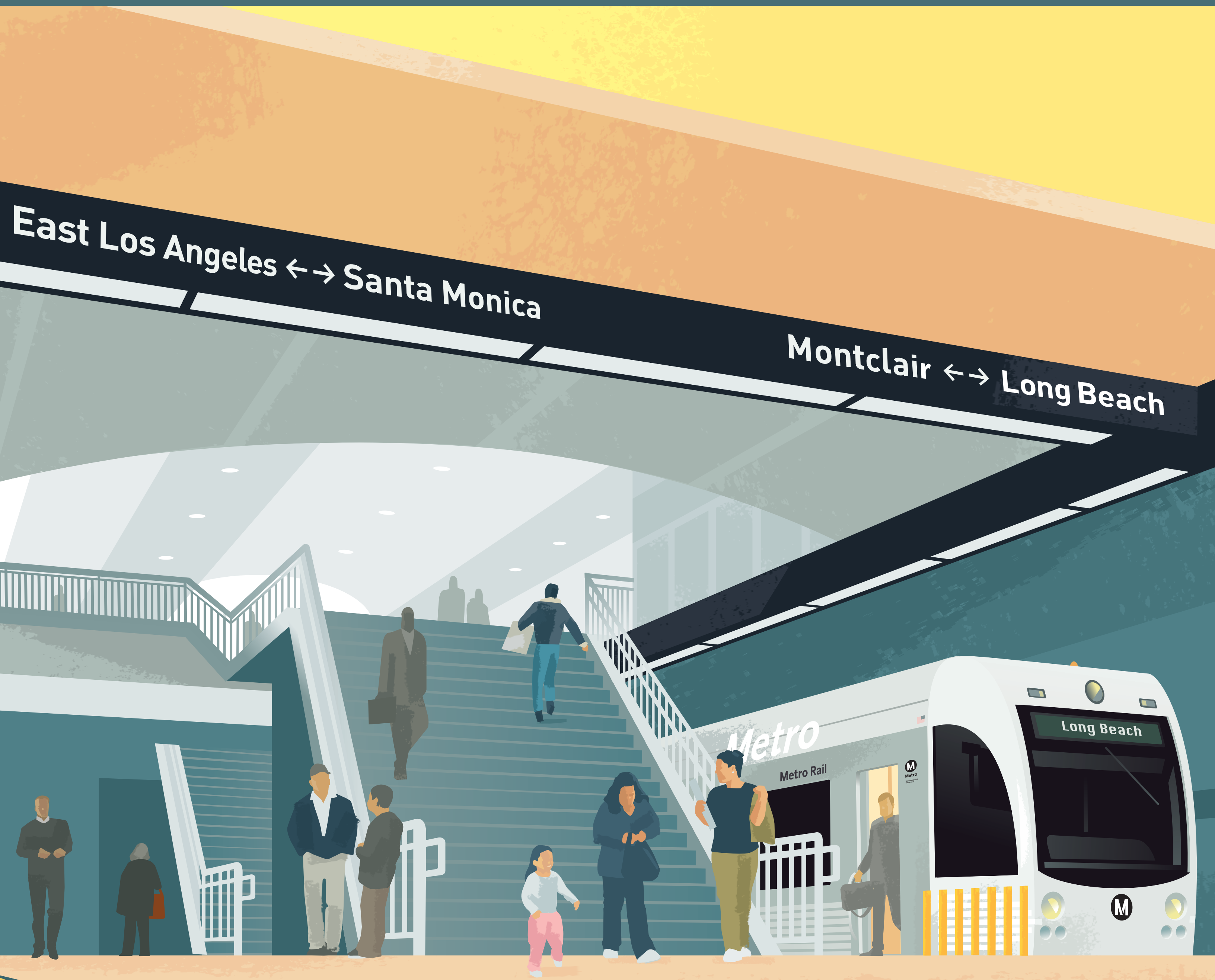
Los Angeles County
Metropolitan Transportation Authority

Regional Connector Transit Corridor

Draft Supplemental Environmental Impact Statement

June 12, 2015



Metro

U.S. Department
of Transportation
Federal Transit
Administration

DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATMENT

for the

REGIONAL CONNECTOR TRANSIT CORRIDOR PROJECT

prepared by the

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL TRANSIT ADMINISTRATION

and the

LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

Submitted pursuant to:

The National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321-4370h, 23 CFR 771, and the Order re Plaintiffs' Combined Motion for Summary Judgment and Defendants' Motion and Cross-Motion for Summary Judgment, dated May 28, 2014 and Order re Plaintiff Today's IV, Inc. and 515/555 Flower Associates, LLC's Motion for Injunctive Relief, dated September 12, 2014, issued by the U.S. District Court in *Today's IV. Inc. v. FTA et. al.* (*Today's IV*), Case No. LA CV13-00378 JAK (PLAx), *Japanese Village, LLC v. FTA et al.* (*Japanese Village*), Case No. LA CV13-00396 JAK (PLAx), *515/555 Flower Assoc., LLC v. FTA* (*Flower Associates*), Case No. LA CV00453 JAK (PLAx) and the Judgments issued on October 24, 2014 by the U.S. District Court in *Today's IV* and *Flower Associates)*.

The FTA may issue a single Final Supplemental Environmental Impact Statement/Record of Decision document pursuant to Pub. L. 112-141, 126 Stat. 405, Section 1319(b) unless the FTA determines statutory criteria or practicability considerations preclude issuance of the combined document pursuant to Section 1319. In that case, FTA would issue a Final Supplemental Environmental Impact Statement followed by a supplement to the Record of Decision, as needed.

Leslie T. Rogers
Region IX Regional Administrator
Federal Transit Administration

Date: MAY 2 6 2015

Phillip A. Washington
Chief Executive Officer
Los Angeles County
Metropolitan Transportation Authority

Date: MAY 2 6 2015

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Abbreviations/Acronyms

AA — Alternative Analysis
ACHP – Advisory Council on Historic Preservation
APE – Area of Potential Effect
CEQA – California Environmental Quality Act
CHL – California Historic Landmarks
CRHR – California Register of Historic Resources
EIR – Environmental Impact Report
EIS – Environmental Impact Statement
EPA – Environmental Protection Agency
EPBM — Earth Pressure Balance Method
FEIR — Final Environmental Impact Report
FEIS — Final Environmental Impact Statement
FHWA — Federal Highway Administration
FTA – Federal Transit Administration
GBV – Ground-borne vibration
KOPs — Key Observation Points
LADOT — Los Angeles Department of Transportation
LOS — Level of Service
LPA – Locally Preferred Alternative
LRT — Light Transit Rail
LRTP — Long Range Transportation Plan
METRO — Los Angeles County Metropolitan Transportation Authority
MMRP — Mitigation Monitoring and Reporting Plan
MOA – Memorandum of Agreement
MPH — Miles Per Hour
MPO — Metropolitan Planning Organization
MRDC — Metro Rail Design Criteria
NEPA – National Environmental Policy Act
NHPA – National Historic Preservation Act
NRHP – National Register of Historic Places
NTP — Notice To Proceed
PPV – Peak Particle Velocity
ROD — Record of Decision
ROW — Right-Of-Way
RTP — Regional Transportation Plan
SAFETEA-LU — Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users
SCAG — Southern California Association of Governments
SEA — Supplemental Environmental Assessment
SEIS — Supplemental Environmental Impact Statement
SEM — Sequential Excavation Method
SHPO – State Historic Preservation Office
SR — State Route
TBM — Tunnel Boring Machine
TIFIA — Transportation Infrastructure Finance and Innovative Action
TSM — Transportation Systems Management
USDA — United States Department of Agriculture
USDOI — United States Department of Interior

USDOT — United States Department of Transportation
USFS — United States Forest Service
CCAA — California Clean Air Act
NAAQS — National Ambient Air Quality Standards
CO — Carbon Monoxide
P_b — lead
NO_2 — Nitrogen dioxide
O_3 — Ozone (commonly known as smog)
PM_{10} — Particulate matter smaller than 10 microns
$PM_{2.5}$ — Particulate matter smaller than 2.5 microns
SO_2 — Sulfur Dioxide
VOC — Volatile Organic Compounds
NO_x— Oxides of nitrogen
CAA— Clean Air Act
Ppm— parts per million of air
Ppb — parts per billion by volume
AAM — Annual Arithmetic Mean
SoCAB — The South Coast Air Basin

EXECUTIVE SUMMARY

This Supplemental Environmental Impact Statement (SEIS) was prepared to address the Order of the United States District Court for the Central District of California in *Today's IV, Inc. vs. Federal Transit Administration et al* and *515/555 Flower Associates, LLC vs. Federal Transit Administration et al*. The Judgment and Order for Partial Injunctive Relief by the Honorable John A. Kronstadt on May 28, 2014 and September 9, 2014, respectively, require that the Federal Transit Administration (FTA) as the federal lead agency pursuant to the National Environmental Policy Act (NEPA) with the Los Angeles County Metropolitan Transportation Authority (Metro) explain why open-face tunneling alternatives were rejected on the Lower Flower Segment in downtown Los Angeles. This SEIS is intended to provide more information on the tunnel construction alternatives on Flower Street that were withdrawn from consideration, specifically Open-Face Shield and Sequential Excavation Method (SEM) tunneling for the Flower Street portion of the Regional Connector project alignment between 4th Street and the 7th Street/Metro Center Station, as required by the Judgment.

Alternatives Evaluated in this Supplemental Environmental Document

The two tunneling method alternatives identified and evaluated in the SEIS propose different combinations of underground construction as options to the cut and cover method planned for the Project between south of 4th Street and south of 6th Street along Flower Street:

- Alternative A – a combination of Earth Pressure Balance Tunnel Boring Machine (EPBM), Open-Face Shield, and SEM construction methods; and with similar horizontal and vertical alignment profiles to that of the Project.
- Alternative B – a combination of EPBM and SEM construction methods with a similar horizontal alignment profile, but a lower vertical alignment profile, than that of the Project.

The tunneling alternatives have the following alignment variations from that of the Project in order to address geologic conditions and other subsurface project constraints along Flower Street:

- Horizontal alignment – Along Flower Street, Alternatives A and B remain located under the existing street right-of-way. The horizontal alignments of these alternatives continue on tangent track from the 2nd/Hope Station south through the 4th Street Bridge foundation piles to 5th Street. The alignments then would transition from a wider oval track center to a narrow track center as the alignment approaches the planned double crossover immediately north of the narrow, rectangular 7th Street/Metro Center Station tail tracks structure.

  The tunneling method alternatives would have a short horizontal transition distance from the 5th Street section of the alignment to the double crossover located before the existing tail tracks structure which would limit the operating speed to 35 miles per hour (mph) as compared to the 55 mph provided by the Project.

Figure ES.1: Alternative A – EPBM/Open-Face Shield/SEM Project Profile Alternative

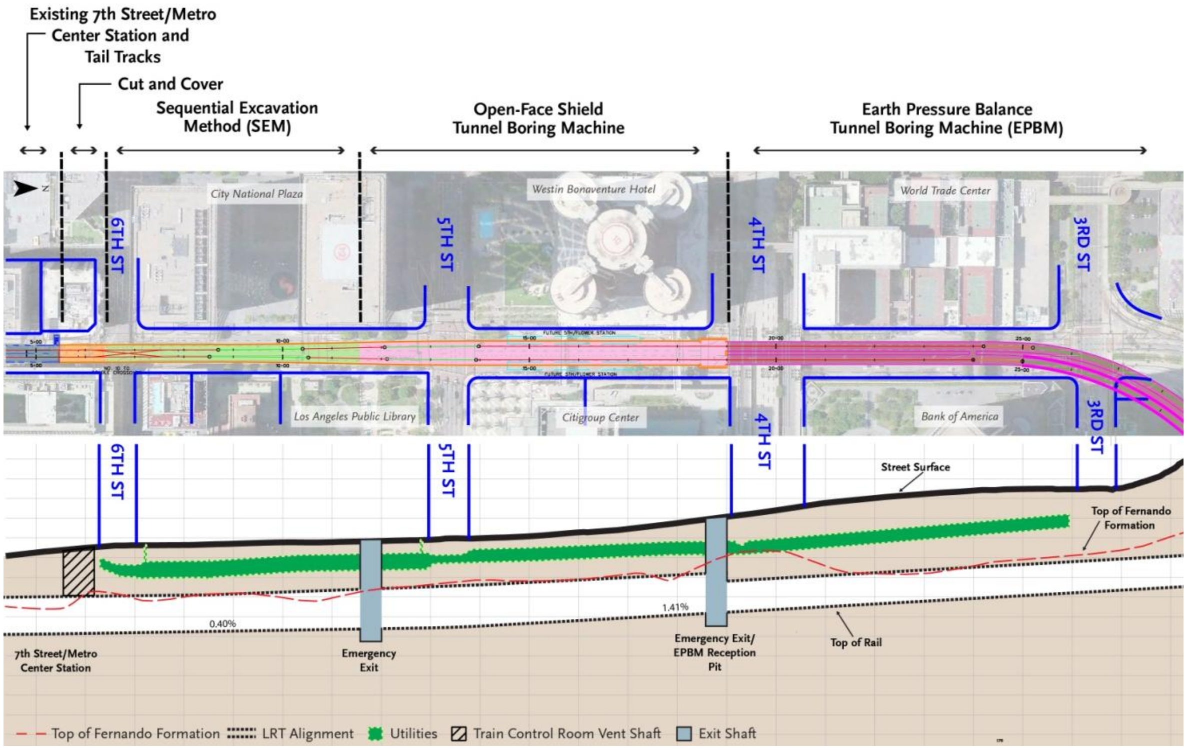
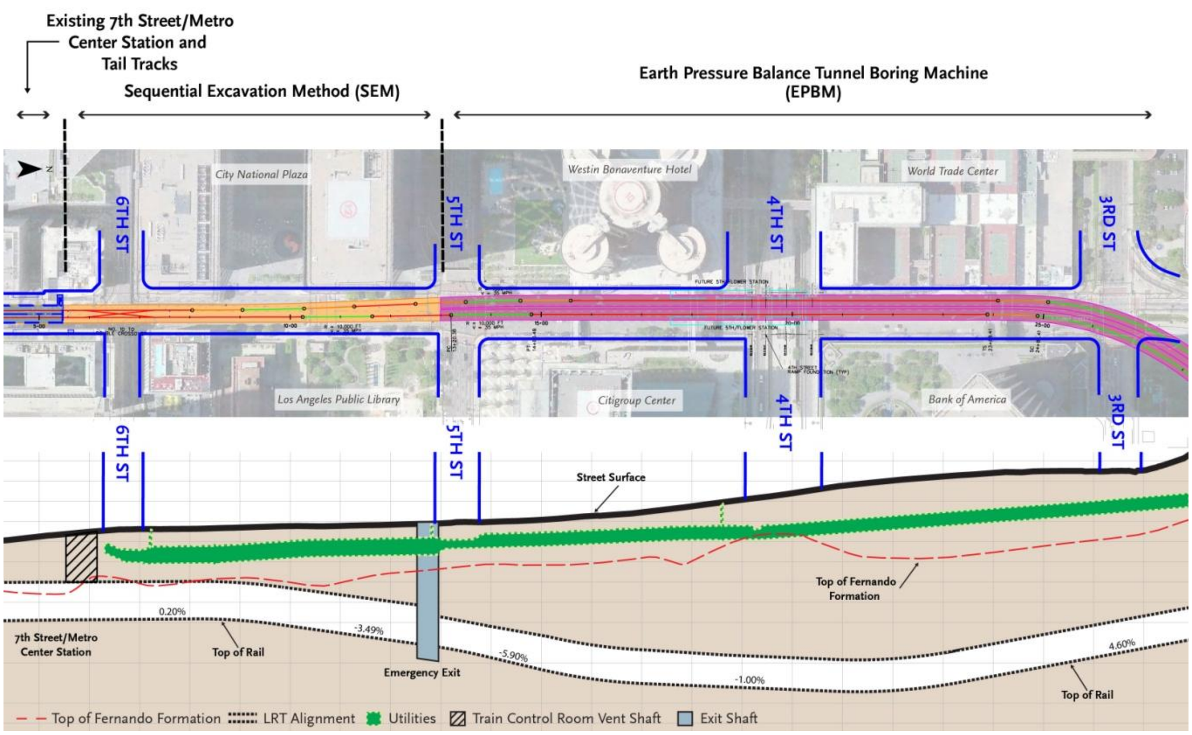


Figure ES.2: Alternative B – EPBM/SEM Low Alignment Alternative



- Vertical alignment – Alternative A would have the same vertical profiles as the Project with an average depth of 40 feet to top of rail (TOR) below ground level. The vertical alignment of Alternative B has a "sag" or low point of 105 feet to TOR below ground level. The sag alignment reduces the probability of the tunnel alignment impacting the 4th Street Bridge foundations, and encountering tie-backs located under Flower Street between 4th Street and just south of 5th Street. Alternative B's lower alignment profile results in a greater depth for the 2nd/Hope Station (128 feet) compared to the Project and Alternative A (96 feet).

Summary of Findings

Based on the environmental analysis in the SEIS and the engineering analysis documented in the *Draft Flower Street Tunneling Methods Alternatives Report*, the construction method alternatives would not perform as well as the Project in meeting purpose and need, would impact Metro operations, would pose construction and safety risks, and would result in environmental impacts, as summarized below.

- **Purpose and Need** – Alternatives A and B would not perform as well as the Project in meeting the purpose and need identified for the Regional Connector project. While they would provide an improved regional connection, implementation of these options would result in reduced operating speeds on the Flower Street segment – 35 mph compared to 55 mph provided by the Project. There would be a corresponding increase in travel times for Gold, Blue, and Exposition Line passengers, as well as for passengers transferring from the Red and Purple Lines. The speed reduction resulting from the tunneling method alternatives would have permanent negative operational effects over the Project due to increased travel times for the operational life of the Regional Connector project.
- **Construction and Risk Considerations** – Construction along the Flower Street segment must address significant challenges including physical operational challenges, difficult surface and underground conditions, and challenging geologic conditions. The geologic conditions include the presence of groundwater, unstable soils, a challenging geologic interface between different soil and rock strata (mixed-face), and hazardous gases. The Project was defined to address those constraints given the segment's high risk and challenges. The tunneling methods proposed by Alternatives A and B would result in significantly higher construction risks, a longer construction schedule, and a higher project cost. The higher construction risks include increased risks of ground instability, loss, and settlement which could threaten public and worker safety.
- **Operational Considerations** – The speed reduction resulting from Alternatives A and B would have negative impacts on rail service headways, run times, and operations over the Project. With a slower operating speed – one-third slower than Metro operational requirements – Alternatives A and B would negatively impact passengers using the Gold, Blue, and Exposition Lines, as well as passengers transferring from the Red and Purple Lines at the 7th Street/Metro Center Station. Metro would be required to operate additional trains and increase the fleet size by approximately six vehicles with a corresponding increase in capital and operational costs. It should be noted that the Project and Alternatives A and B have been

designed to allow for a future 5th/Flower Station. Construction of this station would result in slower operating speeds in the Flower Street segment as the closer station spacing would not allow the LRT trains to reach the desired 55 mph speed. While both alternatives would allow for a future 5th/Flower Street Station, the resulting station configuration for Alternatives A and B would not allow for cross-platform transfers negatively impacting passenger convenience, especially for visitors and infrequent users. Implementation of Alternatives A and B would result in a permanent, substandard operating segment at the heart of the region's LRT system.

- **Schedule Impacts** – Implementation of Alternatives A and B would delay start of revenue service by a minimum of 3.0 years beyond the Project's schedule. The increase in schedule is partially due to longer construction timeframes – 15 and 7 months for Alternatives A and B respectively. In addition, both alternatives would require an additional 29 months over the Project's schedule for pre-construction activities required to revise the engineering design and re-procure the design-build construction contract. A longer construction time would increase the project cost and delay operation of this much needed segment in the region's LRT system.
- **Cost and Funding Considerations** – Based on a cost analysis similar to that performed for the Project, the higher risk for Alternatives A and B translates to $67 to $123 million more for the baseline Year of Expenditure (YOE) cost for the Flower Street segment beyond the cost identified for the Project. Given the higher risk level, a range of an additional $276 to $403million would be required for the construction of Alternatives A and B beyond that identified for the Project. Funding for these additional costs will need to be identified among limited federal, state, and local sources.
- **Environmental Considerations** – The two tunneling method alternatives shift a majority of the effects resulting from the handling of excavation materials from the Flower Street segment, a high-rise commercial district with wide streets, to Little Tokyo, a low to mid-rise mixed use district with visitor and cultural destinations, and identified as an environmental justice community. Use of grouting equipment, required for Flower Street segment ground stabilization for construction of the two alternatives would result in adverse visual, noise and vibration, air quality, and traffic effects during construction that may not be mitigated.

Based on the above conclusions, it was determined that the proposed tunneling alternatives in Alternatives A and B would result in a higher safety risk, would cost more money, would take longer to construct, and would result in additional adverse environmental effects than the Project. Even with the proposed methods to reduce construction risk associated with tunneling in the weak ground conditions under Flower Street, the tunneling method alternatives have a high risk of ground settlement problems. While implementing Alternatives A and B may be technically possible, for the reasons stated in this paragraph and above, those alternatives were considered infeasible as a matter of sound public policy, and thus were withdrawn from further consideration.[1]

[1] *See Res. Ltd., Inc. v. Robertson, 35 F.3d 1300, 1307 (9th Cir. 1997)*

Table ES.1: Overview of Environmental Impacts Due to Construction of the Tunneling Method Alternatives

Resource Area	The Project	Alternative A	Alternative B
Transportation/ Circulation Flower Street Impacts Little Tokyo Impacts	• 3 to 4 travel lanes available on Flower Street during construction • Even with mitigation, the intersections of 4th, 5th and 6th and Flower Streets would be adversely affected during the AM peak hour. With mitigation, the resulting effect would not be adverse under NEPA.	• 2 travel lanes available on Flower Street during grouting and construction. • Longer duration of traffic lane closure due to 12 months (possibly up to 24 months) of grouting activities. • Increases and extends construction truck impacts on Little Tokyo by 15 months.	• 3 travel lanes available on Flower Street: 4th to 5th Streets; 2 travel lanes 5th to 6th Streets. • Longer duration of traffic lane closure due to 8 months (possibly 16 months) of grouting activities. • Increases and extends construction truck impacts on Little Tokyo by 7 months.
Visual Quality	• Construction staging area along the east side of Flower Street would have negative impacts on the visual quality/character that can be screened.	• Construction and grouting staging areas along east side of Flower Street would have adverse impacts on visual quality/character. • Impacts cannot be mitigated due to size of grouting and plant equipment (over 100 feet tall). • With two grouting areas, this alternative would have a more adverse effect than Alternative B.	• Construction and grouting staging areas along east side of Flower Street would have adverse impacts on visual quality/character. • Impacts cannot be mitigated due to size of grouting and plant equipment (over 100 feet tall). • With only one grouting area, this alternative would have less impact than Alternative A, but more than the Project.
Air Quality Peak daily emissions	• During construction, regional construction emissions of VOC, NO_x, and CO will be adverse, significant and unavoidable under NEPA. With mitigation, localized construction emissions will be reduced to less than significant.	• Higher emissions during construction due to use of grouting equipment. • Longer duration of construction emissions by 12 months (up to 24 months) on Flower Street; and by 15 months over the Project.	• Higher emissions during construction due to use of grouting equipment. • Longer duration of construction emissions by 7 months (up to 16 months) on Flower Street; and by 7 months in Little Tokyo over the Project. • With only one grouting area, this alternative would have less impact than Alternative A.
Climate Change MTCO2e/year	• 2017[1] GHG emissions would be 4,870.	• 2017[1] GHG emissions would be 8,040. • Higher GHG emissions than the Project due to use of grouting equipment.	• 2017[1] GHG emissions would be 4,950. • Higher GHG emissions than the Project due to use of grouting equipment. • Less GHG emissions than Alternative A due to need for only one grouting area.
Noise and Vibration Flower Street Impacts	• Noise may inadvertently exceed FTA significance criteria during construction; mitigation measures will control exceedances.	• Results in increased construction noise level over the Project due to use of grouting equipment. • Possible minor increase in vibration impacts due to TBM use further south on Flower Street.	• Results in some noise level increases over the Project due to use of grouting equipment. • Results in lower noise level than Alternative A due to need for only one grouting area.

