available between the property line and the exterior of the permanent structural wall. On previous Metro projects, tangent piles were used extensively at locations to provide a more rigid wall system.

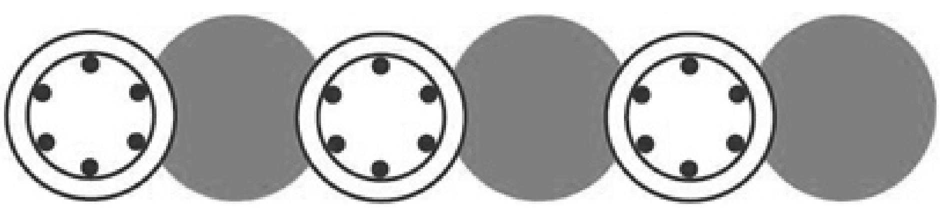
FIGURE 4-10. TANGENT PILES AND REINFORCEMENT ARRANGEMENT



Source: https://railsystem.net/secant-pile-walls/

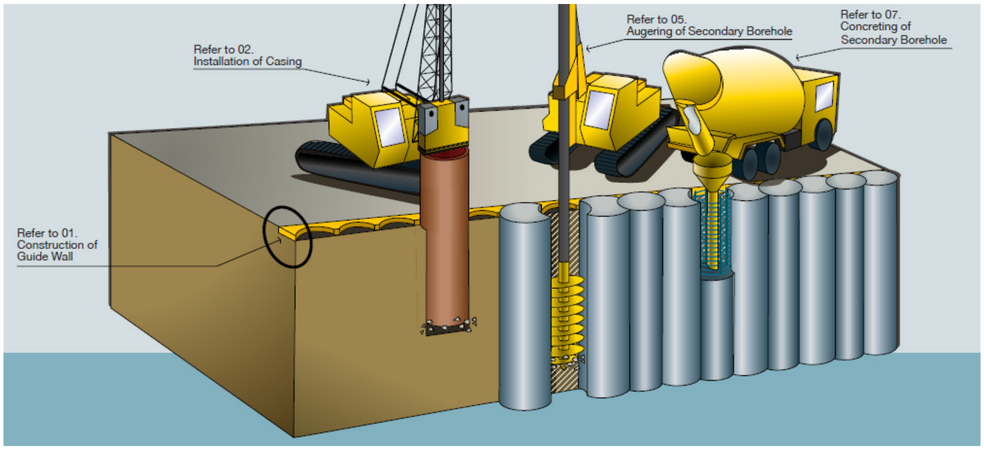
Secant piles are soldier piles placed to interlock to form a continuous wall (Figure 4-11). The wall is constructed by drilling alternate shafts and then back stepping to drill the intermediate shaft. Every second shaft is reinforced, usually with a steel section or a reinforcing steel cage (Figure 4-12). The concrete used in piles without reinforcements is usually lean concrete with a retardant to remain soft for drilling and interlocking of piles. Piles with reinforcements are usually poured with the structural concrete. A typical layout would be three-foot-diameter secant piles on two-foot, six-inch centers that produce a six-inch overlap to form a continuous wall. Excavation begins after completion of the drilling operation. The excavation process with tangent/secant pile walls is very similar to that with the soldier piles and lagging method as laterally supported by horizontal walers, cross lot bracings, and tiebacks. For the project, tangent and secant piles could be used for the TBM launch or holing-through walls.

FIGURE 4-11. SECANT PILES AND REINFORCEMENT ARRANGEMENT



Source: https://railsystem.net/secant-pile-walls/

FIGURE 4-12. SECANT PILE WALL CONSTRUCTION



Source: https://railsystem.net/secant-pile-walls/

4.3.1.3 DEEP SOIL CEMENT MIXING WALLS

The soil cement mixing wall technique consists of mixing cement with in-situ soils and other agents using multiple axis augers and mixing paddles to construct overlapped soil cement columns (Figure 4-13). The overlapped column panel is then extended to form an underground continuous wall for use as an excavation support wall. This type of excavation support was used for the Hollywood/Vine Station on the B Line and for the Expo/Crenshaw Station on the K Line. The wide flange structural steel vertical members would be placed in soil cement mix at a spacing. These vertical steel members would be supported by walers which, in turn, would be supported by cross lot bracings or tiebacks. At the Hollywood/Vine Station, the soil cement mixed wall type performed adequately with respect to the stiffness and the permeability of the excavation support wall. However, construction progress was relatively slow and there were some incidents of slurry overflow onto streets.

FIGURE 4-13. DEEP SOIL CEMENT MIXING WALL

Source: https://www.cmilc.com/case-studies/blu-harbor-cut-off-wall and https://samanpey.com/

4.3.1.4 SLURRY WALLS

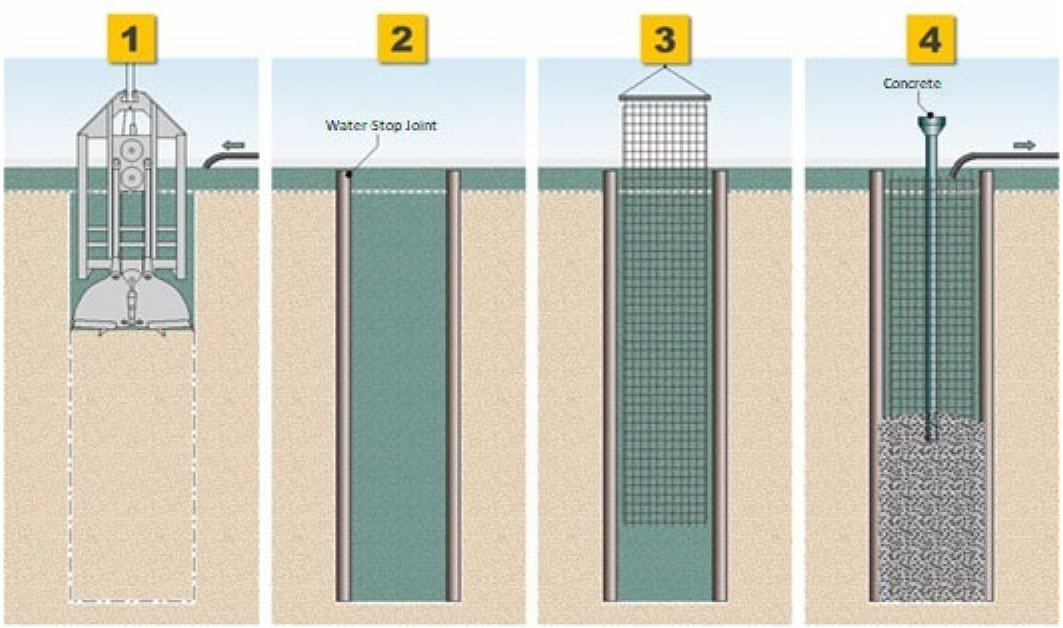
Slurry walls are underground panels built in a series from the surface. They are constructed by digging each panel with a clamshell bucket or "hydromill" (Figure 4-14) and filling it with bentonite slurry. This is followed by lowering a reinforcing cage into the panel where concrete is then placed by the tremie method displacing the slurry (Figure 4-15). A typical slurry wall would include primary and secondary panels (Figure 4-16). Primary panels are excavated first in alternate sequence and tremie concrete is placed with rebar cage. Once the primary panels achieve adequate concrete strength, secondary panels are excavated between two primary panels. The rebar cage is lowered, and concrete is placed in the secondary panels. Concrete hardens in the trench to form a wall. The panel width varies between nine and 25 feet, and thickness varies from 18 to 48 inches with 36-inch-thick walls most common. Slurry walls are used at sites where a relatively watertight excavation support wall is required. At Metro's B and D Line station at Union Station, the contractor used the slurry wall option. The high groundwater table at the Union Station site containing hydrogen sulfide and other contaminants made slurry wall a good solution.

Slurry walls are considered relatively rigid compared to soldier pile and lagging systems. The increased rigidity of the walls is useful to minimize ground settlements adjacent to the excavation and suitable for excavations deeper than 80 feet in the Los Angeles area. However, slurry walls are not as accommodating as soldier pile and lagging walls when utilities are to be maintained in the street. All underground utilities within the slurry wall footprint would have to be cleared or relocated.

FIGURE 4-14. SLURRY WALL EQUIPMENT

Source: https://www.treviicos.com/

FIGURE 4-15. SLURRY PANEL INSTALLATION



Source: http://equipment-construction.be/

FIGURE 4-16. SLURRY WALL

Source: https://upload.wikimedia.org/ WTC 1969

4.3.1.5 DECKING AND CROSS-BRACING

After installation of the excavation support system and initial excavation are advanced, the deck beams are installed, followed by multiple sequences of excavation and installation of cross-bracing. In special situations, such as where cross-bracing impedes access from above or excavation is too wide to install long slander cross-bracings, tie-back systems may be used. Tiebacks are strong cable strands or steel bars that are installed and grouted into pre-drilled holes that extend outward and downward from the excavation support wall. After the grout sets and the cables or bars are firmly anchored into the ground, the tiebacks are tensioned to provide lateral support to the wall. The use of tiebacks may require temporary underground easements if they extend into private property. Generally, tiebacks are de-tensioned before abandoning in place but in some cases would be abandoned in place as tensioned.

Deck panels (Figure 4-17) are placed on the deck beams to allow traffic and pedestrian circulation to resume after the initial excavation. Deck panels are typically made of precast reinforced concrete and installed flush with the existing street and sidewalk.

FIGURE 4-17. STREET DECKING

Source: Metro Regional Connector Transit Corridor Project 2018

4.3.2 DEWATERING

Prior to installation of the ground-support system, dewatering is likely to be required at most station excavation sites to temporarily lower the groundwater level, except for the Hollywood Bowl Station site. Dewatering facilitates installation of the piles, improves soil stability, and allows excavation in dry conditions. If contaminated water is encountered, it is treated at the site prior to discharge. Groundwater is pumped from wells installed around the perimeter of the area to be excavated. At completion of construction, pumping is discontinued, and groundwater is allowed to return to its natural level. In addition, water would be pumped out of sump pits within the excavation as the excavation advances downward. Ditches and gravity flow would be used to drain the water into low-lying sumps. It is anticipated that dewatering flows would be processed on-site to remove oils and solids and then discharged to the local storm drain or sewer systems according to permitting requirements. Contaminated water would require additional treatment and disposal procedures.

4.3.3 SETTLEMENT

Deep excavation for stations can result in ground relaxation and deformation of the retained soils. The magnitude of ground movement depends on the stiffness and strength of the surrounding ground, the characteristics of the shoring system, and the workmanship. The zone potentially susceptible to ground movement generally extends a lateral distance approximately equal to twice the depth of the excavation. Buildings within this zone would be evaluated for responses to the settlement and provided with additional protection measures as needed. For excavations adjacent to sensitive structures or utilities, additional measures, including grouting and underpinning, can be employed to control settlement. The measures used would depend on the ground conditions and structure details at specific areas. Settlement survey data are generally compiled for the duration of the work.

4.3.4 PRESENCE OF TIEBACKS

At station locations adjacent to existing deep basements, abandoned tiebacks may project into the space of the planned station. Although no longer in service, these tiebacks would interfere with the construction of shoring and station walls. In many cases, the locations of these tiebacks can be reasonably well established. Accordingly, if soldier piles and lagging are used, the soldier piles can be spaced to avoid the tiebacks during drilling, and they can later be de-tensioned and cut off. Abandoned tiebacks can be more problematic if tangent or secant piles are installed or if slurry wall systems are used. Specialized methods and equipment to de-tension and cut the tiebacks may be used.

4.3.5 EXISTING FOUNDATIONS

Some of the station excavations would be near existing foundations. Depending on specific situations, foundations may have to be protected. A typical approach to building protection where buildings are near the excavation is to design a more rigid excavation support system that can resist the additional loads imposed by the adjacent foundations. In such cases, a stiffer tangent pile, secant pile, or slurry wall shoring system may be used. Pre-loading of excavation support bracing may also be implemented. For buildings adjacent to cut-and-cover construction, it is anticipated that the shoring system, in conjunction with internal bracing, would provide a relatively rigid temporary support for the proposed excavation. In some cases, underpinning (added foundation systems) may be used to support the adjacent structures.

4.3.6 EXCAVATED MATERIALS

After the decking is installed and the utilities are supported or relocated outside the excavation, the major excavation work for the station box can proceed below the decking. Spoils from station sites would be moved to an off-street work site and loaded into haul trucks, except for the connection box site at the existing Expo/Crenshaw Station, where no off-street work site is available and stockpiling is restricted. The average volume of material from typical station and crossover excavations would be approximately 285,000 CY. This assumes the soils expand by approximately 30 percent through the excavation and loading process. Assuming the use of 20-ton haul trucks generally, and 12-ton haul trucks at restricted locations, the total number of haul truck loads required for a typical station and crossover construction would range from 17,000 to 20,000. For a typical station configuration, this would be approximately 80 to 90 truck trips per day.

Contaminated soils are separated as soon as they are identified during the excavation cycle. These soils would be temporarily stockpiled separately and managed in accordance with applicable regulations for handling and transporting contaminated materials.

Excavated materials would be hauled at night where possible due to the congested freeways and surface streets around station locations during daytime hours. Refer to Appendix B, Haul Routes, for more details.

4.3.7 TRAFFIC

Traffic flow can be affected during the entire period of construction. Mechanisms available to control and maintain traffic at constricted intersections range from use of temporary street decking, to temporarily replacing pavement and sidewalks, and temporary bridges. Decking typically contains hatches or removable panels to facilitate lowering equipment or materials down into the excavation with minimal traffic disruption. Traffic Control Plans need the approval of local jurisdictions.

Cross streets would typically be carried through intersections on similar decked structures. Pedestrian access would remain open, although portions or sections of sidewalks may be closed temporarily. Where sidewalks are temporarily removed, pedestrian access would be maintained by bridges, temporary walkways, and other means. Some streets may also be temporarily closed for limited periods under special circumstances, such as for deck beam and street decking installation.

Normal truck deliveries of supplies are estimated to average five to 15 trucks per workday for the duration of station construction. The number of workers would vary but, for a typical station, would be approximately 70 to 150 personnel daily.

4.3.8 FINAL STRUCTURE

The stations would be constructed with cast-in-place concrete, and the time of construction would vary depending on the length and design configuration for each structure. The duration for completing the concrete and architectural work is expected to be 24 to 36 months. The amount of concrete would likely be in the range of 45,000 to 55,000 CY, which would take approximately 5,500 to 7,000 transit mix truck loads for each station. Reinforcing steel would be in the range of 5,000 to 7,000 tons per station.

The station structures are required to be thoroughly water/gas-proofed without subdrain systems or permanent dewatering wells. Only internal sump pump systems are required to capture any leakage that might occur and to remove fire water in the event of a train or station fire. Upon completion of excavation and grading, the water/gas-proof membrane would be installed around the station box as the concrete lining installation progresses.

The construction sequence for the station structures would commence with construction of the foundation base slab, followed by installation of exterior walls and any interior column elements. Slabs are typically poured as the columns and intermediate floor and roof wall pours progress. Station entrance locations are generally used as access points during construction. Exterior entrances would be constructed after completion of the structure.

During station construction, approximately six to 10 concrete trucks per day are anticipated. Large pours of concrete would also be needed, requiring 20 to 30 trucks per day. The larger pours are expected to be performed at night to ensure supply and delivery of concrete and to minimize traffic impacts. Other support and delivery trucks, up to 10 to 20 per day, would be anticipated during peak station construction periods to deliver materials such as rails, structural steel, and mechanical and electrical equipment.

Station concrete construction and architectural finish work would occur after tunnel construction is completed. Once station structure work is complete, the station excavation would be backfilled and the permanent roadway would be constructed. Decking removal would require full street closure over a few weekends, but surface restoration would generally require partial street closures.

4.3.9 STATION CONSTRUCTION IN GASSY GROUND

The City of Los Angeles Municipal Code, Chapter IX, Building Regulations, Article 1, Division 71, Methane Seepage Regulations, amended by City of Los Angeles Ordinance No. 175790 and No. 180619, requires construction projects located within the Methane Zone or Methane Buffer Zone to comply with the city's Methane Mitigation Standards to control methane intrusion emanating from geologic formations. The Midtown Crossing, Wilshire/La Brea, Wilshire/Fairfax, La Cienega/Beverly, Fairfax/3rd, and La Brea/Beverly Stations would be located within the Methane or Methane Buffer Zones. Mitigation requirements are determined according to the actual methane levels and pressures detected on a site. Tunnels and stations would be designed to provide a redundant protection system against gas intrusion. The primary protection from hazardous gases during operations is provided by the physical barriers (tunnel segment gaskets, station liner membranes) that keep gas out of tunnels and stations. Metro's underground stations require the use of a high-density polyethylene membrane as a passive gas-proofing system. In addition, an active system that includes gas detection, mechanical ventilation, and an alarm system would be provided for the stations. During construction, adequate ventilation and gas monitoring would be provided to detect and dilute hazardous gases in any underground spaces.

4.3.10 BACKFILLING AND SITE RESTORATION

Upon completion of the station structures, backfilling and site restoration would follow. The street or ground surface would be restored to its original condition or better. Typically for station construction, backfilling is required over the top (roof) of the structure to fill the area to the street level. Backfill material would be trucked in, placed, and compacted. During backfilling over stations, utilities would be installed along with new sewer maintenance holes and cable/duct vaults. Removal of street decking would reverse the installation procedure. Full street closures would be required with deck panels and deck beams removed in short sections, and the space occupied by the decking would be backfilled and paved. A series of consecutive weekend street closures for two to three months would be required to remove the decking and pave the street at each station location. Sidewalks would be restored, and the permanent street would be constructed, including paving, striping, and signage. Streets, sidewalks, and landscaping would be restored in accordance with city standards.

Backfilling is typically done with imported soils, which are delivered by truck, or approved slurry mix. Backfilling would be carried out during the last five to eight months as the station is completed. Depending on the station configuration, backfilling would be done in stages. Stations would require from 40,000 to 270,000 CY of imported backfill, or roughly 4,000 to 28,000 truckloads, depending on the size and depth of the station. During peak backfill periods, approximately 50 to 150 trucks per day would be expected at each location.

The number of backfill deliveries during peak traffic times can be reduced by stockpiling excavated materials on-site for re-use. Soils excavated from station sites may be suitable for re-use but would have to be stockpiled at remote locations due to the limited staging areas adjacent to stations. However, it may not be feasible to re-use excavated tunnel materials for backfill because of the conditioning agents or slurry used for tunnel excavation.

4.3.11 VENTILATION SHAFTS AND EMERGENCY EXITS

Ventilation and emergency exit structures would be required for the project. The station/crossover structures would generally house emergency ventilation fan shafts plus separate emergency exit shafts providing ventilation and emergency egress at each end of the station and crossover. Ventilation fans are used to extract smoke from tunnels and stairs for evacuation in emergencies, such as a fire. These shafts are typically constructed as extensions of the station excavation.

4.3.12 STATION COMPLETION

Stations would include some aboveground structures that would be completed near the end of the station construction cycle. These aboveground structures may be limited to entrance features, stairways, and elevator/escalator entry points. Metro operations and maintenance spaces, including power equipment, communications facilities, and control rooms, would be housed in underground structures within the station footprint. Street and site restoration activities and appurtenant features, such as signage and landscaping, would complete each station.

4.3.13 SURFACE IMPACTS

Cut-and-cover construction would require construction staging areas and partial or full temporary street closures (as summarized in Table 4-1 through Table 4-4). Construction activities would generate delivery/dump truck trips, construction noise and vibration, dust, and erosion issues, and may interfere with parking and vehicle/pedestrian access for adjacent buildings. In addition, cut-and-cover construction, typically located in the public ROW, requires extensive planning and coordination with city agencies to protect or relocate utilities. It is essential to plan the utility relocations and subsequent traffic control as early as possible. After the utility lines are cleared, excavation occurs with the support of the excavation installed first. Utility relocation and clearance works would start on the streets about six months to two years prior to installation of the support of excavation. During this period, portions of the street may be partially closed.

Without TBM launching, the station/crossover construction sites typically require about one to two acres of staging area. For sites that include slurry walls or deep soil cement mixing operations, an additional acre would be needed. For an isolated and smaller-scaled cut-and-cover construction site such as a connection box at the existing Expo/Crenshaw Station, construction could be performed within the public ROW without taking properties outside the public ROW. The smaller-scaled cut-and-cover construction site would require one-half to one acre of staging area.

In the beginning stage of a cut-and-cover construction after the utilities are cleared in the area, the excavation support system, such as soldier piles or diaphragm panels, are installed, followed by the street decking which would result in street closures, as summarized in Table 4-1 through Table 4-4. Pedestrian access (sidewalks) would remain open, and vehicular traffic would be re-directed. Special facilities, such as handrails, fences, and walkways, would be provided for the safety of pedestrians. Temporary sidewalk closures may be necessary in some locations for the delivery of oversized materials and for modifications of curbs and sidewalks. Minor cross streets and alleyways may also be temporarily closed, but access to adjacent properties would be maintained. Major cross streets would also be closed to construct the excavation support system where station excavation extends across intersections. Detailed traffic planning and coordination of closures of north-south arterial streets would be required.

The street decking, including deck beams and deck panels, would require temporary street closures as they are installed in progressive stages over several weekends. All traffic lanes over the station/crossover location would be closed for approximately 56 hours over the weekend (Friday evening through Monday morning), and deck sections of approximately 80 feet could be installed in each 56-hour closure. Decking within intersections would require the cross street to be partially or fully closed. To reduce the number of street closures, multiple decking crews may work at more than one location during a single weekend closure. Street decking installation would occur during weekends and would require full temporary street closure of up to about 12 weekends. Once the street decking is completed, street traffic would be restored, and most construction activities would occur within the fenced staging area and under the street decks. During backfill and surface restoration, the decking structures would be removed. Street decking removal would also require full temporary street closure of up to about 12 weekends.

TABLE 4-1. SAN VICENTE–FAIRFAX STREET ALIGNMENT CLOSURES DURING CONSTRUCTION

APPROXIMATE LOCATIONS	CONSTRUCTION ACTIVITIES	TYPE OF CLOSURE	CONSTRUCTION DURATION (AT EACH SITE)
Stations, Crossovers, and Connection Structures • Crenshaw/Adams Station (Crenshaw Boulevard between Adams Boulevard and 29th Street) • Midtown Crossing Station (Pico Boulevard west of San Vicente Boulevard) • Wilshire/Fairfax (Fairfax Avenue between Wilshire Boulevard and Lindenhurst Avenue) • Fairfax/3rd (Fairfax Avenue between 3rd Street and Farmer's Market Place) • La Cienega/Beverly Station (Beverly Boulevard between La Cienega Boulevard and Orange Avenue) • San Vicente/Santa Monica (Santa Monica Boulevard between Larrabee Street and Westbourne Drive) • Fairfax/Santa Monica (Santa Monica Boulevard between Fairfax Avenue and Genesee Avenue) • La Brea/Santa Monica (Santa Monica Boulevard between La Brea Avenue and Sycamore Avenue) • Hollywood/Highland (Highland Avenue between Sunset Boulevard and Franklin Avenue) • Expo/Crenshaw Connection Box (Crenshaw Boulevard south of Expo Boulevard) – duration of full street closures for connection box would be shorter than for station boxes	Utility Relocation and Preparation	Partial Street Closures	Intermittent over a one- to two-year period
	Pile Installation	Partial Street Closures	Six to 12 months
	Initial Street Excavation and Street Decking Installation	Full Street Closures, Full or Partial Intersection Closures	Approximately three to 12 weekends (56 hours, Friday evening through Monday morning)
	Street Decking Removal	Full Street Closures	Approximately three to 12 weekends (56 hours, Friday evening through Monday morning)
	Surface Restoration	Full Street Closures, Full or Partial Intersection Closures	Approximately 20 weekends (56 hours, Friday evening through Monday morning)
Cross-passages • Various locations along alignment spaced approximately every 800 feet	Ground Improvement	Partial	Three to four weeks
• San Vicente/Santa Monica Station (Santa Monica Boulevard) • La Brea/Santa Monica (Santa Monica Boulevard)	TBM Launch	Full Street Closures	Approximately two weekends (56 hours, Friday evening through Monday morning)

APPROXIMATE LOCATIONS	CONSTRUCTION ACTIVITIES	TYPE OF CLOSURE	CONSTRUCTION DURATION (AT EACH SITE)
• Expo/Crenshaw (Crenshaw Boulevard) • Wilshire/Fairfax (Fairfax Avenue) • San Vicente/Santa Monica (Santa Monica Boulevard) • Hollywood/Highland (Highland Avenue)	TBM Retrieval	Full Street Closures	Approximately two weekends (56 hours, Friday evening through Monday morning)

Source: Connect Los Angeles Partners 2024
TBM = tunnel boring machine

TABLE 4-2. FAIRFAX ALIGNMENT– STREET CLOSURES DURING CONSTRUCTION

APPROXIMATE LOCATIONS	CONSTRUCTION ACTIVITIES	TYPE OF CLOSURE	CONSTRUCTION DURATION (AT EACH SITE)
Stations and Crossovers • Crenshaw/Adams Station (Crenshaw Boulevard between Adams Boulevard and 29th Street) • Midtown Crossing Station (Pico Boulevard west of San Vicente Boulevard) • Wilshire/Fairfax (Fairfax Avenue between Wilshire Boulevard and Lindenhurst Avenue) • Fairfax/3rd (Fairfax Avenue between 3rd Street and Farmer's Market Place) • Fairfax/Santa Monica (Santa Monica Blvd between Fairfax Avenue and Genesee Avenue) • La Brea/Santa Monica (Santa Monica between La Brea Avenue and Sycamore Avenue) • Hollywood/Highland (Highland Avenue between Sunset Boulevard and Franklin Avenue) • Expo/Crenshaw Connection Box (Crenshaw Boulevard south of Expo Boulevard) – duration of full street closures for connection box would be shorter than for station boxes	Utility Relocation and Preparation	Partial Street Closures	Intermittent over a one- to two-year period
	Pile Installation	Partial Street Closures	Six to 12 months
	Initial Street Excavation and Street Decking Installation	Full Street Closures, Full or Partial Intersection Closures	Approximately three to 12 weekends (56 hours, Friday evening through Monday morning)
	Street Decking Removal	Full Street Closures	Approximately three to 12 weekends (56 hours, Friday evening through Monday morning)
	Surface Restoration	Full Street Closures, Full or Partial Intersection Closures	Approximately 20 weekends (56 hours, Friday evening through Monday morning)
Cross-passages • Various locations along alignment spaced approximately every 800 feet	Ground Improvement	Partial	Three to four weeks
• La Brea/Santa Monica (Santa Monica Boulevard)	TBM Launch	Full Street Closures	Approximately two weekends (56 hours, Friday evening through Monday morning)