Note: [1] Mid-point of construction.

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1.0 BACKGROUND, PURPOSE AND SCOPE OF THE SEIS

1.1 Background

The Regional Connector Transit Corridor Project approval and certification of the Final Environmental Impact Statement (Final EIS) was the culmination of prior planning and environmental studies and projects completed in the past two decades. The Federal Transit Administration (FTA) is the federal lead agency pursuant to the National Environmental Policy Act (NEPA), with the Los Angeles County Metropolitan Transportation Authority (Metro) as the joint lead agency. The Final EIS was prepared for the Board-designated Locally Preferred Alternative (LPA known as the "Project") and was completed in February 2012, with Metro Board of Directors approval of the Project on April 26, 2012. A Record of Decision (ROD) was issued by FTA on June 29, 2012.

This Supplemental Environmental Impact Statement (SEIS) was prepared to address the Order of the United States District Court for the Central District of California in *Today's IV, Inc. vs. Federal Transit Administration et al* and *515/555 Flower Associates, LLC vs. Federal Transit Administration et al*. The Judgment and Order for Partial Injunctive Relief by the Honorable John A. Kronstadt on May 28, 2014 and September 9, 2014, respectively, require that the FTA and Metro explain why open-face tunneling alternatives were rejected on the Lower Flower Segment in downtown Los Angeles. This SEIS is intended to provide more information on the tunnel construction alternatives on Flower Street that were withdrawn from consideration, specifically Open-Face Shield and Sequential Excavation Method (SEM) tunneling for the Flower Street portion of the Regional Connector project alignment between 4th Street and the 7th Street/Metro Center Station, as required by the Judgment.

This SEIS supplements the FEIS, pursuant to FTA NEPA implementation procedures (23 CFR 771.130), to address the court's determinations in those orders, which are discussed in further detail below (submitted pursuant to the National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321-4370h, 23 CFR 771, and the Order re Plaintiffs' Combined Motion for Summary Judgment and Defendants' Motion and Cross-Motion for Summary Judgment, dated May 28, 2014 and Order re Plaintiff Today's IV, Inc. and 515/555 Flower Associates, LLC's Motion for Injunctive Relief, dated September 12, 2014, issued by the U.S. District Court in *Today's IV. Inc. v. FTA et. al.* (*Today's IV*), Case No. LA CV13-00378 JAK (PLAx), *Japanese Village, LLC v. FTA et al.* (*Japanese Village*), Case No. LA CV13-00396 JAK (PLAx), *515/555 Flower Assoc., LLC v. FTA* (*Flower Associates*), Case No. LA CV00453 JAK (PLAx) and the Judgments issued on October 24, 2014 by the U.S. District Court in *Today's IV* and *Flower Associates).*

1.2 Purpose and Scope of this Supplemental Environmental Document

The preparation of this SEIS is consistent with 23 CFR 771.130(f) which states that a supplemental EIS may be required to address issues of limited scope, such as the extent of proposed mitigation of the evaluation of location or design variations for a limited portion of the overall project. This SEIS is a limited-scope document that provides additional detail on tunneling methods not selected for construction along Flower Street, specifically Open-Face Shield and SEM tunneling for the Flower

Street portion of the Regional Connector project alignment between 4th Street and the 7th Street/Metro Center Station (as shown in Figure 1.1-1). The two tunneling method alternatives identified and evaluated in the SEIS propose different combinations of underground construction as options to the cut and cover method planned for the Project between south of 4th Street and south of 6th Street along Flower Street:

- Alternative A – a combination of Earth Pressure Balance Tunnel Boring Machine (EPBM), Open-Face Shield, and SEM construction methods; and with similar horizontal and vertical alignment profiles to that of the Project.
- Alternative B – a combination of EPBM and SEM construction methods with a similar horizontal alignment profile, but a lower vertical alignment profile than that of the Project.

The SEIS evaluation effort focuses on the effects of proposed construction method changes to the Flower Street segment of the Regional Connector project, as described above, and the corresponding impacts on the Mangrove portal site in Little Tokyo, which may result from the use of different combinations of underground construction along the Flower Street segment. There is no change in the location of the Project or the Project Area studied, which remains as presented in the Final EIS.

Potential effects related to the two tunnel method construction alternatives were assessed and areas with possible adverse effects were studied in the SEIS as presented in Chapter 3, Transportation and Circulation and Chapter 4, Affected Environment and Environmental Consequences. The following environmental impact areas were identified as potentially being effected by the tunneling method alternatives and were studied in the SEIS:

- Transportation and Circulation
- Visual Quality
- Air Quality
- Climate Change
- Noise and Vibration
- Geotechnical
- Energy Resources
- Historic Resources
- Environmental Justice
- Cumulative

All of the other environmental topic areas were evaluated in the Final EIS, and no additional impacts were identified as resulting from implementation of either of the tunneling method alternatives under evaluation. A Section 4(f) evaluation was documented in Chapter 5 of the Final EIS. The two tunneling method alternatives were determined to have the same findings as the Project. Therefore, a Section 4(f) section was not included in the SEIS.

1.3 Environmental Review Process

With completion of the Draft SEIS, there will be a 45-day public review and comment period. The Final SEIS will include and address all of the comments received during the circulation of the Draft SEIS.

The FTA may issue a single Final Supplemental Environmental Impact Statement/Record of Decision document pursuant to Pub. L. 112-141, 126 Stat. 405, Section 1319(b), 42 U.S.C. § 4332a, unless the FTA determines statutory criteria or practicability considerations preclude issuance of the combined document pursuant to Section 4332a. In that case, FTA would issue a Final SEIS followed by a supplement to the Record of Decision, as needed.

1.4 Project Schedule

The Project schedule reflected in the SEIS was based on initiation of final design and construction by the Design-Build Contractor with a Notice to Proceed (NTP) date of July 7, 2014 and a Revenue Service Date to occur in mid 2020. Implementation of either of the tunneling method alternatives studied in this SEIS would extend the total project schedule from start of construction to revenue service by a minimum of 36 months or three years over the Project's schedule. The longer schedule duration for the tunneling method alternatives is due to: 1) new pre-construction activities related to updating the engineering design and re-procuring of the construction contract; and 2) an extended construction duration due to muck removal for the tunneling alternative on Flower Street through the westbound tunnel to the Mangrove portal, which is more time-consuming than cut and cover construction. Extending the duration of muck removal from the Mangrove would also delay the construction of all station facilities, which are dependent on the completion of tunneling operations.

2.0 ALTERNATIVES CONSIDERED

This chapter provides the background of the Regional Connector Project (Project) and the two alternatives for tunnel construction on the Flower Street segment as directed by the U.S. District Court in the Summary Judgment Order, Order re Injunctive Relief and Judgment. The Regional Connector Project, including the Flower Street Segment evaluated in this SEIS, is illustrated in Figure 2.1-1. The Flower Street segment extends north from the existing 7th Street/Metro Center Station tail tracks structure to the south side of 4th Street. The northern limit for the Flower Street segment was identified as 4th Street as this is the location where construction of the Project and the two tunnel construction alternatives changes from tunnel boring machine to various construction techniques south to connect with the existing tail tracks structure of the 7th Street/Metro Center Station. There is no change in the location of the Project or the Project Area studied, which remains as presented in the Final Environmental Impact Statement (EIS).

This chapter provides a discussion of: 1) the **Project Background** with an overview of the Regional Connector Project study process, including a discussion of the alternative development and evaluation process, which resulted in the identification of the Locally Preferred Alternative (the Project), and a description of the construction methods and staging needs of the Project along the Flower Street Segment; 2) **Development of Alternatives** discussing the basis for the identification and evaluation of the tunneling method alternatives, including Flower Street segment surface and underground constraints, and the tunneling construction methods considered; and 3) **Alternatives Considered in the SEIS** providing a description of the two alternatives for tunnel construction identified as the tunneling method alternatives in this SEIS.

2.1 PROJECT BACKGROUND

This section provides an overview of the Regional Connector Project study efforts leading to the identification of the Locally Preferred Alternative (LPA) or the Project, in actions taken by the Metro Board of Directors and as documented in the ROD issued by the FTA. A description of the Project's construction methods and staging needs is provided.

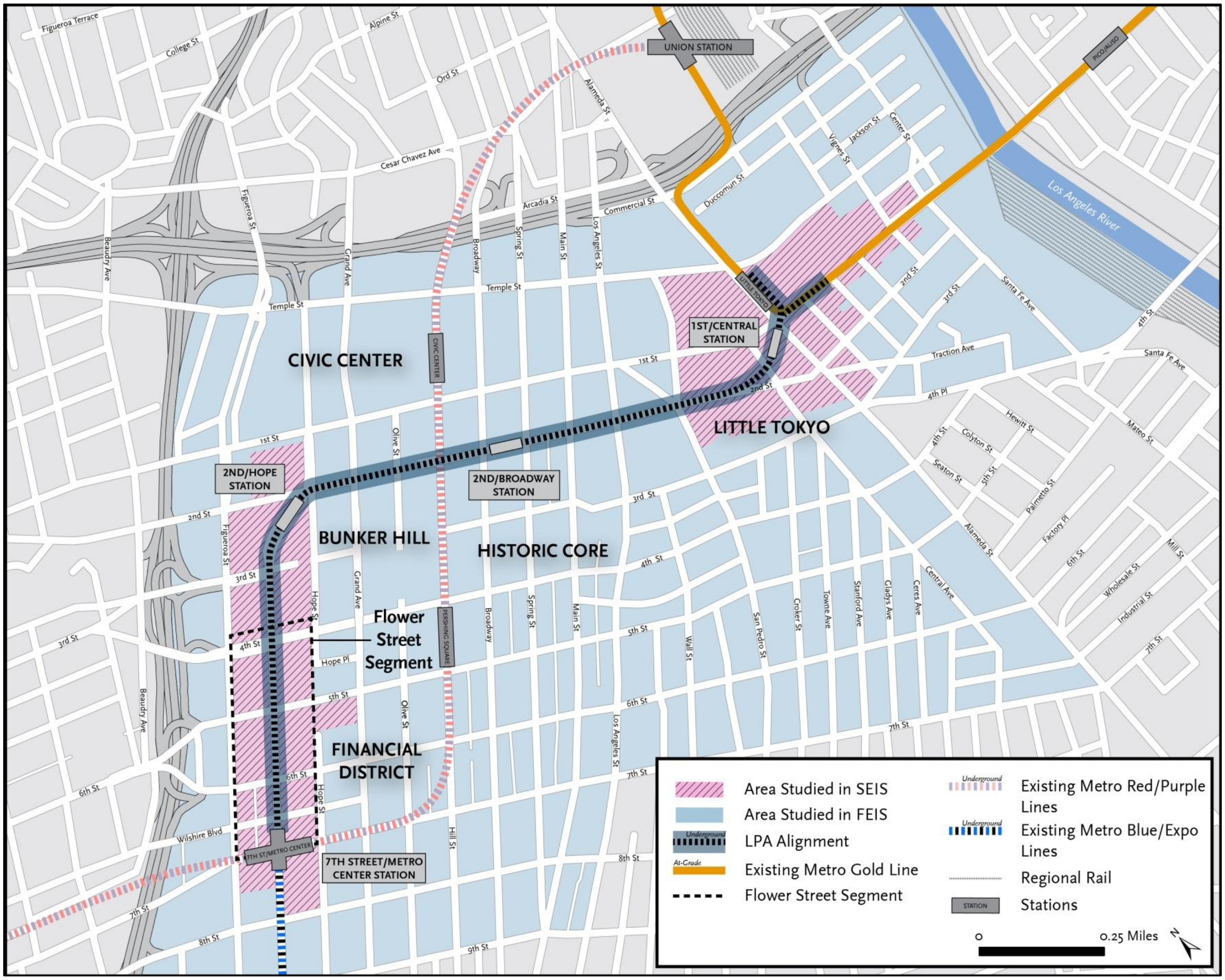
2.1.1 Efforts Leading to the Identification of the Project

Alternatives for the Regional Connector Project were identified and evaluated as documented in the *Final Alternatives Analysis Report (December 2008)*, the *Draft EIS (2010)*, the *Supplemental EIS (2011),* and the *Final EIS (2012)*.

During the Alternatives Analysis (AA) study phase, an extensive outreach, research, and analytical process included the following activities:

- Comments received from community involvement activities, including meetings with stakeholders, public agencies, local jurisdictions, and the public.
- Analysis of the engineering and geographic constraints of building new infrastructure in a dense central business district.

Figure 2.1-1: Project Area from the Final EIS for the Locally Preferred Alternative



- Surveys of land use and travel patterns to determine the most ideal routes and station locations.

The AA process identified and screened 36 potential transportation alternatives in light of the project's purpose and need, goals, and objectives. The process included initial technical analyses and community and public agency feedback gathered at meetings and public workshops. Alternatives considered in the AA represented the full spectrum of reasonable means of achieving the goals and objectives of the Regional Connector project. The AA evaluated the potential alternatives based on their environmental impacts, efficiency, cost, effectiveness, and equity.

From the AA effort, the No Build, Transportation System Management, and three build light rail transit (LRT) alternatives emerged which were analyzed further in the Draft EIS and were confirmed and refined based on a unique and intense community engagement process. Based on this extensive public outreach effort, the Fully Underground LRT Alternative evolved to more adequately address the community of Little Tokyo's concerns. The Metro Board of Directors voted in February 2010 to add this alternative to the Draft EIS analysis.

On October 28, 2010, the Metro Board concurred with staff's recommendation to designate the Fully Underground LRT Alternative as the LPA, with elimination of the 5th/Flower Station, and authorized the project to proceed into the Final EIS phase. The LPA is essentially the same configuration as the Fully Underground LRT Alternative as analyzed in the Draft EIS, except that the LPA does not include the 5th/Flower Station and it has been further refined to reduce impacts. Key refinements in the Flower Street segment included creation of an enhanced pedestrian walkway along the east side of Flower Street between 4th Street and the existing 7th Street/Metro Center Station entrance. Changes were made in the Little Tokyo area, including the decision to insert the Tunnel Boring Machine (TBM) at the Mangrove property (formerly known as the Nikkei development) where it would begin excavating westward. Tunnel boring activities from the Mangrove property insertion site would allow tunneling to proceed farther down Flower Street to 4th Street instead of ending at the proposed 2nd/Hope Station.

Metro published a Supplemental Environmental Assessment (EA) document to formally introduce refinements made to the LPA (the Project) after the publication of the Draft EIS in July 2011. The Supplemental EA was recirculated through a 45-day comment period from July 22, 2011 to September 6, 2011. The preparation of the Final EIS was completed in January 2012, and the Metro Board of Directors approved the Project on April 26, 2012 with a ROD issued by the FTA on June 29, 2012.

2.1.2 Construction Methods of the Project

As discussed in the Final EIS, the Flower Street segment of the Project would be constructed with a combination of cut and cover and a tunneling method known as earth pressure balance tunnel boring machine (EPBM) method as summarized below and illustrated in Figure 2.1-2:

- 2nd/Hope Station to 4th Street – EPBM construction would be used to bore a single tunnel south to 4th Street where a reception pit would allow for the extraction of the EPBM for reuse on the second parallel tunnel drive. The use of EPBM tunneling was identified as the most viable tunneling method given the unique underground conditions along this portion of the alignment, discussed in detail below, and to be in conformance with Metro tunneling policies. The depth of the tunnel was designed to avoid conflicts with abandoned construction tie-backs and adverse impacts to the existing 4th Street Bridge foundations, to accommodate a future 5th/Flower Station, and to provide sufficient ground cover over the tunnel at the reception pit south of 4th Street. Retrieval of the EPBM would be through a reception pit that would be backfilled as part of cut and cover tunnel construction project completion activities.
- 4th Street to the 7th Street/Metro Center Station Tail Tracks – This section of the Flower Street alignment would be built with the cut and cover construction method, which would require the relocation of utilities and the installation of soldier piles to create the required alignment structure box in Flower Street from 4th to 6th Street. Excavation of the top portion of the street and provision of a temporary concrete decking system between the solider piles would

occur in a phased approach to minimize impacts to Flower Street traffic by allowing a minimum of three traffic lanes to remain open during the day time period.

2.1.3 Construction Staging for the Project

During construction, the Project, similar to any tunneling project, would require construction staging areas for:

- Equipment assembly and storage
- Construction materials delivery and storage
- Materials production
- Dewatering activities
- Construction worker parking
- Access roads
- Temporary trailer offices
- Demolition staging
- Removal of excavated materials, including truck staging areas
- Other related construction activities.

Construction staging areas are temporary as they would only be required during duration of construction activities, which is estimated to be 37 months on Flower Street and 38 months in Little Tokyo for the Project. Staging areas would be located either within the street right-of-way or in off-street locations. As documented in the Final EIS, construction staging activities in the Flower Street segment from 4th and 6th Streets would be accommodated through temporary two lane traffic lane closures for the duration of construction as illustrated in Figure 2.1-3, with some additional short-term closures for specific construction activities, such as for solder pile efforts for cut and cover construction. Street detours and closures would be coordinated with the Los Angeles Department of Transportation (LADOT).

During construction of the Project, removal of tunneling material excavated in this segment would be handled from the construction staging areas along Flower Street, while tunnel boring spoils would be transported back along the alignment within the newly constructed tunnels and removed at the Mangrove site (former Nikkei site) located at the northeast corner of 1st and Alameda Streets in Little Tokyo. As illustrated in Figure 2.1-3, the Project would use two locations within the cut and cover excavation area along the eastern side of Flower Street to remove excavation materials and allow access to construction activities under the temporary concrete decking:

- Location 1: On Flower Street, just south of 4th Street; and
- Location 2: On Flower Street, just south of 5th Street.

Figure 2.1-2: Flower Street Segment Construction Methods of the Project

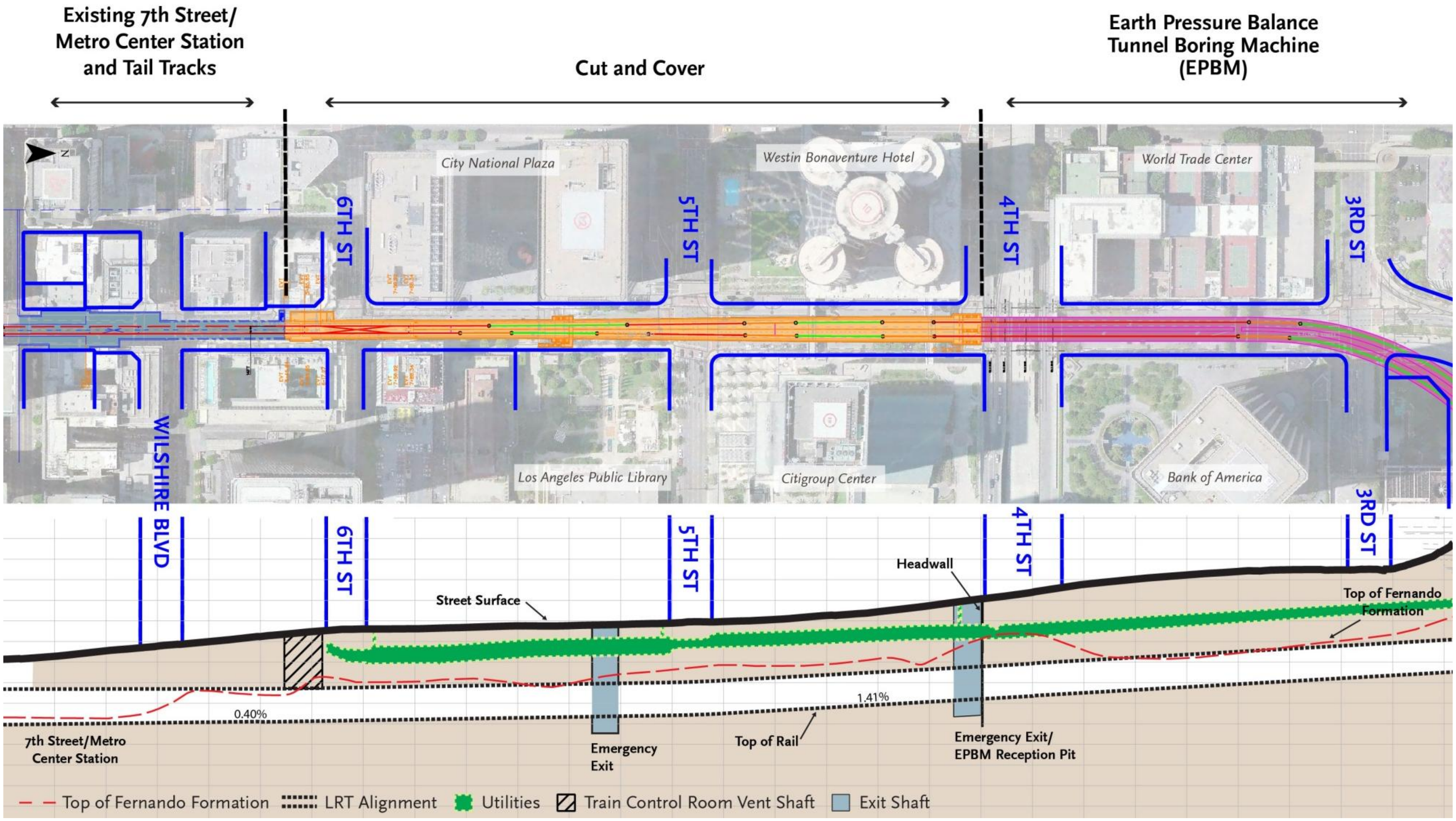


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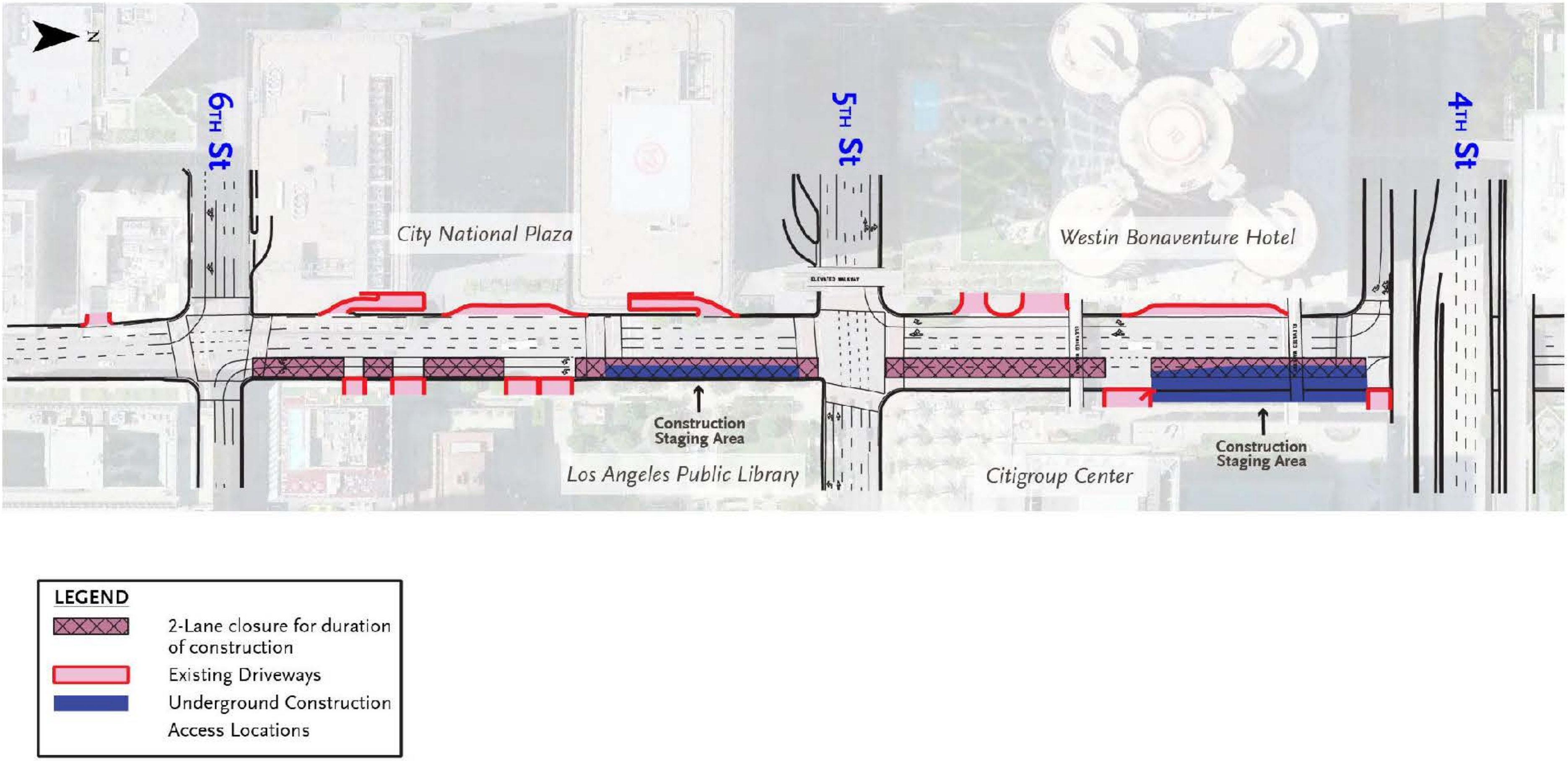
Figure 2.1-3: The Project – Construction Staging Areas