APPROXIMATE LOCATIONS	CONSTRUCTION ACTIVITIES	TYPE OF CLOSURE	CONSTRUCTION DURATION (AT EACH SITE)
• Expo/Crenshaw (Crenshaw Boulevard) • Wilshire/Fairfax (Fairfax Avenue) • Hollywood/Highland (Highland Avenue)	TBM Retrieval	Full Street Closures	Approximately two weekends (56 hours, Friday evening through Monday morning)

Source: Connect Los Angeles Partners 2024
TBM = tunnel boring machine

TABLE 4-3. LA BREA ALIGNMENT– STREET CLOSURES DURING CONSTRUCTION

APPROXIMATE LOCATIONS	CONSTRUCTION ACTIVITIES	TYPE OF CLOSURE	CONSTRUCTION DURATION (AT EACH SITE)
Stations and Crossovers • Crenshaw/Adams Station (Crenshaw Boulevard between Adams Boulevard and 29th Street) • Midtown Crossing Station (Pico Boulevard west of San Vicente Boulevard) • Wilshire/La Brea (La Brea Avenue between 8th Street and 6th Street) • La Brea/Beverly (La Brea Avenue between Beverly Boulevard and Oakwood Avenue) • La Brea/Santa Monica (La Brea Avenue between Santa Monica Boulevard and Lexington Avenue) • Hollywood/Highland (Highland Avenue between Sunset Boulevard and Franklin Avenue) • Expo/Crenshaw Connection Box (Crenshaw Boulevard south of Expo Boulevard) – duration of full street closures for connection box would be shorter than for station boxes	Utility Relocation and Preparation	Partial Street Closures	Intermittent over a one- to two-year period
	Pile Installation	Partial Street Closures	Six to 12 months
	Initial Street Excavation and Street Decking Installation	Full Street Closures, Full or Partial Intersection Closures	Approximately three to 12 weekends (56 hours, Friday evening through Monday morning)
	Street Decking Removal	Full Street Closures	Approximately three to 12 weekends (56 hours, Friday evening through Monday morning)
	Surface Restoration	Full Street Closures, Full or Partial Intersection Closures	Approximately 20 weekends (56 hours, Friday evening through Monday morning)
Cross-passages • Various locations along alignment spaced approximately every 800 feet	Ground Improvement	Partial	Three to four weeks
• La Brea/Santa Monica (La Brea Avenue)	TBM Launch	Full Street Closures	Approximately two weekends (56 hours, Friday evening through Monday morning)
• Expo/Crenshaw (Crenshaw Boulevard) • Wilshire/La Brea (La Brea Avenue) • Hollywood/Highland (Highland Avenue)	TBM Retrieval	Full Street Closures	Approximately two weekends (56 hours, Friday evening through Monday morning)

Source: Connect Los Angeles Partners 2024
TBM = tunnel boring machine

TABLE 4-4. STREET CLOSURES FOR HOLLYWOOD BOWL DESIGN OPTION

APPROXIMATE LOCATIONS	CONSTRUCTION ACTIVITIES	TYPE OF CLOSURE	CONSTRUCTION DURATION (AT EACH SITE)
Cahuenga End Shaft (Cahuenga Boulevard near Pilgrimage Bridge)	Pile Installation	Partial Street Closures	One to two months
	Initial Street Excavation and Street Decking Installation	Full Street Closures, Full or Partial Intersection Closures	Approximately three weekends (56 hours, Friday evening through Monday morning)
	Street Decking Removal	Full Street Closures	Approximately three weekends (56 hours, Friday evening through Monday morning)
	Surface Restoration	Full Street Closures, Full or Partial Intersection Closures	Approximately five weekends (56, hours Friday evening through Monday morning)
Cross-passages South of Hollywood Fault	Ground Improvement	Partial	Three to four weeks

Source: Connect Los Angeles Partners 2024

4.3.14 METRO RAIL IMPACTS

The alignments would connect the Metro E, B, and D Lines. In order to construct the transfer stations and tie KNE into the existing rail network, the following construction activities at existing stations would be necessary:

- Knock-out panel demolition and station connection consisting of removal of existing knock-out panels and reconfiguration of existing station (i.e., shifting ticket vending machines)
- Concourse construction consisting of constructing additional concourse at existing stations where needed; installation of additional structural support elements; and new vertical circulation
- Systems integration, including mechanical, electrical, and plumbing upgrades; communications and signals connections; track and traction power connections; and system testing

As a result of these construction activities, service along the Metro E, B, D, and K Lines would be temporarily affected. Table 4-5 through Table 4-7 summarize the potential effects of construction activities to the Metro rail network.

TABLE 4-5. SAN VICENTE–FAIRFAX ALIGNMENT– CONSTRUCTION EFFECTS ON METRO B, D, E, AND K LINE STATIONS

STATION	EFFECT	DURATION
E Line Expo/Crenshaw	E Line track closure across Crenshaw Boulevard between the westbound and eastbound Expo/Crenshaw Station platforms. Passengers would disembark the train and cross Crenshaw Boulevard on foot to transfer to a train at the other platform.	23 weeks plus intermittent closures over the course of two years
K Line Expo/Crenshaw	Single tracking from MLK Station or Leimert Park Station to Expo/Crenshaw Station	Up to 20 weekends
D Line Wilshire/Fairfax	Train access only (no passengers) with single tracking	Occasional night and weekend closures over the course of two years
	Train and limited passenger access (east end of station) with single tracking	Two years
B Line Hollywood/Highland Entrance Option 1 (Southwest)	Partial station mezzanine closure; access to platform, entrance, and tracks not affected	Occasional night and weekend closures over the course of six months
B Line Hollywood/Highland Entrance Option 2 (Southeast)	Partial platform closure; access to mezzanine, entrance, and tracks not affected	Occasional night and weekend closures over the course of six months

Source: Connect Los Angeles Partners 2023

TABLE 4-6. FAIRFAX ALIGNMENT– CONSTRUCTION EFFECTS ON METRO B, D, E, AND K LINE STATIONS

STATION	EFFECT	DURATION
E Line Expo/Crenshaw	E Line track closure across Crenshaw Boulevard between the westbound and eastbound Expo/Crenshaw Station platforms. Passengers would disembark the train and cross Crenshaw Boulevard on foot to transfer to a train at the other platform.	23 weeks plus intermittent closures over the course of two years
K Line Expo/Crenshaw	Single tracking from MLK Station or Leimert Park Station to Expo/Crenshaw Station	Up to 20 weekends
D Line Wilshire/Fairfax	Train access only (no passengers) with single tracking	Occasional night and weekend closures over the course of two years
	Train and limited passenger access (east end of station) with single tracking	Two years
B Line Hollywood/Highland Entrance Option 1 (Southwest)	Partial station mezzanine closure; access to platform, entrance, and tracks not affected	Occasional night and weekend closures over the course of six months
B Line Hollywood/Highland Entrance Option 2 (Southeast)	Partial platform closure; access to mezzanine, entrance, and tracks not affected	Occasional night and weekend closures over the course of six months

Source: Connect Los Angeles Partners 2023

TABLE 4-7. LA BREA ALIGNMENT– CONSTRUCTION EFFECTS ON METRO B, D, E, AND K LINE STATIONS

STATION	EFFECT	DURATION
E Line Expo/Crenshaw	E Line track closure across Crenshaw Boulevard between the westbound and eastbound Expo/Crenshaw Station platforms. Passengers would disembark the train and cross Crenshaw Boulevard on foot to transfer to a train at the other platform.	23 weeks plus intermittent closures over the course of two years
K Line Expo/Crenshaw	Single tracking from MLK Station or Leimert Park Station to Expo/Crenshaw Station	Up to 20 weekends
D Line Wilshire/La Brea	Limited access to D Line entrance	Occasional night and weekend closures over the course of six months
B Line Hollywood/Highland Entrance Option 1 (Southwest)	Partial station mezzanine closure; access to platform, entrance, and tracks not affected	Occasional night and weekend closures over the course of six months
B Line Hollywood/Highland Entrance Option 2 (Southeast)	Partial platform closure; access to mezzanine, entrance, and tracks not affected	Occasional night and weekend closures over the course of six months

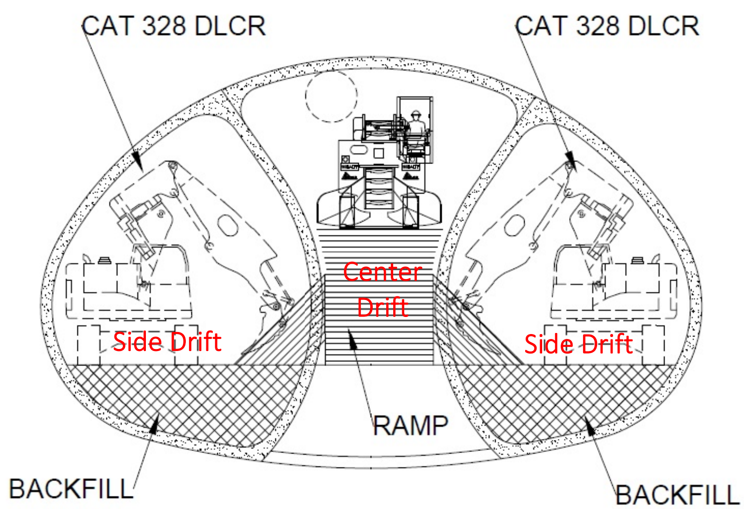
Source: Connect Los Angeles Partners 2023

4.4 SEM CONSTRUCTION

The optional Hollywood Bowl Station would be built as part of the Hollywood Bowl Design Option. The design option would involve construction of a station under Highland Avenue, and includes a station cavern, two crossover caverns, conventionally mined guideway tunnels, and an end shaft at the end of tail tracks. The station and crossover caverns in the Hollywood Bowl Design Option would be constructed in hard rock formations using SEM performed with several working shafts. The working shafts would be excavated within the construction staging area and later would be used to accommodate entrance, ventilation, and/or emergency egress structures. If excavated by SEM, the station and crossover caverns would be about 70 feet wide and 43 feet high. The station cavern would include two guideways with a center platform and a concourse level. The crossover cavern would include a No. 10 or No. 15 double crossover with side emergency walkways and an emergency ventilation plenum in the crown. Caverns would have a final lining of cast-in-place reinforced concrete that would be placed after installation of the water/gas-proofing membrane following the completion of excavation.

The SEM excavates small portions of ground in sequences until the anticipated excavation geometry is achieved. At each step in the excavation sequence, the newly exposed ground is stabilized by installing a ground-support system before the subsequent excavation advances. This repeating pattern of excavation is referred to as an “excavation cycle.” Each “excavation cycle” consists of excavation, mucking spoils, and installation of ground support. A typical SEM ground-support system for the project may include rock reinforcement, shotcrete, lattice girder with shotcrete, and forepoling or spiling. Depending on the ground condition, pre-grouting, dewatering, and/or ground freezing may be required. Figure 4-18 shows a typical SEM excavation sequence and a typical SEM excavation site. First, the side drifts are advanced sequentially as initial ground supports are installed. Second, the center drift is advanced in top heading and benches as initial ground supports are installed. Third, the center walls (previously initial ground supports for side drifts) are demolished leaving a large single-spanned opening.

FIGURE 4-18. TYPICAL SEM SEQUENCE WITH SHOTCRETE LINING



Source: Metro Contract No. C0980 (Regional Connector) 2017

Mechanical means would be used as the primary mining method for SEM excavation on Metro projects. Mechanical means often include roadheader, demolition hammer, and an excavation bucket with teeth. Figure 4-2 shows a "roadheader," which is typically used for excavation of cemented soils and rocks. Where rock conditions dictate, blasting could be used if justified and permitted. Depending on the rock mass strength encountered within the Hollywood Bowl area, localized controlled blasting could be needed for SEM excavation.

In addition, the SEM technique would be used to construct cross-passages for the project. To minimize surface disruption in the right soil conditions, crossovers could be constructed in a cavern excavated in soils by SEM limiting the use of cut-and-cover construction in other locations of the project. In alluvial soil conditions, SEM may require ground improvements by grouting.

The cavern construction activities for the Hollywood Bowl Design Option would be limited within the construction staging site of four acres identified in Section 4.2.1.2. It is estimated that this site could produce about 250 to 430 CY of crushed rocks per day, which can be converted to about 10 to 25 dump truck trips per day, assuming six excavation crews are employed. The mechanical excavation in deep bedrock would not be a concern, but any potential blasting that may be required for localized areas may have to address the construction noise and vibration issues for neighboring stakeholders.

4.5 MSF CONSTRUCTION

Construction of the MSF would include standard methods associated with construction of trackwork and buildings, including demolition of existing facilities, leveling of land, relocation of utilities, and construction of new sheds and maintenance buildings, fencing, pavement, and landscaping, as well as track work, traction power, and OCS for storage of LRVs. Refer to Section 3.6 for details about the MSF construction approach.

4.6 LRT SYSTEMS INSTALLATION

4.6.1 TRACKWORK

Trackwork would be constructed below grade in the completed tunnels and station structures. Trackwork construction involves installation of trackbed components on the completed concrete structures, followed by the laying of rails. In general, overhead conductor rail (traction power) and conduits for systems installations would be constructed at the same time as, or closely following, the trackwork. Rails, special trackwork, conduits, and associated components would be brought into the tunnels at selected station locations with appropriate off-street access and, in some cases, via the existing system. Rails would be delivered in stock lengths of 40 or 80 feet and welded into long strings typically 480 feet within the station boxes.

4.6.2 ELECTRICAL SUBSTATIONS AND FACILITIES

In general, electrical substation and backup/standby power sources must be provided and would be located within available spaces in the stations, cross-passages, ventilation shafts, and emergency exits. Some electric power equipment may be located within street-level spaces at the MSF site. Substations would include traction power substations and smaller substations. The substations would be spaced along the alignment and may be located at or near each station. These electrical facilities would be separated from public areas of the system and would include appropriate security.

4.6.3 COMMUNICATIONS AND SIGNALING

Communications and signaling systems would be accommodated within rooms and niches in the stations, tunnels, cross-passages, ventilation shafts, and emergency exits. These systems would be spaced along the alignment and positioned at or near each station. They would be separated from public areas and would include appropriate security. Operations and control facilities would be housed within existing Metro facilities or may be incorporated into the MSF.

4.7 SYSTEMS TESTING AND PRE-REVENUE OPERATIONS

Planning for systems testing, including the use of rail vehicles, should commence at least six months in advance of opening and should follow completion of Local Field Acceptance Testing of those systems. Systems testing, especially involving the use of LRVs, must be carefully planned and sequenced. Figure 4-19 provides an example for how testing should ideally be sequenced.

FIGURE 4-19. EXAMPLE SYSTEMS TESTING SEQUENCE

Source: Connect Los Angeles Partners 2023

In support of systems testing, safety procedures need to be developed and enforced, including track allocation, red tag, and power down and ground. An important aspect would be to control movement between the KNE alignment and K Line revenue tracks, as well as scheduling when and how train control and traction power systems are integrated and cut-over between KNE and the revenue system. The latter activities would require some level of existing service disruption, probably in the form of weekend bus bridging.

In general, systems testing would commence with integration between field systems and LRVs. As field systems are tested and are shown to be stable, testing can move between field systems and the Rail Operating Center to verify command and control integrity.

As systems testing, especially testing at the Rail Operating Center, comes to fruition, the project would become ready for transition to pre-revenue operations. This step is when Metro Operations takes over command and control of KNE and performs various safety exercises, trains train operators, and practices revenue service, although without passengers. Careful planning should commence at least six months beforehand. Progress of testing, remaining installation, punch list walk-throughs, track, signal ventilation and power systems handover, training, and related activities would need to be tracked to ensure KNE is ready for handover and that the state of completion is acceptable to Metro Operations.

APPENDIX A **CONSTRUCTION STAGING AND LAYDOWN AREAS**

APPENDIX A: **CONSTRUCTION STAGING AND LAYDOWN AREAS**

This appendix summarizes the proposed construction staging and laydown areas during construction of the K Line Northern Extension Project. Table A-1 shows anticipated construction staging activities organized by locations along the alignments, and the following sections describe in detail the principal activities at each of the construction staging and laydown areas.

TABLE A-1. CONTRACTOR STAGING AND LAYDOWN AREAS—PRINCIPAL ACTIVITIES BY LOCATION

ACTIVITY	EXPO/ CRENSHAW (CONNECTION)	CRENSHAW/ ADAMS (STATION)	MIDTOWN CROSSING (STATION/TBM)	WILSHIRE/ FAIRFAX (STATION)	WILSHIRE/ LA BREA (STATION)	LA CIENEGA/ BEVERLY (STATION)	FAIRFAX/ 3RD (STATION)	LA BREA/ BEVERLY (STATION)	SAN VICENTE/ SANTA MONICA (STATION/TBM)	FAIRFAX/ SANTA MONICA (STATION)	LA BREA/ SANTA MONICA (STATION/TBM)	HOLLYWOOD/ HIGHLAND (STATION)	FRANKLIN/ HIGHLAND (END SHAFT)	HOLLYWOOD BOWL (STATION/ MINING)	CAHUENGA (END SHAFT)
Contractor field office		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Metro field office			✓						✓		✓			✓	
Parking		✓	✓						✓		✓			✓	
Foam/slurry plant			✓						✓		✓				
Grout plant			✓						✓		✓			✓	
Slurry/DSCM wall				✓	✓							✓			
Controlled blasting														✓	✓
Electrical substation		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Air compressor station		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dry house			✓	✓	✓				✓		✓			✓	
Materials storage		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Fossil box storage				✓	✓										
Tunnel segment storage			✓						✓		✓				
Crane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mechanical shop			✓						✓		✓			✓	
Electrical shop			✓						✓		✓			✓	
Desilting basin/tank		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Water treatment plant		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Rock crusher														✓	
Muck storage (excavation)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Muck storage (TBM)			✓						✓		✓				
Truck loading	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Concrete pumping	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Source: Connect Los Angeles Partners 2024
DSCM = deep soil cement mixing;TBM = tunnel boring machine

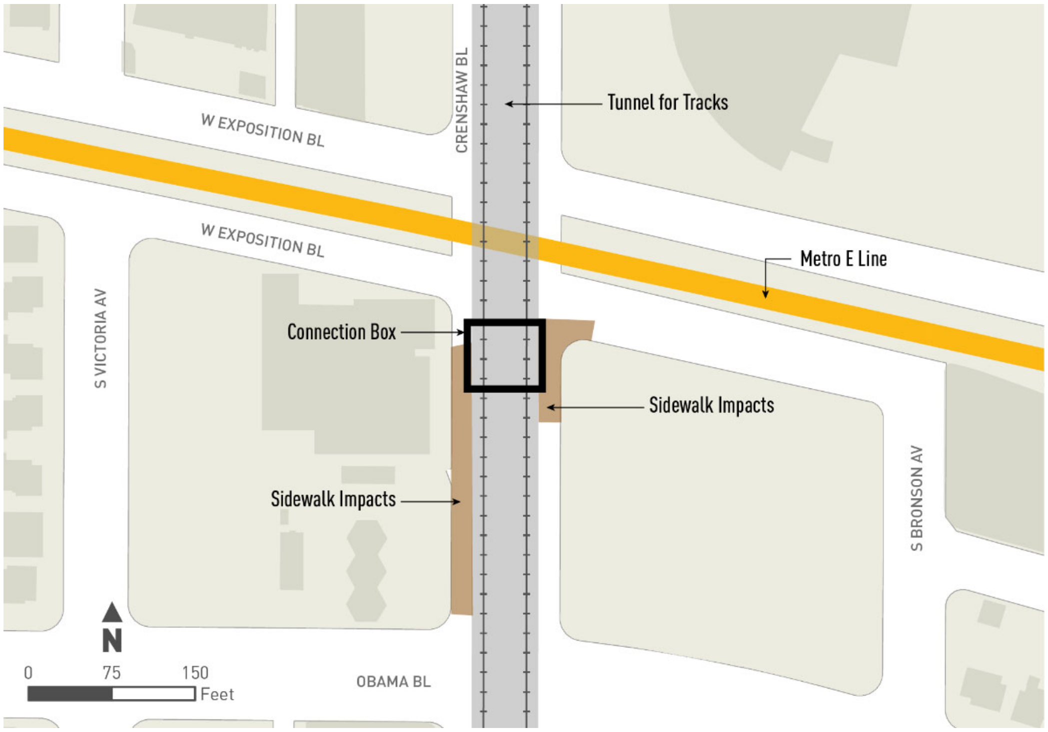
EXPO/CRENSHAW

At Expo/Crenshaw, a cut-and-cover structure would be constructed to retrieve the two TBMs launched from Midtown Crossing and to make the connection between new tunnels and the existing Expo/Crenshaw Station (Figure A-1). Within the excavation, the knock-out panels on the existing station would be exposed and cut out, then the connection box would be constructed between the existing station and the twin tunnels. After the TBM's retrieval, the shaft can be used for personnel to access the tunnels without passing through the existing Expo/Crenshaw Station and to move materials to/from the tunnels. The shaft may be used to pump concrete into the tunnels for the construction of tunnel invert and walkways and possibly for the construction of cross-passages.

A minimum laydown area of 0.5-acre would be required within the public ROW requiring sidewalk, parking shoulder, and lane closure for the duration of the construction at this site. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the shaft footprint, street modifications, and to store the materials and equipment used to install the temporary shoring and street decking. The laydown area would overlay a portion of the shaft to maintain an "access opening" to the shaft. The "access opening" would allow the contractor to move personnel, materials, and equipment in and out of the shaft. The other portion of the shaft under the street would be decked over to keep the street open for traffic. In the beginning of the excavation, a full street closure during several weekends would be necessary for the street decking; thereafter, a partial sidewalk and a couple of lanes would remain closed until backfill of the shaft. Stockpiling the excavated materials and storing construction materials at this site would be restricted. The haulage and delivery must be scheduled without stockpiling or queuing at the surface while excavation and construction work can continue during regularly scheduled workhours. In addition, each TBM retrieval would require a full street closure over a weekend or at night.

This laydown area would have limited spaces for contractor field offices, parking, and amenities for the site-based workforce, as well as a plant for treatment of dewatering effluent. A remote space may be needed to facilitate these activities.

FIGURE A-1. CONNECTION BOX EXCAVATION FOOTPRINT



Source: Connect Los Angeles Partners 2024

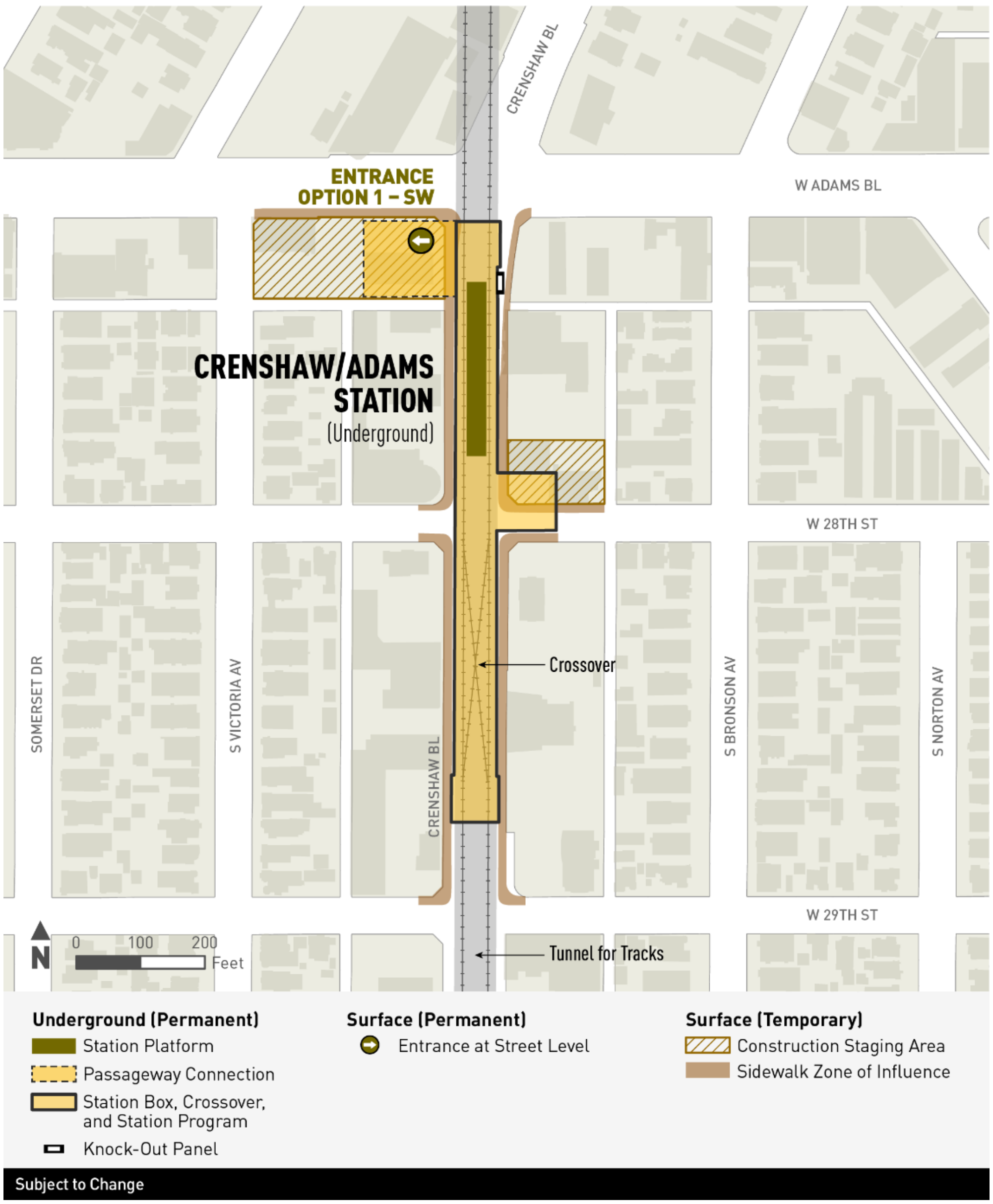
CRENSHAW/ADAMS

Crenshaw/Adams is a station and crossover construction site (Figure A-2 and Figure A-3). A minimum laydown area of one acre would be needed, principally for the construction of the station and crossover. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the station/crossover footprint, street modifications, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

Laydown areas are required adjacent to the station/crossover excavation to store materials and equipment used to perform the cut-and-cover construction. An "access adit" into the excavation from the laydown areas would allow the contractor to move personnel, materials, and equipment in and out of the station/crossover excavation beneath the decked street without the need to close traffic lanes. During the excavation, the "access adit" would allow excavated materials to be removed without disruption to the public ROW and would allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue at regularly scheduled times.

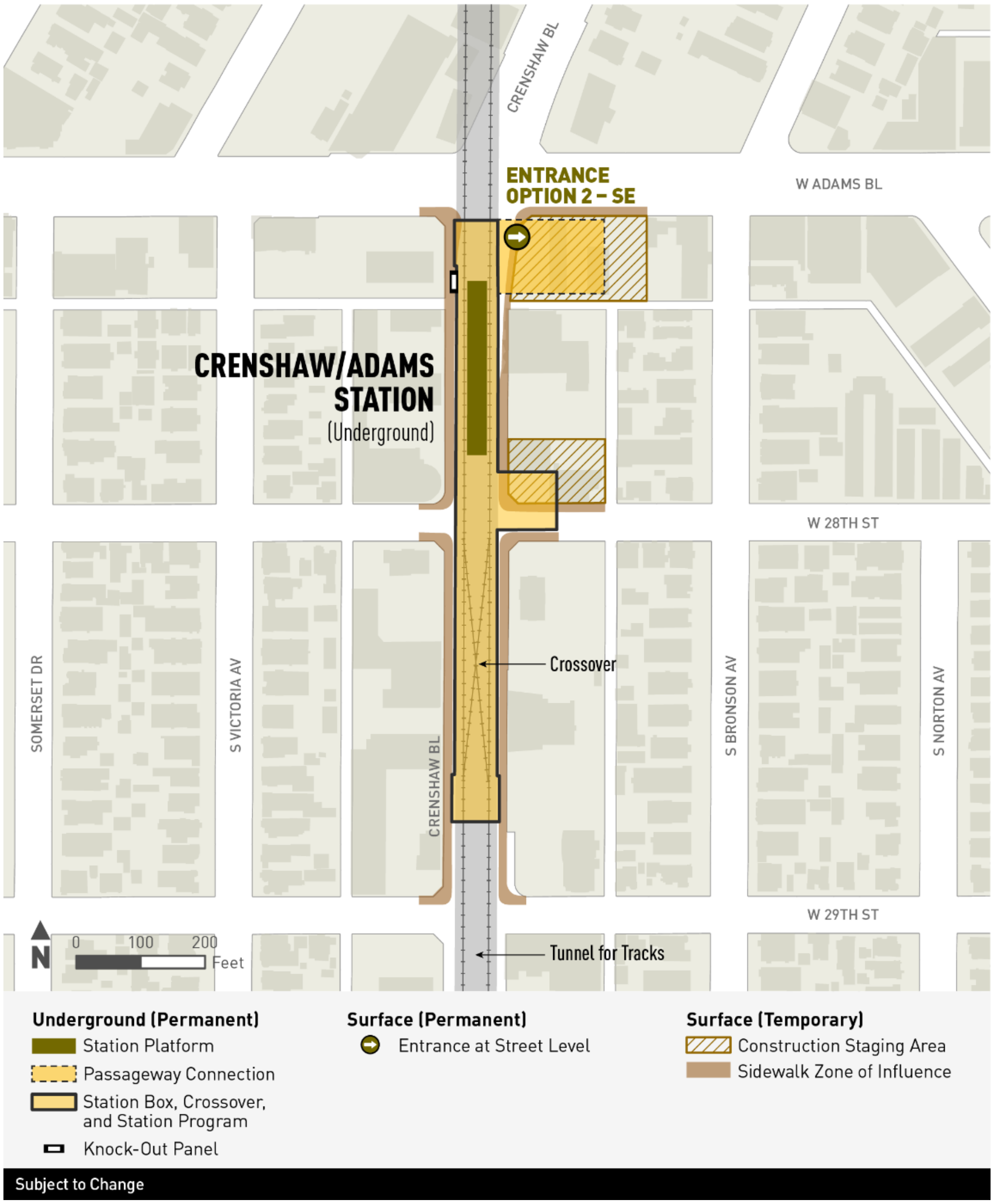
The laydown area would serve as a location for contractor field offices and amenities for the site-based workforce, as well as for a plant for treatment of dewatering effluent. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

FIGURE A-2. CRENSHAW/ADAMS STATION – ENTRANCE OPTION 1 – SW



Source: Connect Los Angeles Partners 2024

FIGURE A-3. CRENSHAW/ADAMS STATION – ENTRANCE OPTION 2 – SE



Source: Connect Los Angeles Partners 2024

MIDTOWN CROSSING

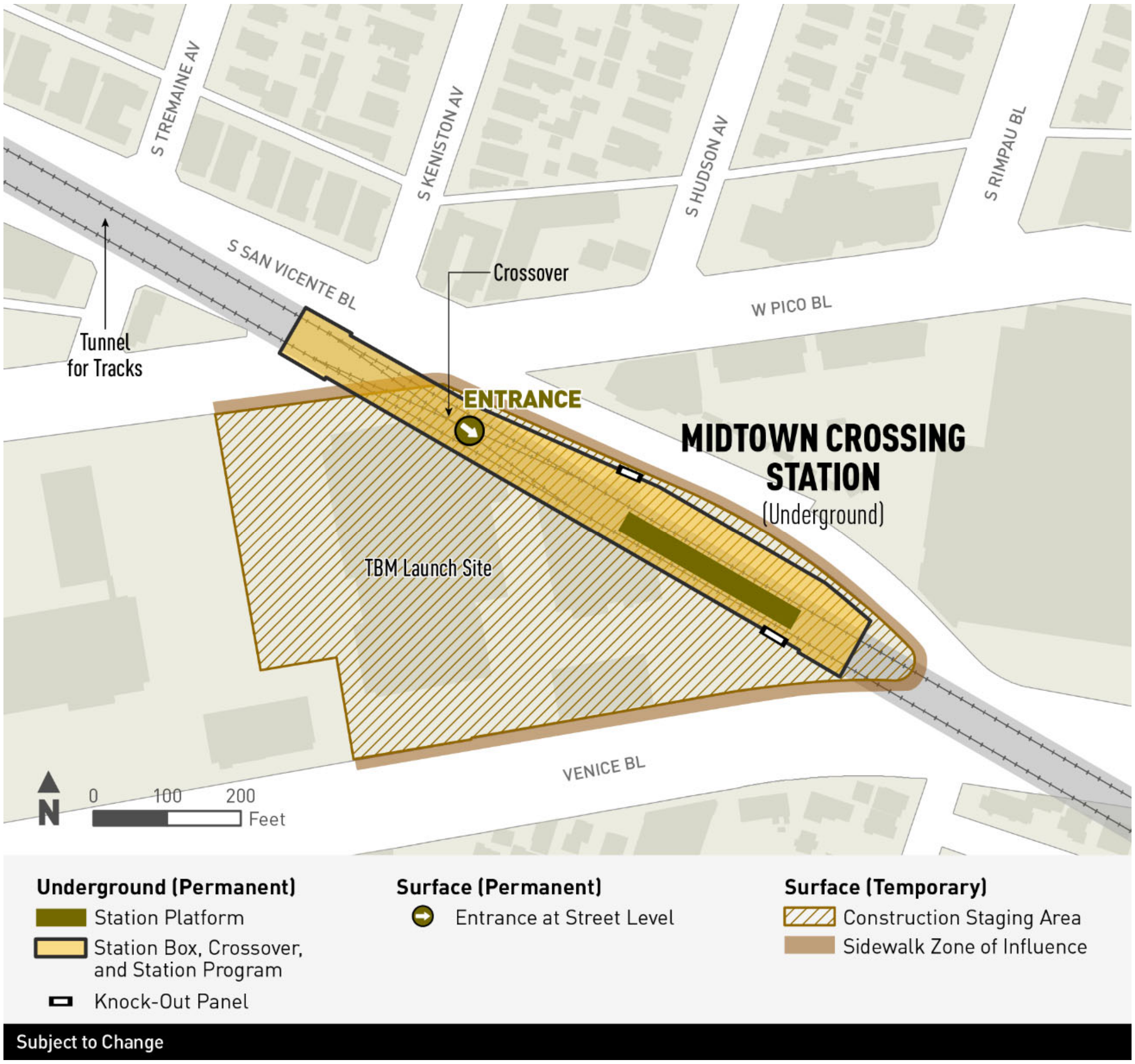
Midtown Crossing is not only a station and crossover construction site but also a TBM launch site supporting the TBM tunneling operation (Figure A-4). A minimum laydown area of three acres would be needed, principally for the construction of the tunnels, station, and crossover. The Midtown Crossing site is approximately six acres. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the station/crossover footprint, street modifications for site preparations, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

Laydown areas are required adjacent to the station/crossover excavation to store materials and equipment used to perform the cut-and-cover construction and the TBM operation. The station/crossover excavation is primarily located outside the public ROW in the laydown area, such that most of the excavation does not need to be decked over and direct access is provided to the excavation from the laydown area. Direct access would be used to move personnel, materials, and equipment in and out of the station/crossover excavation. The portion of excavation within the public ROW would be decked over to support street traffic. During excavation, direct access would allow excavated materials to be removed and allow concrete pumps and concrete trucks to be set up within the laydown area and work without interruption to traffic without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled workhours.

The laydown area would be used as a staging area to prepare and inspect TBM components and support equipment as they are delivered to this site and to store such equipment until the TBM is assembled within the excavation.

The laydown area would serve as a location for contractor field offices, parking, amenities for the site-based workforce, and for the plant and equipment supporting tunnel drives to Expo/Crenshaw and Wilshire/Fairfax or Wilshire/La Brea. TBM support equipment and facilities would include an electrical substation, compressed air plant, a grout plant, storage for bentonite slurry and/or EPB conditioner, a slurry separation plant, and storage for tunnel supplies and materials, including precast concrete segments, pipe, rail and sleepers, power cables, workshops to repair and maintain equipment, and spare parts. The laydown area would be used to stockpile and dry tunnel spoil prior to off-site disposal. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

FIGURE A-4. MIDTOWN CROSSING STATION



Source: Connect Los Angeles Partners 2024

WILSHIRE/FAIRFAX

Wilshire/Fairfax is a relatively deep station/crossover construction site due to deep vertical alignment that crosses under the existing Metro D Line station (Figure A-5). A minimum laydown area of two acres would be needed, principally for construction of the station and crossover. Particularly because of deep excavation, a larger staging area would be required to install a rigid excavation support system such as slurry walls or deep soil cement mixing walls. Initially, the laydown area would be used to support advance work associated with the protection and relocation of utilities within the station/crossover footprint, street modifications for site preparation, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

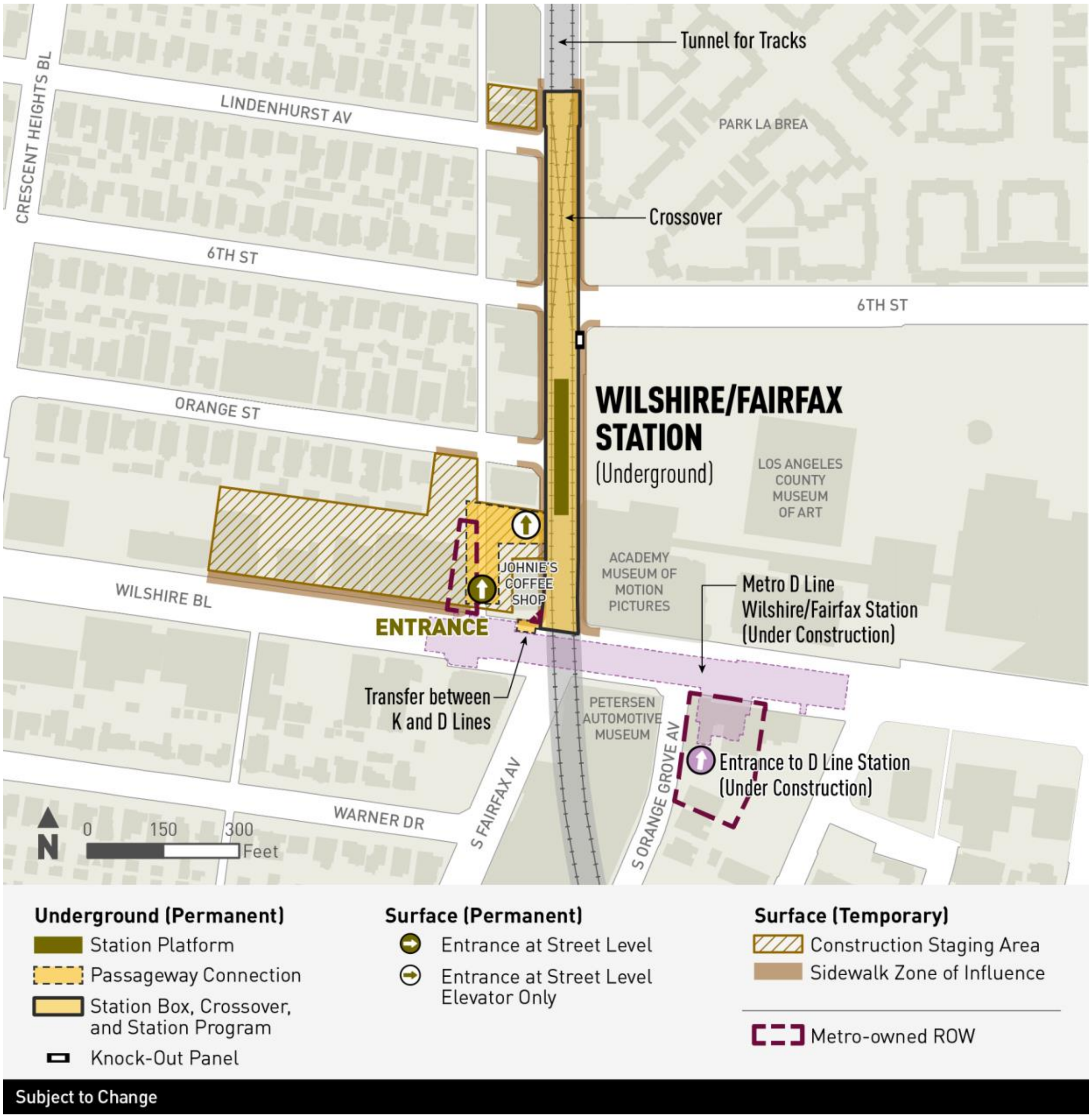
Laydown areas are generally required adjacent to the station/crossover excavation to store materials and equipment used to perform the cut-and-cover construction, but some laydown areas can be remotely located in the vicinity as possibly being used for dewatering effluent treatment or a slurry plant with lines running. An “access adit” into the excavation from the adjacent laydown areas would allow the contractor to move personnel, materials, and equipment in and out of the station/crossover excavation beneath the decked street without the need to close traffic lanes. During the excavation, the “access adit” would allow excavated materials to be removed without disruption to the public ROW. It would allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled workhours.

If fossils are encountered during excavation, fossil boxes removed from the excavation would be stored at this site or at the Midtown Crossing site, either until the boxes can be transported off-site for processing or stored until fossil processing is done.

The laydown area would serve as a location for contractor field offices and amenities for the site-based workforce, as well as for a plant for treatment of dewatering effluent. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

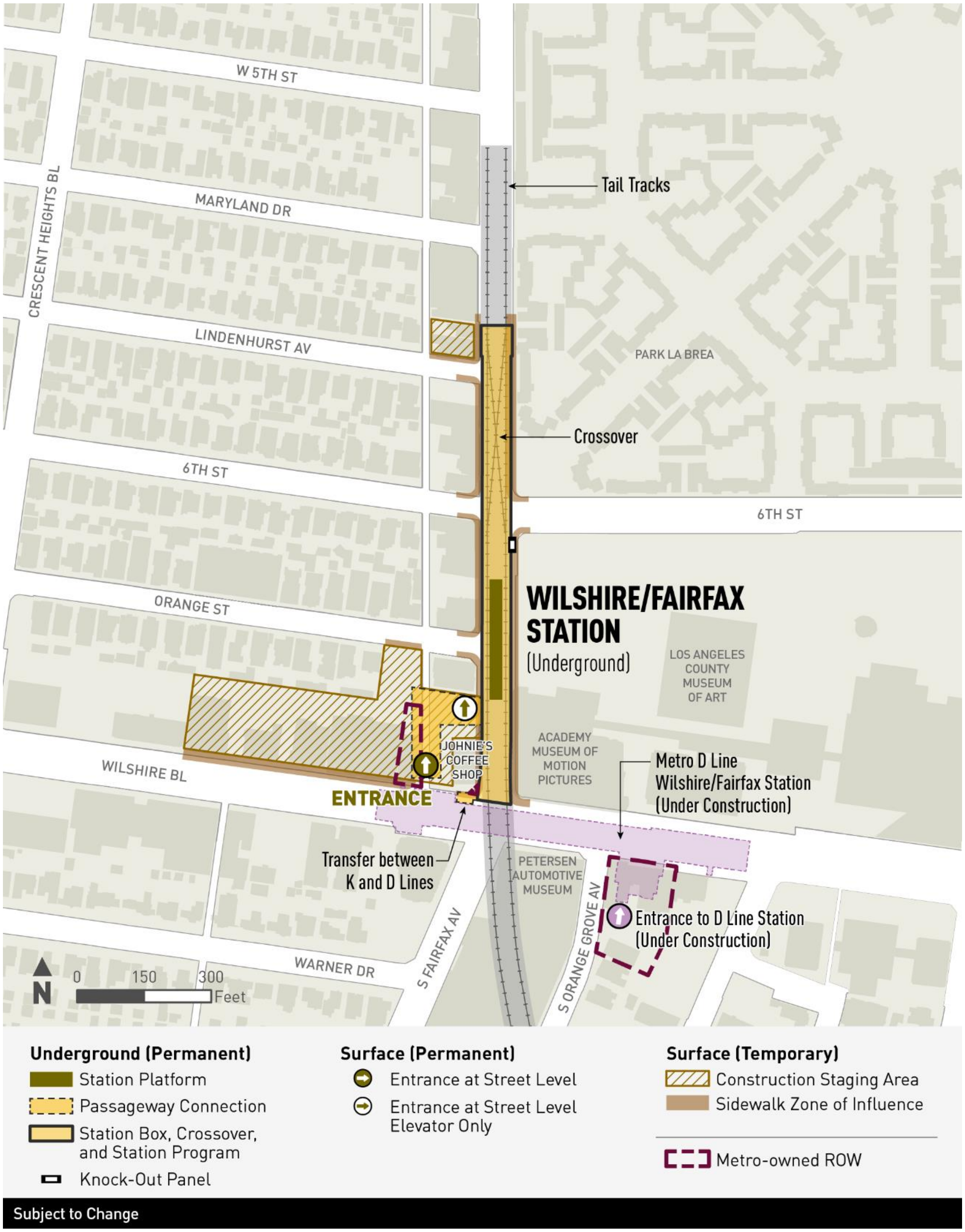
If the Wilshire/Fairfax Station were constructed as a terminus station for Section 1, the station would also include tail tracks north of the station box to allow the station to operate as a terminus, as shown in Figure A-6**.** The tail tracks would extend 320 feet north of the Wilshire/Fairfax station box. The laydown areas would be the same whether or not the station is a terminus.

FIGURE A-5. WILSHIRE/FAIRFAX STATION



Source: Connect Los Angeles Partners 2024

FIGURE A-6. WILSHIRE/FAIRFAX STATION – SECTION 1 TERMINUS



Source: Connect Los Angeles Partners 2024

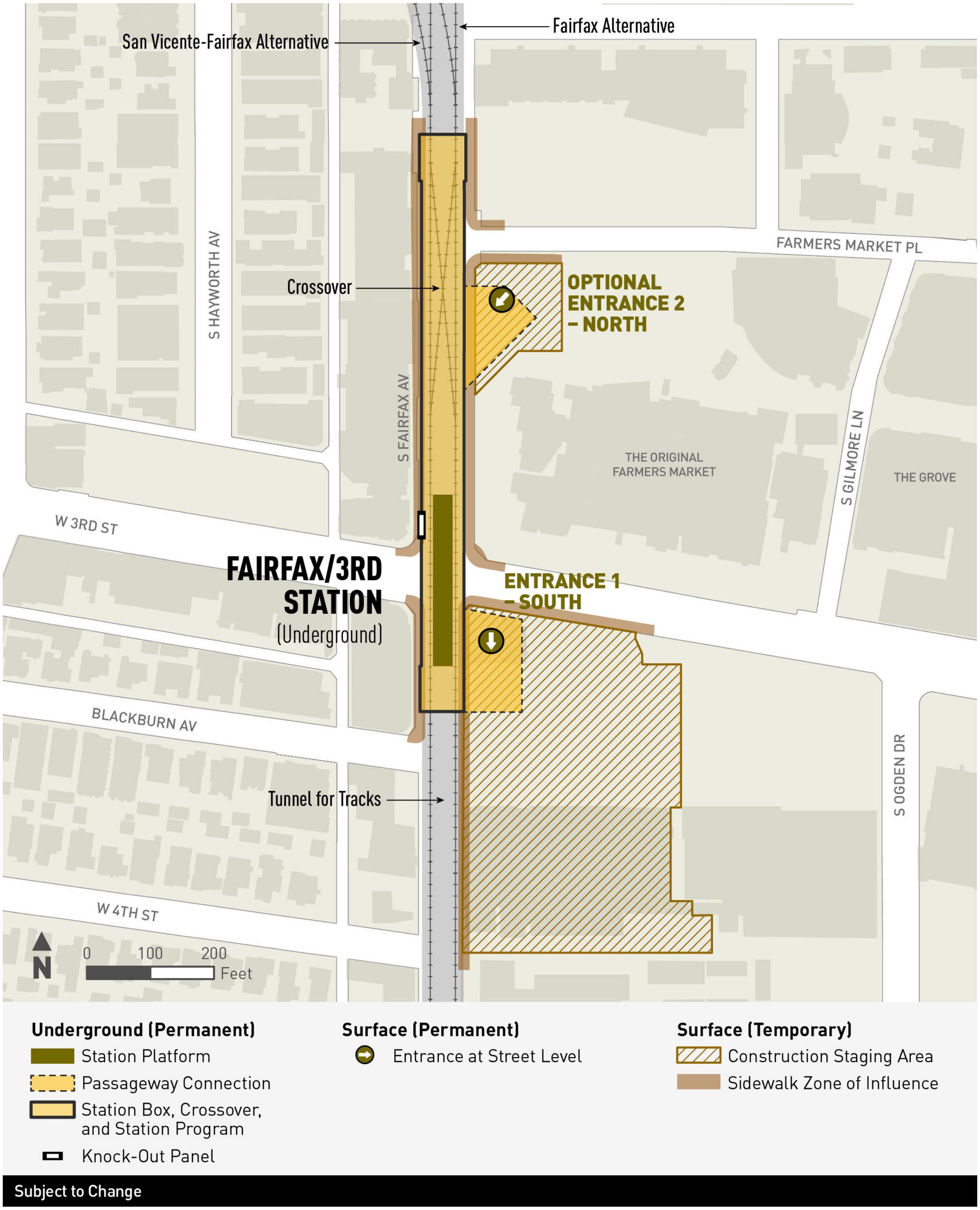
FAIRFAX/3RD

Fairfax/3rd is a station and crossover construction site (Figure A-7). A minimum laydown area of one acre would be needed, principally for construction of the station and crossover. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the station/crossover footprint, street modifications for site preparation, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

Laydown areas are required adjacent to the station/crossover excavation to store materials and equipment used to perform the cut-and-cover construction. An "access adit" into the excavation from the laydown areas would allow the contractor to move personnel, materials, and equipment in and out of the station/crossover excavation beneath the decked street without the need to close traffic lanes. During the excavation, the "access adit" would allow excavated materials to be removed without disruption to the public ROW. It would allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled times.

The laydown area would serve as a location for contractor field offices and amenities for the site-based workforce, as well as for a treatment plant of dewatering effluent. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

FIGURE A-7. FAIRFAX/3RD STATION



Source: Connect Los Angeles Partners 2024

LA CIENEGA/BEVERLY

La Cienega/Beverly is a station and crossover construction site (Figure A-8). A minimum laydown area of one acre would be needed, principally for the construction of the station and crossover. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the station/crossover footprint, street modifications for site preparation, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

Laydown areas are required adjacent to the station/crossover excavation to store materials and equipment used to perform the cut-and-cover construction. An “access adit” into the excavation from the laydown areas would allow the contractor to move personnel, materials, and equipment in and out of the station/crossover excavation beneath the decked street without the need to close traffic lanes. During the excavation, the “access adit” would allow excavated materials to be removed without disruption to the public ROW. It would allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled times.