2.2 DEVELOPMENT OF ALTERNATIVES

This section presents the basis for identifying and evaluating the tunneling method alternatives in the SEIS. It includes a discussion of the Flower Street segment surface and underground constraints, Metro Rail Design Criteria (MRDC), and the tunneling construction methods that shaped the Project and the tunneling method alternatives. This section's discussion draws on and reflects the *Draft Flower Street Tunneling Method Alternatives Report (2014)* (Appendix A) prepared to document engineering and construction study efforts to identify and evaluate viable tunneling method options. This effort resulted in the identification of two possible tunneling method alternatives for further evaluation. The alternatives presented in the following section of this chapter, Alternatives A and B, are the same as Alternatives A and B discussed in the tunneling method alternatives report.

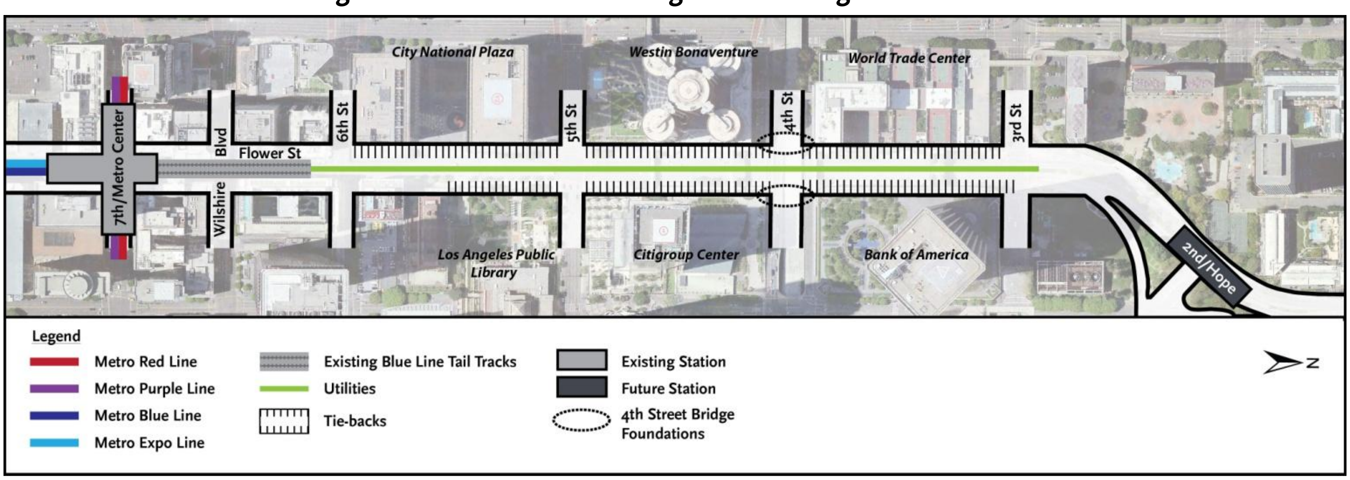
Alternatives A and B propose different combinations of underground construction methods as alternatives to the cut and cover method planned for the Project along Flower Street between 4th Street and 7th Street:

- Alternative A considers an open-face tunnel shield to construct a portion of the tunnels from 4th Street south to approximately 5th street followed by SEM construction of the balance of the tunnels and double crossover to the existing 7th/Street Metro Center Station.
- Alternative B considers extending EPBM tunneling on a lower alignment to avoid tie-backs from 4th Street south to approximately 5th Street followed by SEM construction of the balance of the tunnels and double crossover to the existing 7th/Street Metro Center Station.

2.2.1 Flower Street Existing Conditions

There are a significant number of surface and underground constraints combined with the requirements of the MRDC and desired future operations of the Regional Connector Project that have framed the design and construction of the Flower Street section, as illustrated in Figure 2.2-1.

Figure 2.2-1: Flower Street Segment Existing Conditions



Metro

2.2.1.1 Flower Street Segment Surface Context and Constraints

Flower Street has surface constraints to future subway construction which includes possible impacts to vehicular, bus, and shuttle traffic, impacts to pedestrian and bicycle circulation, and restricted access to off-street parking and adjacent properties. Flower Street is a one-way southbound major arterial ranging in width from five lanes between 3rd and 6th Streets to four lanes south of 6th Street. The street is heavily used by cars, local delivery trucks, buses, shuttles, and bicycles without a designated bike lane. There is heavy pedestrian activity on the sidewalks on both sides of the street, which is heaviest on weekdays with growing activity on weekends due to increasing numbers of residents and visitors.

Flower Street is lined with a diverse land use mix including high and mid-rise buildings consisting of commercial, office, hotel, and residential properties. Some of the specific properties include the Citigroup Center and Bank of America along the east side of the street, and the City National Plaza and World Trade Center on the west side; mid-rise office buildings converted to residential uses; the Standard Hotel and Westin Bonaventure Hotel; the California Club, and Maguire Gardens; and the Los Angeles Central Library garage.

2.2.1.2 Flower Street Underground Context and Constraints

There are significant underground constraints which pose challenges to the design and construction of the future rail tunnel on the Flower Street segment of the Regional Connector Project. These constraints include: 1) connecting with the existing narrow, shallow rectangular tail tracks structure of the 7th Street/Metro Center Station; 2) numerous abandoned underground tie-backs (used to support the excavation of building foundations) extending into the path of the future rail tunnel from adjacent building foundations along both sides of Flower Street south of 3rd Street; 3) unstable soil conditions; 4) many utilities; and 5) the 4th Street Bridge foundations which restrict the location of a future rail tunnel to a narrow vertical and horizontal corridor between the foundation piers.

Metro Rail Design Criteria (MRDC) has been developed and documented to reduce construction risks and to ensure the design and construction of rail system projects will meet Metro's long-term operational requirements. For the Flower Street segment of the Regional Connector project, MRDC criteria were used to design the Project and to evaluate the two tunneling method alternatives. In addition to the very constrained physical setting noted above, the design of the Project and two tunnel alternatives included rail transit operational considerations to address: 1) the alignment and grade of the connection with the existing 7th Street/Metro Center Station; 2) provisions for a new track crossover; 3) accommodation of a future 5th/Flower Station; and 4) design of the vertical alignment to facilitate the final operational speed of this vital central regional segment in the Metro light rail transit (LRT) system which will carry more trains than any other rail segment in Los Angeles. Changes to the vertical alignment will have potential impacts to the depth of the 2nd/Hope Station.

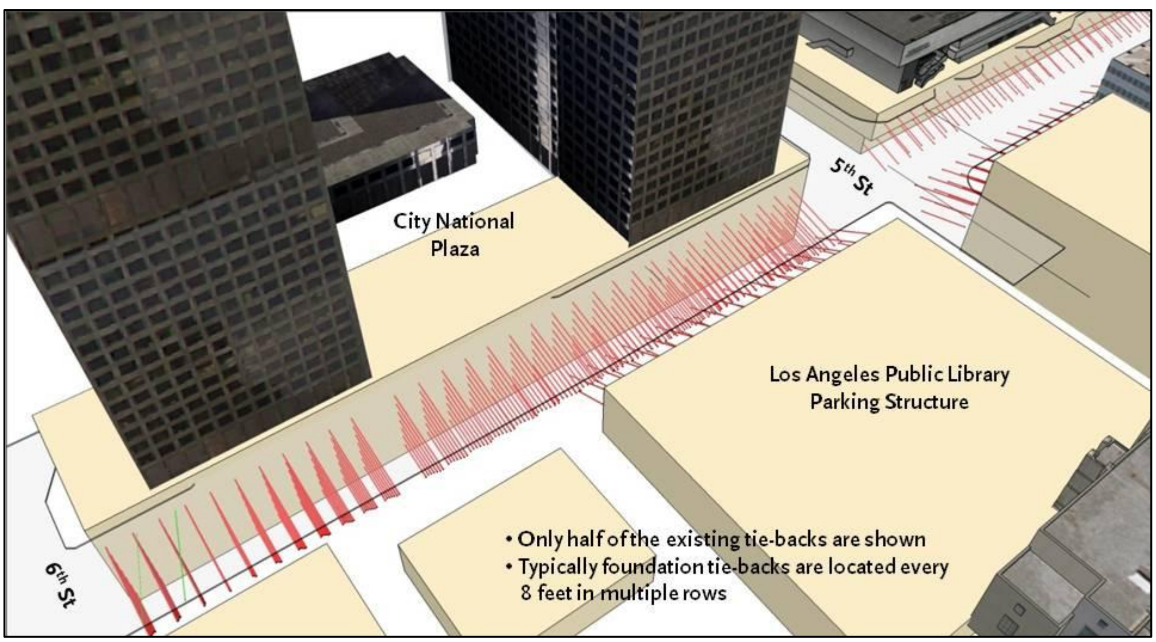
Connection to Existing 7th Street/Metro Center Station

In the Flower Street segment, the Regional Connector project alignment will connect with and operate from the existing 7th Street/Metro Center Station tail tracks structure located just north of the station's side loading platforms. Any tunneling connection must be designed to consider the fit with the geometry and size of the tail tracks structure as well as the alignment gradient required to ensure a smooth operational connection. In addition, a new double track crossover will be necessary north of the existing tail tracks as the Regional Connector project is a trunk system which will accommodate a significant number of LRT system trains. As identified in the MRDC, this new double crossover with No. 10 turnouts will provide operational flexibility during single-track operations, such as when one track is required to store a disabled train.

Tie-Backs

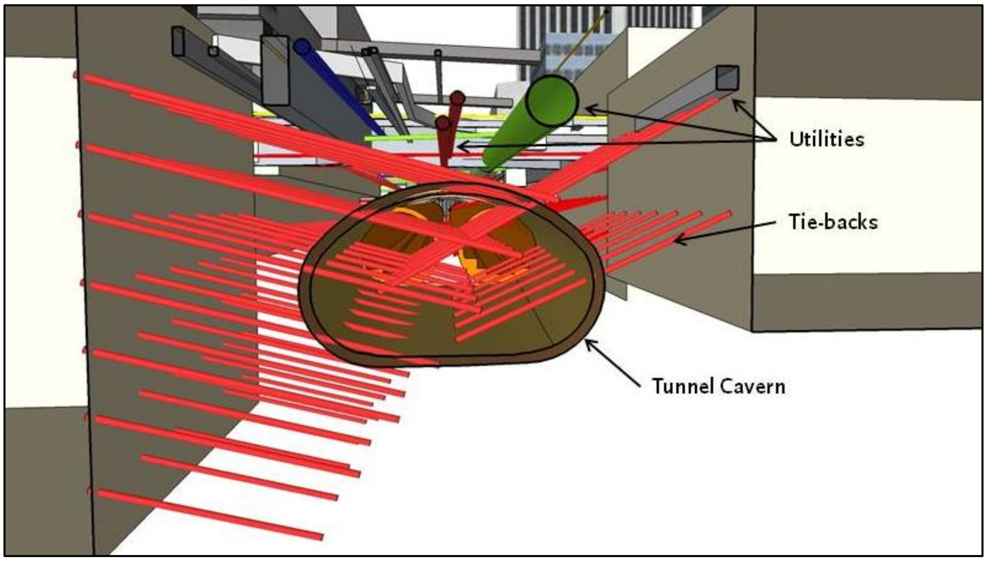
Tie-backs consisting of steel bars or cables grouted in the ground were used to laterally support the excavations for and construction of parking and building foundations for the Los Angeles Central Library garage, the Citigroup Center, and Bank of America along the east side of Flower Street, and the City National Plaza, Westin Bonaventure Hotel, and World Trade Center on the west side as shown in Figures 2.2-1, 2.2-2, and 2.2-3. Following industry practice, these tie-backs were abandoned within the street after construction was complete but it is uncertain if the tie-backs were de-tensioned. Along Flower Street, steel tie-backs are typically located every six to eight feet, and range in size from 30 to 90 feet in length, and extend below ground at a 15 to 45 degree angle across the width of the street right-of-way from both sides. There are multiple rows consisting of hundreds of tie-backs forming a “mesh” that are located within the Flower Street segment tunnel alignment, particularly south of 4th Street and with an even higher density south of 5th Street.

Figure 2.2-2: Overview of Flower Street Tie-back Locations



These tie-backs pose a major obstruction to tunnel construction under Flower Street, particularly for tunnel boring machines whose cutter heads could become entangled with the steel and cable tie-backs. Any construction method used on Flower Street must address removal of tie-backs by torch cutting or avoidance through a deeper alignment. Tie-backs pose another risk to tunneling activities as many of the existing tie-backs were installed when quality control of hole drilling and concreting was not as well-developed as it is today, and the tie-backs may become pathways for surface or groundwater to flow into the tunnels or excavation areas. During tunneling, groundwater flow along the edge of the tie-back can erode the surrounding soil resulting in potentially large amounts of soil and water flowing into the tunnel. If uncontrolled, this can progressively lead to ground settlement, which if allowed to continue can create a sinkhole at the ground surface.

Figure 2.2-3: Flower Street Segment Cross Section at Tunnel Cavern before Transition to Twin Tunnels (South of 5th Street) showing Tie-backs



Ground Conditions

The geologic conditions include the presence of groundwater, unstable soils, a challenging geologic interface between different soil or rock strata (mixed face), and hazardous gases. A description of these conditions and the challenges they pose to tunneling are presented below.

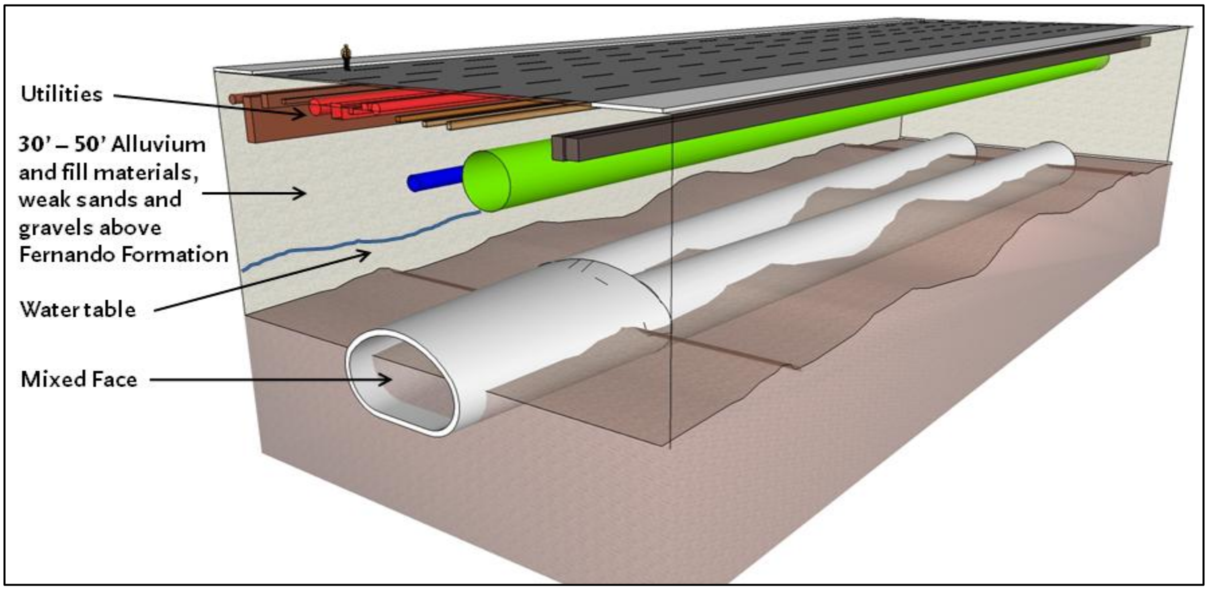
Before development of downtown Los Angeles, Flower Street served as a natural drainage path which became a stream during rainfall with seasonal variations of groundwater below ground. Today, development has affected groundwater flow due to cuts and fills altering the street's topography, the leveling and paving of streets, and constructing of buildings with deep parking structures. Groundwater is anticipated to follow the historic underground water course and pose problems for the stability of open-face tunnel excavations. Borings made for building sites along Flower Street between 5th and 7th Streets have encountered groundwater seepage at relatively shallow depths ranging from 15 to 35 feet, which is close to or within the proposed tunnel envelope. Groundwater within the lower portion of the alluvial deposits, most likely perched above the Fernando Foundation, has been reported at depths of 18 to 27 feet adjacent to Flower Street between 2nd and 5th Streets.

Ground conditions under Flower Street consist of fill and alluvial soils overlaying the Fernando Formation found at approximately 40 feet below ground surface, as shown in Figure 2.2-4:

- The fill is a combination of gravel, sand, silt, and clay mixed with construction debris. The depth of fill material varies along Flower Street.

- The water-bearing alluvial deposit consists of interlayered silty clays, sandy silts, clayey sands, and silty sands, with some sand layers containing variable gravel and cobbles.
- The Fernando Formation is primarily comprised of weak to very weak siltstone/claystone.

Figure 2.2-4: Flower Street Segment Ground Conditions



The Fernando Formation is comprised of a "weak" to "very weak" mix of siltstone and claystone which is a qualitative statement about its relative strength to support tunneling based on its unconfined compressive strength and the rock strength category of the International Society of Rock Mechanics (1978). The siltstone and claystone are weakly cemented or held together, which does not provide a strong condition for tunneling with an unsupported face, especially near the interface between the fill and alluvial soils and the Fernando Formation.

The geologic interface where the alluvial soils meet the Fernando Formation is a recognized geologic tunneling hazard. If the tunnel is located fully below the geologic interface, and there is adequate depth in the Fernando Formation (one tunnel diameter or approximately 22 feet) between the top of the tunnel and interface, tunneling risks are reduced. High tunneling risks occur when the geologic interface is located just above the tunnel, or within the face ("mixed face") of the tunnel being excavated.

When tunneling though weak rocks, the "stand-up" time, or the time the rock could accommodate an unsupported tunnel face, would not be long enough to avoid a collapse and ground loss resulting in tunnel failure without ground stabilization. Ideal tunneling conditions are competent ground void of water without any mixed-face conditions or obstructions with good "standup" time that accommodates an unsupported mining face for several hours without the risk of ground loss and resultant settlement. The existing top layer of alluvium, fill materials, sands, and gravels is unstable and not suitable for tunneling purposes without significant ground stabilization efforts as discussed below in Section 2.2.3.5. Even with extensive ground stabilization, such as grouting, total ground stability is not assured given the geologic conditions along Flower Street.

The major ground condition hazard on Flower Street is the alluvial materials running in an uncontrolled flow into the tunnel, and with the presence of groundwater, that risk is increased. Typically these risks are mitigated by either modifying the soft ground using grouting techniques to create ground conditions that inhibit water flow or through the use of pressurized-face (closed-face) TBMs, which can safely deal with such conditions with limited risk of ground loss.

In the past, both sides of the current I-110 Freeway were lined with oil wells. Today, construction still encounters methane and hydrogen sulfide (H2S), with recent methane gas occurrences observed during construction of the Wilshire Grand Plaza located at Figueroa and 7th Streets one block west of the Flower Street alignment. Several sections of the project tunnels will be constructed through Methane Buffer Zones; and Cal/OSHA has classified all of the underground construction for the Regional Connector as "potentially gassy." Metro requires specific designs and tunneling methods where gassy conditions are present including the use of pressurized face tunnel boring machines and the installation of double-gasketed segmental precast tunnel lining to prevent methane from entering the tunnels.

The aforementioned geologic conditions on Flower Street can contribute to ground instability, ground loss, and settlement if not addressed by the construction method including cut-and-cover or tunneling with ground stabilization techniques, such as grouting, to reduce the risks. Even with grouting, total ground stability during tunneling is not assured given the geologic conditions along Flower Street.

Utilities

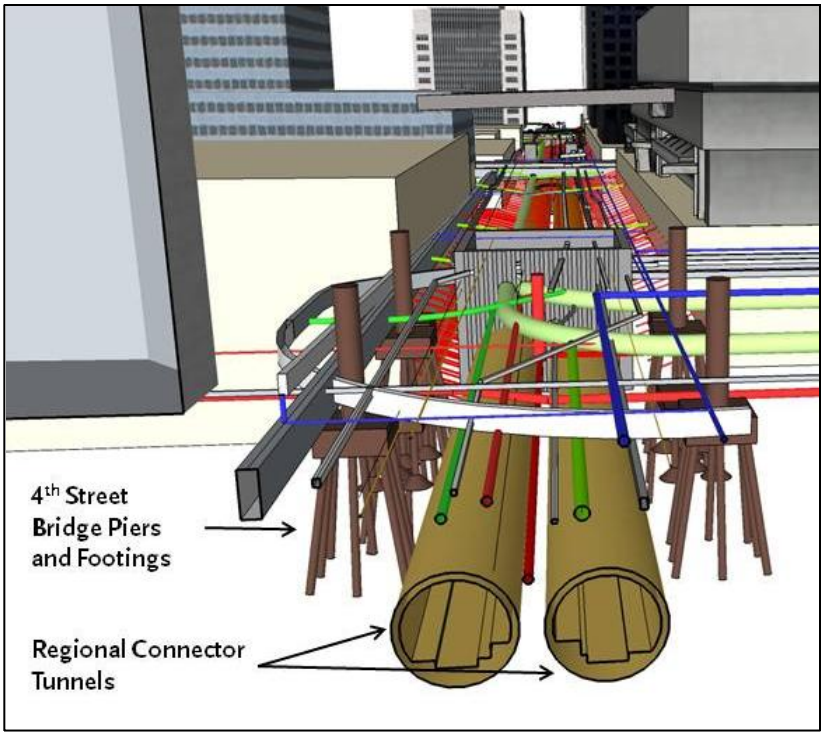
Construction of underground stations and guideway tunnel structures would result in impacts to existing utilities located under Flower Street. The utilities include gas, electricity, water, sewer, communication lines, and storm drains. The storm drains range in size up to an 84-inch diameter reinforced concrete pipe approximately 18 feet below the ground surface. Utility relocation will be required as part of the project for impacted utilities, regardless of the construction technique. Impact mitigation to existing utilities is typically provided by relocating and/or protecting the utilities in place. For the Project, utilities would be protected by hanging them underneath the street decking system provided in the cut and cover sections on Flower Street with construction occurring below the utilities. The exception is those utilities that are in conflict with installation of the street decking and support of excavation structures. For the other identified tunneling methods, such as the use of tunnel boring machines, utility relocation would be necessary for utilities that are located within a three to four foot zone known as the "support of excavation system corridor" around the tunnel. As discussed below in Section 2.2.3, tunneling methods other than cut and cover in the Flower Street segment have been identified as requiring ground stabilization due to poor ground conditions as discussed above and illustrated in Figure 2.2-4. The recommended ground stabilization technique is high-pressure grouting to stabilize ground conditions to enable tunneling.

4th Street Bridge Foundations

The 4th Street Bridge crosses Flower Street at a raised elevation to connect the west side of downtown with the higher Bunker Hill area to the east. The bridge is built on four sets of bridge piers located on either side of Flower Street with foundations that extend 64 feet below the surface on the west side and

83 feet below on the east side as shown in Figure 2.2-5. These foundations include piles that are "battered" or slanted at approximately 10 degrees from the vertical. Any tunnel located in this portion of Flower Street must "thread the needle" between these piers, or use a deeper alignment to avoid impacting the piers.

Figure 2.2-5: Flower Street Segment: 4th Street Bridge Foundations Looking South from 3rd Street



Future 5th/Flower Station

While the 5th/Flower Station is not included in the funded Regional Connector project, the Flower Street segment is required by action of the Metro Board of Directors to be designed and constructed so as not to preclude a future 5th/Flower Station. This station would be constructed between 4th and 5th Streets under Flower Street. Based on the MRDC, the future station should be built on a 370-foot long tangent alignment with a maximum vertical grade of one percent. The Project alignment using cut and cover construction allows for the construction of a station in the future. The ability of each of the tunneling alternatives to accommodate a future 5th/Flower Station is discussed in Section 2.3 of this chapter.

2nd/Hope Station

The Flower Street portion of the Regional Connector project has the challenge of connecting at one end with the existing and relatively shallow 7th Street/Metro Center Station tail tracks structure (42 feet from the surface to top of rail) and at the other end with the future 2nd/Hope Station located under Bunker Hill at a depth of 96 feet from top of rail (TOR) to the ground surface. This proposed station depth is due to the significant elevation variation from Flower Street to the higher Bunker Hill area where the 2nd/Hope Station is located. As the TOR elevation is fixed at the existing station and tail tracks, any modification to the project's vertical alignment depth along Flower Street, such as proposing a deeper alignment to avoid conflicts with the hundreds of tie-backs located under the street, may impact the elevation of the future 2nd/Hope Station. A deeper alignment on Flower Street would require shifting the 2nd/Hope Station even deeper resulting in higher risks associated with the construction of a deeper station.

2.2.2 Little Tokyo

Any changes to tunneling methods on Flower Street would have impacts in the Little Tokyo area. A deeper tunnel alignment to avoid tie backs in order to tunnel further under Flower Street than proposed in the Project would increase the amount of tunnel excavation materials to be handled through the tunnel portal at the Mangrove site in Little Tokyo. Under the Project, 81 percent of the tunnel excavation materials from construction of the Flower Street segment would be handled on Flower Street and 19 percent through the Mangrove site. Any reduction in cut and cover construction and the related reduction in the handling of the excavation materials along the Flower Street segment would increase the quantity of tunnel muck excavation materials at the Mangrove site in Little Tokyo.

2.2.3 Tunnel Construction Methods

This section provides an overview of tunnel construction methods considered for the Flower Street portion of the Regional Connector, both through the AA/DEIS/FEIS process described in Section 2.1.1 and for this SEIS as documented and supported in the *Draft Flower Street Tunneling Method Alternatives Report (2014)* (Appendix A). This report documented engineering and construction evaluation efforts to identify viable tunneling method options if possible to the planned cut and cover construction, and resulted in the identification of two possible construction method alternatives for further evaluation in this SEIS. As discussed below, the alternative construction methods considered include: earth pressure balance pressurized face tunneling, sequential excavation method, and open-face shield tunneling. Ground improvement techniques required to support implementation of the proposed tunneling alternatives are also discussed.

2.2.3.1 Cut and Cover Method

Cut and cover is a tunneling excavation method in which a concrete deck is installed over the underground construction site to minimize disruption to surface street operations, while allowing for construction activities to occur below. The excavation support system provides temporary support for the adjacent ground while the permanent cast-in-place concrete structures are constructed. The deck is then removed and the excavation is backfilled and the street is restored. This construction method involves a sequence of five activities illustrated in Figure 2.2-6. Cut and cover has been successfully used on past Metro rail projects, where the excavation support system of braced soldier pile and lagging minimized settlement and accommodated surface traffic operations and underground utility requirements. This construction technique is relatively unaffected by the variations and uncertainty related to the presence of man-made and natural obstructions and geologic conditions, such as those that exist along Flower Street.

Key benefits of this method for the Flower Street segment is that it allows for the easy removal (cut in place) of tie-backs as they are encountered during excavation, and that the support system can be revised to adapt to unforeseen underground conditions. Given the challenging geologic conditions in this segment, including perched groundwater and a geologic strata consisting of fill and alluvium over "weak rock," can be managed based on past cut and cover construction experience in downtown Los Angeles. The presence of weak rock, which is generally stiffer than the alluvium, provides for positive conditions for excavation stability with the soldier piles drilled into the relatively stiff Fernando Formation.

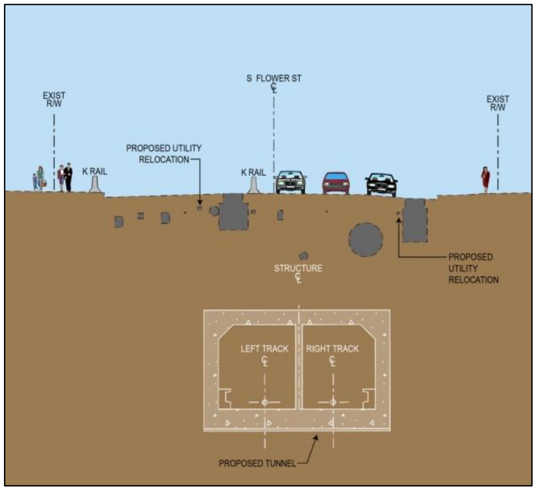
As this method has been used successfully for construction of all of the underground transit stations and major modern buildings in downtown Los Angeles, cut and cover was identified as the preferred construction method for the Flower Street segment of the Project north from the 7th Street/Metro Center Station tail tracks structure to the southern side of 4th Street, where tunnel construction would shift to the use of an EPBM tunnel boring machine. Small segments of the tunneling method alternatives studied in this SEIS also would be constructed with the cut and cover method, including shafts for tunnel boring machine retrieval, emergency exits, and a train control room.

2.2.3.2 Earth Pressure Balance Tunnel Boring Machine Method

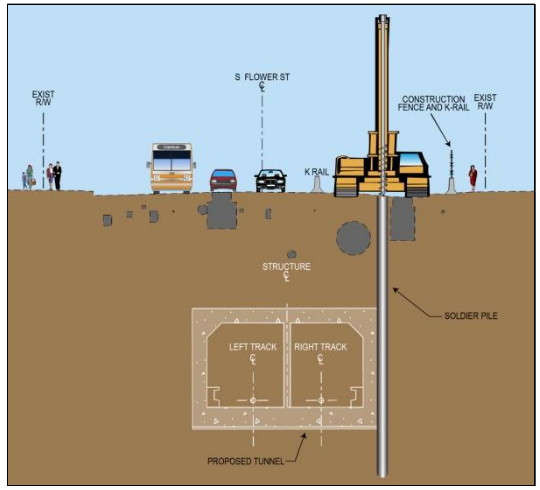
Earth pressure balance tunnel boring machines, commonly known as EPBMs, are one type of a pressurized face tunnel boring machine. EPBM refers to a pressurized closed-face TBM with the ability to apply pressure in the cutterhead chamber that is equal to the pressure of the ground being excavated by the rotating cutterhead located at the front of the machine as shown in Figure 2.2-7. The cylindrical shield behind the cutterhead is sealed and provides ground support accommodating safe installation of the tunnel lining. The soil excavated by the cutterhead is removed as a semi-solid in muck cars by rail or a conveyor as shown in Figure 2.2-8. EPBMs are most suitable for tunneling through soft soil and weak rock. They are the preferred type of tunnel boring machine for tunneling in the Los Angeles area due to past experience.

Pressurized face tunnel boring machines became the tunneling method of choice for underground rail projects in the Los Angeles area following the Metro Red Line construction experience with open-face tunneling, which resulted in excessive settlement on Hollywood Boulevard. Based on the recommendations of a specially convened Metro Tunnel Advisory Panel in 1995 the Metro Board instituted the policy to reduce or avoid construction risk of excessive settlement resulting from use of open-face tunnel shields by requiring pressurized-face (EPBM) tunneling. Since then, pressurized closed-face TBMs, and specifically EPBMs, have been used successfully for Metro Projects, such as the recent Eastside Extension project,

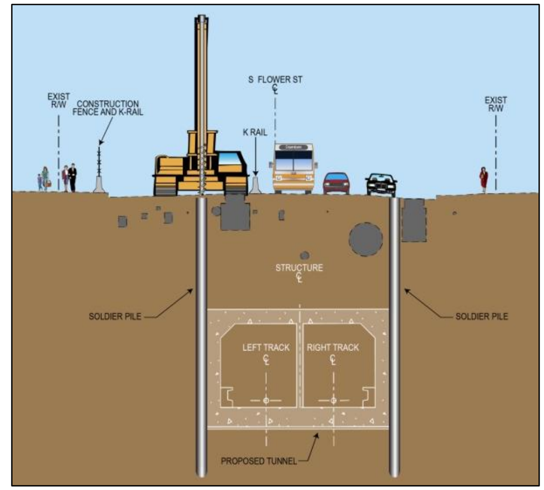
Figure 2.2-6: Cut and Cover Construction Method Stages



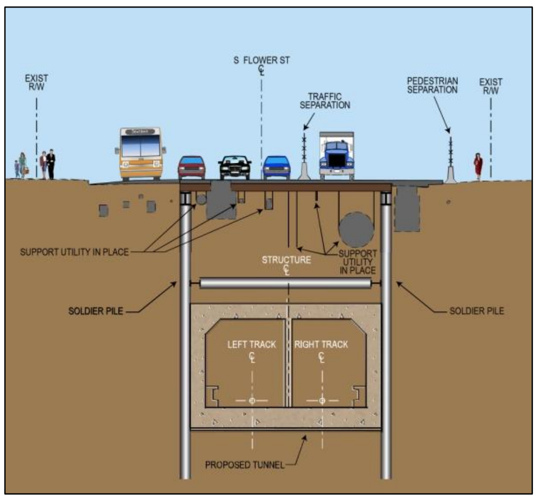
STAGE 1: Relocate Utilities



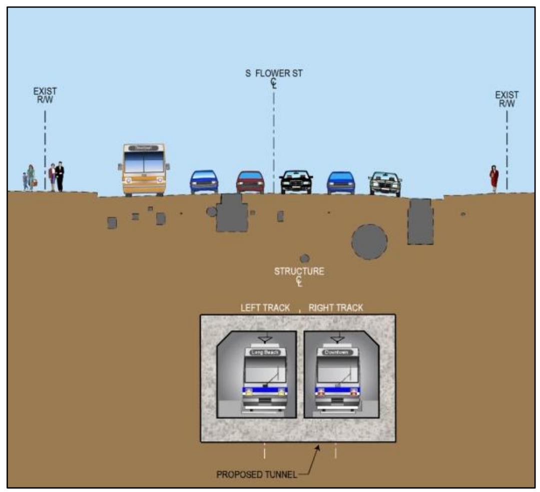
STAGE 2: Install soldier piles and construction shoring system



STAGE 3: Complete shoring system and excavate down from ground surface

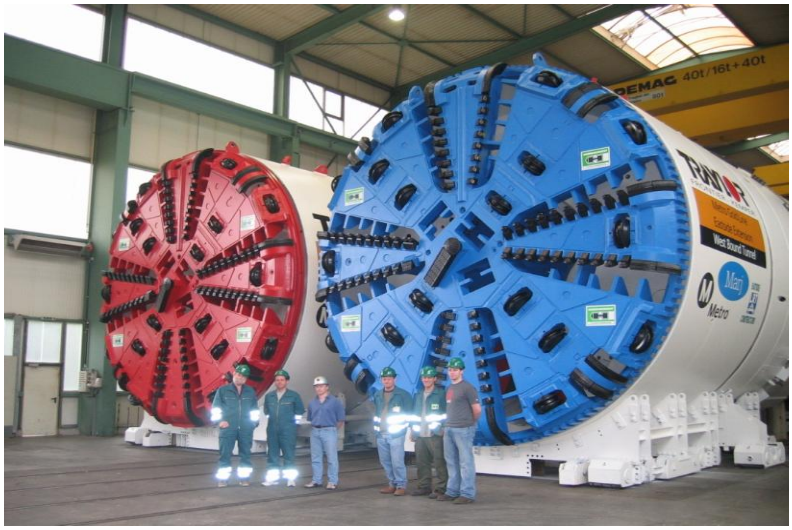


STAGE 4: Place a temporary concrete deck over excavated area and construct rail tunnel



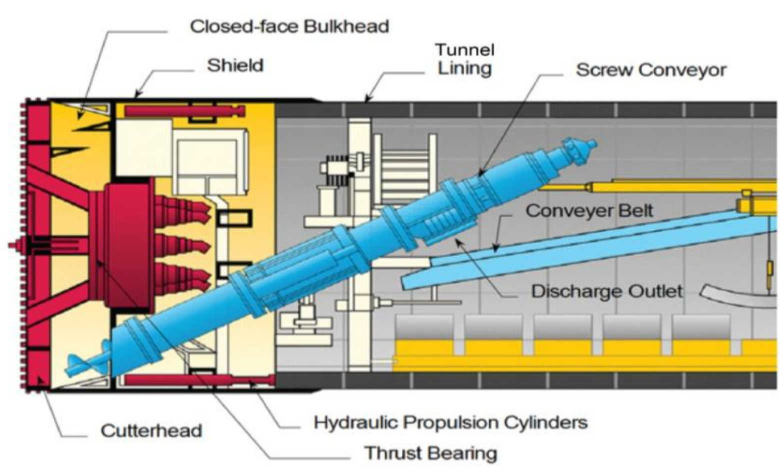
STAGE 5: Backfill and restore surface once tunnel box is complete

Figure 2.2-7: EPBMs Used for Construction of Los Angeles Eastside LRT Tunnels



The primary risk to the use of EPBMs under Flower Street is the presence of the many tie-backs. These represent a hazard to closed-face tunneling as the cutterhead is not capable of "chewing-up" or otherwise processing the steel tie-backs. If tie-backs were to become entangled with the cutterhead, the entangled and displaced tie-backs could disturb surrounding soils causing raveling of the adjacent ground resulting in settlement beneath utilities, roadway surfaces, and adjacent structures. To remove tie-backs in advance of the EPBM requires a very hazardous and time consuming process working through the spokes of the cutterhead or ahead of the cutterhead to manually cut and remove the tie-backs. For the Project, the overall risk in encountering the numerous tie-backs along Flower Street will be reduced through the recommended use of cut and cover construction south from 4th Street with EPBM tunneling only north of this location where tie-back locations are minimal and fairly well known.

Figure 2.2-8: Cross-section of Typical EPBM



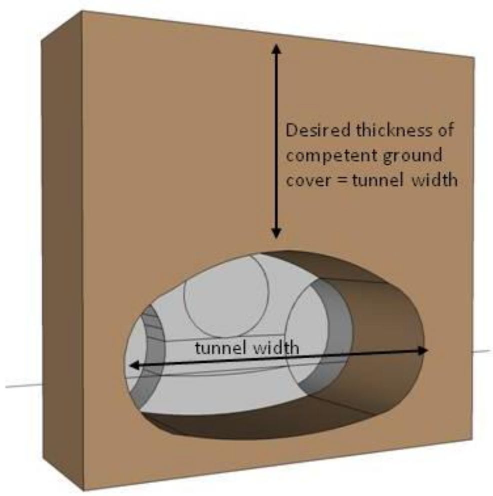
For the Project, EPBM tunneling has been recommended for use along Flower Street between the south side of 4th Street north to the 2nd/Hope Station with the provision that limited number of tie-backs are identified and removed in advance of tunneling by excavating tie-back removal pits with cut and cover techniques to remove the tie-backs within the tunnel corridor.

The two tunneling method alternatives studied in the SEIS assume that tunneling from Little Tokyo to the 4th and Flower Street intersection would be constructed as defined in the Project using EPBMs. Alternative B evaluates the extension of EPBM tunneling activities further south to the south side of 5th Street.

2.2.3.3 Sequential Excavation Method

Sequential Excavation Method (SEM) is a tunnel mining method that involves a sequence of excavation and installation of initial ground support systems, shown in Figure 2.2-9. In soft ground conditions, it typically uses conventional excavation equipment, such as excavators or roadheaders, together with an initial ground support system including lattice girders and sprayed-on concrete (shotcrete). SEM was considered for the Flower Street portion of the Project, but was identified as having a high risk for creating possible ground collapse and settlement conditions due to the shallow tunnel cover and unstable soil conditions. It is preferable to use SEM in deep tunnel alignments with adequate ground cover and favorable ground conditions not requiring extensive ground stabilization, such as through the use of grouting.

Figure 2.2-9: SEM Construction Technique



Industry practice: Ground cover should be no less than the width of the tunnel excavation.

Small tunnel sections are excavated and temporarily supported in a specific sequence.

SEM risk is reduced with a layer of competent ground cover above the tunnel equal to or greater than the width of the tunnel. Less cover increases the risk of ground settlement and large ground loss, and requires the use of extensive pre-support and ground stabilization efforts. If used on Flower Street, the SEM excavation would be approximately 60 feet in width to accommodate the two track system and double crossover. An SEM excavation of this size would require a suitable ground cover of 60 feet or more. Due to the alignment and grade constraints, an SEM tunnel on Flower Street would only have approximately 20 feet or less of poor soil cover. The low cover combined with ground water and gas conditions and a close proximity to utilities result in a high risk for excessive ground settlement, subsidence, or collapse. In addition, SEM relies upon the natural arching effect of the ground, and minimal arching is anticipated under Flower Street due to low ground cover, poor ground, and existing utilities. Use of SEM would require extensive use of ground stabilization, such as grouting discussed below. Even with grouting, total ground stabilization is not assured given the geologic conditions along Flower Street, and the high risk for ground settlement would remain.

While tie-backs, shown in Figure 2.2-10, would be directly removed from the tunnel face under SEM, the absence of a tunnel shield, which stabilizes the soil, increases the risk of creating unstable conditions where mixed-face conditions are present, as they are along Flower Street. Tie-backs can act as conduits for water to enter tunnel excavations, and may block effective grouting efforts.

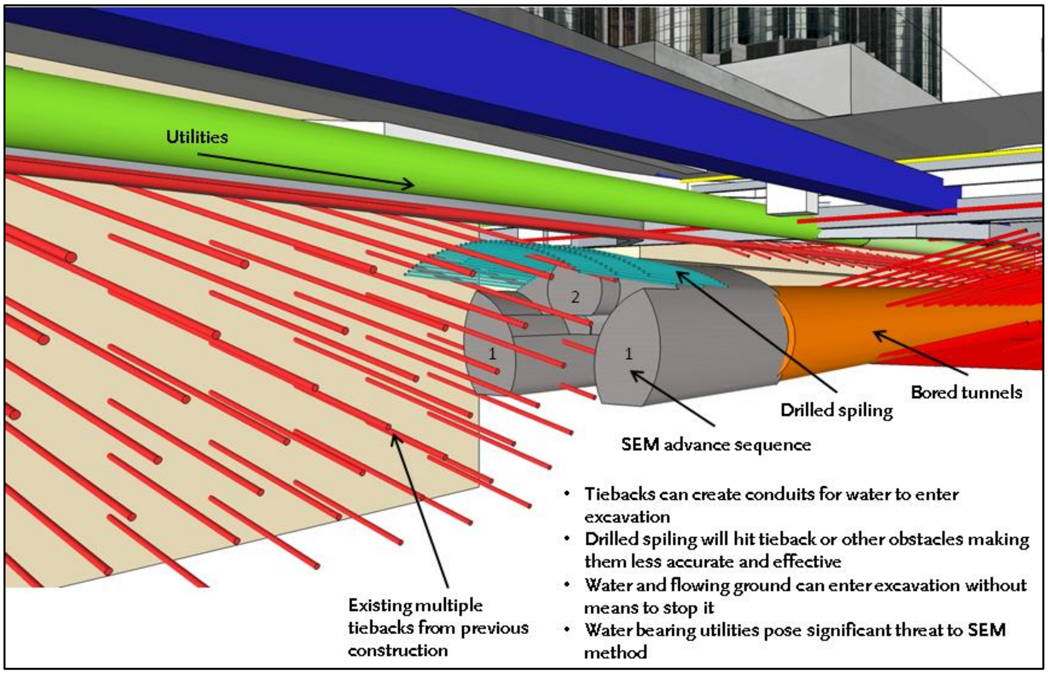
For the Project, SEM has been recommended for use in portions of the project alignment with stronger soil conditions and for smaller spaces, such as cross passages. Use of SEM has been identified and evaluated for construction of the two tunneling method alternatives in the portion of the Flower Street alignment that connects south from 5th Street to the 7th Street/Metro Center Station and tail tracks structure as described in Section 2.3, Alternatives Considered in the SEIS as follows:

- Alternative A – Open-face shield tunneling to just south of 5th Street where construction would change to SEM for one block to the south side of 6th Street where construction would become cut and cover to provide the connection to the existing 7th Street/Metro Center station tail tracks structure; and
- Alternative B – Earth pressure balance tunnel boring machine (EPBM) to the south side of 5th Street where construction would change to SEM for approximately one-and-a-half blocks to connect with the existing 7th Street/Metro Center station tail tracks structure.