The laydown area would serve as a location for contractor field offices and amenities for the site-based workforce, as well as for a treatment plant of dewatering effluent. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

FIGURE A-8. LA CIENEGA/BEVERLY STATION

Source: Connect Los Angeles Partners 2024

SAN VICENTE/SANTA MONICA

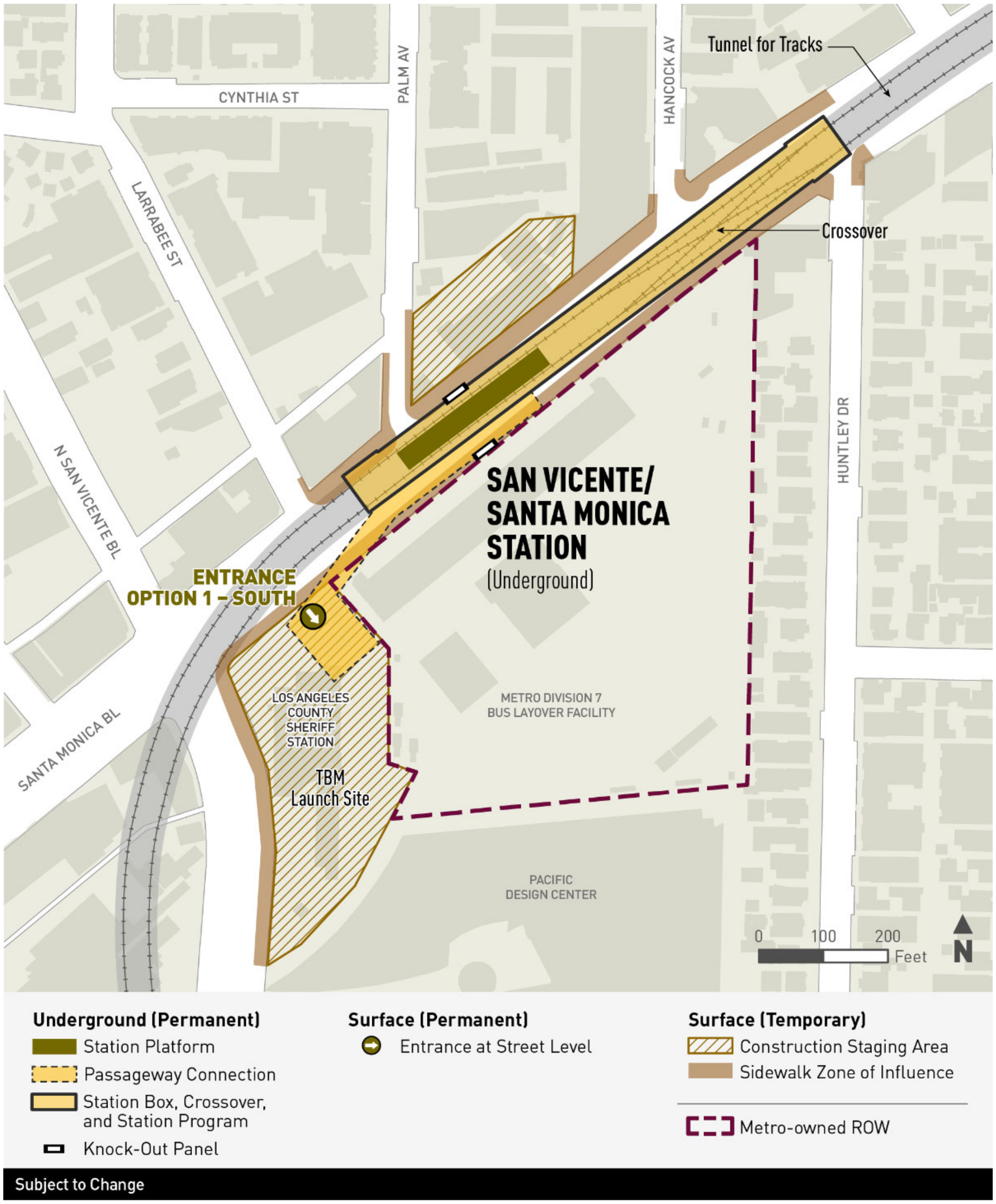
San Vicente/Santa Monica is not only a station and crossover construction site but also a TBM launch site supporting the TBM tunneling operation (Figure A-9 and Figure A-10). A minimum laydown area of three acres would be needed, principally for construction of the tunnels, station, and crossover. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the station/crossover footprint, street modifications for site preparations, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

Laydown areas are required adjacent to the station/crossover excavation to store materials and equipment used to perform the cut-and-cover construction and the TBM operation. An "access adit" into the excavation from the laydown areas would allow the contractor to move personnel, materials, and equipment in and out of the station/crossover excavation beneath the decked street without the need to close traffic lanes. During the excavation, the "access adit" would allow excavated materials to be removed without disruption to the public ROW. It would allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled workhours.

The laydown area would be used as a staging area to prepare and inspect TBM components and support equipment as they are delivered to this site and to store such equipment until the TBM is assembled within the excavation.

The laydown area would serve as a location for contractor field offices, parking, and amenities for the site-based workforce, as well as for the plant and equipment to support tunnel drives to Wilshire/Fairfax. TBM support equipment and facilities would include an electrical substation, compressed air plant, a grout plant, storage for bentonite slurry and/or EPB conditioner, a slurry separation plant, and storage for tunnel supplies and materials, including precast concrete segments, pipe, rail and sleepers, power cables, workshops to repair and maintain equipment, and spare parts. The laydown area would be used to stockpile and dry tunnel spoil prior to being trucked away for off-site disposal. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

FIGURE A-9. SAN VICENTE/SANTA MONICA STATION – ENTRANCE OPTION 1 – SOUTH



Source: Connect Los Angeles Partners 2024

FIGURE A-10. SAN VICENTE/SANTA MONICA STATION – ENTRANCE OPTION 2 – NORTH

Source: Connect Los Angeles Partners 2024

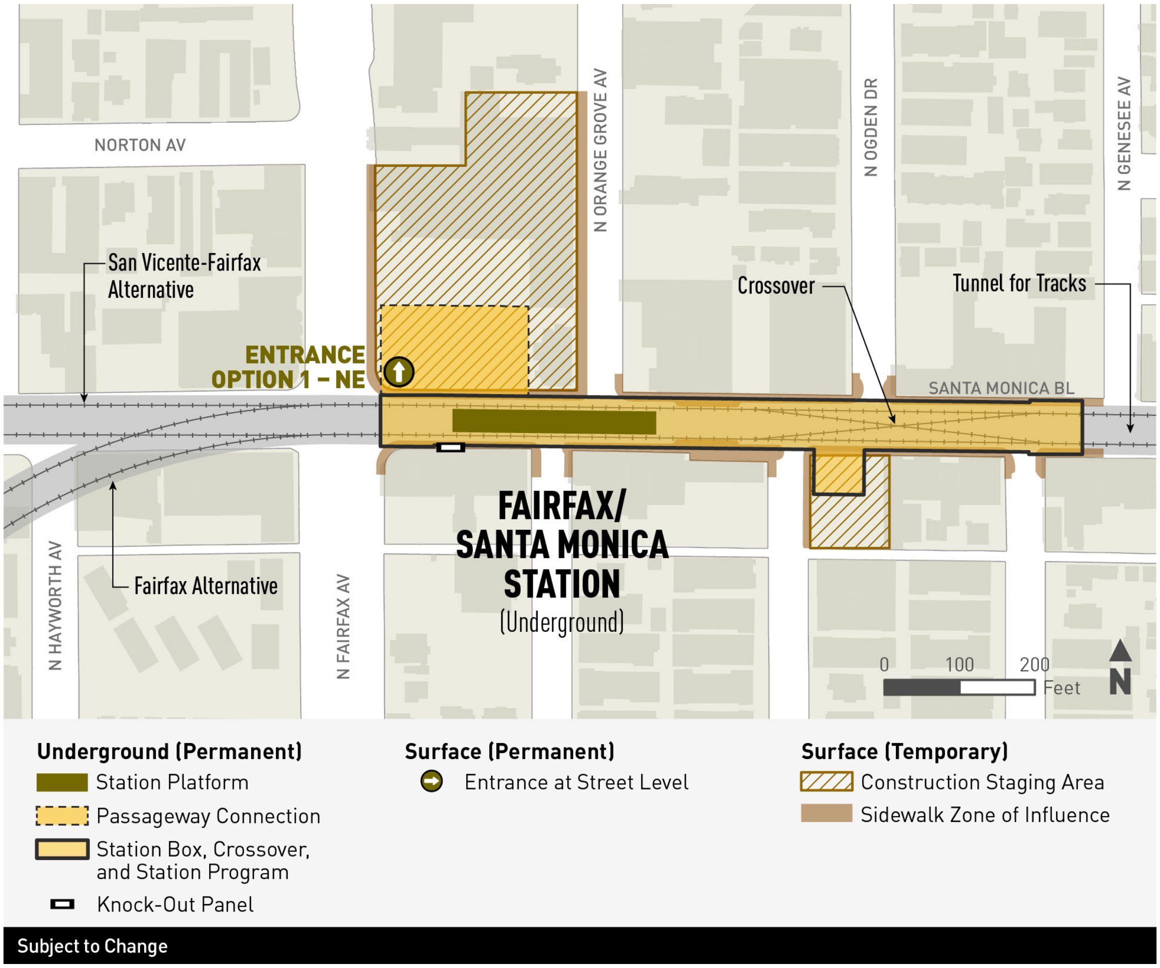
FAIRFAX/SANTA MONICA

Fairfax/Santa Monica is a station and crossover construction site (Figure A-11 and Figure A-12). A minimum laydown area of one acre would be needed, principally for the construction of the station and crossover. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the station/crossover footprint, street modifications for site preparation, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

Laydown areas are required adjacent to the station/crossover excavation to store materials and equipment used to perform the cut-and-cover construction. An “access adit” into the excavation from the laydown areas would allow the contractor to move personnel, materials, and equipment in and out of the station/crossover excavation beneath the decked street without the need to close traffic lanes. During the excavation, the “access adit” would allow excavated materials to be removed without disruption to the public ROW. It would allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled times.

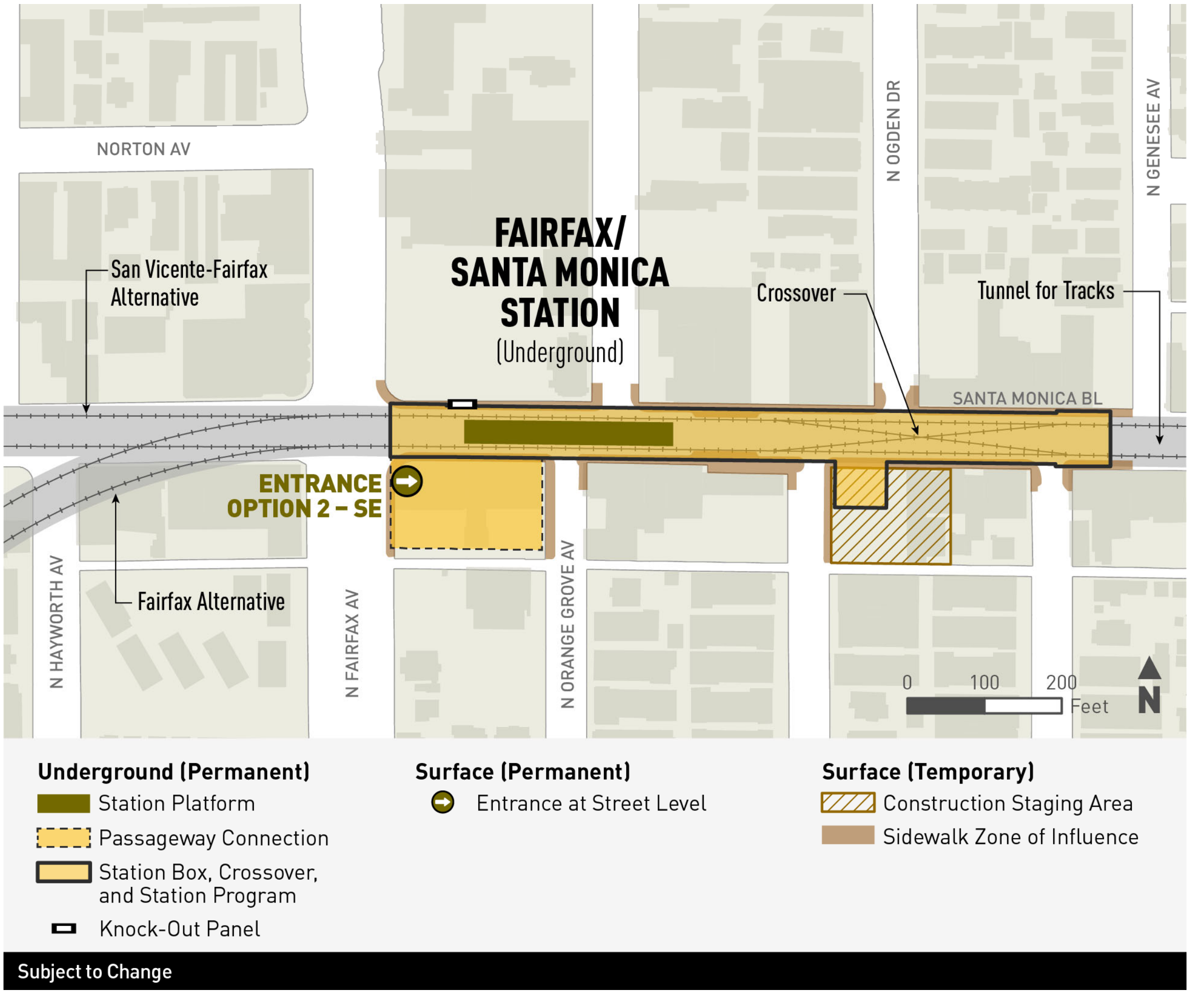
The laydown area would serve as a location for contractor field offices and amenities for the site-based workforce, as well as for a plant to treat dewatering effluent. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

FIGURE A-11. FAIRFAX/SANTA MONICA STATION – ENTRANCE OPTION 1 – NE



Source: Connect Los Angeles Partners 2024

FIGURE A-12. FAIRFAX/SANTA MONICA STATION – ENTRANCE OPTION 2 – SE



Source: Connect Los Angeles Partners 2024

LA BREA/SANTA MONICA

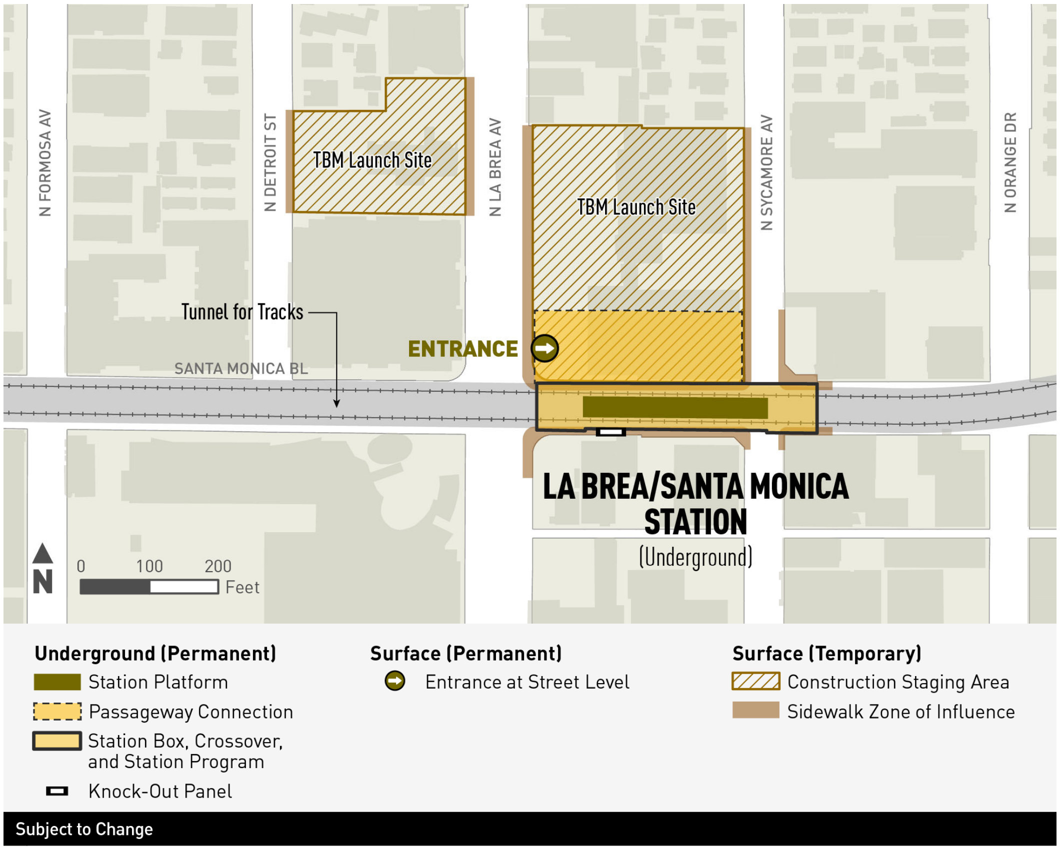
La Brea/Santa Monica is both a station site and a TBM launch site supporting operation of the TBMs (Figure A-13 and Figure A-14). A minimum laydown area of three acres would be needed, principally for the construction of the tunnels, station, and crossover. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the station/crossover footprint, street modifications for site preparations, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

Laydown areas are required adjacent to the station/crossover excavation to store materials and equipment used to perform the cut-and-cover construction and the TBM operation. An “access adit” into the excavation from the laydown areas would allow the contractor to move personnel, materials, and equipment in and out of the station/crossover excavation beneath the decked street without the need to close traffic lanes. During the excavation, the “access adit” would allow excavated materials to be removed without disruption to the public ROW. It would allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled workhours.

The laydown area would be used as a staging area to prepare and inspect TBM components and support equipment as they are delivered to this site and to store such equipment until the TBM is assembled within the excavation.

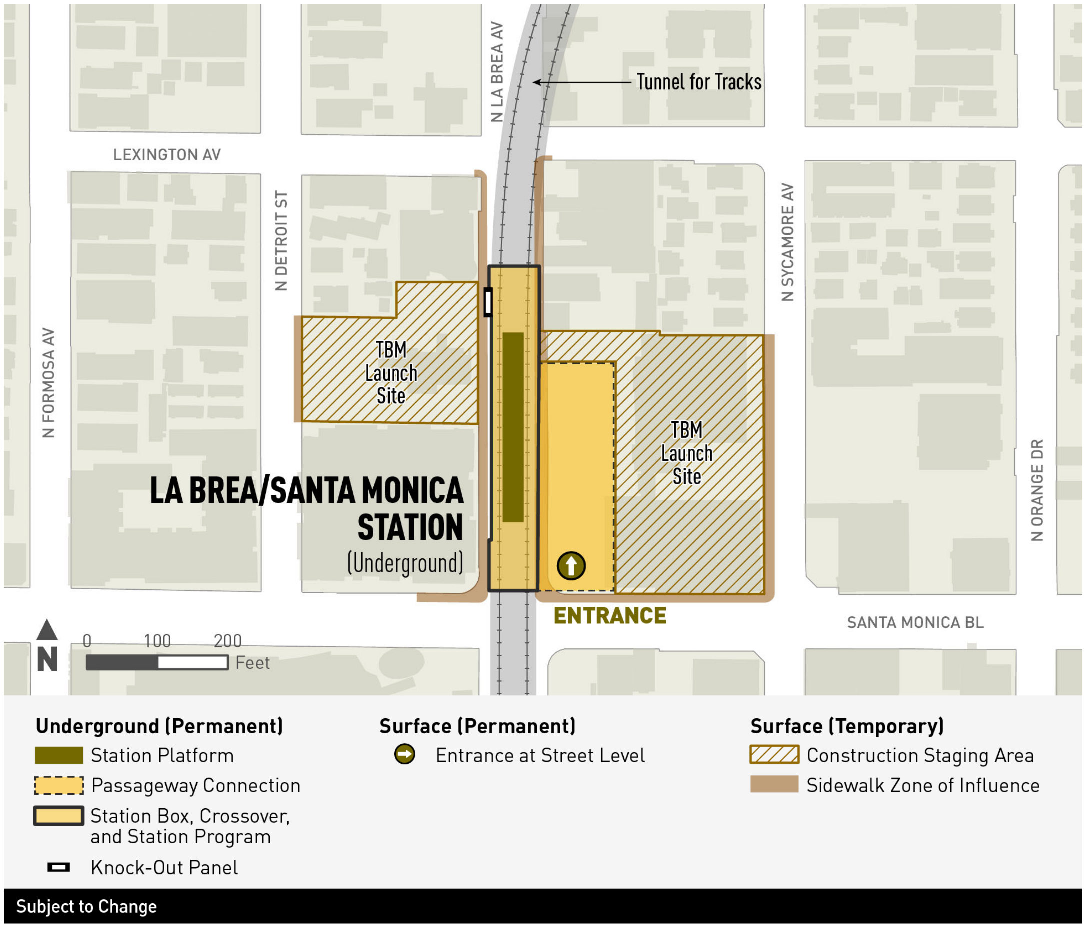
The laydown area would serve as a location for contractor field offices, parking, and amenities for the site-based workforce, as well as for the plant and equipment to support tunnel drives to San Vicente/Santa Monica or Wilshire/La Brea. TBM support equipment and facilities would include an electrical substation, compressed air plant, a grout plant, storage for bentonite slurry and/or EPB conditioner, a slurry separation plant, and storage for tunnel supplies and materials, including precast concrete segments, pipe, rail and sleepers, power cables, workshops to repair and maintain equipment, and spare parts. The laydown area would be used to stockpile and dry tunnel spoil prior to being trucked away for off-site disposal. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

FIGURE A-13. LA BREA/SANTA MONICA STATION (SAN VICENTE–FAIRFAX AND FAIRFAX ALIGNMENTS)



Source: Connect Los Angeles Partners 2024

FIGURE A-14. LA BREA/SANTA MONICA STATION (LA BREA ALIGNMENT)



Source: Connect Los Angeles Partners 2024

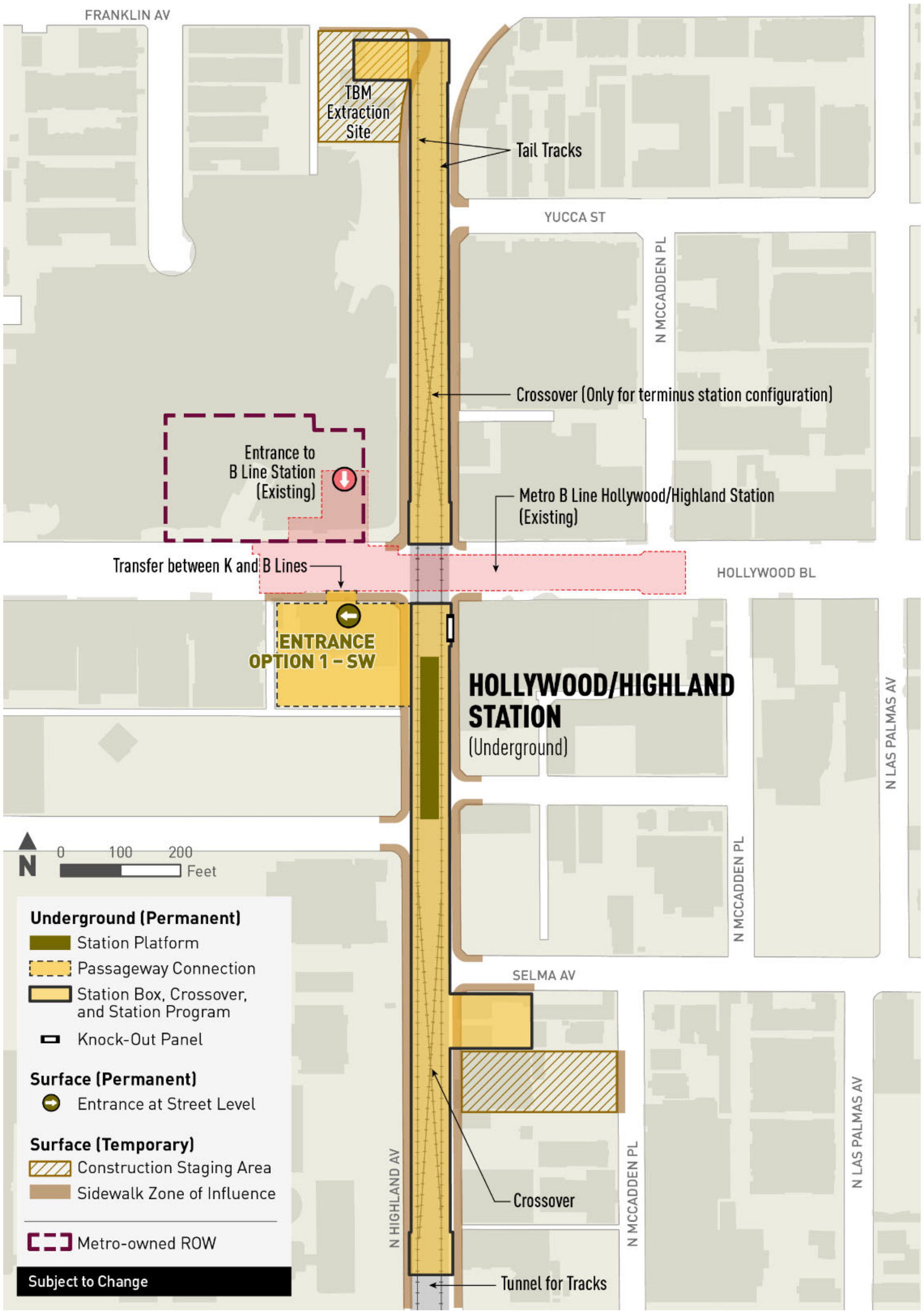
HOLLYWOOD/HIGHLAND

Hollywood/Highland is a relatively deep station/crossover construction site due to the deep vertical alignment that crosses under the existing B Line station (Figure A-15 and Figure A-16). A minimum laydown area of two acres would be needed, principally for the construction of the station and crossover. Particularly because of deep excavation, a larger staging area would be required to install a rigid excavation support system for deep excavation such as slurry walls or deep soil cement mixing walls. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the station/crossover footprint and street modifications for site preparation, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

Laydown areas are generally required adjacent to the station/crossover excavation to store materials and equipment used to perform the cut-and-cover construction, but some laydown areas can be remotely located in the vicinity as possibly being used for dewatering effluent treatment or a slurry plant. An “access adit” into the excavation from the adjacent laydown areas would allow the contractor to move personnel, materials, and equipment in and out of the station/crossover excavation beneath the decked street without the need to close traffic lanes. During the excavation, the “access adit” would allow excavated materials to be removed without disruption to the public ROW. It would allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled workhours.