During initial preparation of this SEIS, an alternative using SEM construction for the Flower Street segment from south of 4th Street south to the 7th Street/Metro Center Station, or possibly a full SEM alternative was considered. The use of SEM construction in the 4th to 5th Street Flower Street segment or further north to 3rd Street was identified as having a significantly higher risk than construction using an open-face shield or EPBM tunnel boring machine due to the existing ground conditions, and was removed from further consideration.

An SEM alternative would have a high risk for excessive settlement, uncontrolled subsidence, or collapse due to the width of the tunnel compared to the minimal thickness of poor soil cover possible along Flower Street. SEM increases the risk of tunnel collapse and threatens public and worker safety due to the absence of a tunnel boring machine (TBM) shield which assists in supporting the Flower Street segment's weak ground. Potential mitigation against subsidence or tunnel collapse with SEM methods, such as a pipe canopy or other support system, would be inadequate and too costly and slow to implement an SEM alternative.

Figure 2.2-10: SEM Construction Through Flower Street Tie-backs Looking North



2.2.3.4 Open-Face Shield Tunneling

An open-face TBM also called a "digger shield," is a steel shield equipped with an excavator like a backhoe to excavate the tunnel. The excavated material (muck) is moved by the excavator through the shield to muck cars or conveyor systems behind the shield. The shield provides ground support for erection of the precast segmental lining behind the excavator as the machine advances forward. The disadvantage of open-face tunnel boring machines compared to a pressurized closed-face TBM is the inability to support the face and prevent ground loss and groundwater and gas inflows. Ground control risks are always present when an open tunnel face is in alluvium and where water is present, or where a mixed-face heading is present, such as alluvium over the Fernando Formation, as occurs along Flower Street, as shown in Figure 2.2-4. In such conditions, the ground at the heading of the open-face shield could become unstable with a high risk of unacceptable loss of ground, raveling, running, or flowing of disturbed soil into the tunnel heading all of which can result in excessive ground settlement and possible creation of a sinkhole at the ground surface.

This was the case during the construction of the Metro Red Line A146 contract (segment between Pershing Square and 7th Street/Metro Center stations) when the tunnel was constructed using the open "digger" shield shown in Figure 2.2-11. In portions of the alignment, the upper part of the tunnel encountered cohesionless sand, which ran uncontrolled into the tunnel face and created a void ahead of and over the tunnel shield. A number of ground losses occurred during tunneling with volumes as great as 36 cubic yards (more than the size of a full-size automobile). Further surface settlement was avoided by a soil stabilization program consisting of holes drilled from the ground surface to backfill the voids created by the ground losses with concrete, known as compaction grouting.

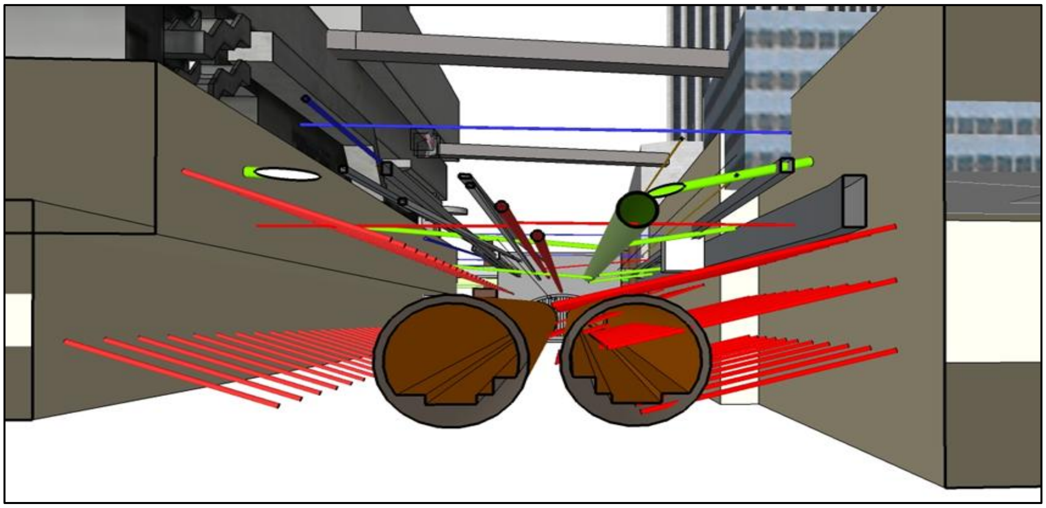
Figure 2.2-11: Open-Face of Digger Shield used to Construct Metro Red Line Contract A146 Tunnels

Open-face shield tunneling has the advantage that when an obstruction, such as a tie-back is encountered, it can be more easily removed via openings in the shield as illustrated in Figure 2.2-12. The tunnel face is accessible and the tie-back can be removed in pieces manually by torch cutting or metal cut-off saw. It is a time-consuming effort that requires grouting where unstable soils are present.

The Metro Red Line Hollywood experience with ground loss and collapse using open-face shield tunneling served as the baseline example of the methods and risks that the Metro Board of Directors has directed staff to avoid on future subway projects. Based on that Metro tunneling experience, open-face tunnel shields, and any tunneling method that would have to rely upon grouting from inside the tunnel to ensure safe construction, with the exception of grouting for cross passage construction, are now deemed by Metro to result in an unacceptable level of risk to workers and the public. Grouting from the tunnel face does not reliably provide the needed ground improvement beneath streets and utilities, particularly under large storm drains similar to the one located in the center of Flower Street, and would result in “windows” of ungrouted soil which would become unstable as shown in Figure 2.2-13.

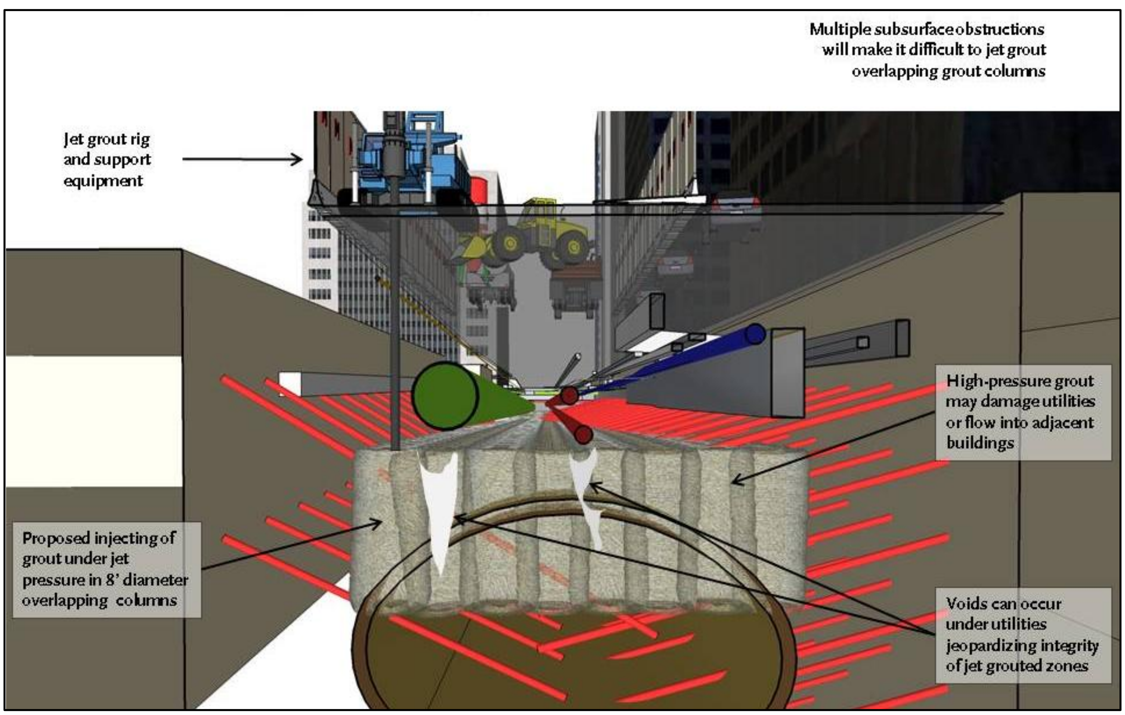
For the Regional Connector Project, open-face shield tunneling was considered and rejected for the Project due to high risks related to possible uncontrolled settlement in the alluvial and fill materials underlying the street and the mixed-face geologic conditions identified along Flower Street. The resulting instability of the tunnel face would pose unacceptable risks without complete soil stabilization, such as the use of grouting. Even with grouting, total ground stabilization is not assured with the geologic conditions along Flower Street, and the risk for ground settlement would remain.

Figure 2.2-12: Open-Face Shield Tunnel Construction Through Flower Street Tie-backs (at SEM Cavern Interface with Twin Tunnels)



Open-face shield tunneling was considered and evaluated in Alternative A for construction of an approximately one block portion of the tunnels between 4th and 5th Streets. The balance of the underground construction considered in Alternative A from the end of the open-face shield tunneling at 5th Street to the 7th Street/Metro Center Station evaluated the SEM method of underground construction using the constructed tunnels at 5th Street for underground access.

Figure 2.2-13: Possible Grouting Impacts Related to SEM Construction



2.2.3.5 Ground Improvement Methods

Given weak ground soils, perched groundwater, and mixed-face geologic interface conditions along the Flower Street segment, ground improvement methods have been identified and evaluated for SEM, open-face shield, or EPBM tunneling south along Flower Street from 4th Street. These ground improvement methods include permeation grouting, ground freezing, compaction grouting, compensation grouting, and jet grouting, and would be performed from the ground surface as discussed below.

Permeation Grouting

Permeation grouting involves filling the pore spaces in soil with chemicals or fine cement, while individual soil grains are not disturbed or moved, to solidify the soil and reduce the capacity for water to flow through the soil. The structure and dimension of the soil pore spaces dictate the type of grout that can be effectively used. Generally, permeation grouting is suitable for sandy soils containing less than 10 to 20 percent silt or clay. As documented in *The Geotechnical Baseline Report*, the silt and clay content varies from 70 percent in the alluvial soils layer to greater than 90 percent in the Fernando Formation.

For tunneling projects, permeation grouting is done from the ground surface or, when unusual or extreme conditions dictate, from the tunnel face. This grouting method requires drilling and injecting grout into the targeted ground areas requiring stabilization. Typical drilling spacing is four to six feet between grout holes. Working from the surface permits control of the grouting to the targeted ground requiring improvement. Permeation grouting from the tunnel face requires horizontal and sub-horizontal grout holes which can easily miss the targeted areas, and therefore not able to achieve the required ground improvement. In addition, the resulting grouting may be compromised by the many tie-backs and utilities located under Flower Street. Locating conflicting utilities to avoid issues with grouting efforts would be similar to cut and cover utility relocation efforts and would require additional time and cost, and still may result in extensive construction impacts due to the unknown exact location of some utilities.

This ground stabilization technique was not recommended for further consideration on Flower Street due to the soils content (silt and clay) of the alluvial conditions which would limit the extent of grout permeation, making it difficult to improve the ground conditions. The interlayered nature of the sands and fine soils would also make it difficult to achieve a uniformly grouted condition, and some areas would not be groutable or marginally groutable due to soil conditions. With so many utility lines located under Flower Street, there is a high risk that permeation grouting would damage or penetrate existing and relocated utility lines causing service disruptions and halting construction. The inherent and unavoidable but temporary impact from permeation grouting is the significant surface disturbance due to grouting equipment and possible grouting spillage.

Ground Freezing

Ground freezing is based on withdrawing heat from the ground soil as the process converts in-situ water in the soil pore spaces into ice. The ice binds the soil particles imparting strength to the frozen soil mass. For the creation of a frozen soil body, a pattern of vertical, and sometimes horizontal, freeze pipes are installed in drilled holes. Each freeze pipe consists of an open-end inner pipe and a closed-end freeze pipe. The inner pipe is filled with a cooling medium, usually brine or liquid nitrogen. The coolant removes the heat from the soil, and the freeze takes place over time as the frost penetrates the soil. Setting up for the freeze, establishing the freeze, tunneling, and demobilizing the freezing is time-consuming taking months to complete and would occupy a minimum of two to three traffic lanes on the surface. It is not feasible to do freezing from an underground position due to the challenges in drilling shafts to position the pipes at exactly the right location around the future tunnel envelope. There is also a significant challenge in obtaining a full freeze zone coverage due to the significant number of utilities and tie-backs located under this street segment.

This ground stabilization technique was not recommended for further consideration and was identified as not feasible on this project. In the Flower Street segment, once the limited perched groundwater is frozen, the freeze could not continue because the alluvial soils are substantially dry and do not contain a sufficient quantity of water to freeze. Along Flower Street, the freeze would be incomplete, not uniform and continuous, and would provide insufficient ground stability for tunneling.

Compaction Grouting

Compaction grouting involves injection of very stiff grout at a high pressure into the ground creating grout columns and densifying the surrounding soils at the injection points. The grout holes are typically vertical and spaced on a grid of six to 12 feet apart. The resulting grout columns are not designed to overlap or even touch each other, as the soils left in place between the columns are presumed to be densified. Developed in the 1970s, compaction grouting has had limited use as subsequent compensation grouting development provided a more manageable and effective technique for tunneling applications. Today, compaction grouting is seldom used as a tunneling settlement mitigation method. The introduction of pressurized-face tunneling has reduced tunneling ground losses, which further decreases the need for the use of this technique.

This ground stabilization technique was not recommended for further consideration as it was seen as not being effective for preventing large ground loss and reducing the risk of surface subsidence along Flower Street if tunneling were continued south of 4th Street. The alluvial deposits located along the Flower Street segment would be difficult to improve by compaction grouting and would not prevent an unstable tunnel face with raveling or running ground. Keeping the placement of the grout in a globular mass sufficient to provide density required for tunneling would be difficult due to the interlayered nature of the ground soils, as well as the many utilities and abandoned tie-backs located under Flower Street. Relocation of utilities would require additional time and cost, and may still result in extensive construction impacts due to the unknown precise location of some utilities.

Compensation Grouting

Compensation grouting is used concurrently with tunneling or excavation to mitigate ground settlement resulting from excavation or tunneling activities. Steel or plastic grout pipes with sleeve ports are installed in holes drilled from the surface or grout pits prior to tunneling. Compensation grouting displaces the surrounding soils at the grouting points along the grout pipe to compensate for settlement caused by construction activities. As the grout penetrates the ground, it forms a network of wedges and displaces and "heaves" the ground to compensate for settlement. As tunneling advances and settlement occurs, compensation grouting is activated to maintain settlement within acceptable limits. Once the ground movement is stabilized, the grouting pipes and equipment are abandoned in place. Implementation along Flower Street would require shafts to be drilled within the street ROW to install the grout pipes, whose placement may be constrained by the tie-backs and utilities located under Flower Street. Similar to other grouting techniques, utility relocation would require additional time and cost, and may still result in extensive construction impacts due to the unknown precise location of some utilities.

This ground stabilization technique was not recommended for further consideration to provide ground improvement in support of tunneling efforts on Flower Street. Compensation grouting would be only suitable for mitigation of settlement of utilities along this segment of the project, and would be completely ineffective in avoiding ground loss and collapse of the tunnel face leading to a sinkhole in the street by open-faced TBM or SEM tunneling.

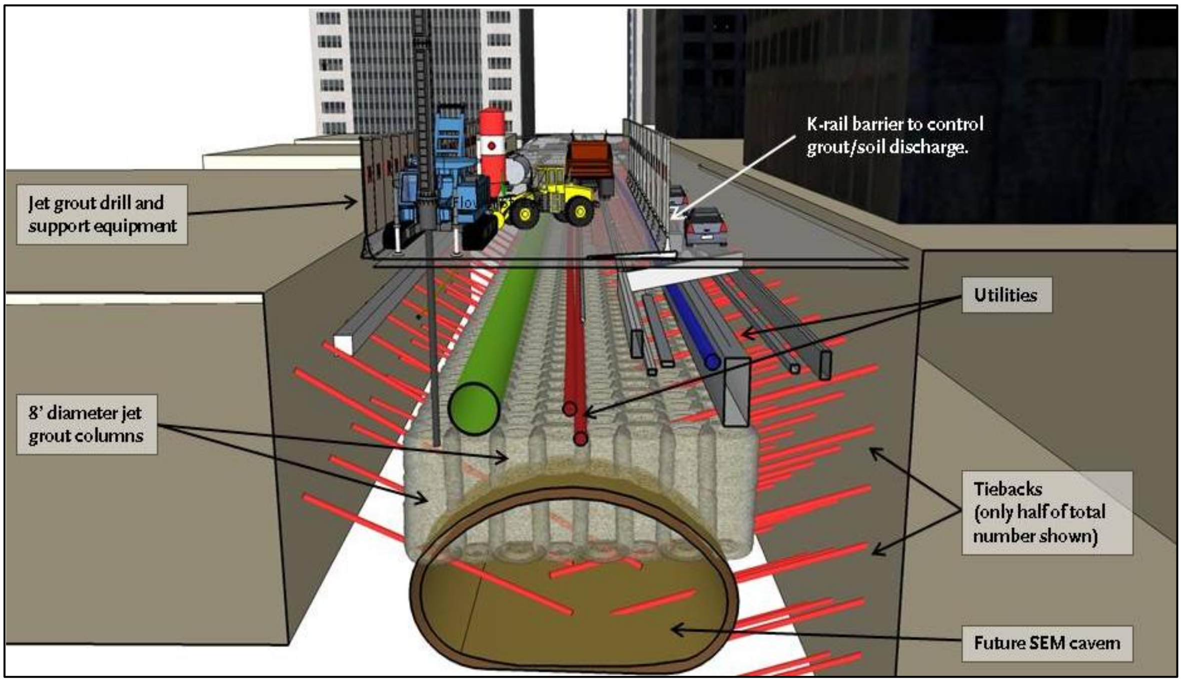
Jet Grouting

Jet grouting mixes cement grout with the in-situ soil to result in a stronger mixed grout-soil material. With jet grouting, the weak soils under Flower Street would be strengthened resulting in "firm" ground conditions that would allow for tunneling and in some cases, reduce tunneling risks. The technique requires drilling grout holes on a five- to-10 foot spacing throughout the area to be grouted such that the neighboring grout-soil mix columns would overlap or touch each other. Grout holes would typically extend from the ground surface creating vertical grout-soil mix columns extending approximately 40 feet from the ground surface to reach the relatively stronger Fernando Formation, as shown in Figure 2.2-14. The resulting grout columns would improve ground stability, but may be compromised by the many tie-backs and utilities along Flower Street.

Jet grouting was identified as the most suitable method to improve the existing soil conditions along Flower Street, and to provide adequate strength given the width and depth of the required grout-soil mix block above the tunnel crown. The method has relatively good control over assuring the quality of grouted soil blocks but has remaining concerns of extensive environmental impacts on the street, the risk of utility damages, and the risk of incomplete ground improvement. A jet grouting canopy, installed by horizontal drilling, alone would not provide adequate support for the tunnel under Flower Street. A major risk is the interference created by utilities that prevent full coverage by jet grouting. As previously illustrated in Figure 2.2-13, it would not be possible to fully jet grout below the 84-inch diameter storm drain and a "window" of ungrouted ground would be present above the tunnel. The ungrouted ground would tend to transmit groundwater and, if intersected by the tunnel excavation using SEM or open-face shield methods, would be the point where an uncontrollable run or flow of soil in the tunnel would start, which in turn could lead to a sinkhole at the street surface.

Ground stabilization through jet grouting would be required for the open-face shield tunneling and SEM tunnel construction portions of both tunneling alternatives A and B primarily due to the unstable soil conditions along Flower Street. Without an extensive jet grouting program, construction of these alternatives would have a substantial risk of tunnel face instability with the high potential for soil runs during tunneling by open-face shield or SEM, particularly when dealing with tie-backs.

Figure 2.2-14: Grouting Equipment and Impacts



This method has extensive street level environmental impacts due to the type and size of grouting equipment required for grout production and delivery, and the challenge in controlling grouting activities. Grouting equipment includes grout drilling rigs, a mixing plant, compressors, pumps, generators, cement delivery trucks, and support machinery. The drilling rigs are typically more than 100 feet in height. Jet grouting requires high grouting pressure, typically 6,000 pounds per square inch (psi), and this high pressure makes it difficult to control spills and unintended grout discharges. Grouting spills and discharges typically occur when uncoupling hoses and when the grout under pressure breaks out either around the grout pipe casing or through the ground. With so many utility lines located under Flower Street, there is a high risk that high pressure grouting can damage or penetrate into the utility lines causing major service disruptions and halting construction. An example of probable jet grouting equipment and resulting impacts are shown in Figure 2.2-15 for a similar LRT tunneling project when under construction in San Francisco for the MUNI system.

As discussed in Section 2.3 of this chapter and in Chapter 3, Transportation and Circulation, Section 4.1 Visual Quality, Section 4.2 Air Quality, Section 4.2 Climate Change, Section 4.4 Noise and Vibration, 4.6 Energy Resources, and Chapter 5, Comparison of the Alternatives, grouting would have traffic and transit, air quality, climate change, noise and vibration, visual and aesthetic, historic resource, and environmental justice impacts.

Figure 2.2-15: Grouting Equipment and Impacts (San Francisco, MUNI LRT Tunneling, 2013)

2.3 ALTERNATIVES CONSIDERED IN THE SEIS

As analyzed and documented in the *Draft Flower Street Tunneling Method Alternatives Report (2014)* (Appendix A) and summarized in Table 2.3-1, Alternatives A and B propose different combinations of underground construction methods as alternatives to the cut and cover method planned for the Project along Flower Street between 4th Street and 7th Street. This section presents an overview of the construction methods for each of the tunneling method alternatives, including the need for ground stabilization for the proposed construction methods along the Flower Street segment, construction staging requirements, and an evaluation of the tunneling method alternatives.

2.3.1 Construction Methods and Staging for Tunneling Method Alternatives

Construction methods for Alternatives A and B propose different combinations of underground construction methods as alternatives to the cut and cover method planned for the Project along Flower Street between 4th Street and 7th Street.

1. EPBM/Open-Face Shield/SEM Project Profile Alternative (Alternative A) – a combination of EPBM, Open-Face Shield and SEM construction methods; and with similar horizontal and vertical alignment profiles to that of the Project.
2. EPBM/SEM Low Alignment Alternative (Alternative B) – a combination of EPBM and SEM construction methods with a similar horizontal alignment profile, but a lower vertical alignment profile, than that of the Project.

The two tunneling alternatives have the following alignment variations from that of the Project in order to address geologic conditions and other subsurface project constraints as previously discussed:

- Horizontal alignment – Along Flower Street, Alternatives A and B remain located under the existing street right-of-way. The horizontal alignments of these alternatives continue on tangent track from the 2nd/Hope Station south through the 4th Street Bridge foundation piles to 5th Street. The alignments then would transition from a wider oval track center to a narrow track center as the alignment approaches the planned double crossover immediately north of the narrow, rectangular 7th Street/Metro Center Station tail tracks structure.

  As further discussed below in Section 2.3.2.1 describing Alternative A and Section 2.3.2.2 presenting Alternative B, these alternatives would have a short horizontal transition distance from the 5th Street section of the alignment to the double crossover located before the existing tail tracks structure, which would limit the LRT operating speed to 35 mph as compared to the 55 mph specified by the MRDC Operating Standards, and provided by the Project.

- Vertical alignment – Alternative A would have the same vertical profile as the Project with an average depth of 40 feet to top of rail (TOR) below ground level. The vertical alignment of Alternative B has a “sag” or a low point of 105 feet to TOR below ground level. The sag alignment reduces the probability of the tunnel alignment impacting the 4th Street Bridge foundations and encountering tie-backs located under Flower Street between 4th Street and just south of 5th Street. The abandoned steel tie-backs typically range from 30 to 90 feet in length, and extend below ground at a 15 to 45 degree angle to a depth of approximately 45 to

64 feet across the width of the street right-of-way from both sides. The 4th Street Bridge foundations extend 64 feet below the surface on the west side and 83 feet on the east side. Alternative B's lower alignment profile at 105 feet to TOR avoids tunneling impacts from the tie-backs and bridge foundations. It does result in a greater depth for the 2nd/Hope Station (128 feet) compared to the station depth for the Project and Alternative A (96 feet).

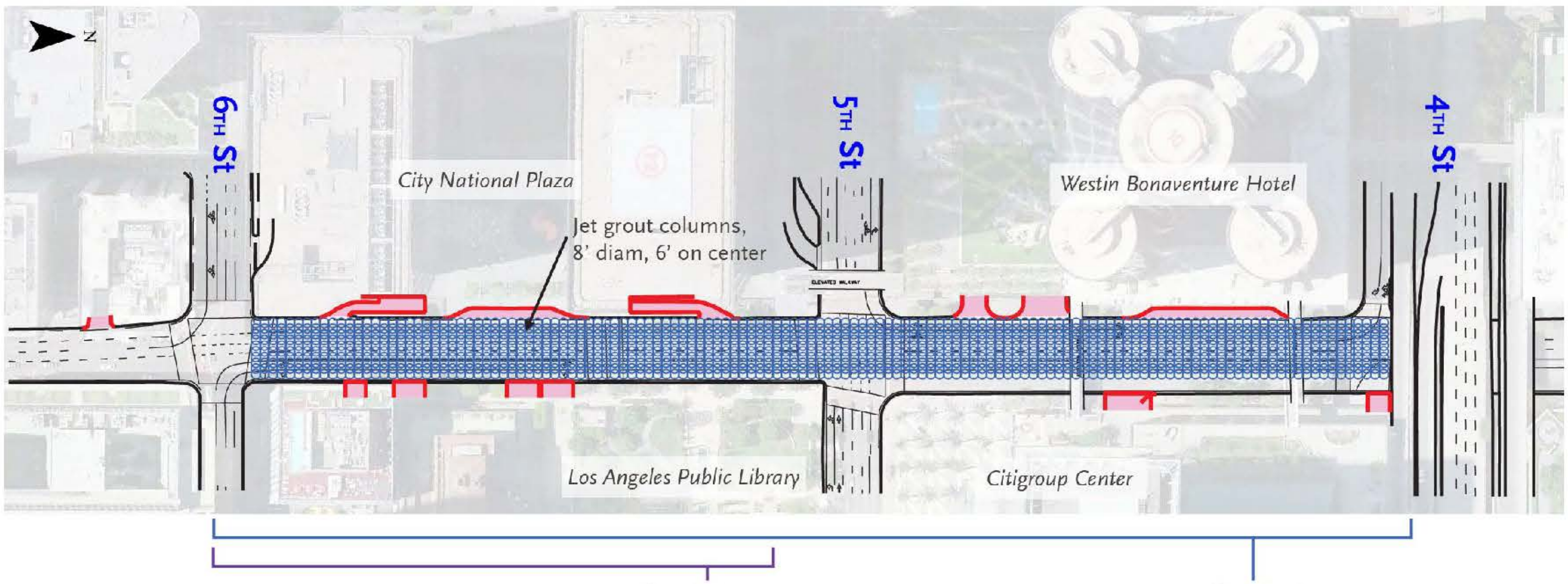
In addition to the construction methods described above, the tunneling method alternatives would require small segments of cut and cover construction for shafts to allow for emergency exits, tunnel boring machine retrieval, and train control room ventilation. Both alternatives would require the use of grouting to stabilize Flower Street soil conditions to allow for tunnel construction as shown in Figure 2.3-1. Alternative-specific shaft requirements are described in the discussions about each alternative below.

Table 2.3-1: Comparison of Project and Tunneling Method Alternatives

	The Project	Alternative A EPBM/Open-Face Shield/SEM Project Profile	Alternative B EPBM/SEM Low Alignment
Construction Description[1]	• EPBM to south of 4th Street • C&C from 4th Street to 7th Street/Metro Center Station tail tracks	• EPBM to 4th Street • Open-face shield TBM to 5th Street • SEM from 5th to 7th Street/Metro Center Station tail tracks	• EPBM to south of 5th Street • SEM from 5th Street to 7th Street/Metro Center Station tail tracks
Horizontal Alignment	Baseline	Slight shift to west of Project alignment	Slight shift to west of Project alignment
Depth To Top of Rail	40’	40’	40’ to 105’ (at sag)
Mucking Locations	• Flower Street • Mangrove site in Little Tokyo	• Flower Street (for emergency exits and train control room vent only) • Mangrove site in Little Tokyo	• Flower Street (for emergency exit and train control room vent only) • Mangrove site in Little Tokyo
Handling of Flower Street Segment Excavation Materials (by location)	Flower Street Site: 81% Mangrove Site: 19%	Flower Street Site: 25% Mangrove Site: 75%	Flower Street Site: 20% Mangrove Site: 80%
Corresponding Excavation Materials/ Construction Trucks Per Day	On Flower Street segment: 32 In Little Tokyo: 8	On Flower Street segment: 18 In Little Tokyo: 22	On Flower Street segment: 8 In Little Tokyo: 32
Construction Shaft	TBM retrieval shaft at 4th Street (part of cut and cover construction)	TBM retrieval shaft south of 4th St.	EPBM removed through Mangrove portal
Permanent Shafts	• Emergency exit south of 4th Street • Emergency exit south of 5th Street • Train control room vent shaft 7th Street/ Metro Center tail tracks structure	• Emergency exit south of 4th Street • Emergency exit south of 5th Street • Train control room vent shaft 7th Street/ Metro Center Station tail tracks structure	• Emergency exit south of 5th Street • Train control room vent shaft 7th Street/ Metro Center Station tail tracks structure
2nd/Hope Station Depth	96’	96’	128’
Maximum Design Speed	55 mph	35 mph	35 mph
Double Track Crossover Before 7th Street/Metro Center Station	Yes	Yes	Yes
Future 5th/Flower Station	Center platform with mezzanine	Side platform with no mezzanine	Side platform with mezzanine Requires tunnel reconstruction
Project Delivery Duration (months) • **Construction** • **Pre-Construction Activities**[2] • **Total Duration (difference)**	78 -- 78	93 (+ 15 months) 29 122 (44 months or 3.7 years longer)	85 (+ 7 months) 29 114 (36 months or 3 years longer)
Project Cost (Millions, YOE)3	$171	$295-332[4] (+$124 to $161 more than the Project)	$295-332[4] (+$67 to $95 more than the Project)

Notes: [1] **Construction Techniques** include C&C - Cut and cover; EPBM- earth pressure balance tunnel boring machine; SEM- sequential excavation method. [2] **Pre-construction Activities** include engineering design revisions and re-procurement of the design-build construction contract. [3] **Project Cost YOE** is the year of expenditure using 2017 as mid-point of construction. [4] **Project Cost** Range for two alternatives provides a low and high cost estimate based on risk. The range does not include increased costs resulting from procurement delay, construction delay, or escalation due to delays.

Figure 2.3-1: Grout Holes Required on Flower Street for Alternatives A and B



LEGEND

- Jet Grout Column
- Existing Driveways

Alternative B:

- Jet grouting south of 5th St to 6th St
- Two lane closure required at a time
- Grouting duration estmated to be a total of 8 months (possibly up to 16 months depending on underground conditions encountered) for this alternative assuming 2 drill rigs and the following:
  - 5-day mobilization
  - 5 working days per week
  - One ten-hour shift per day
  - 3-holes per shift per rig
- Grouting is performed concurrent with construction

Alternative A:

- Jet grouting south of 4th St to 6th St
- Two lane closure required at a time
- Grouting duration estmated to be a total of 12 months (possibly up to 24 months depending on undergound conditions encountered) assuming 2-4 drill rigs and the following:
  - 5-day mobilization
  - 5 working days per week
  - One ten-hour shift per day
  - 3-holes per shift per rig
- Grouting is performed concurrent with construction

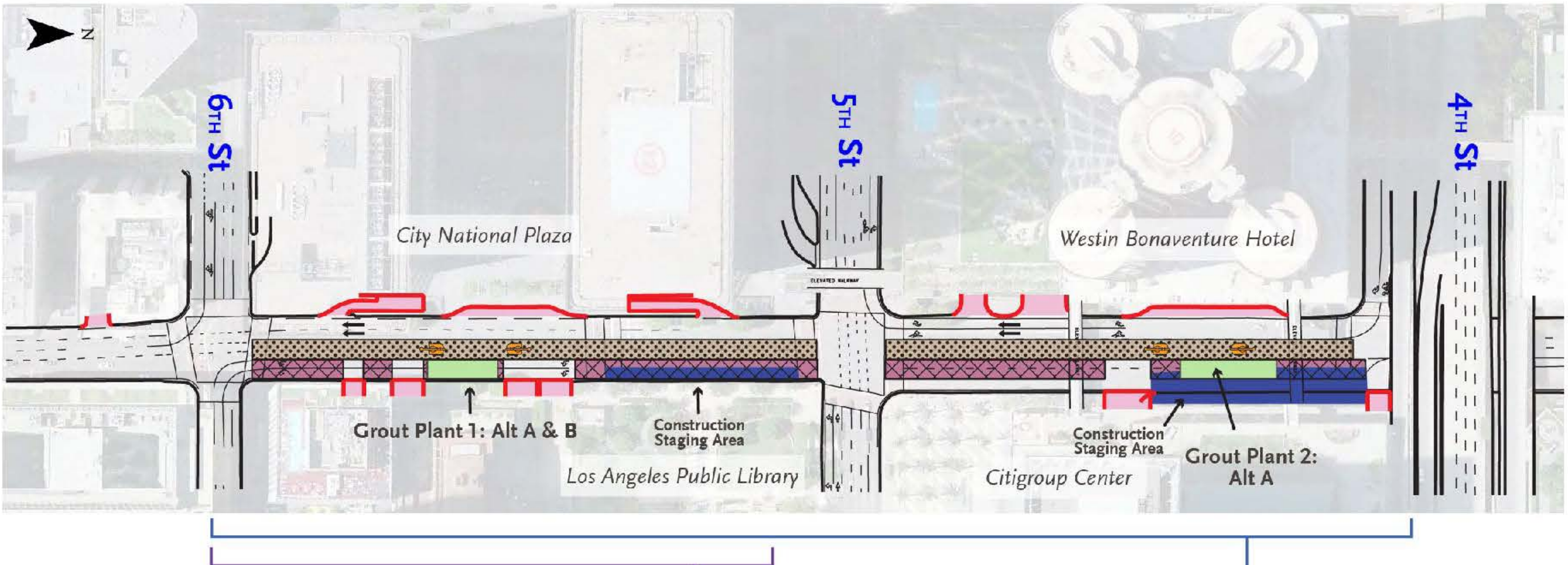
2.3.1.1 Construction Staging Areas

Similar to the Project as discussed in section 2.1.3, Alternatives A and B would require construction staging areas. Construction staging areas are temporary for the duration of construction, and would be located either within the street right-of-way or in off-street locations. Potential construction staging areas have been identified for Alternatives A and B and are summarized in Table 2.3-2 in comparison to the Project. Two grouting phases are required for the tunneling method alternatives to allow for the shifting of grouting activities from one side of Flower Street to the other to accommodate the reach of the grouting rigs. The two phases of grouting activities are illustrated in Figures 2.3-2 and 2.3-3 with construction and grouting staging activities in the Flower Street segment accommodated through temporary traffic lane closures between 4th and 6th Streets. Detours and closures would be coordinated with the LADOT.

During construction of the two tunneling method alternatives, removal of excavated materials in the Flower Street segment would be handled either along Flower Street or would be transported back along the alignment within the newly constructed tunnels and removed at the Mangrove site in Little Tokyo. As shown in Table 2.3-3, the two alternatives would significantly decrease the amount of tunnel excavation materials handled along Flower Street and correspondingly increase the materials handled through the Mangrove site. Under the Project, the higher percentage (81 percent) of the total excavation materials from the Flower Street segment handled along Flower Street is due to cut and cover construction that would be loaded into trucks on-site. With the reduction in cut and cover construction proposed by the two alternatives, the increase in tunneling would be handled with tunnel boring spoils transported back along the alignment within the newly constructed tunnels and removed at the Mangrove site at the northeast corner of 1st and Alameda Streets where it would be removed by trucks traveling through Little Tokyo.

Under Alternative B, extending EPBM tunneling to 5th Street, along with a deeper alignment, is proposed under Flower Street. The deeper alignment would require lowering the 2nd/Hope Station deeper from 96 feet to 128 feet below the ground surface. This added tunnel length and alignment depth would result in an increased quantity of tunnel excavation materials to be handled through the Mangrove site. The additional excavated materials for the deeper 2nd/Hope Station also would be removed from the station site.

Figure 2.3-2: Alternatives A and B – Grouting Activities Phase I



LEGEND

- 2-Lane closure for duration of construction/grouting
- 2-Lane closures at a time
- Existing Driveways
- Underground Construction Access Locations
- Grouting Rig
- Grouting Plant Area

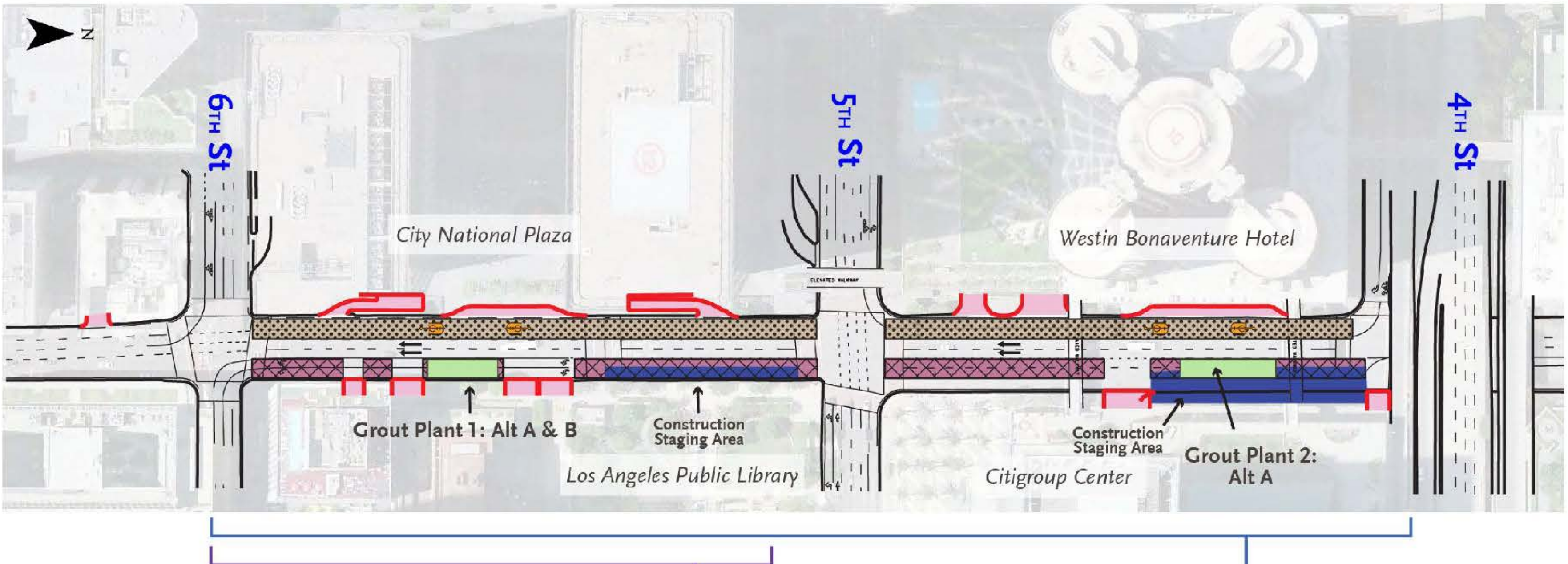
Alternative B:

- Jet grouting south of 5th St to 6th St
- Two lane closure required at a time
- Grouting duration estmated at 4 months during this phase (possibly up to 8 months depending on underground conditions encountered) assuming 2 drill rigs and the following:
  - 5-day mobilization
  - 5 working days per week
  - One ten-hour shift per day
  - 3-holes per shift per rig
- Total grouting duration (both phases) is 8 months (possibly up to 16 months)

Alternative A:

- Jet grouting south of 4th St to 6th St
- Two lane closure required at a time
- Grouting duration estmated at 6 months during this phase (possibly up to 12 months depending on underground conditions encountered) assuming 2-4 drill rigs and the following:
  - 5-day mobilization
  - 5 working days per week
  - One ten-hour shift per day
  - 3-holes per shift per rig
- Total grouting duration(both phases) is 12 months (possibly up to 16 months)

Figure 2.3-3: Alternatives A and B – Grouting Activities Phase II



LEGEND

- 2-Lane closure for duration of construction/grouting
- 2-Lane closures at a time
- Existing Driveways
- Underground Construction Access Locations
- Grouting Rig
- Grouting Plant Area

Alternative B:

- Jet grouting south of 5th St to 6th St
- Two lane closure required at a time
- Grouting duration estmated at 4 months during this phase (possibly up to 8 months depending on underground conditions encountered) assuming 2 drill rigs and the following:
  - 5-day mobilization
  - 5 working days per week
  - One ten-hour shift per day
  - 3-holes per shift per rig
- Total grouting duration (both phases) is 8 months (possibly up to 16 months)

Alternative A:

- Jet grouting south of 4th St to 6th St
- Two lane closure required at a time
- Grouting duration estmated at 6 months during this phase (possibly up to 12 months depending on underground conditions encountered) assuming 2-4 drill rigs and the following:
  - 5-day mobilization
  - 5 working days per week
  - One ten-hour shift per day
  - 3-holes per shift per rig
- Total grouting duration(both phases) is 12 months (possibly up to 16 months)

Technically every station along the project alignment could serve as a tunnel spoil removal site, but the Final EIS restricts tunnel spoil removal to the Mangrove site. Handling tunnel spoils at the 2nd/Hope station area adjacent to the Disney Hall, the Music Center, the Colburn School of Music, the Broad Museum, the Museum of Contemporary Art, and two high-rise residential buildings would be difficult given the built-out nature of this station area with noise-sensitive land uses. Similarly, the 2nd/Broadway Station cannot serve as a spoils removal location due to the built out nature of surrounding land uses. In addition, the right of way is narrow and congested at this segment of 2nd Street.

Spoil removal under Alternatives A and B assumes that the excavated materials by tunneling methods under Flower Street are removed through the bored tunnels to the portal at Little Tokyo using the tunneling conveyor or muck transport systems in the tunnels which are not designed to accommodate discharge at 2nd/Broadway station. Changing the muck conveyance system to discharge at 2nd/Broadway station would adversely affect the construction of the 2nd/Broadway cut and cover station causing significant delay to the project. Additionally, the 2nd and Broadway station site is a narrow site in a heavily built up area with limited surface area to accommodate muck handling and disposal operations from the tunnel.

Table 2.3-2: Flower Street Construction and Grouting Staging and Grouting Activity Areas for the Project and Tunneling Method Alternatives

	Construction Staging Two locations occupying two travel lanes on east side of Flower Street: • South of 4th Street • South of 5th Street	**Grouting Staging Areas** Two locations occupying two travel lanes on east side of Flower Street: • South of 4th Street • Between 5th and 6th Streets	**Grouting Activities** Two phases occupying two travel lanes at a time: • Phase I – two middle travel lanes • Phase II – two travel lanes on west side of street
The Project	Both locations	--	--
Alternative A	Both locations	Both locations	Both phases
Alternative B	Both locations	North of 6th street only	Both phases

A comparison of the quantity of Flower Street segment excavation materials that would be handled either along Flower Street or through the Mangrove site by Alternatives A and B as compared to the Project is provided in Table 2.3-3. As discussed below in the description of each tunneling method alternatives, with the extension of tunneling further south on Flower Street, there would be a major shift in the handling of excavated materials from Flower Street to Little Tokyo. This would have a corresponding increase in the number of excavation trucks required to handle the higher quantity of excavated materials at the Mangrove site. Under Alternative A, Flower Street truck activity would be approximately cut in half, while the number of trucks operating through Little Tokyo would more than double. Alternative B has a more significant impact on Little Tokyo with quadruple the number of trucks. For both alternatives, the duration of the impacts would increase by 7 months under Alternative B to 15 months under Alternative A.

Table 2.3-3: Comparison of Flower Street Segment Excavation Materials Handling

Impact	The Project	Alternative A	Alternative B
Hauling of Excavated Materials from Flower Street			
- On Flower Street • Percentage of total Flower Street excavation materials • Duration of hauling activities	81% 9 Months	25% 1 Month	20% 1 Month
- In Little Tokyo • Percentage of total excavation materials • Duration of hauling activities	19% 2.5 Months	75% 19 Months	80% 17 Months
Excavation/Construction Trucks Per Day			
- On Flower Street	32	18	8
- In Little Tokyo	8	22	32
Duration of Truck Impacts (for hauling excavated materials)	9 Months	19 Months (10 months longer than the Project)	17 Months (8 months longer than the Project)

Source: *Draft Flower Street Tunneling Method Alternatives Report (2014)*

2.3.2 Description of Tunneling Method Alternatives

2.3.2.1 Alternative A – EPBM/Open-Face Shield/SEM Project Profile Alternative

Alternative A would extend tunneling south to the 7th Street/Metro Center Station through the use of a combination of open shield tunnel boring and sequential excavation method (SEM) construction techniques. The EPBM/Open-Face Shield/SEM Project Profile Alternative, as illustrated in Figure 2.3-4, is defined as follows:

> EPBM-bored twin tunnels following the Project alignment from 2nd Street to south of 4th Street, with open-face shield tunnel excavation from 4th Street to 5th Street (with the shields abandoned underground), and SEM tunnel construction from 5th Street to the 7th Street/Metro Center Station tail tracks structure.

The Flower Street horizontal alignment of this alternative would remain similar to the Project with a slight shift to the west with the alignment continuing south on tangent track from the 2nd/Hope Station through the 4th Street Bridge piles to 5th Street. It would transition from a wider track center to a narrow track center by the time the alignment approaches the required double crossover immediately north of the narrow 7th Street/Metro Center Station tail tracks structure.