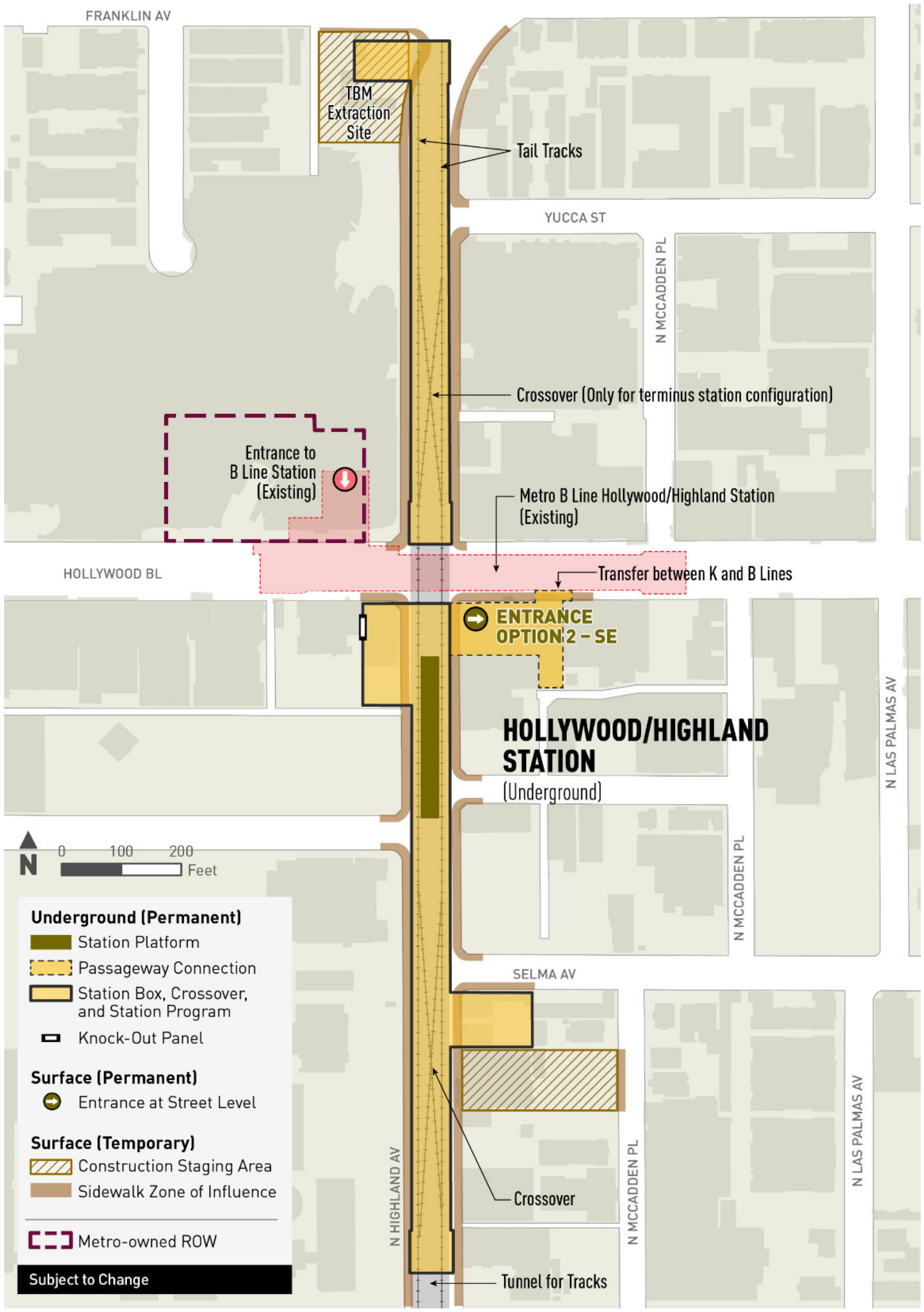
The laydown area would serve as a location for contractor field offices and amenities for the site-based workforce, as well as a plant for treatment of dewatering effluent. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

FIGURE A-15. HOLLYWOOD/HIGHLAND STATION – TERMINUS STATION, ENTRANCE OPTION 1 – SW



Source: Connect Los Angeles Partners 2024

FIGURE A-16. HOLLYWOOD/HIGHLAND STATION – TERMINUS STATION, ENTRANCE OPTION 2 – SE



Source: Connect Los Angeles Partners 2024

WILSHIRE/LA BREA

Wilshire/La Brea is a relatively deep station/crossover construction site due to a deep vertical alignment that crosses under the existing Metro D Line station (Figure A-17). A minimum laydown area of two acres would be needed, principally for the construction of the station and crossover. Particularly because of deep excavation, a larger staging area would be required to install a rigid excavation support system such as slurry walls or deep soil cement mixing walls. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the station/crossover footprint, street modifications for site preparation, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

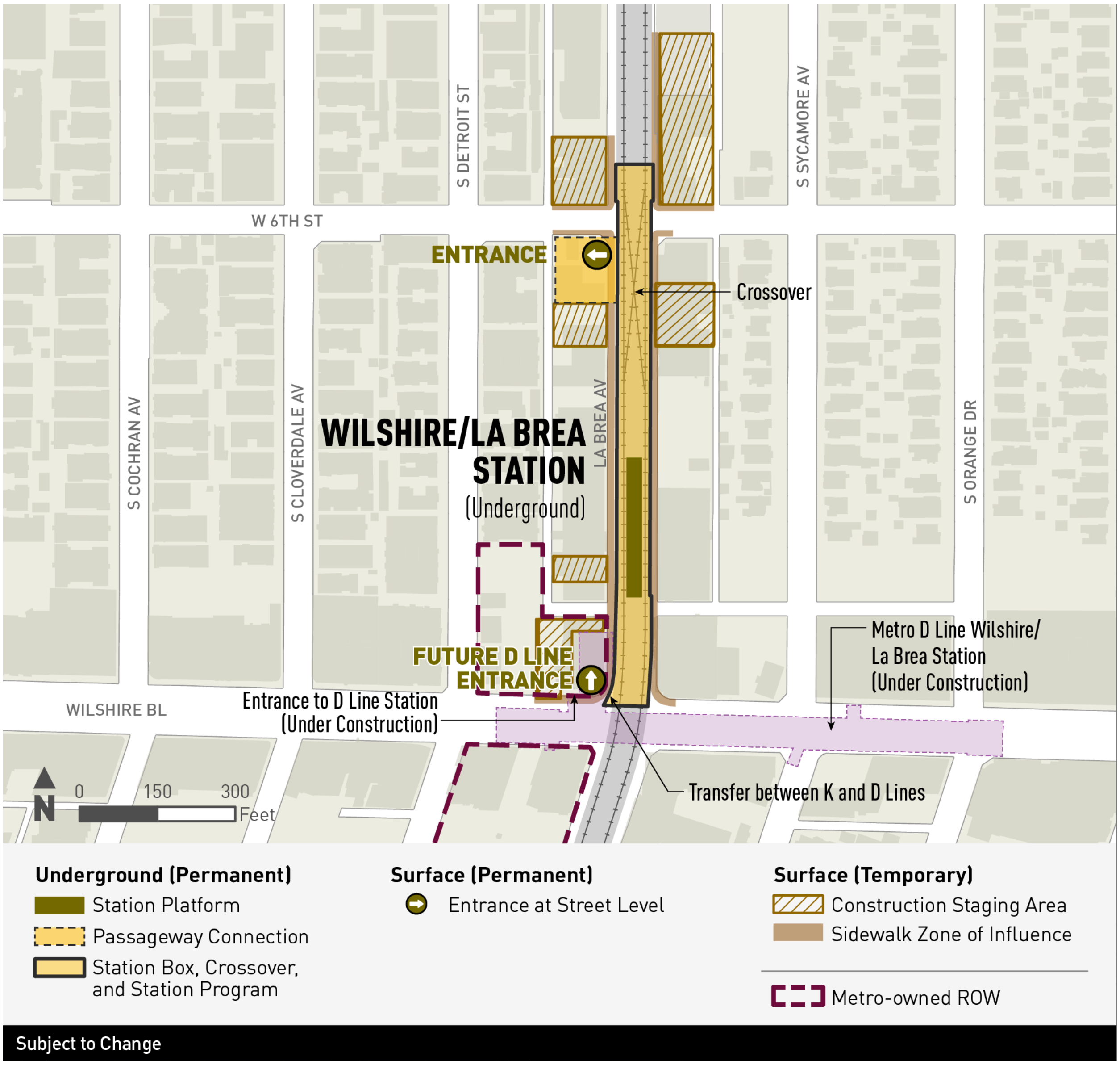
Laydown areas are generally required adjacent to the station/crossover excavation to store materials and equipment used to perform the cut-and-cover construction, but some laydown areas can be remotely located in the vicinity as possibly being used for dewatering effluent treatment or a slurry plant. An “access adit” into the excavation from the adjacent laydown areas would allow the contractor to move personnel, materials, and equipment in and out of the station/crossover excavation beneath the decked street without the need to close traffic lanes. During the excavation, the “access adit” would allow excavated materials to be removed without disruption to the public ROW. It would allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled workhours.

If fossils are encountered during excavation, fossil boxes removed from the excavation would be stored at this site or at the Midtown Crossing site, either until the boxes can be transported off-site for processing or stored until fossil processing is done.

The laydown area would serve as a location for contractor field offices and amenities for the site-based workforce, as well as for a plant for treatment of dewatering effluent. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

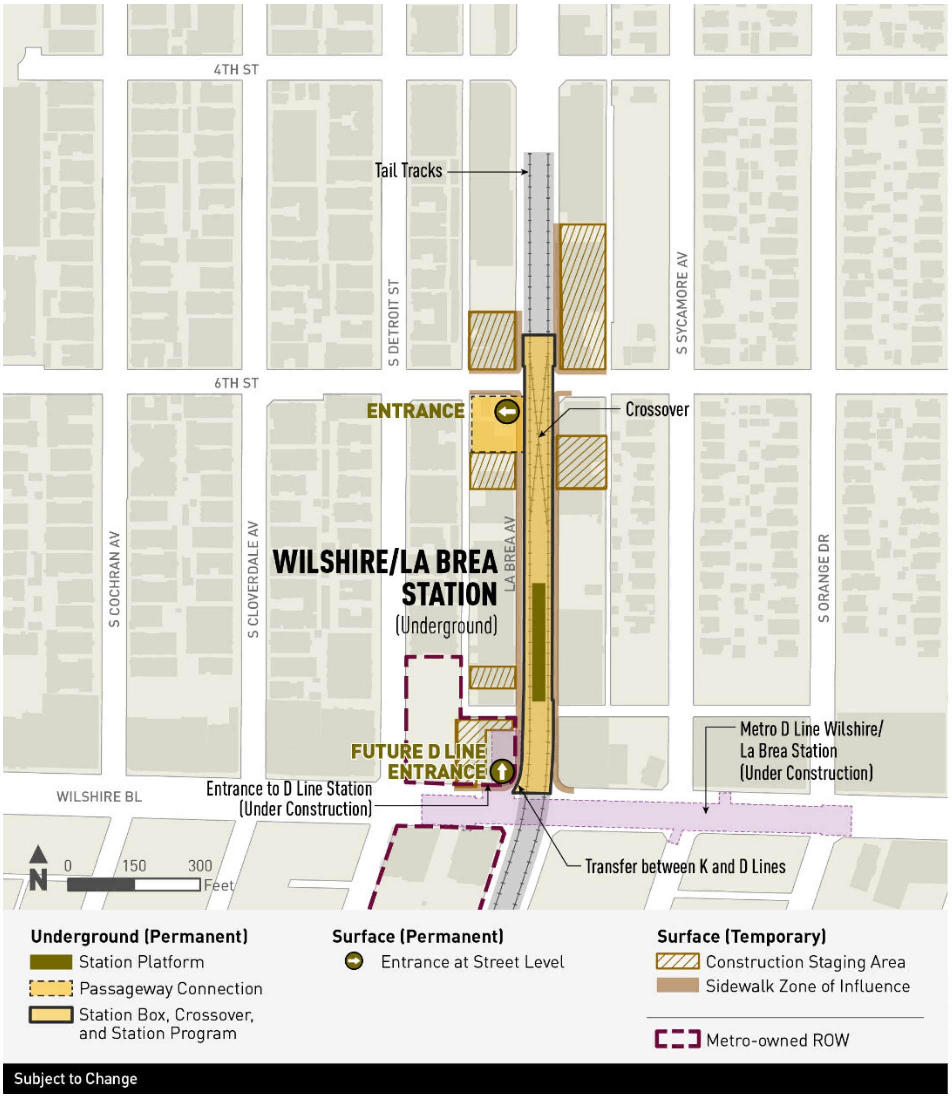
If the Wilshire/La Brea Station were constructed as a terminus station for Section 1, the station would also include tail tracks north of the station box to allow the station to operate as a terminus, as shown in Figure A-18. The tail tracks would extend 320 feet north of the Wilshire/La Brea station box. The laydown areas would be the same whether or not the station is a terminus.

FIGURE A-17. WILSHIRE/LA BREA STATION



Source: Connect Los Angeles Partners 2024

FIGURE A-18. WILSHIRE/LA BREA STATION –SECTION 1 TERMINUS



Source: Connect Los Angeles Partners 2024

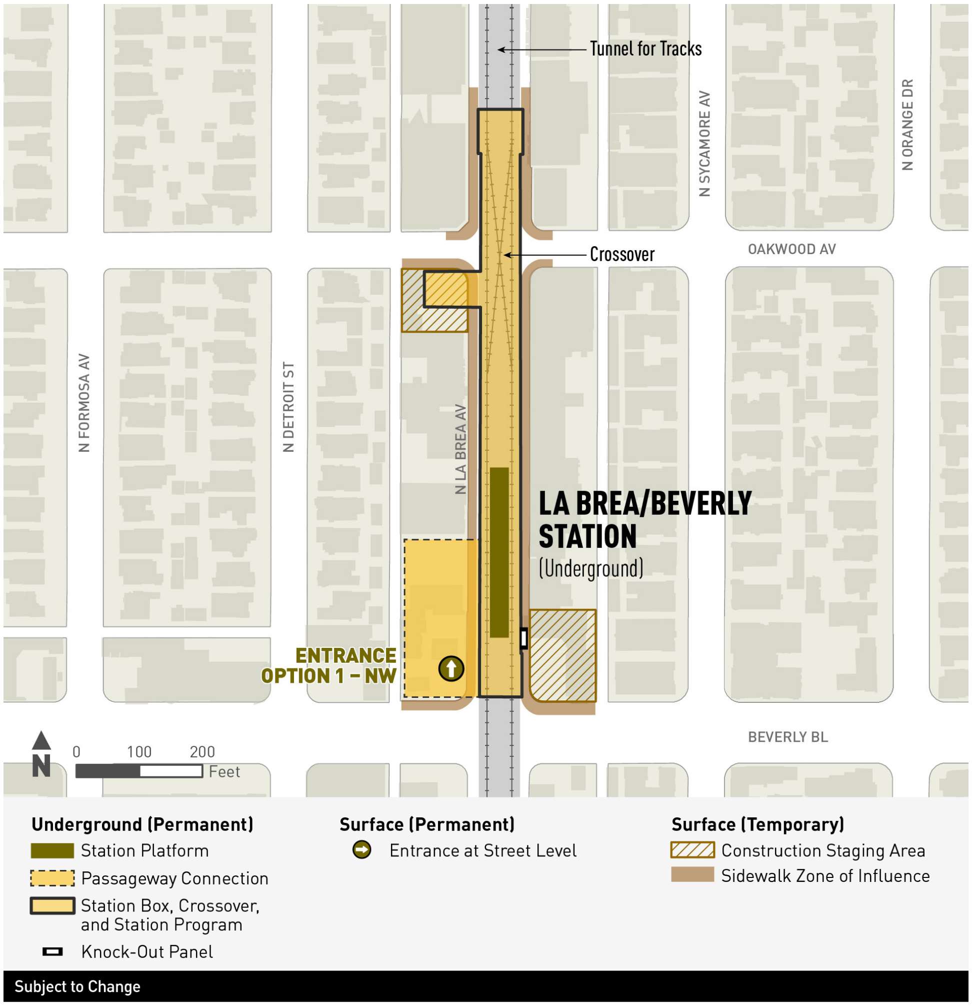
LA BREA/BEVERLY

La Brea/Beverly is a station and crossover construction site (Figure A-19 and Figure A-20). A minimum laydown area of one acre would be needed, principally for construction of the station and crossover. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the station/crossover footprint, street modifications for site preparation, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

Laydown areas are required adjacent to the station/crossover excavation to store materials and equipment used to perform the cut-and-cover construction. An “access adit” into the excavation from the laydown areas would allow the contractor to move personnel, materials, and equipment in and out of the station/crossover excavation beneath the decked street without the need to close traffic lanes. During the excavation, the “access adit” would allow excavated materials to be removed without disruption to the public ROW. It would allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled times.

The laydown area would serve as a location for contractor field offices and amenities for the site-based workforce, as well as for a plant to treat dewatering effluent. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

FIGURE A-19. LA BREA/BEVERLY STATION – ENTRANCE OPTION 1 – NW



Source: Connect Los Angeles Partners 2024

FIGURE A-20. LA BREA/BEVERLY STATION – ENTRANCE OPTION 2 – SE

Source: Connect Los Angeles Partners 2024

FRANKLIN/HIGHLAND

Franklin/Highland is a relatively deep crossover/tail track/end shaft construction site due to a deep vertical alignment that crosses under the existing B Line station nearby (Figure A-15 and Figure A-16). A minimum laydown area of one acre would be needed, principally for the construction. Because of deep excavation, a larger staging area would be required to install a rigid excavation support system for deep excavation such as slurry walls or deep soil cement mixing walls. However, being close to the Hollywood/Highland site, some staging areas for both the Hollywood/Highland and Franklin/Highland sites would be shared. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the excavation footprint and street modifications for site preparation, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

Laydown areas are generally required adjacent to the excavation to store materials and equipment used to perform the cut-and-cover construction, but some laydown areas can be remotely located in the vicinity as possibly being used for dewatering effluent treatment or a slurry plant. An "access adit" into the excavation from the adjacent laydown areas would allow the contractor to move personnel, materials, and equipment in and out of the station/crossover excavation beneath the decked street without the need to close traffic lanes. During the excavation, the "access adit" would allow excavated materials to be removed without disruption to the public ROW. It would allow concrete pumps and concrete trucks to be set up off street and work without interruption to traffic and to be able to work through peak traffic periods without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled workhours.

The laydown area would serve as a location for a dewatering effluent treatment plant and would be used to receive and store the rebar and concrete formwork needed for the structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

HOLLYWOOD BOWL

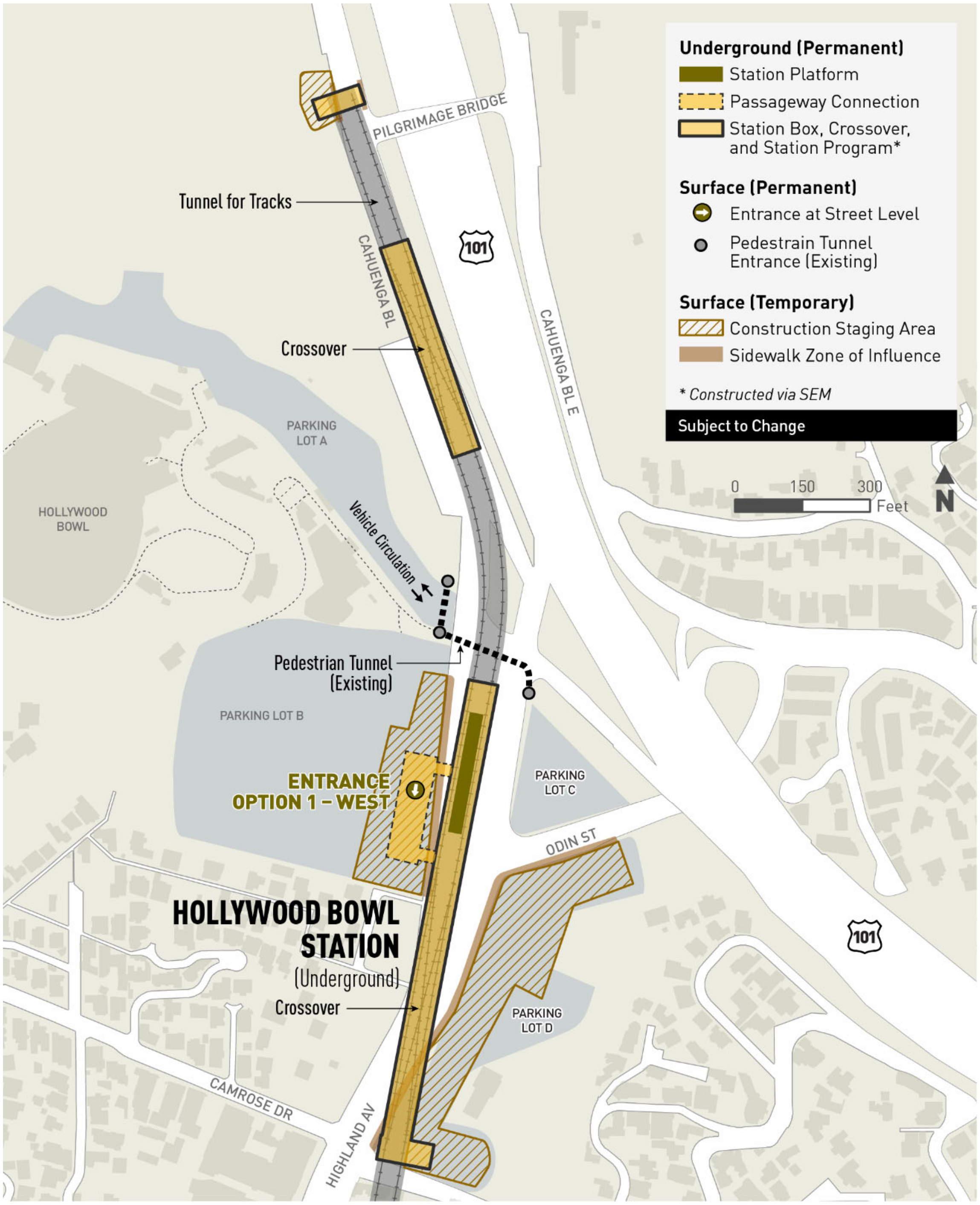
Hollywood Bowl is a station and crossover construction site but also a conventional hard rock mining site supporting the mined tunnel and cavern constructions (Figure A-21 and Figure A-22). A minimum laydown area of three acres would be needed, principally for the construction of the tunnels, station, and crossover. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the station/crossover footprint, street modifications for site preparations, and to store the materials and equipment used to install the temporary shoring and street decking. This would include steel beams and precast concrete panels for the street decking.

The Hollywood Bowl Design Option includes a station cavern, two crossover caverns, two emergency ventilation and egress shafts, two entrance shafts, entrance-to-station connection adits, and horseshoe-shaped guideway tunnels. The entrance and ventilation/egress shafts would be the main working shafts for the tunnels and caverns. For this design option, laydown areas are required adjacent to the shaft excavations to store materials and equipment used to perform the shaft sinking and mining operation. The shaft excavations are located in the laydown area such that the excavation does not need to be decked and provides direct access to the underground excavation from the laydown area to move personnel, materials, and equipment in and out of the underground excavation. During the excavation, direct access through the shafts would allow excavated materials to be removed and allow concrete pumps and concrete trucks to be set up within the laydown area and work without interruption to traffic without lane closures. The laydown area would allow excavated materials to be temporarily stockpiled so that haulage can be scheduled for off-peak traffic hours while excavation and construction work can continue during regularly scheduled workhours.

In general, the laydown area would serve as a location for contractor field offices, parking, and amenities for the site-based workforce and for the plant and equipment to support conventional mining to the Hollywood Fault crossing where the TBMs would break into and walk through the mined tunnels with the enlarged section. The TBMs would be retrieved through the emergency ventilation/egress shaft south of the station. Support for equipment and facilities for conventional mining would include an electrical substation, compressed air plant, a rock crusher, a grout plant, and storage for supplies and materials, including cast-in-place concrete materials, pipe, rail and sleepers, power cables, workshops to repair and maintain equipment, and spare parts.

The laydown area would be used to crush rocks and to stockpile muck prior to being trucked away for off-site disposal. Major dewatering would not be required at this site. The laydown area would also be used to receive and store the rebar and concrete formwork needed for the station/crossover structural concrete and later to receive and store architectural materials and mechanical and electrical equipment.

FIGURE A-21. HOLLYWOOD BOWL STATION – ENTRANCE OPTION 1 – WEST



Source: Connect Los Angeles Partners 2024

FIGURE A-22. HOLLYWOOD BOWL STATION – ENTRANCE OPTION 2 – EAST

Source: Connect Los Angeles Partners 2024

CAHUENGA

At Cahuenga Boulevard near the Pilgrimage Bridge, an emergency ventilation and egress shaft would be constructed at the end of the tail track tunnels for the Hollywood Bowl Design Option (Figure A-21 and Figure A-22). The shaft construction would involve hard rock shaft sinking. Upon completion of the shaft excavation, the final shaft structure and ventilation equipment would be installed, and the surface and native vegetation would be restored.