The vertical alignment for this alternative would be similar to that of the Project with a tunnel alignment depth of approximately 40 feet to TOR below the street surface. Alternative A would allow for construction of a double track crossover and a future 5th/Flower Street Station; and the 2nd/Hope Station would be located at the same depth (96 feet) as the Project. For this alternative, the operational speed would be limited to 35 mph due to the short horizontal transition distance from the 5th Street segment to the double crossover before the existing tail tracks structure. The future 5th/Flower Street Station configuration would have to be a side platform station without a mezzanine, as the narrow center-to-center spacing of the twin tunnels would preclude construction of a center platform, and the relatively shallow depth would not provide sufficient distance for a mezzanine. Passengers would not be able to make cross-platform transfers, but would have to exit the station to transfer from one travel direction to the other. Deviations would be required from Metro rail design standards to accommodate the site-specific conditions.

Alternative A would require three separate cut and cover excavation sites for: 1) emergency exit construction and tunnel boring machine retrieval shaft south of 4th Street; 2) an emergency exit construction located south of 5th Street; and 3) a train control room vent shaft south of the 7th Street/Metro Center Station tail tracks structure. Similar to the Project, cut and cover excavation materials would be handled from the construction staging sites located along Flower Street, while tunnel muck would be removed through the bored tunnel to the Mangrove portal site in Little Tokyo.

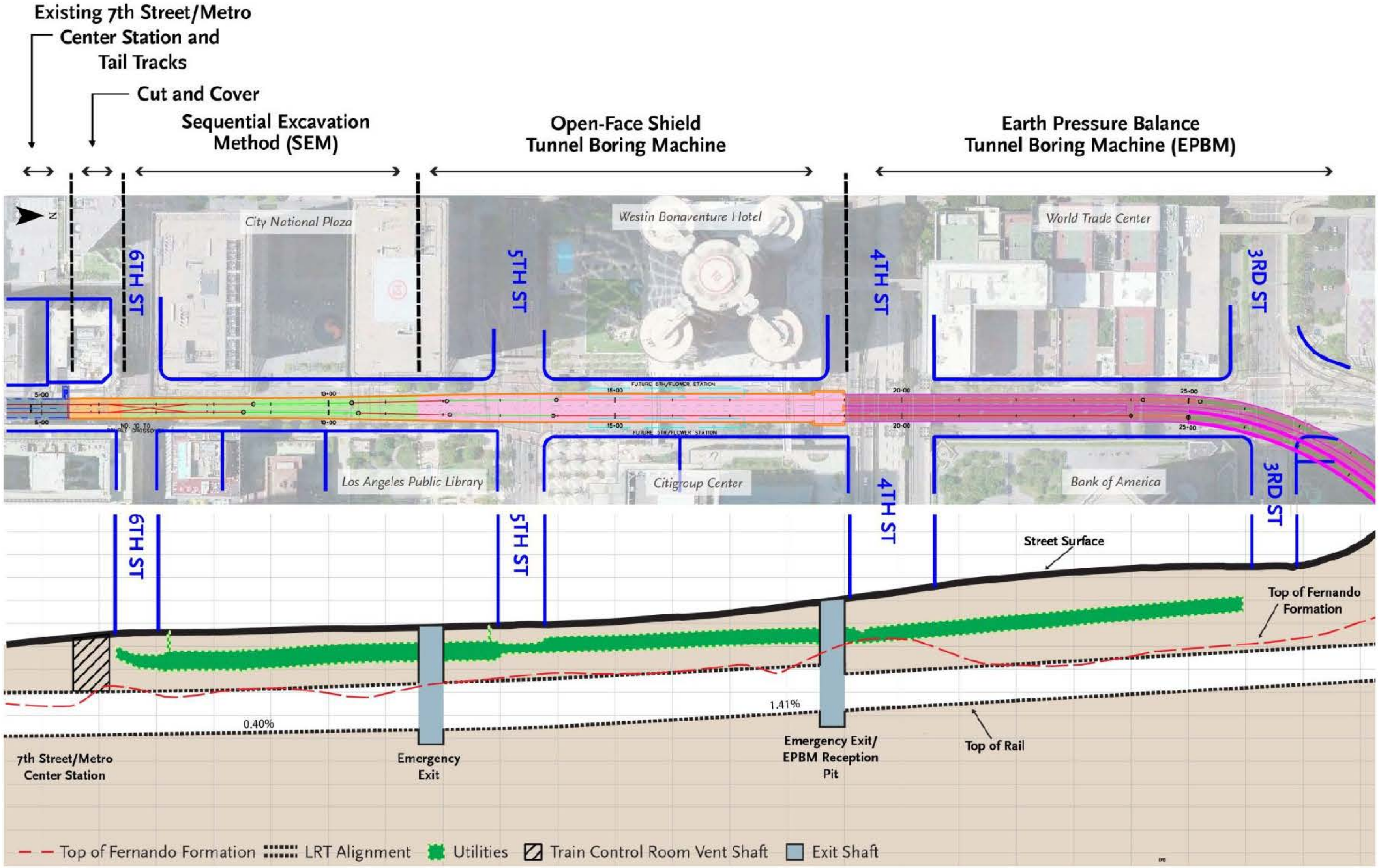
With the lengthening of tunnel boring activities further south on Flower Street, there would be a corresponding increase in the amount of excavated materials handled through the Mangrove site over the Project conditions. For Alternative A, it is estimated that 25 percent (compared to 81 percent for the Project) of the excavated materials would be handled from locations along Flower Street, with an increase to 75 percent (compared to 19 percent under Project conditions) of tunneling materials would be accommodated through the Little Tokyo site.

Construction Method Risks and Need for Grouting

The Flower Street SEM excavation for the crossover may be as wide as 60 feet, but would only have approximately 20 feet thickness or less of poor soil cover combined with close proximity to utilities, ground water, and methane gas conditions making it a very high risk for excessive settlement, uncontrolled subsidence or collapse. SEM relies on the natural arching effect of the ground, and not much arching can be expected along Flower Street due to the low ground cover, poor soils conditions, and many utilities. In such poor ground conditions, SEM construction is more susceptible to earthquake forces and its seismic design requirements would be greater compared than those for cut and cover excavation.

Due to the use of a combination of open-face shield tunnel boring and SEM tunnel construction techniques, the use of extensive jet grouting would be required from south of 4th Street to 6th Street for Alternative A. Without grouting, this alternative has substantial risk of tunnel face instability with the high potential for soil runs during tunneling by open-face shield or SEM, particularly when dealing with tie-backs. There would be approximately five feet of the Fernando Formation above the open-face shield section. Based on the limited number of borings, the location of the Fernando Formation has substantial uncertainty and the stability of the open-face shield tunnel face is not guaranteed. Ground improvement would be required. In addition, the open-face shield tunneling would encounter the Pacific Electric tunnel which may include pea gravel backfill between its final lining and the surrounding ground as commonly used in earlier tunneling methods. As the open-face shield tunnel approaches, this backfill may run into the new tunnel creating large voids around the Pacific Electric tunnel directly underneath Flower Street and the adjacent properties. For the SEM portion of the

Figure 2.3-4: Alternative A – EPBM/Open-Face Shield/SEM Project Profile Alternative



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tunneling, the single twin-tunnel is larger and the tunnel will have varying amounts of mixed face conditions in the tunnel heading. In this situation, there would be a high risk of subsidence creating sinkholes on Flower Street and therefore jet grouting would be required.

The jet grouting for the open-face shield and SEM portions would require drilling grout holes on a six-foot by six-foot pattern throughout the area to be grouted as previously shown in Figure 2.3-1. Grout holes would extend from the ground surface through the weak fill and alluvial soils to just into the relatively stronger Fernando Formation, a distance of more than 40 feet. Alternative A would require a 50-foot-wide zone in Flower Street to be grouted. Depending on the number of required grout holes, two to four drill rigs would be utilized to drill and grout this area. Approximately 1,900 jet holes are expected for Alternative A and would require approximately 12 months (with a risk of doubling the effort for up to 24 months) using two drill rigs.

For Alternative A, the horizontal tunnel alignment is shifted slightly to the east between 5th and 6th Streets, and the tunnel alignment occupies the middle of Flower Street between 4th and 5th Streets. Therefore, the jet grouting staging areas would occupy the east side of Flower Street during a majority of the jet grouting activities. As previously presented, Figures 2.3-2 and 2.3-3 illustrate the grouting and staging areas required along Flower Street for Phases I and II of grouting activities for this alternative. As shown in the figures, construction of Alternative A would require long term closure of two travel lanes on the east side of Flower Street for location of the grouting plant and equipment storage, along with an additional two lane closure on the west side to accommodate grouting activities. A total of four lanes would be closed for 12 months, possibly up to 24 months due to unforeseen underground conditions, when grouting is taking place.

Schedule Impacts

Implementation of Alternative A would extend the project construction duration by 15 months over the Project, and the longer construction duration is due only to construction changes along Flower Street and related impacts to Little Tokyo. Under the Project, cut and cover excavation and construction work would occur concurrently with the excavation of the bored tunnels and other construction activities throughout the alignment. For Alternative A, the primarily tunneling work needs to be performed sequentially, which results in a longer construction timeframe. While the required grouting activity can be performed concurrently with the EPBM tunneling work, but not the SEM effort, grouting activity will further impact construction duration with Alternative A requiring two to four grouting rigs for approximately 12 months, and possibly up to 24 months depending on the underground conditions experienced along Flower Street during construction. In addition, muck removal for this alternative would occur through the westbound track tunnel to the Mangrove portal, and with the extension of tunneling further south on Flower Street, would require longer tunnel runs with increased amounts of excavated materials over those of the Project. Extending the use of the westbound tunnel track would delay the construction of all station facilities, which are dependent on the completion of tunneling operations.

The resulting construction method-related schedule changes are not simply add-ons to the construction schedule duration identified for the Project. The Regional Connector project construction schedule is complex and involves the carefully considered interrelationships between many activities, some that can be performed concurrently, while other activities are sequential. Due to the need to remove all Flower Street segment tunnel spoils through the Mangrove portal, the tunneling operation would continue until excavation and construction of the Flower Street segment. This would hold the start of station construction work for the 2nd/Hope and 2nd/Broadway stations and all cross passages until after the Flower Street segment tunneling is complete.

Table 2.3-4: Construction Duration Comparison

	Project (Months)	Alternative A (Months)	Alternative B (Months)
Pre-construction[1]	--[2]	29	29
Construction	78	93	85
Total Duration	78	122	114
Duration Difference Compared to the Project			
Months	--	44	36
Years	--	3.7	3.0
Revenue Service Date	Mid 2020	Early 2024	Mid 2023

Note: [1] Pre-construction Activities include engineering design revisions and re-procurement of the design-build construction contract.
[2] Pre-construction activities already completed
Source: *Draft Flower Street Tunneling Method Alternatives Report (2014)*

As shown in Table 2.3-4, implementation of Alternative A would require 44 months over the Project's schedule. The longer duration is due to: 1) an additional 29 months for pre-construction activities; and 2) a longer construction duration by 15 months. Pre-construction activities for this alternative would include the preparation of detailed engineering design plans, re-procurement activities for the design-build project contract, and re-permitting efforts. As the Project is currently under construction, implementation of either tunneling method alternative would require stopping current construction activities and re-mobilization efforts for the new alternative project configuration using different construction techniques and equipment than the Project. Alternative A would have a longer construction duration as the identified tunneling excavation and construction activities would have to be performed sequentially rather than concurrently as under the Project. Additional construction time would be required for the jet grouting activities that must be performed prior to tunneling efforts to provide needed ground stabilization. In summary, under Alternative A, the duration of construction activities along the Flower Street segment would be reduced, while the duration of construction activities in Little Tokyo would increase. For this alternative, the total project schedule from initiation of construction to start of revenue service would be 10.2 years compared to 6.5 years for the Project.

2.3.2.2 Alternative B – EPBM/SEM Low Alignment Alternative

Alternative B would extend tunneling south to the 7th Street/Metro Center Station through the use of a combination of earth pressure balance tunnel boring machine (EPBM) and sequential excavation method (SEM) construction techniques. The EPBM/SEM Low Alignment Alternative, as shown in Figure 2.3-5, is defined as follows:

EPBM-bored twin tunnels on a deep alignment to south of 5th Street, with SEM tunnel construction from south of 5th Street to the 7th Street/Metro Center Station tail tracks structure.

The Flower Street horizontal alignment of this alternative would remain similar to the Project with a slight shift to the west with the alignment continuing south on tangent track from the 2nd/Hope Station through the 4th Street Bridge piles to 5th Street, and transitioning from a wider track center to a narrow track center by the time the alignment approaches the required double crossover immediately north of the narrow 7th Street/Metro Center Station tail tracks structure. The operational speed would be limited to 35 mph due to the short horizontal transition distance from 5th Street to the double crossover before the existing tail tracks structure.

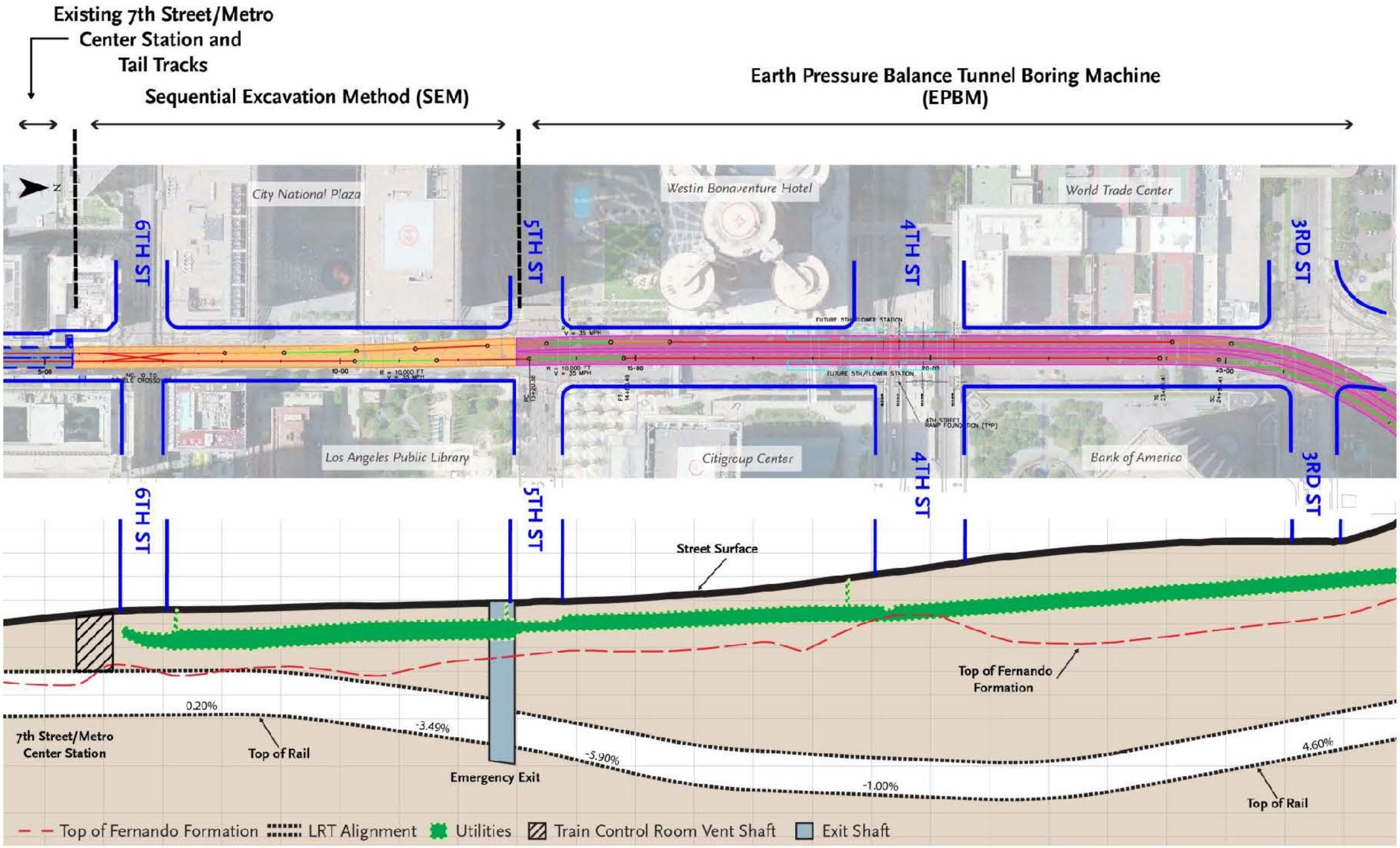
The vertical alignment for Alternative B would be designed with a modified "sag" to reduce the probability of the tunnel alignment encountering tie-backs located under Flower Street between 4th Street and impacting the 4th Street Bridge foundations. This alternative's vertical alignment design would result in an alignment depth varying from 40 feet at the high point to 105 feet to TOR below street surface at the low point. The resulting 5.9 percent gradient on the south end and a 4.6 percent gradient on the north end of the sag would also contribute to the reduction of the Flower Street segment's operational speed from 55 mph under the Project to 35 mph for this alternative.

On steep grades, Metro design criteria limits the grade of the track profile for three-car LRT trains to prevent train slippage. The design criteria identifies a maximum grade of five percent grade change for a track length of 500 to 1,000 feet between vertical points of intersection with flatter segments, and six percent for a grade length of less than 500 feet between vertical points of intersection. Provision of horizontal and vertical curves in the same track segment further reduce the maximum allowable grades. A track profile that does not follow the criteria can result in a reduced design speed that may not meet the Metro Design Criteria requirement for operating headways. The desired operational speed for the Flower Street segment is 55 miles per hour (mph), as identified by MRDC Section 10 – Operations, which is provided by the Project.

The deeper alignment proposed by Alternative B would have significant impacts on the future 5th/Flower and the 2nd/Hope stations:

- The modified sag provides for a flat spot at a one percent grade to accommodate a future 5th/Flower Station. The future station would have to be configured as a side platform since the narrow center-to-center spacing of the twin tunnels would preclude construction of a center platform. The depth of this alternative's tunnels would accommodate construction of a mezzanine. Construction of the future station side platforms would require demolition of a portion of each tunnel in order to provide an opening to connect with the two side platforms.

Figure 2.3-5: Alternative B – EPBM/SEM Low Alignment Alternative



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Transit service would be interrupted for a substantial length of time to permit this major construction work to take place. Deviations would be required from Metro rail design standards to accommodate the site-specific conditions.

- Due to this alternative's greater depth, the 2nd/Hope Station would be shifted down by 32 feet from the Project station depth (96 feet) to 128 feet from TOR to the street surface. This station location would be deeper because the low point in Alternative B was shifted to the north to accommodate a future 5th/Flower Station. The greater station depth would have an increased risk to stability and safety of excavation shoring; this is an unprecedented depth for work of this nature in Los Angeles, which is not addressed by Metro Support of Excavation standards. Excavating at this depth would increase the difficulty in ventilating the excavation pit during construction, and increase the risk of exposure to hazardous gases. The greater depth would increase the spoils (23,000 cubic yards) required to be handled at the 2nd/Hope station site.

Alternative B would require a minor amount of cut and cover construction for two shafts: 1) an emergency exit south of 5th Street; and 20 a train control room vent shaft north of the 7th Street/ Metro Center Station rail tracks structure. This alternative would not require a tunnel boring machine retrieval shaft as the EPBM would be disassembled and removed through the tunnel to the Mangrove site in Little Tokyo with the EPBM shield left in place. Similar to the Project, cut and cover excavation materials would be handled from excavation sites located along Flower Street, while tunnel muck would be handled through the construction tunnel to the Mangrove portal site in Little Tokyo.

With the extension of tunneling activities further south on Flower Street, there would be a corresponding increase in the amount of excavated materials handled through the Mangrove site over the Project conditions. For Alternative B, it is estimated that 20 percent (compared to 81 percent for the Project) of the excavated materials would be handled from locations along Flower Street, with an increase to 80 percent (compared to 19 percent under Project conditions) of the tunneling would be accommodated through the Little Tokyo site.

Construction Method Risks and Need for Grouting

For Alternative B, ground stabilization would be required for the SEM section of the tunneling, but not the EPBM portion. For the SEM portion of the tunneling, the single twin-track tunnel is larger and the tunnel will have varying amounts of mixed-face geologic conditions in the tunnel heading. In this situation, there would be a high risk of creating sinkholes or subsidence on Flower Street. Mitigation by jet grouting would be required.

The jet grouting for the SEM portion would require drilling grout holes on a six-foot by six-foot pattern throughout the area to be grouted as previously shown in Figure 2.3-1. Grout holes would extend from the ground surface through the weak fill and alluvial soils to just into the relatively stronger Fernando Formation, a distance of more than 40 feet. Alternative B would require a 50-foot-wide zone in Flower Street to be grouted. Approximately 1,000 jet holes would be drilled and grouted for this alternative requiring require approximately 8 months (with a risk of doubling the effort for up to 16 months) using two drill rigs as shown in Figure 2.3-1.

The SEM tunneling and related grouting activities for Alternative B would be located between south of 5th Street to just south of 6th Street. As shown in Figures 2.3-2 and 2.3-3, the jet grouting staging areas would occupy the east side of Flower Street during a majority of the jet grouting activities. As shown in the figures, construction of Alternative B would require long term closure of two travel lanes on the east side of Flower Street to house the grouting plant and for equipment storage, along with an additional two closure on the west side to accommodate grouting activities. A total of four lanes would be temporarily closed for eight months, possibly extending to 16 months due to unforeseen underground conditions, when grouting is taking place.

Schedule Impacts

Implementation of Alternative B would extend the project construction duration by seven (7) months over the Project, and the longer construction duration is due only to changes on Flower Street and related impacts to Little Tokyo. As stated previously, under the Project, cut and cover excavation and construction work would occur concurrently with the excavation of the bored tunnels and other construction activities throughout the alignment. For Alternative B, the primarily tunneling work needs to be performed sequentially, which results in a longer construction timeframe. While the required grouting activity can be performed concurrently with the EPBM tunneling work, but not the SEM work, grouting activity will further impact construction duration with Alternative B requiring two grouting rigs for approximately eight months, and possibly up to 16 months depending on the underground conditions experienced along Flower Street during construction. Due to the need to remove all Flower Street segment tunnel spoils through the Mangrove portal, the tunneling operation would continue until the SEM work is complete. This would hold the start of station construction work for the 2nd/Hope and 2nd/Broadway stations, and of the 2nd/Broadway SEM cavern and all cross passages until after the Flower Street segment tunneling is complete.

The resulting construction method-related scheduled changes are not simply add-ons to the Project construction schedule. As shown previously in Table 2.3-4, implementation of Alternative B would require 36 months over the Project's schedule. The longer duration is due to: 1) an additional 29 months for pre-construction activities; and 2) a longer construction duration by seven (7) months. Pre-construction activities for this alternative would include the preparation of detail engineering design plans, re-procurement activities for the design-build project contract, and re-permitting efforts. As the Project is currently under construction, implementation of this alternative would require stopping current construction activities and re-mobilization efforts for the new alternative project configuration using different construction techniques and equipment than the Project. Alternative B would have a longer construction duration as the identified tunneling excavation and construction activities would have to be performed sequentially rather than concurrently as under the Project. Additional construction time would be required for the jet grouting activities that must be performed prior to tunneling efforts to provide needed ground stabilization. In summary, under Alternative B, the duration of construction activities along the Flower Street segment would be reduced under this alternative, while the duration of construction activities in Little Tokyo would increase. For Alternative B, the total project schedule from initiation of construction to start of revenue service would be 9.5 years compared to 6.5 years for the Project.