A minimum laydown area of 0.5 acre would be required within the public ROW. Initially, the laydown area would be used to support advance work associated with the protection and/or relocation of utilities within the shaft footprint, street modifications, and to store the materials and equipment used to install the temporary shoring and street decking. The laydown area would overlay a portion of the shaft to maintain an “access opening” to the shaft. The “access opening” would allow the contractor to move personnel, materials, and equipment in and out of the shaft. The other portion of the shaft would be decked over under the street to keep the street open for traffic. In the beginning of the excavation, a full street closure during several weekends would be required for the street decking; thereafter, one lane would remain closed until restoration of the surface. Stockpiling the excavated materials and storing construction materials at this site would be restricted. The haulage and delivery must be scheduled without queuing at the site while excavation and construction work can continue during regularly scheduled workhours.

This laydown area would have no or limited space for contractor field offices or amenities for the site-based workforce. Dewatering would not be required at this site.

APPENDIX B **HAUL ROUTES**

APPENDIX B: **HAUL ROUTES**

Excavated soils and excess material would be transported off-site to approved disposal sites. To facilitate the removal of excavated materials, haul routes to disposal sites would be predetermined by agreement with local authorities prior to construction. Testing of materials would be required prior to transportation. Depending on the test results of the soils, disposal options could include the following sites:

California Hazardous (metals) Class I facilities:

- Waste Management Inc., Kettleman City, CA (175 miles)
- Clean Harbors Environmental Services, Buttonwillow, CA (135 miles)
- Veolia Environmental Services, Azusa, CA (27 miles)
- US Ecology Nevada, Inc., Beatty, NV (308 miles)

Non-hazardous, total petroleum hydrocarbon-containing wastes:

- Thermal Processing Systems Treatment, Adelanto, CA (90 miles)

Non-hazardous soil:

- Philadelphia Recycling, Mira Loma, CA (49 miles)
- Municipal landfills (15 miles)
- Other locations identified by the contractor

Routes would follow streets and highways that form the safest, shortest route with the fewest adverse effects on traffic, residences, and businesses. In addition, the transport of excavated materials would occur during off-peak hours. The exhibits on the following pages illustrate the proposed routes from the identified construction sites to the nearest freeway. Due to the large number of industrial and warehouse land uses in the vicinity of the project, the streets identified currently carry large truck traffic. Precise routes would be confirmed prior to construction.

B.1 DESCRIPTION OF HAUL ROUTES

B.1.1 SUMMARY

The proposed truck haul routes identified in the following sections are conceptual and subject to change. They may be updated, revised, and/or refined once additional and more detailed construction sequencing information is provided during the construction phase of the project. In addition, the proposed haul routes will be subject to the approval of Metro, LADOT, City of West Hollywood, and/or the local jurisdiction's transportation department. In general, trucks will be primarily used to remove and haul excavated materials such as spoils and muck from the construction areas. In order to minimize peak period traffic disruptions, truck hauling activities are anticipated to take place during off-peak and nighttime periods of the day and on weekends. Descriptions of the proposed truck haul routes are presented in the following sections and illustrated in the Haul Route Map exhibits.

B.1.2 EXPO/CRENSHAW CONNECTION BOX

At this location, a cut-and-cover structure would be constructed to retrieve the two tunnel boring machines (TBMs) and to make the connection between the new tunnels and the existing K Line Expo/Crenshaw Station. From the construction site and the construction laydown area, the anticipated truck haul route will be northerly along Crenshaw Boulevard to the I-10/Crenshaw Boulevard freeway interchange, for both eastbound and westbound directions. The length of the proposed haul route is about 0.9 miles from the construction site to the freeway interchange. Approximately 25-50 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-1.

LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE AND TBM RETRIEVAL LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

INFORMATION CONFIDENTIAL: All plans, drawings, specifications, and or information furnished here-with shall remain the property of the Los Angeles Metropolitan Transportation Authority and shall be held confidential; and shall not be used for any purpose not provided for in agreements with the Los Angeles Metropolitan Transportation Authority.

REV.	DATE		BY SUB	APP.

DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
DATE

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CONNECT LOS ANGELES PARTNERS Creating Connected Communities

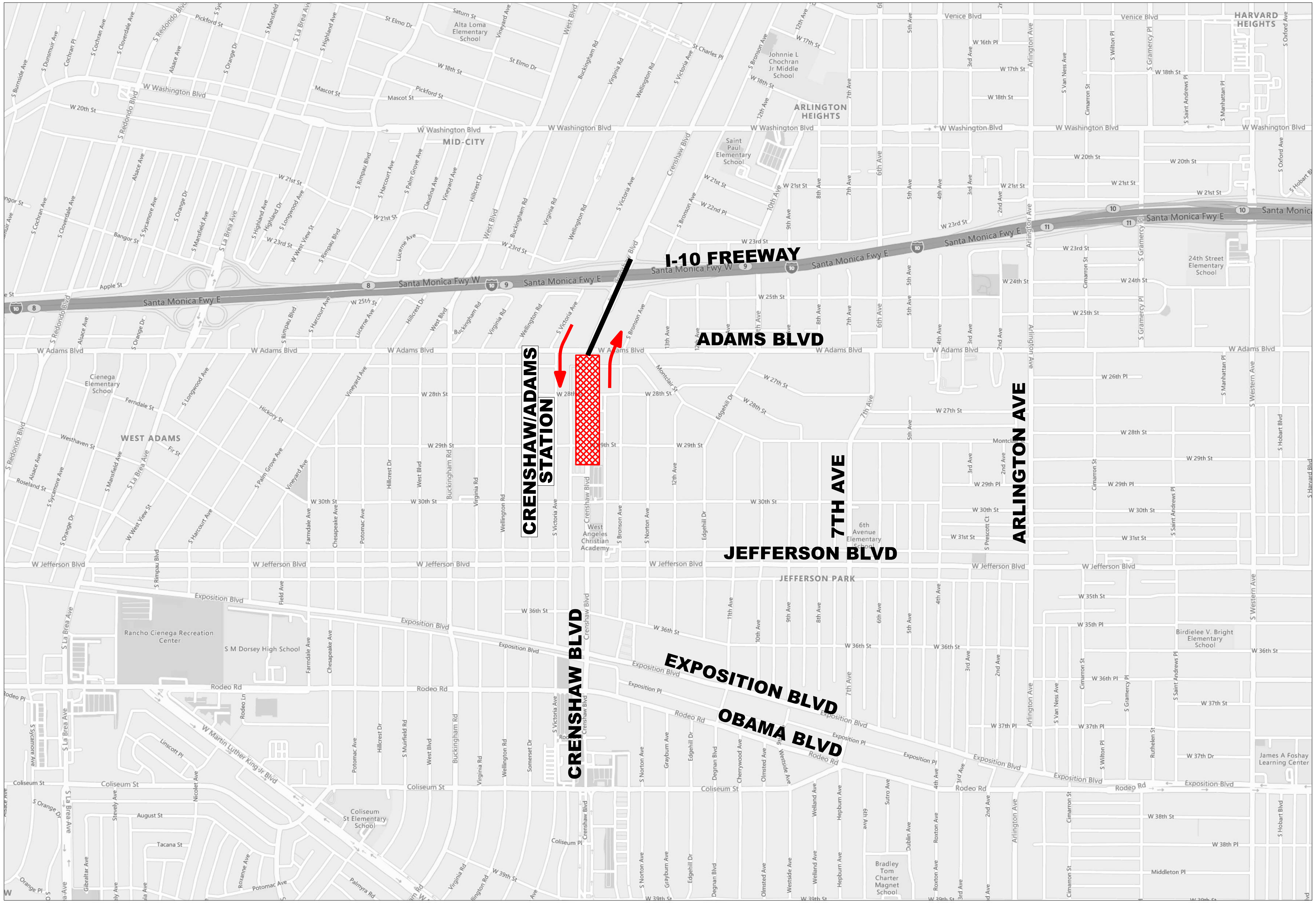
SUBMITTED: ______ PROJECT MANAGER
APPROVED: ______

K LINE NORTHERN EXTENSION
EXPO/CRENSHAW - CONNECTION BOX
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.
DRAWING NO. **B-1**
REV
SCALE **NOT-TO-SCALE**
SHEET NO.

B.1.3 CRENSHAW/ADAMS STATION

This location is a station and crossover site with a construction laydown area. Similar to the Expo/Crenshaw construction site, the anticipated truck haul route will be northerly along Crenshaw Boulevard to the I-10/Crenshaw Boulevard freeway interchange, for both eastbound and westbound directions. The length of the proposed haul route is about 0.25 miles from the construction site to the freeway interchange. Approximately 60-100 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-2.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

$USERNAME$ $TIME$ $DATE$ $FILE$

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SUBMITTED: ____ PROJECT MANAGER

APPROVED: ____

K LINE NORTHERN EXTENSION
CRENSHAW/ADAMS STATION
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.

DRAWING NO. **B-2**

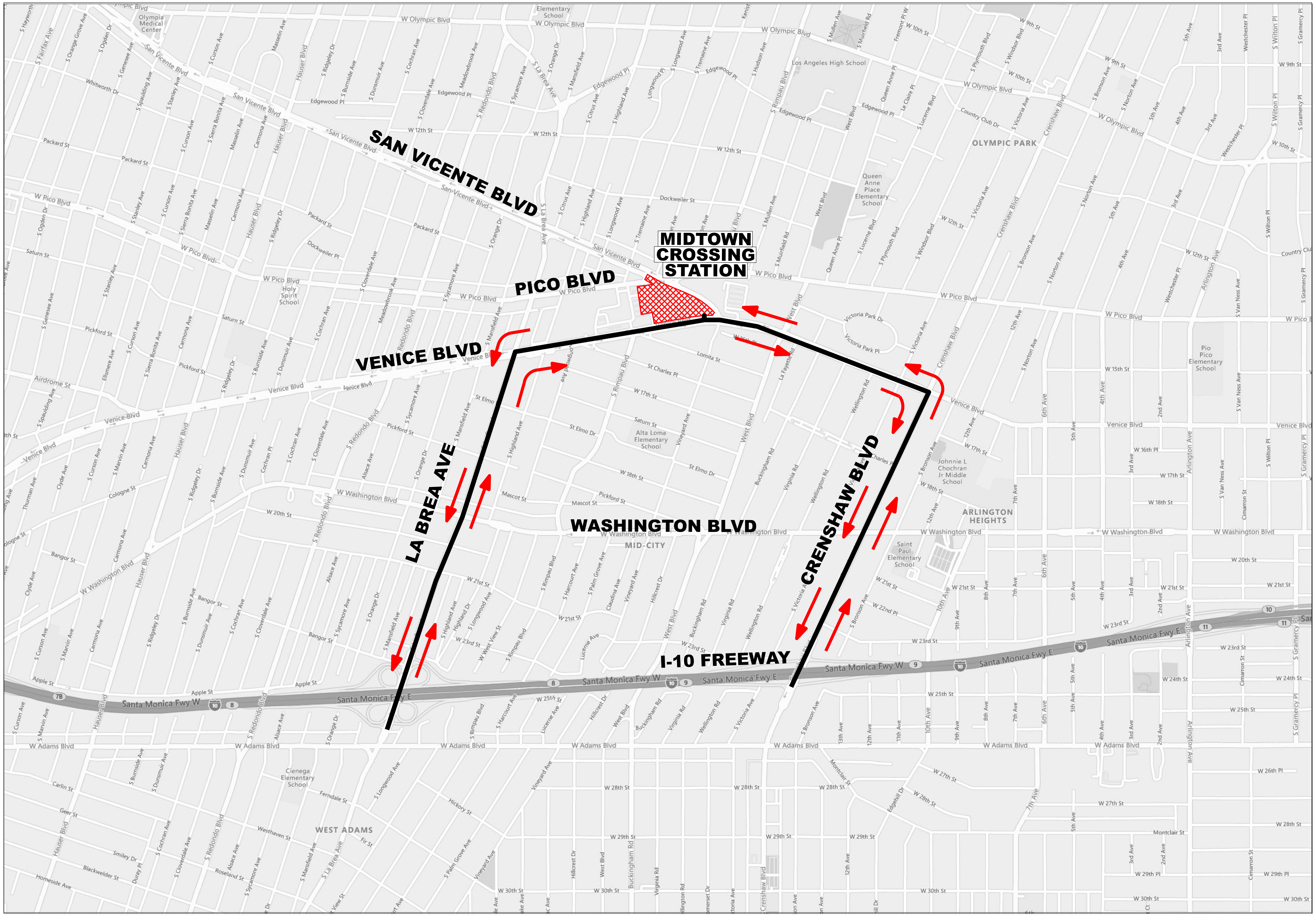
REV

SCALE **NOT-TO-SCALE**

SHEET NO.

B.1.4 MIDTOWN CROSSING STATION

This location is a station and crossover site and also a TBM launch location with a large construction laydown area. One anticipated truck haul route will be southeasterly along Venice Boulevard, continuing southerly onto Crenshaw Boulevard to the I-10/Crenshaw Boulevard freeway interchange, for both eastbound and westbound directions. The other anticipated truck haul route will be southwesterly along Venice Boulevard, continuing southerly onto La Brea Avenue to the I-10/La Brea Avenue freeway interchange, for both eastbound and westbound directions. The length of the proposed haul route is about 1.3 miles from the construction site to the I-10/Crenshaw Boulevard freeway interchange and about 1.45 miles to the I-10/La Brea Avenue freeway interchange. Approximately 60-100 haul truck trips per day are anticipated at this location for the station and crossover cut-and-cover activities. In addition, the TBMs would be launched from this location: one going north and one going south. Supporting tunnel excavation activity would require approximately 80-120 haul truck trips per day for each direction. The proposed haul routes at this location are presented in Exhibit B-3.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE AND TBM LAUNCH LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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METROPOLITAN TRANSPORTATION AUTHORITY

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SUBMITTED: ____________ PROJECT MANAGER

APPROVED: ____________

K LINE NORTHERN EXTENSION
MIDTOWN CROSSING STATION
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.

DRAWING NO. **B-3**

REV

SCALE **NOT-TO-SCALE**

SHEET NO.

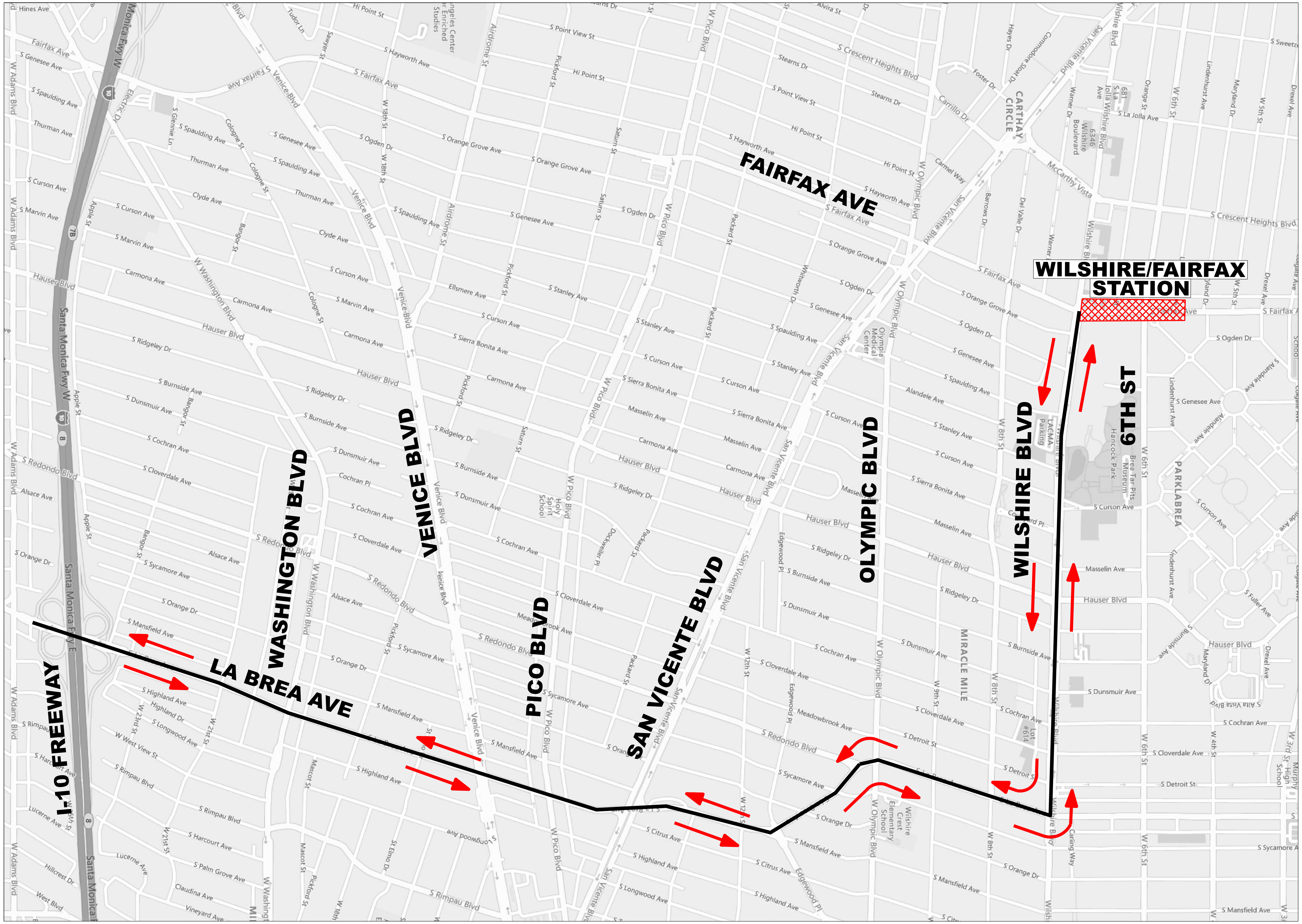
$USERNAME$

$TIME$

$DATE$
$FILE$

B.1.5 WILSHIRE/FAIRFAX STATION

This location is a station and crossover site with a construction laydown area. The anticipated truck haul route will be easterly along Wilshire Boulevard and continuing southerly onto La Brea Avenue to the I-10/La Brea Avenue freeway interchange, for both eastbound and westbound directions. The length of the proposed haul route is about 3.15 miles from the construction site to the freeway interchange. Approximately 60-100 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-4.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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DESIGNED BY

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Metro

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CONNECT LOS ANGELES PARTNERS Creating Connected Communities

SUBMITTED: PROJECT MANAGER

APPROVED:

K LINE NORTHERN EXTENSION

WILSHIRE/FAIRFAX STATION HAUL ROUTE MAP EXHIBIT

CONTRACT NO.

DRAWING NO. B-4

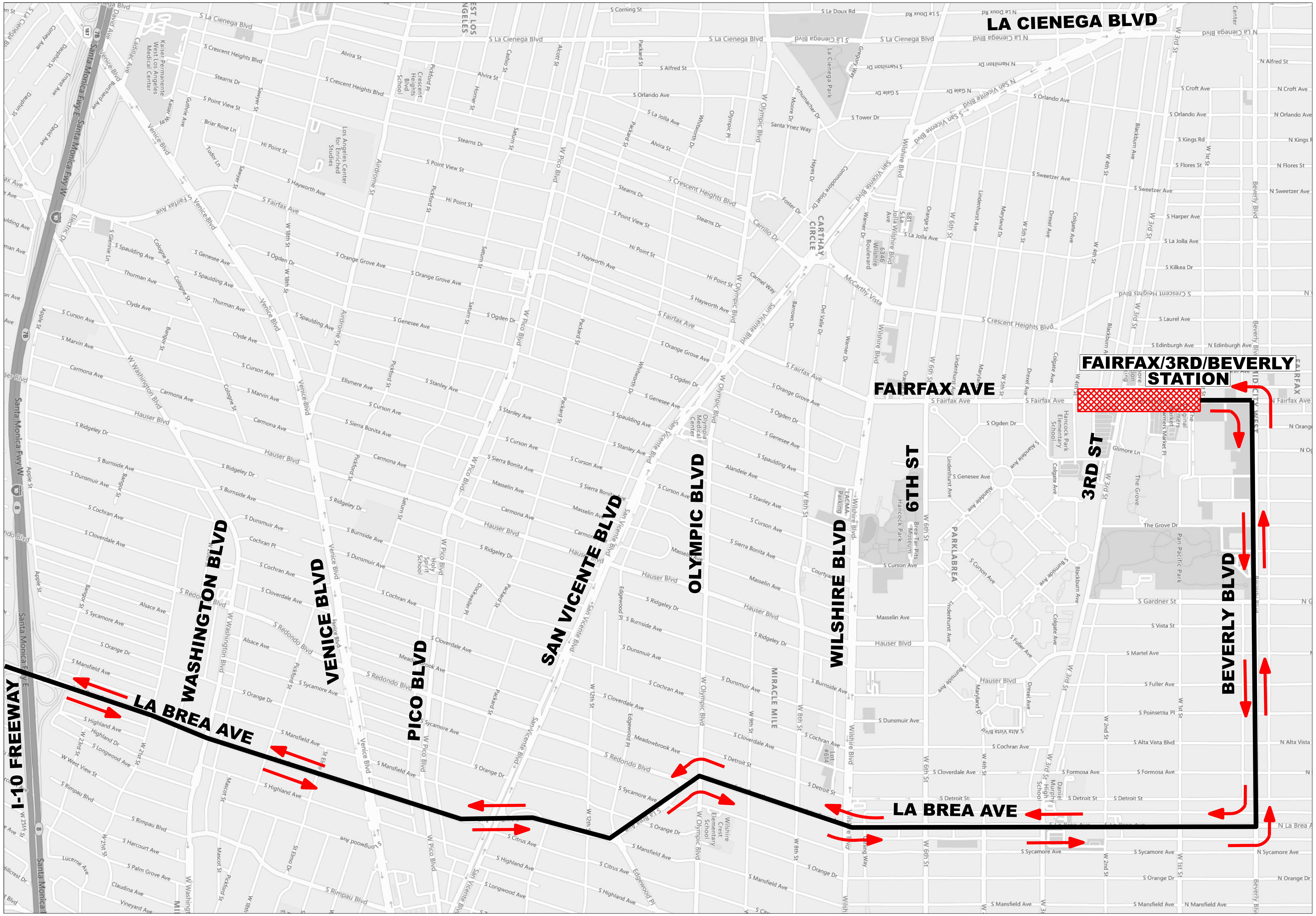
REV

SCALE NOT-TO-SCALE

SHEET NO.

B.1.6 FAIRFAX/3RD STATION

This location is a station and crossover site with a construction laydown area. The anticipated truck haul route will be northerly along Fairfax Avenue continuing easterly onto Beverly Boulevard then continuing southerly onto La Brea Avenue to the I-10/La Brea Avenue freeway interchange, for both eastbound and westbound directions. The length of the proposed haul route is about 4.2 miles from the construction site to the freeway interchange. Approximately 60-100 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-5.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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DESIGNED BY

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APPROVED BY

DATE

Metro

LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CONNECT
LOS ANGELES PARTNERS
Creating Connected Communities

SUBMITTED: ______________
PROJECT MANAGER

APPROVED: ______________

K LINE NORTHERN EXTENSION
FAIRFAX/3RD/BEVERLY STATION
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.

DRAWING NO. **B-5**

REV

SCALE **NOT-TO-SCALE**

SHEET NO.

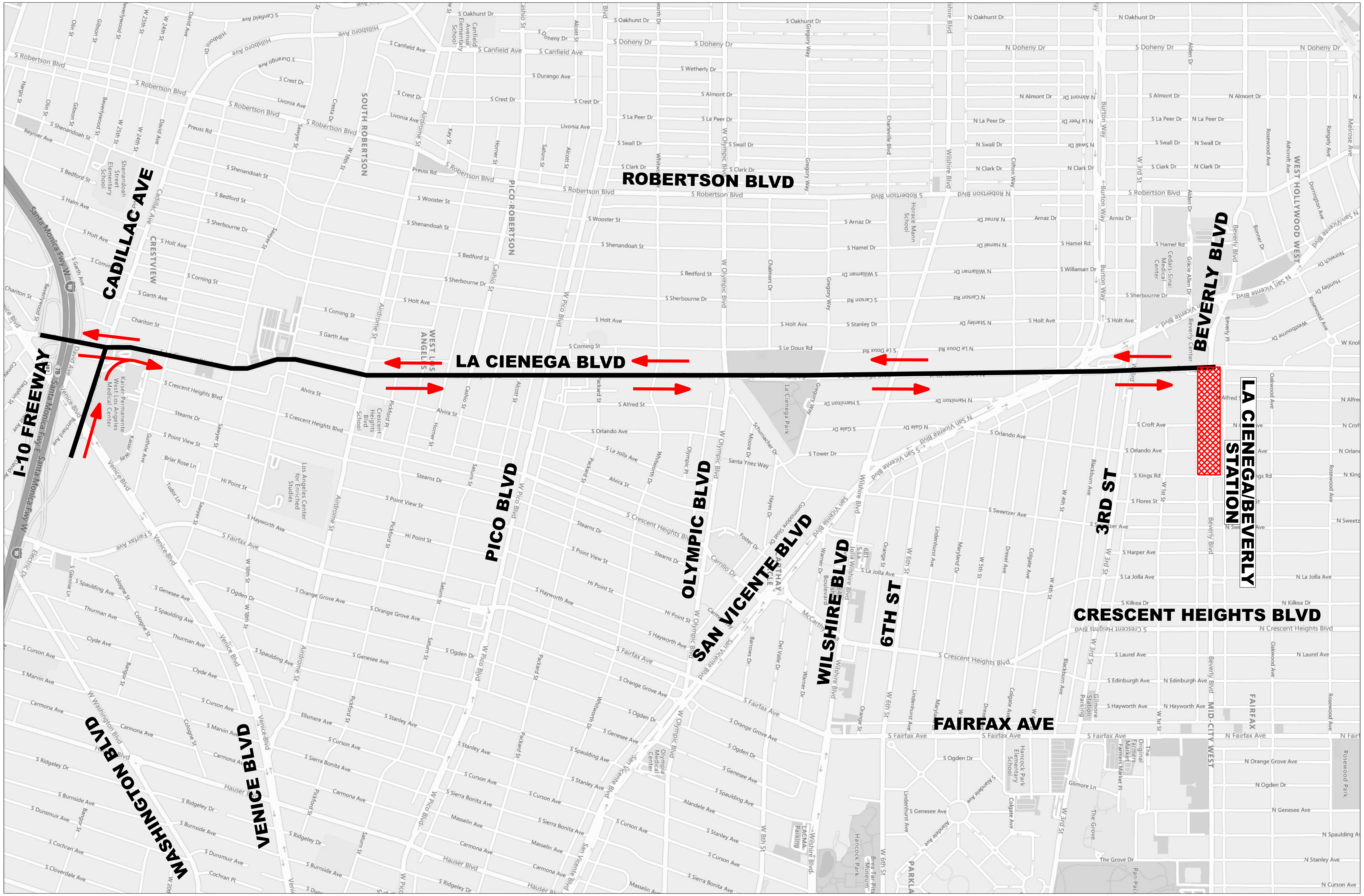
$USERNAME$

$TIME$

$DATE$
$FILE$

B.1.7 LA CIENEGA/BEVERLY STATION

This location is a station and crossover site with a construction laydown area. The anticipated truck haul route will be southerly along La Cienega Boulevard to the I-10/La Cienega Boulevard freeway interchange, for both eastbound and westbound directions. Haul trucks coming from the westbound direction of the freeway will exit at the Venice Boulevard off-ramp and continue on Cadillac Avenue to La Cienega Boulevard. The length of the proposed haul route is about 3.05 miles from the construction site to the freeway interchange. Approximately 60-100 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-6.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

INFORMATION CONFIDENTIAL:
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APPROVED: ______

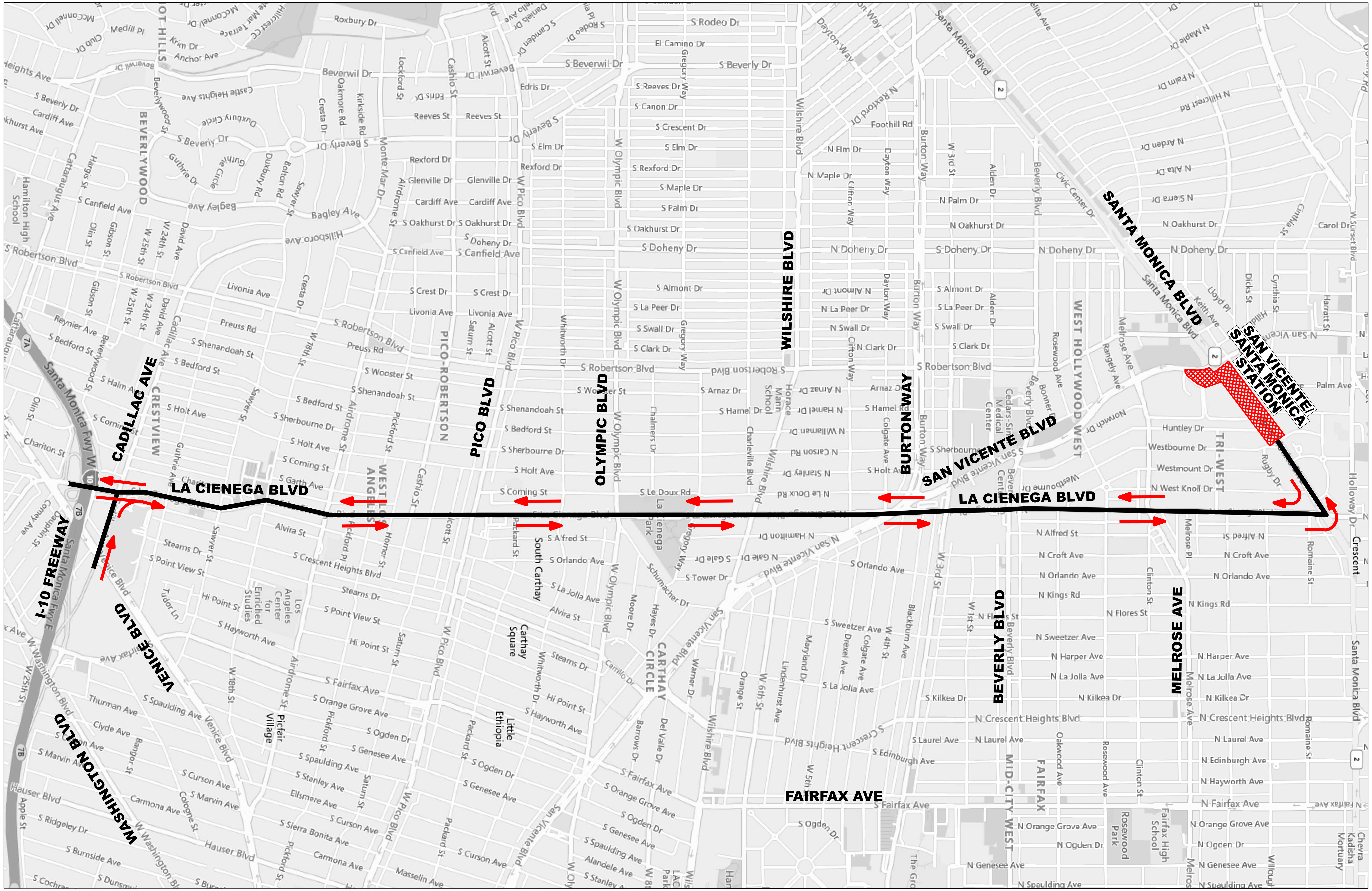
K LINE NORTHERN EXTENSION
LA CIENEGA/BEVERLY STATION HAUL ROUTE MAP EXHIBIT

CONTRACT NO.
DRAWING NO. B-6
REV
SCALE NOT-TO-SCALE
SHEET NO.

$DATE$ $FILE$
$TIME$
$USERNAME$

B.1.8 SAN VICENTE/SANTA MONICA STATION

This location is a station and crossover site and also a TBM launch location with a large construction laydown area. The anticipated truck haul route will be easterly along Santa Monica Boulevard continuing southerly onto La Cienega Boulevard to the I-10/La Cienega Boulevard freeway interchange, for both eastbound and westbound directions. Haul trucks coming from the westbound direction of the freeway will exit at the Venice Boulevard off-ramp and continue on Cadillac Avenue to La Cienega Boulevard. The length of the proposed haul route is about 4.2 miles from the construction site to the freeway interchange. Approximately 60-100 haul truck trips per day are anticipated at this location for the station and crossover cut-and-cover activities. In addition, the TBMs would be launched from this location towards the south. Supporting tunnel excavation would require approximately 80-120 haul truck trips per day. The proposed haul route at this location is presented in Exhibit B-7.



LEGEND:

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE AND TBM LAUNCH LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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APPROVED: ______

K LINE NORTHERN EXTENSION

SAN VICENTE/SANTA MONICA STATION HAUL ROUTE MAP EXHIBIT

CONTRACT NO.

DRAWING NO. **B-7**

REV

SCALE **NOT-TO-SCALE**

SHEET NO.

$USERNAME$ $TIME$ $DATE$ $FILE$

B.1.9 FAIRFAX/SANTA MONICA STATION

This location is a station and crossover site with a construction laydown area. The anticipated truck haul route will be easterly along Santa Monica Boulevard to the US-101/Santa Monica Boulevard freeway interchange for trucks coming from and going to the south and to the US-101/Western Avenue freeway interchange for trucks coming from and going to the north. The length of the proposed haul route is about 3.3 miles from the construction site to the freeway interchange. Approximately 60-100 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-8.

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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DATE

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APPROVED: ____________

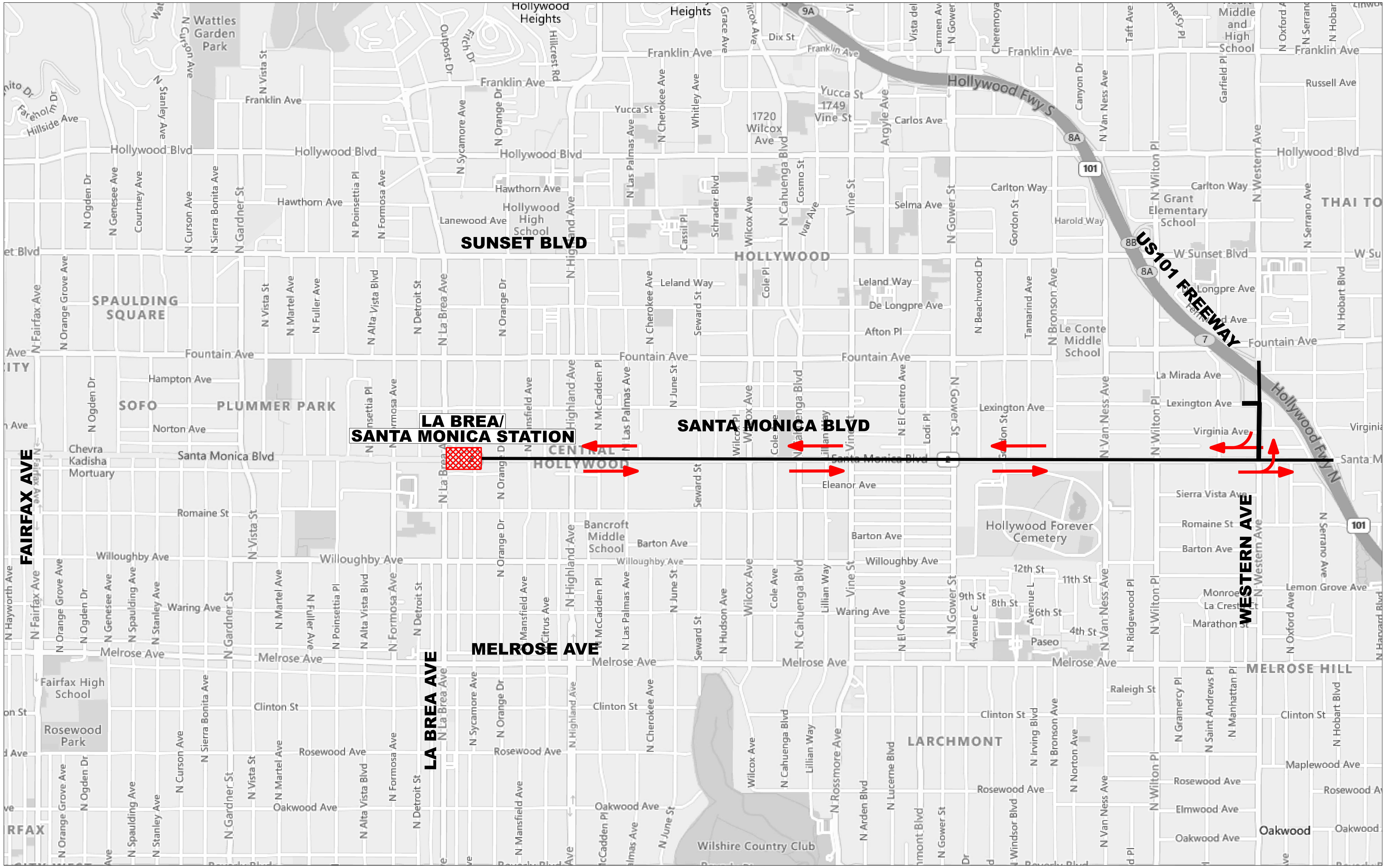
K LINE NORTHERN EXTENSION
FAIRFAX/SANTA MONICA STATION
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.
DRAWING NO. **B-8**
REV
SCALE **NOT-TO-SCALE**
SHEET NO.

$USERNAMES
$TIMES
$DATES
$FILE$

B.1.10 LA BREA/SANTA MONICA STATION

This location is a station-only construction site and also a TBM launch location with a large construction laydown area. Similar to the Fairfax/Santa Monica Station, the anticipated truck haul route will be easterly along Santa Monica Boulevard to the US-101/Santa Monica Boulevard freeway interchange for haul trucks coming from and going to the south and to the US-101/Western Avenue freeway interchange for haul trucks coming from and going to the north. This proposed truck haul route applies to both the La Brea/Santa Monica Station options for the San Vicente-Fairfax and Fairfax alignment alternatives, as well as the La Brea alignment alternative. The length of the proposed haul route is about 2.4 miles from the construction site to the freeway interchange. Approximately 60-100 haul truck trips per day are anticipated at this location for the station and crossover cut-and-cover activities. In addition, the TBMs would be launched from this location: one going north and one going south. Supporting tunnel excavation would require approximately 80-120 haul truck trips per day for each direction. The proposed haul routes for the two alignment alternatives are shown in Exhibits B-9 and B-14.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE AND TBM LAUNCH LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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DATE

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PROJECT MANAGER

APPROVED: ____________

K LINE NORTHERN EXTENSION
LA BREA/SANTA MONICA STATION
LA BREA ALTERNATIVE
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.

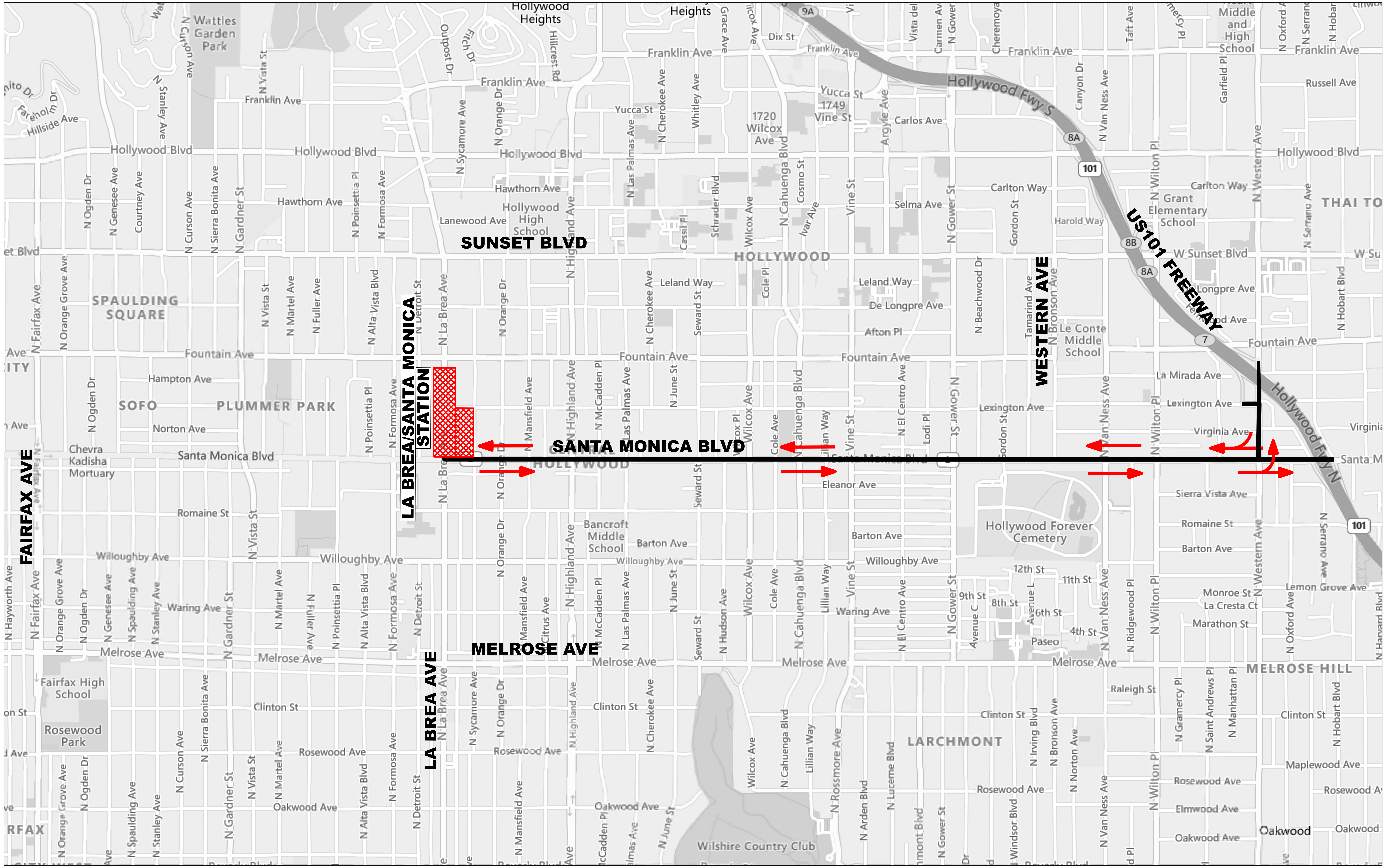
DRAWING NO. B-9

REV

SCALE NOT-TO-SCALE

SHEET NO.

$USERNAMES
$TIMES
$DATES $FILE$



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE AND TBM LAUNCH LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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APPROVED BY
DATE

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PROJECT MANAGER

APPROVED: ____________

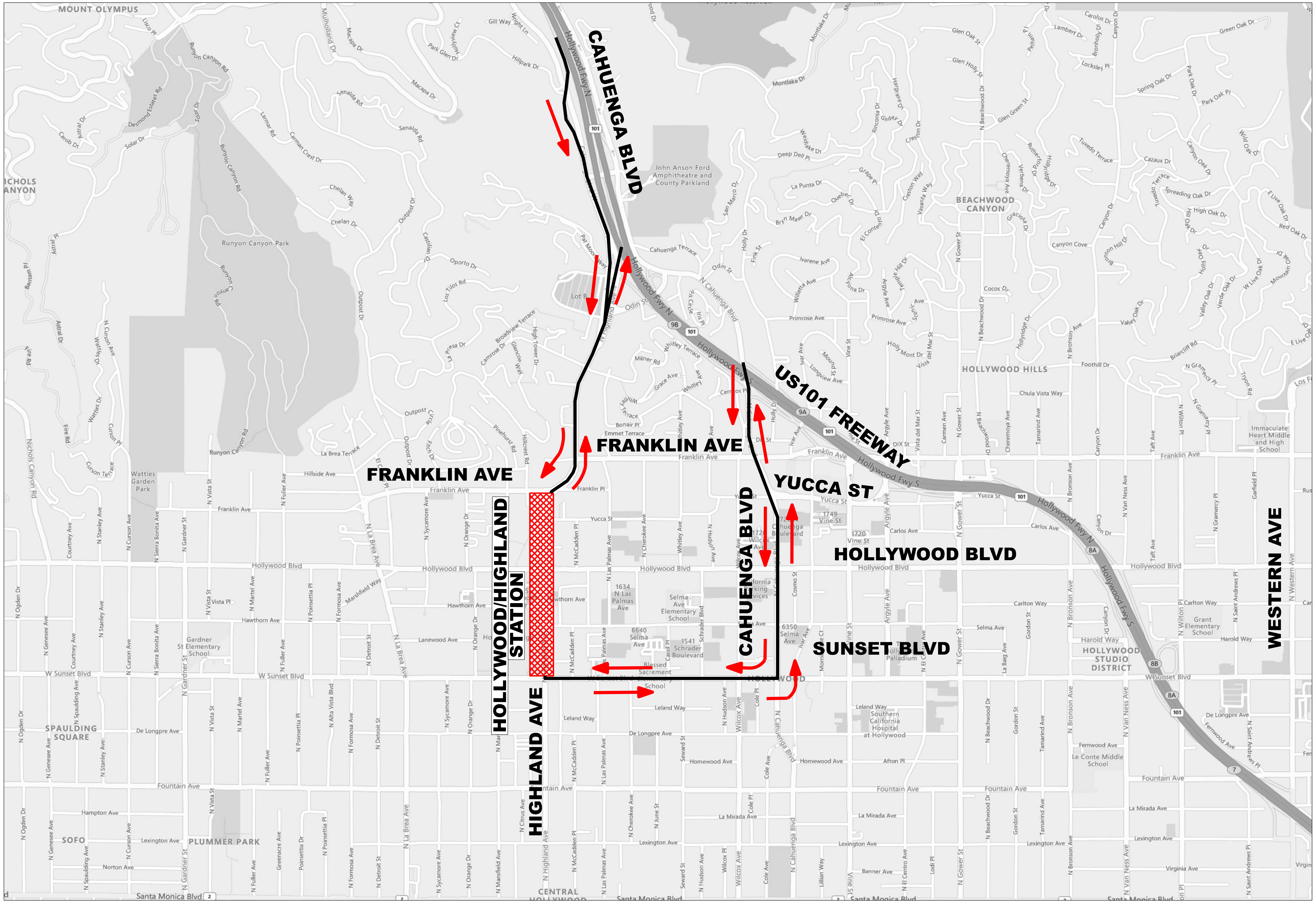
K LINE NORTHERN EXTENSION
LA BREA/SANTA MONICA STATION
SAN VICENTE/FAIRFAX & FAIRFAX ALT.
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.
DRAWING NO. **B-14**
REV
SCALE **NOT-TO-SCALE**
SHEET NO.

$DATE$ $FILE$ $TIME$ $USERNAME$

B.1.11 HOLLYWOOD/HIGHLAND STATION

This location is a station and crossover site with a construction laydown area. The anticipated truck haul route will be easterly along Sunset Boulevard continuing northerly onto Cahuenga Boulevard to the US-101/Cahuenga Boulevard freeway interchange for trucks coming from and going to the south. Haul trucks going to the north would use the Highland Avenue left entrance northbound on-ramp to the US-101 freeway and haul trucks coming from the north would use the US-101/Highland Avenue/Cahuenga Boulevard southbound off-ramp. The length of the proposed haul route is about 1.3 miles from the construction site to the US-101/Cahuenga Boulevard freeway interchange and about 1.1 miles to the US-101/Highland Avenue/Cahuenga Boulevard freeway interchange. Approximately 60-100 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-10.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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SUBMITTED: ____ PROJECT MANAGER

APPROVED: ____

K LINE NORTHERN EXTENSION
HOLLYWOOD/HIGHLAND STATION
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.

DRAWING NO. **B-10**

REV

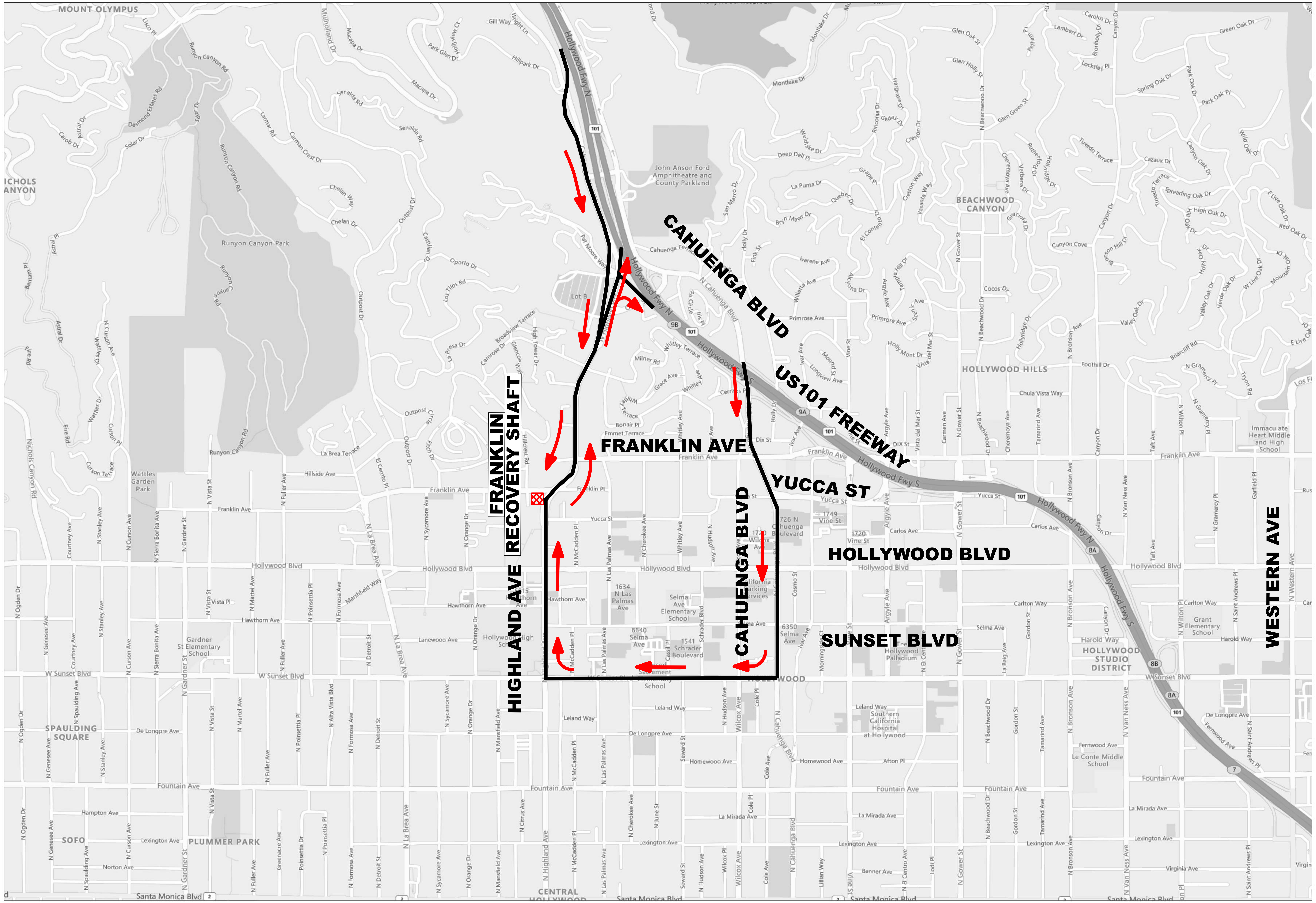
SCALE **NOT-TO-SCALE**

SHEET NO.

$USERNAME$ $TIME$ $DATE$ $FILE$

B.1.12 FRANKLIN RECOVERY SHAFT

This location is a crossover, tail track, and end shaft TBM retrieval site with a construction laydown area. For haul trucks going to the south, the anticipated truck haul route will be northerly along Highland Avenue to the US-101/Highland Avenue freeway interchange. For haul trucks coming from the south, the route will be to exit from the US-101 freeway at Cahuenga Boulevard, continue southerly along Cahuenga Boulevard to Sunset Boulevard, then westerly on Sunset Boulevard continuing northerly onto Highland Avenue to the construction site. Haul trucks going to the north would use the Highland Avenue left entrance northbound on-ramp to the US-101 freeway and haul trucks coming from the north would use the US-101/Highland Avenue/Cahuenga Boulevard southbound off-ramp. The length of the proposed haul route is about 0.6 miles from the construction site to the US101/Highland Avenue freeway interchange, about 1.0 miles to the US-101/Highland Avenue/Cahuenga Boulevard southbound off-ramp, and about 1.7 miles to the US101/Cahuenga Boulevard northbound off-ramp. Approximately 40-80 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-11.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE AND TBM RETRIEVAL LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

INFORMATION CONFIDENTIAL:
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SUBMITTED: ______
PROJECT MANAGER

APPROVED: ______

K LINE NORTHERN EXTENSION
FRANKLIN RECOVERY SHAFT HAUL ROUTE MAP EXHIBIT

CONTRACT NO.

DRAWING NO. **B-11**

REV

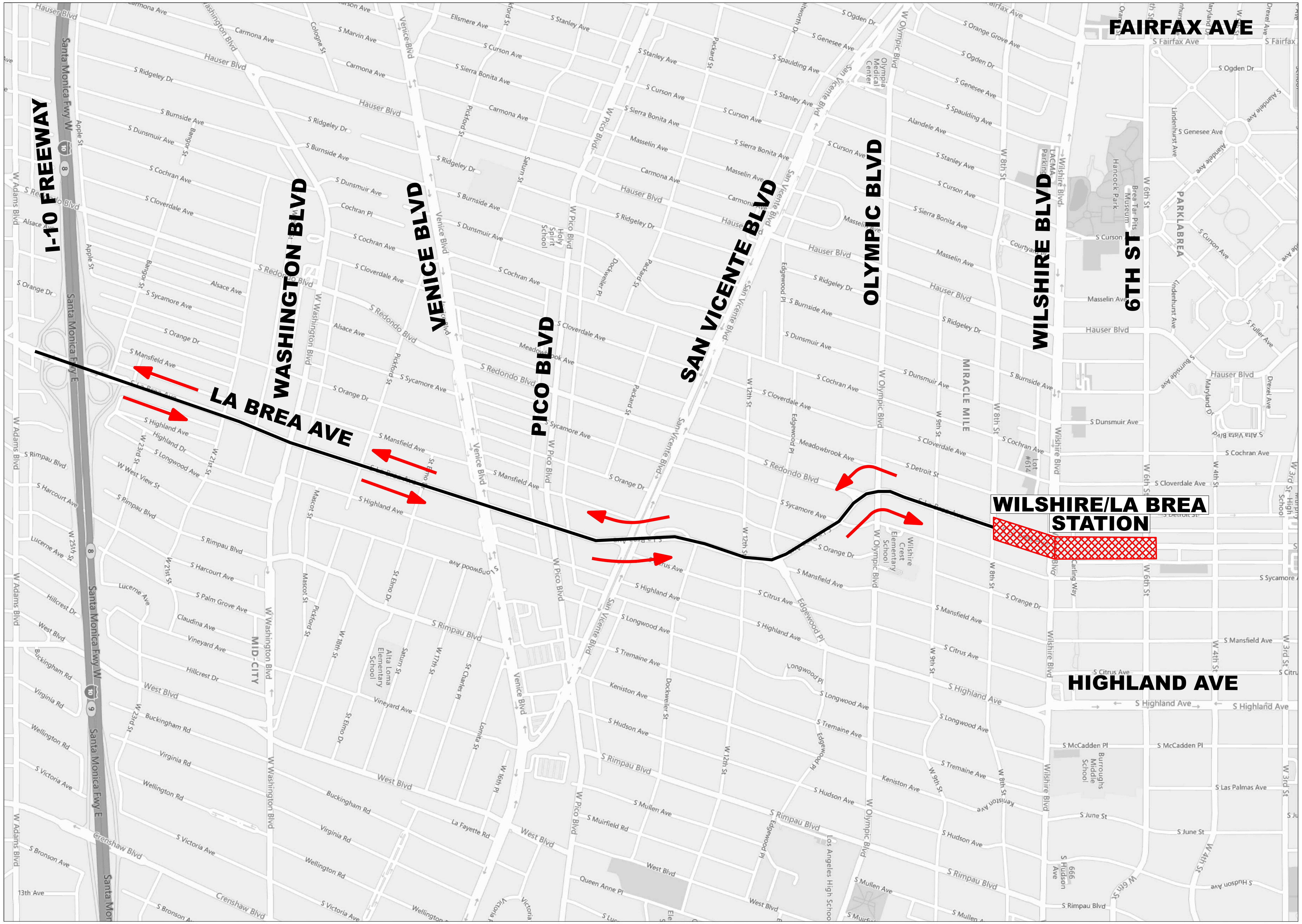
SCALE **NOT-TO-SCALE**

SHEET NO.

$USERNAME$ $TIME$ $DATE$ $FILE$

B.1.13 WILSHIRE/LA BREA STATION

This location is a station and crossover site with a construction laydown area. The anticipated truck haul route, for both the north and south double crossover options, will be southerly along La Brea Avenue to the I-10/La Brea Avenue freeway interchange, for both eastbound and westbound directions. The length of the proposed haul route is about 2.0 miles from the construction site to the freeway interchange. Approximately 60-100 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-12.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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DRAWN BY

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APPROVED BY

DATE

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APPROVED: ____

K LINE NORTHERN EXTENSION

WILSHIRE/LA BREA STATIONS NORTH & SOUTH DXO OPTIONS HAUL ROUTE MAP EXHIBIT

CONTRACT NO.

DRAWING NO. B-12

REV

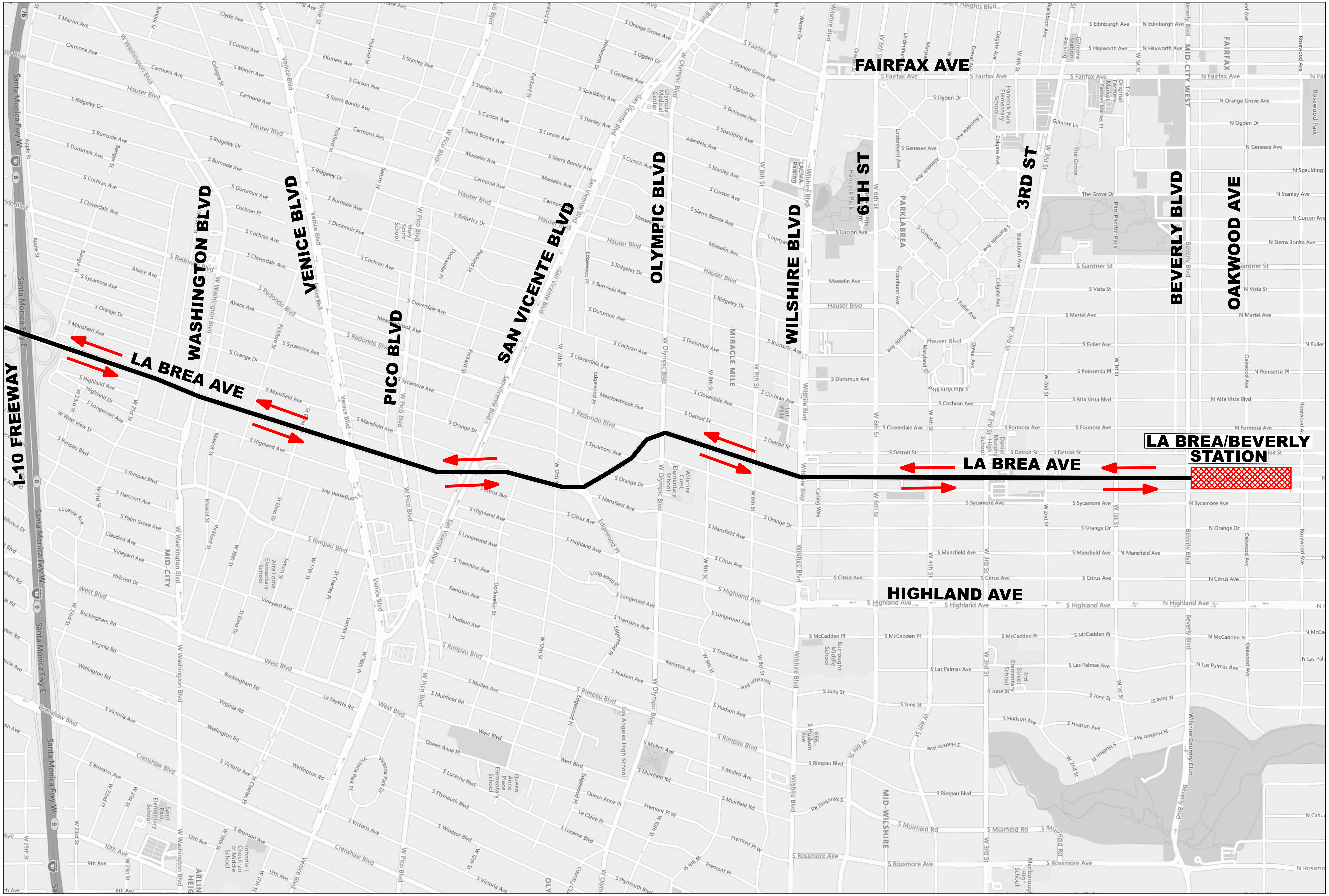
SCALE NOT-TO-SCALE

SHEET NO.

$USERNAME$ $TIME$ $DATE$ $FILE$

B.1.14 LA BREA/BEVERLY STATION

This location is a station and crossover site with a construction laydown area. The anticipated truck haul route will be southerly along La Brea Avenue to the I-10/La Brea Avenue freeway interchange, for both eastbound and westbound directions. The length of the proposed haul route is about 3.05 miles from the construction site to the freeway interchange. Approximately 60-100 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-13.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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APPROVED: ____________

K LINE NORTHERN EXTENSION
LA BREA/BEVERLY STATION
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.

DRAWING NO. B-13

REV

SCALE NOT-TO-SCALE

SHEET NO.

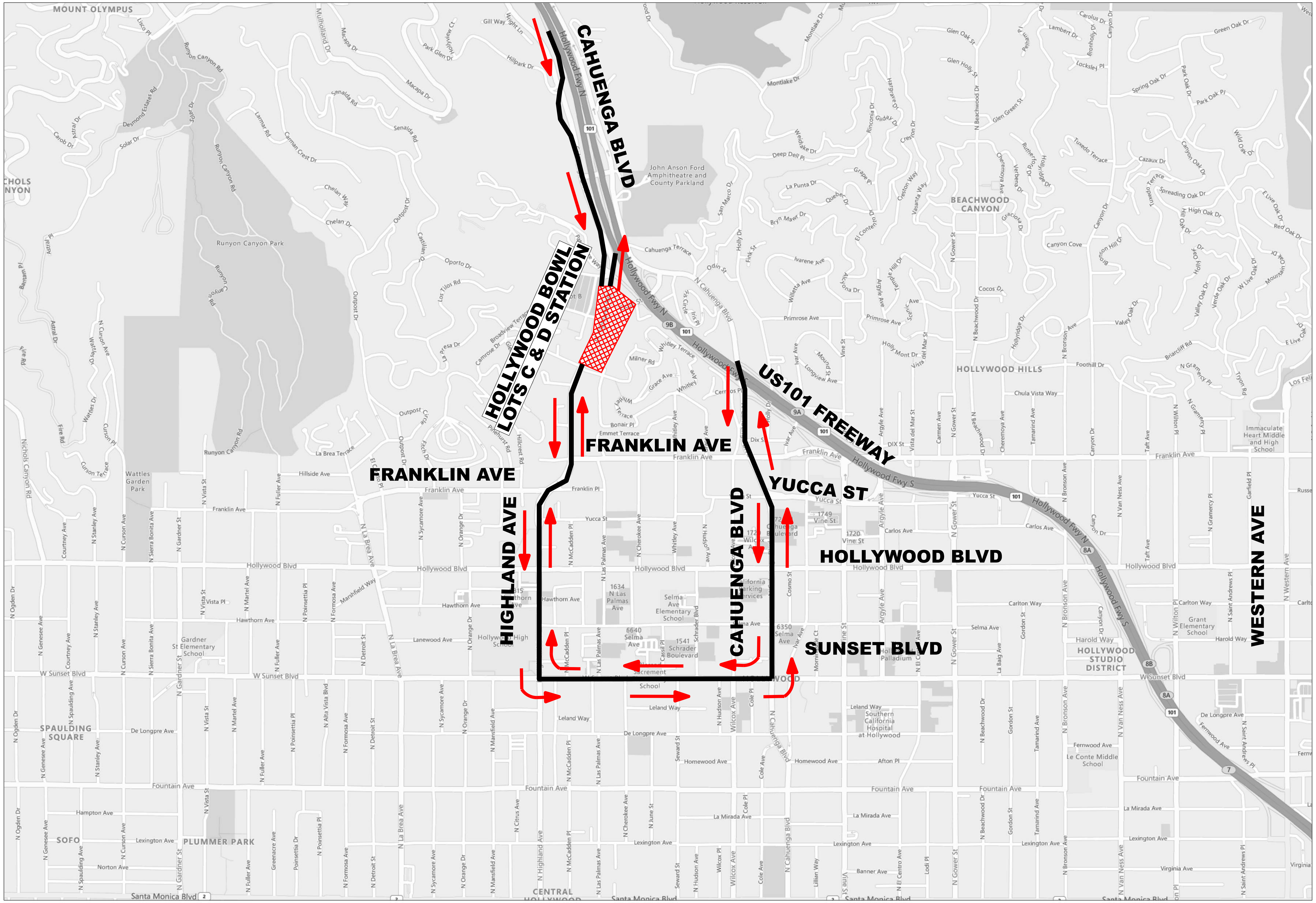
$USERNAME$

$TIME$

$DATE$ $FILE$

B.1.15 HOLLYWOOD BOWL STATION

This location is a station and crossover site with a large construction laydown area. The anticipated truck haul route will be southerly along Highland Avenue, continuing easterly on Sunset Boulevard and northerly onto Cahuenga Boulevard to the US-101/Cahuenga Boulevard freeway interchange for trucks coming from and going to the south. Haul trucks going to the north would use the Highland Avenue left entrance northbound on-ramp to the US-101 freeway and haul trucks coming from the north would use the US-101/Highland Avenue/Cahuenga Boulevard southbound off-ramp. The length of the proposed haul route is about 2.0 miles from the construction site to the US-101/Cahuenga Boulevard freeway interchange and about 0.25 miles to the US-101/Highland Avenue/Cahuenga Boulevard southbound off-ramp. Approximately 60-100 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-15.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

INFORMATION CONFIDENTIAL:
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APPROVED BY

DATE

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APPROVED: ______

K LINE NORTHERN EXTENSION
HOLLYWOOD BOWL STATION
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.

DRAWING NO. **B-15**

REV

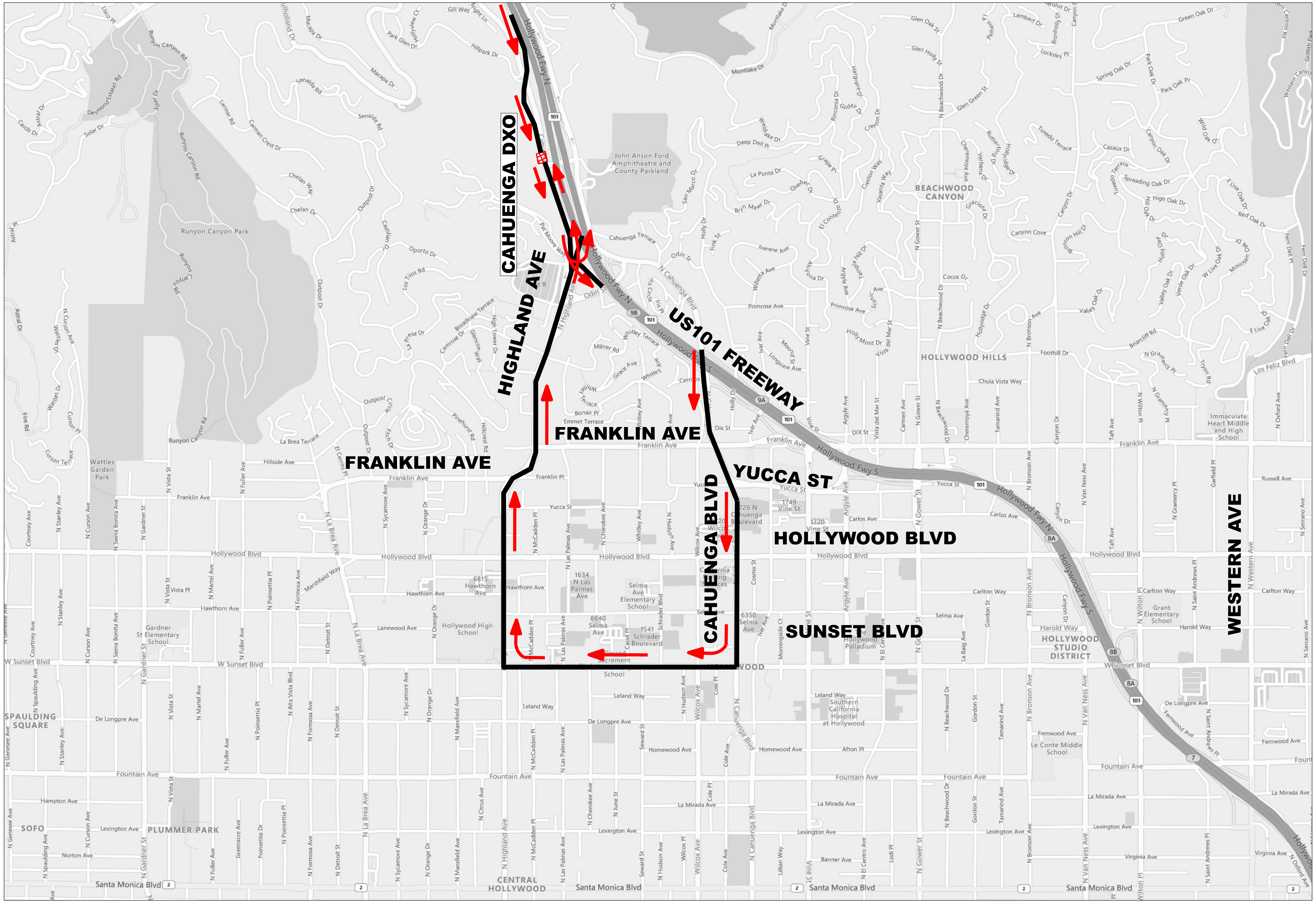
SCALE **NOT-TO-SCALE**

SHEET NO.

$USERNAME$ $TIME$ $DATE$ $FILE$

B.1.16 CAHUENGA DOUBLE CROSSOVER

This location is an emergency ventilation and egress shaft construction site with a laydown area. The anticipated truck haul route for trucks arriving to the site from the south will be to exit from the US-101 freeway at Cahuenga Boulevard, continue southerly along Cahuenga Boulevard to Sunset Boulevard, then westerly on Sunset Boulevard continuing northerly onto Highland Avenue to the construction site. Haul trucks going to the north or to the south will travel southerly on Cahuenga Boulevard West and enter the freeway at the US101/Highland Avenue interchange. Finally, haul trucks coming from the north would use the US-101/Highland Avenue/Cahuenga Boulevard southbound off-ramp to the construction site. The length of the proposed haul route is about 2.45 miles from the construction site to the US-101/Cahuenga Boulevard freeway interchange and about 0.25 miles to both the US101/Highland Avenue freeway interchange and the US-101/Highland Avenue/Cahuenga Boulevard southbound off-ramp. Approximately 40-80 haul truck trips per day are anticipated at this location. The proposed haul route is shown in Exhibit B-16.



LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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CHECKED BY
APPROVED BY
DATE

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SUBMITTED: ____ PROJECT MANAGER

APPROVED: ____

K LINE NORTHERN EXTENSION
CAHUENGA DOUBLE CROSSOVER (DXO)
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.

DRAWING NO. **B-16** REV

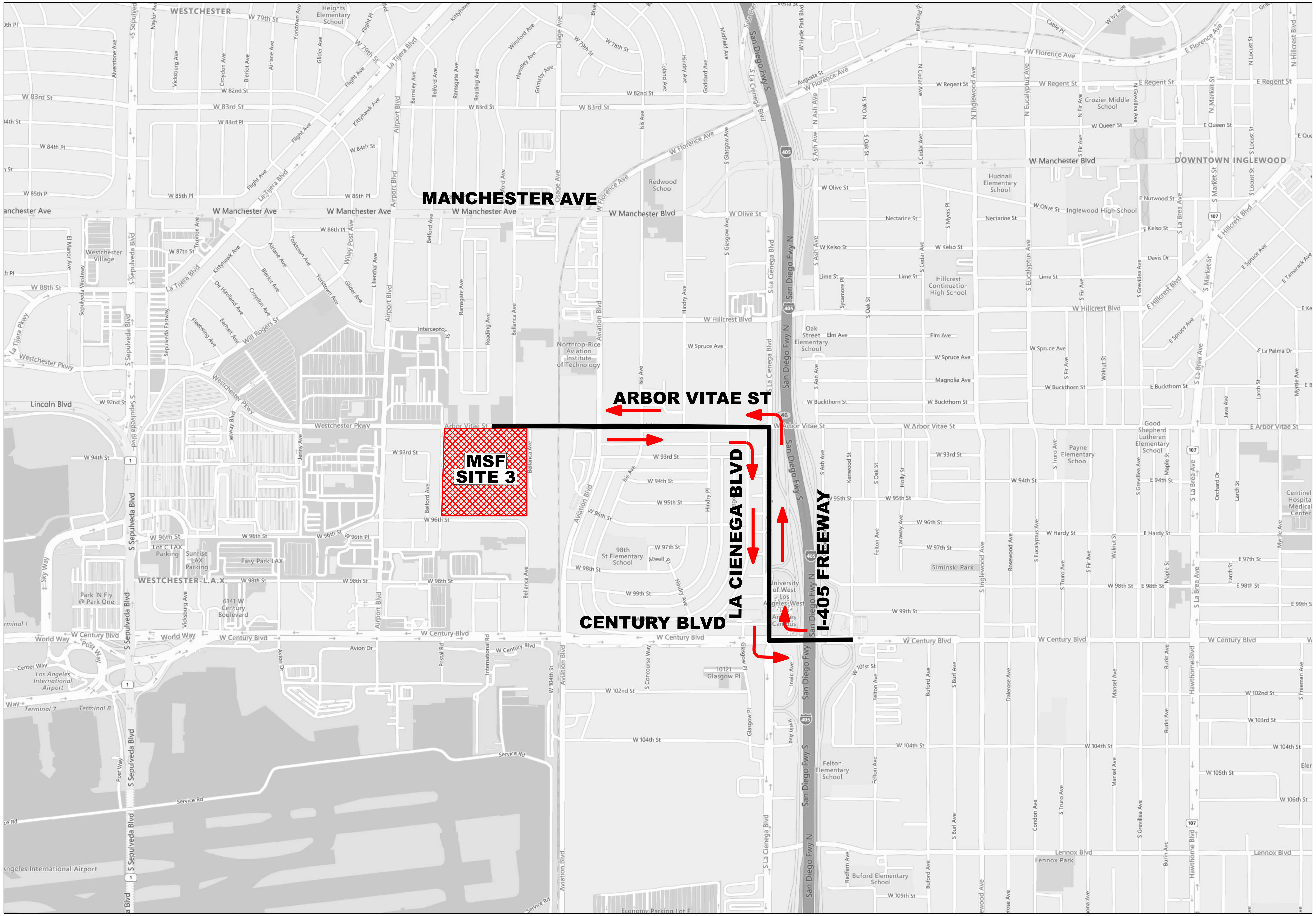
SCALE **NOT-TO-SCALE**

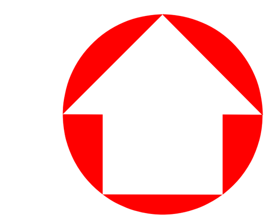
SHEET NO.

$USERNAME$ $TIME$ $DATE$ $FILE$

B.1.17 MAINTENANCE AND STORAGE FACILITY

One MSF site is under consideration, which is located adjacent to the existing K Line tracks and Arbor Vitae Street in the City of Los Angeles. The anticipated truck haul route will be easterly along Arbor Vitae Street continuing southerly onto La Cienega Boulevard to the south I-405 freeway ramps and continuing easterly on Century Boulevard to the north I-405 freeway ramps. The length of the proposed haul route is about 1.35 miles from the construction site to the freeway interchange for MSF Site 3. Approximately 40-80 haul truck trips per day are anticipated at the proposed MSF site. The proposed haul route for the MSF site is presented in Exhibits B-19.





LEGEND :

= DIRECTION OF TRAVEL

= CONSTRUCTION ZONE LOCATION

CONCEPTUAL LAYOUT - SUBJECT TO CHANGE

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DRAWN BY
CHECKED BY
APPROVED BY
DATE

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CONNECT LOS ANGELES PARTNERS
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SUBMITTED: ______ PROJECT MANAGER
APPROVED: ______

K LINE NORTHERN EXTENSION
MSF SITE 3
HAUL ROUTE MAP
EXHIBIT

CONTRACT NO.
DRAWING NO. **B-19**
REV
SCALE **NOT-TO-SCALE**
SHEET NO.

$USERNAME$
$TIME$
$DATE$ $FILE$