3.0 TRANSPORTATION AND CIRCULATION

This chapter evaluates traffic circulation, transit, parking, pedestrian, bicycle, and rail operational conditions in the Project Area, and the resulting impacts from Alternatives A and B compared to the Project. In order to compare potential impacts during construction of the tunneling method alternatives, only impacts from construction activities along Flower Street and in Little Tokyo were analyzed. Impacts from construction activities for other portions of the project alignment were not analyzed as they would be similar for the tunneling method alternatives as for the Project.

3.1 Affected Environment

This section identifies the existing conditions being evaluated for the Project Area transportation environment. The transportation environment consists of transit, traffic circulation, parking, other modes (e.g., pedestrians and bicycles), and operations.

3.1.1 Transit

Existing bus and rail transit services, including destinations, existing headways, service characteristics, and operating time periods, remain unchanged from those documented in the Final EIS.

3.1.2 Traffic Circulation

This section describes the existing (2014) traffic conditions in the Project Area.

3.1.2.1 Roadway Network

Traffic was evaluated along Flower Street and key roadways within the Little Tokyo area that could potentially be impacted by changes in construction methods proposed by Alternatives A and B. The evaluated roadway segments are listed below:

1. Flower Street north of 5th Street
2. Flower Street north of 6th Street
3. First Street at Alameda Street
4. Alameda Street at First Street
5. Alameda Street at Temple Street
6. Central Street south of First Street
7. San Pedro Street at First Street
8. San Pedro Street at Second Street
9. Temple Street at Alameda Street
10. Temple Street at Judge John Aiso Street

Level of Service (LOS) is the measurement used to relate the quality of traffic service, and is used to analyze roadways by assigning quality levels of traffic based on measurements such as speed, density, etc. The LOS categories are shown in Table 3.1-1. Table 3.1-2 shows the existing LOS at each of the ten study area roadway segments along Flower Street and in Little Tokyo.

Table 3.1-1: Level of Service (LOS) Categories and Criteria

Level of Service	Average Vehicle Delay (in seconds)	Definition
A	<10.0	EXCELLENT. No vehicle waits longer than one red light and no approach phase is fully used.
B	>10.0 and <20.0	VERY GOOD. An occasional approach phase is fully utilized; many drivers begin to feel somewhat restricted within groups of vehicles.
C	>20.0 and <35.0	GOOD. Occasionally, drivers may have to wait through more than one red light; backups may develop behind turning vehicles.
D	>35.0 and <55.0	FAIR. Delays may be substantial during portions of the rush hours, but enough lower volume periods occur to permit clearing of developing lines, preventing excessive backups.
E	>55.0 and <80.0	POOR. Represents the most vehicles that intersection approaches can accommodate; may be long lines of waiting vehicles through several signal cycles.
F	>80.0	FAILURE. Backups from nearby intersections or on cross streets may restrict or prevent movement of vehicles out of the intersection approaches. Tremendous delays with continuously increasing queue lengths.

As shown in Table 3.1-1, all ten study area roadway segments currently operate at an acceptable LOS C or better during both the morning (AM) and evening (PM) peak hours.

3.1.2.2 Parking

For the SEIS, the affected Flower Street and Little Tokyo street segments for each of the two tunneling method alternatives were surveyed to review the existing number of parking spaces and associated peak period parking restriction information to provide a baseline for assessing impacts. There are no changes to the parking information presented in the Final EIS. In summary, there is limited on-street parking along Flower Street and adjacent to the Mangrove site in Little Tokyo. On Flower Street, metered two hour parking (8:00 AM to 8:00 PM) is provided only on the east side of the street in two locations between: 1) 4th and 5th Streets; and 2) 6th Street and Wilshire Boulevard.

3.1.2.3 Pedestrians

The central downtown area experiences heavy pedestrian traffic on weekdays, particularly during the commute and lunch hours. Much of the pedestrian traffic occurs in areas with daytime employment, such as Bunker Hill, the Financial District, and the Historic Core. Pedestrian movement also occurs between the Civic Center and Little Tokyo along Temple, 1st, and 2nd Streets.

Table 3.1-2: Existing Roadway Level of Service (LOS) Analysis (2014)

No.	Roadway	No. of Lanes	Peak Hour Capacity[1]	AM Peak Hour			PM Peak Hour		
				Volume	V/C[2]	LOS	Volume	V/C	LOS
1	Flower St n/o 5th St	6	4,800	1,239	0.258	A	1,595	0.332	A
2	Flower St n/o 6th St	6	4,800	1,219	0.254	A	1,651	0.344	A
3	First St at Alameda St	4	3,200	1,385	0.433	A	1,756	0.549	A
4	Alameda St at First St	4	3,200	2,218	0.693	B	1,976	0.618	B
5	Alameda St at Temple St	4	3,200	2,395	0.748	C	2,177	0.680	B
6	Central St s/o First St	3	2,400	858	0.358	A	1,142	0.476	A
7	San Pedro St at First St	4	3,200	570	0.178	A	847	0.265	A
8	San Pedro St at Second St	4	3,200	1,093	0.342	A	1,299	0.406	A
9	Temple St at Alameda St	4	3,200	697	0.218	A	1,092	0.341	A
10	Temple St at Judge John Aiso	4	3,200	1,050	0.328	A	1,302	0.407	A

Notes:
[1] Capacity values of 800 vehicles per hour per through lane for arterial segment analysis based on 2010 Los Angeles Congestion Management Plan (CMP), Appendix D guidelines
[2] V/C = volume to capacity ratio
Source: Los Angeles City Department of Transportation, 2014; Los Angeles CMP; and AECOM, 2014

Despite heavy pedestrian activity, analysis of the area near the evaluated alternatives along Flower Street between 3rd and 6th Streets, including the Project, did not reveal any particularly problematic pedestrian crossings (insufficient crosswalks, sidewalk overcrowding, inadequate pedestrian walk signal time, etc.).

The Financial District attracts a high number of pedestrians during weekdays. Seventh Street experiences large volumes of pedestrians due to Metro rail portals and bus stops, the location of hotels (Sheraton, The Standard, and the Los Angeles Athletic Club), major retail and restaurant row along 7th Street (The Bloc/former Macy's Plaza and 7th at Fig Shopping Center), and employment centers throughout. While weekend pedestrian activity has increased as well, weekday volumes are still significantly higher. Unlike years past where pedestrian activity decreased at night in the central downtown area as a majority of the daytime population left after business hours, downtown has experienced a resurgence of nighttime activity due to residents and visitors. The growing residential population has activated the evening pedestrian experience, as have tourists, convention center attendees, and LA Live entertainment venue visitors. Previous pedestrian hubs remain, such as Little Tokyo and the Arts District, that have high evening activity due to increases in housing and a solid commercial base of restaurants and cultural destinations.

3.1.2.4 Bicycles

There are no exclusive bike lanes on Flower Street or adjacent to the Mangrove site in Little Tokyo. There are bike lanes in/around the vicinity of the Financial District along Figueroa Street. In Little Tokyo, there is a shared-lane or sharrowed bike route along 1st and 2nd Streets. These streets in both areas are used by bicyclists, particularly along Flower Street near City National Plaza, where bicycle messengers assemble in between delivery assignments.

3.1.2.5 Operational Impacts

The operational impacts resulting from implementation of the tunneling method alternatives on traffic circulation, transit, parking, pedestrian, and bicycle is discussed, along with the resulting quality of rail system operational performance.

3.2 Environmental Consequences

This section describes the potential impacts of Alternatives A and B on transit, traffic circulation, parking, pedestrians, and bicyclists during construction and operation. Impact conclusions for the tunneling method alternatives are based on the thresholds identified in Appendix B – Regulatory Framework Section 1.1 of this document.

3.2.1 Alternative A – EPBM/Open Face Shield/SEM Project Profile

3.2.1.1 Construction Impacts

Alternative A would result in an increase in the level and duration of excavation-related activity in Little Tokyo over Project conditions, as previously presented in Table 2.3-1, and would have corresponding construction-related transportation impacts. Even though surface-related excavation activities along Flower Street under Alternative A are reduced in comparison to conditions under the Project, the required grouting operations would result in the closure of two additional travel lanes at a time to provide space for grouting equipment and staging areas for the two phases of grouting activity. Alternative A would decrease the share of excavation materials handled on Flower Street from 81 percent under the Project to 25 percent. Correspondingly, it would increase the quantity of Flower

Street excavation materials handled in Little Tokyo from 19 percent under the Project to 75 percent, and would increase the duration of those activities and impacts by 15 months. It should be noted that these percentages reflect the volume of excavated materials from the Flower Street segment only, not of the entire Regional Connector project.

For Alternative A, a minor amount of cut and cover construction would be required for three shafts: an emergency exit and tunnel boring machine retrieval shaft south of 4th Street, an emergency exit south of 5th Street, and a train control room vent shaft north of the 7th Street/Metro Center Station tail tracks structure. The excavated materials of these shafts would be primarily handled along Flower Street.

In order to stabilize the ground for open-face shield and SEM excavations, extensive jet grouting will be required from south of 4th to 6th Streets. Construction of Alternative A would require the closure of two travel lanes at a time for approximately 12 months to accommodate the two phases of grouting activities. Grouting activities could extend up to approximately 24 months due to unforeseen underground conditions. Figure 3.1 shows driveway access, traffic circulation impacts, and staging areas required for the Project, and Figures 3.2 and 3.3 illustrate the grouting areas, as well as equipment staging areas, required along Flower Street for Alternatives A and B. During Phase I, construction of Alternative A would require the closure of two lanes on the east side of Flower Street for construction and grouting equipment staging, as well as closure of the two center travel lanes for grouting activities. During Phase II, the two lanes on the west side of Flower Street would be used for grouting activities along with the two lanes on the east side for equipment staging. A total of four lanes would be temporarily closed during periods when grouting is taking place for approximately 12, possibly up to 24 months.

Transit

Alternative A may require relocation of two Flower Street bus stops between 4th and 6th Streets due to Phase II grouting activities along the eastern side of the street. Although construction would occur during nighttime and weekend hours, under the two phased grouting scenario (shown in Figures 3.2 and 3.3), construction would require the use of two traffic lanes at a time for grouting equipment during weekday hours. Additionally, bus service may need to be rerouted in the case of night closures of Flower Street in its entirety.

Alternative A would have an adverse transit effect on Flower Street between 4th and 6th Streets due to the need for additional lane closures compared to the Project.

Figure 3.1: Driveway Access, Traffic Circulation Impacts, and Staging Areas during Construction – The Project

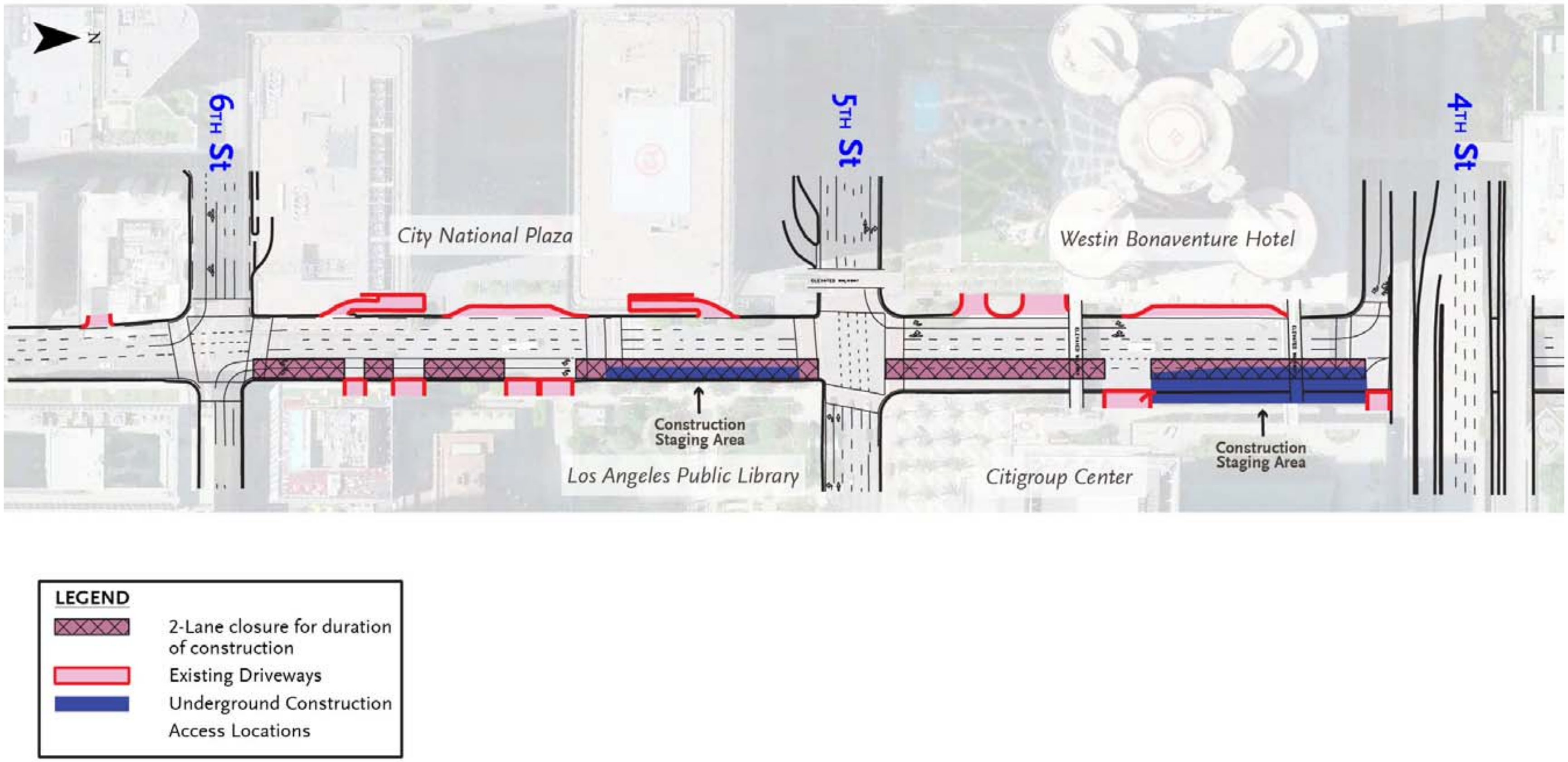
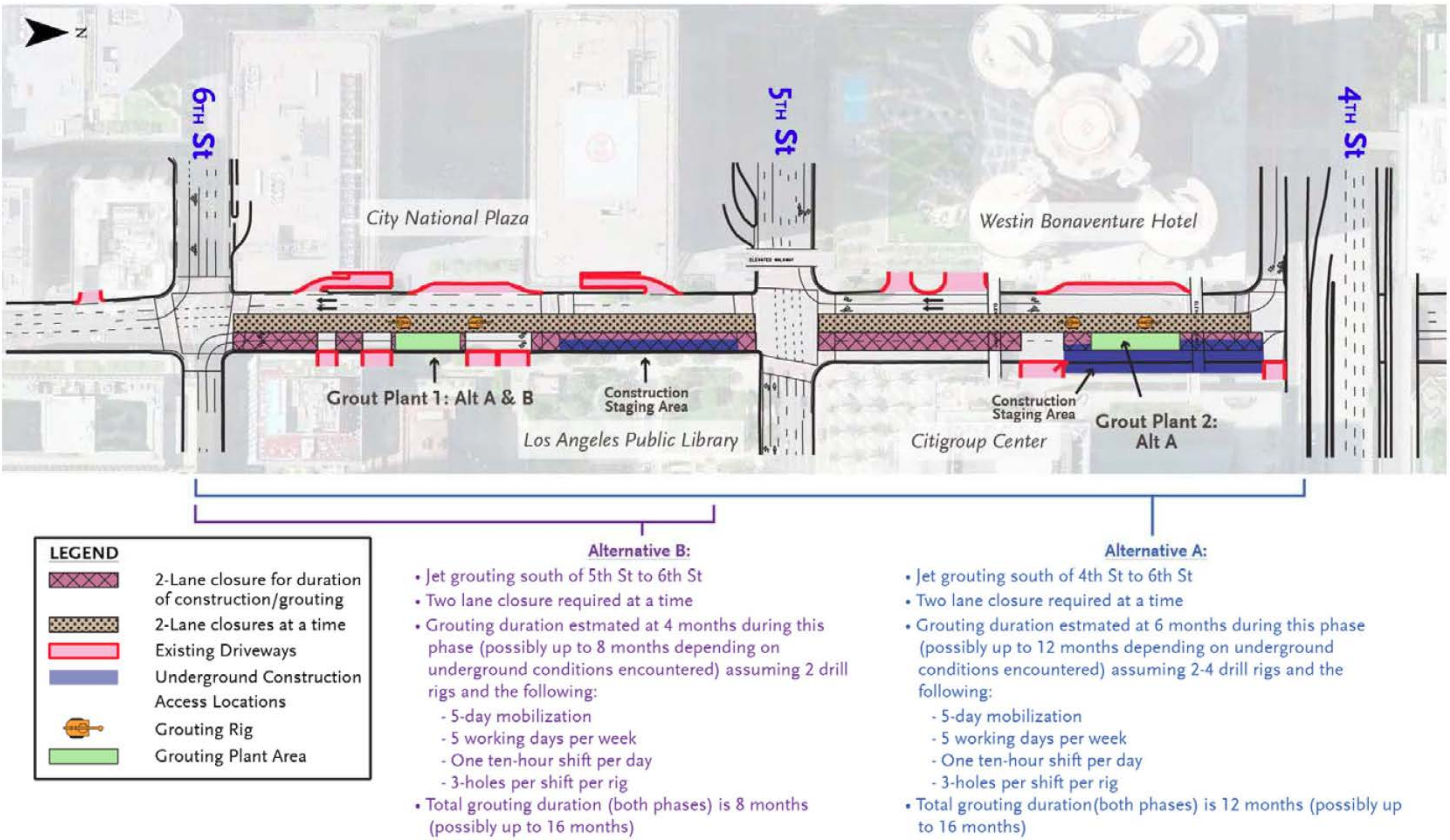
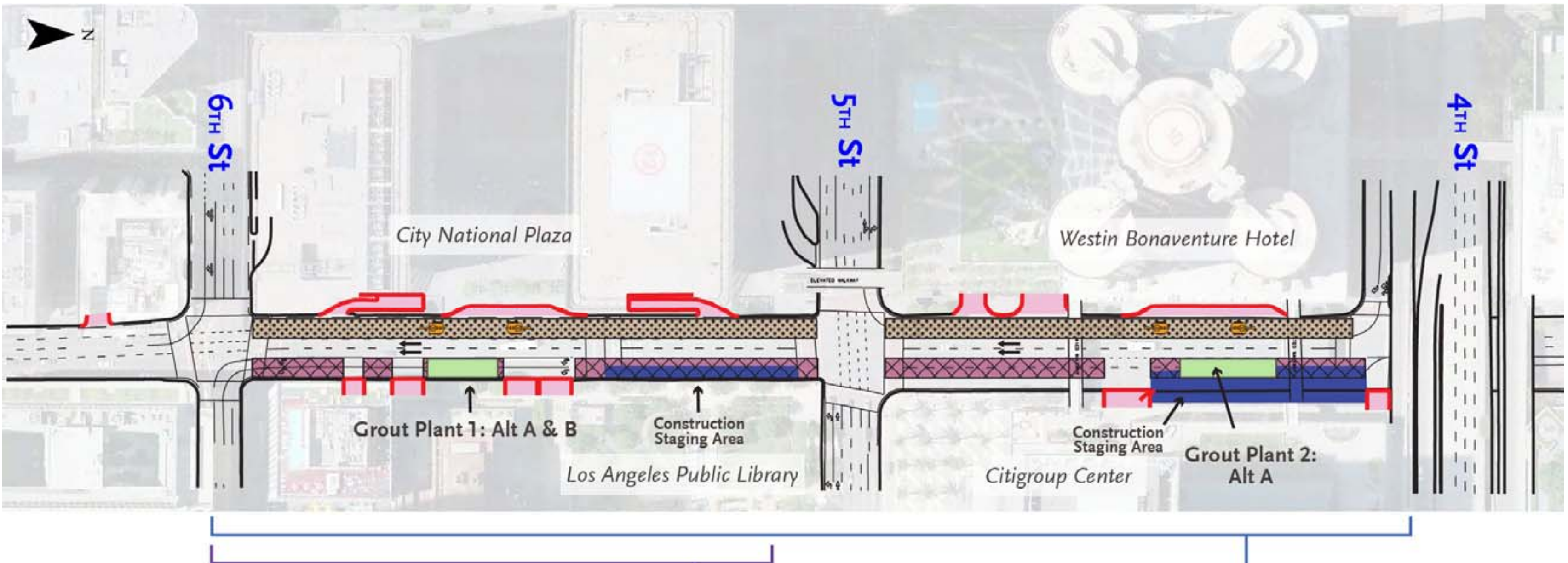


Figure 3.2: Driveway Access, Traffic Circulation Impacts, Construction Staging, and Grouting Areas (Phase I) – Alternatives A and B



Note: Figure is representative of a concept grouting operation. The final grouting and traffic plans would be dependent on the Contractor's design.

Figure 3.3: Driveway Access, Traffic Circulation Impacts, Construction Staging, and Grouting Areas (Phase II) – Alternatives A and B



LEGEND

- 2-Lane closure for duration of construction/grouting
- 2-Lane closures at a time
- Existing Driveways
- Underground Construction Access Locations
- Grouting Rig
- Grouting Plant Area

Alternative B:

- Jet grouting south of 5th St to 6th St
- Two lane closure required at a time
- Grouting duration estmated at 4 months during this phase (possibly up to 8 months depending on underground conditions encountered) assuming 2 drill rigs and the following:
  - 5-day mobilization
  - 5 working days per week
  - One ten-hour shift per day
  - 3-holes per shift per rig
- Total grouting duration (both phases) is 8 months (possibly up to 16 months)

Alternative A:

- Jet grouting south of 4th St to 6th St
- Two lane closure required at a time
- Grouting duration estmated at 6 months during this phase (possibly up to 12 months depending on underground conditions encountered) assuming 2-4 drill rigs and the following:
  - 5-day mobilization
  - 5 working days per week
  - One ten-hour shift per day
  - 3-holes per shift per rig
- Total grouting duration(both phases) is 12 months (possibly up to 16 months)

Note: Figure is representative of a concept grouting operation. The final grouting and traffic plans would be dependent on the Contractor's design.

Traffic Circulation

Under Alternative A, handling of Flower Street segment excavation materials on Flower Street would decrease from 81 percent under the Project to 25 percent, with a corresponding increase in the amount of Flower Street segment materials handled through the Mangrove portal site in Little Tokyo. The number of soils excavation and construction trucks using the Flower Street route would decrease to 18 trucks per day compared to 32 for the Project, while the number of trucks using the Little Tokyo haul routes would increase to 22 trucks per day versus eight trucks under the Project.

Table 3.2-1 shows the effect of the shift in excavation truck trips from Flower Street to Little Tokyo on study area roadway segments. Table 3.2-1 also reflects the reduction in capacity on Flower Street from six lanes to two lanes to accommodate construction and grouting equipment staging. Figures 3.4 and 3.5 provide a comparison of the Project and Alternative A in the Flower Street and Little Tokyo study areas, respectively.

Figure 3.4: Flower Street LOS for Each Alternative (During Construction, 2014-2017)

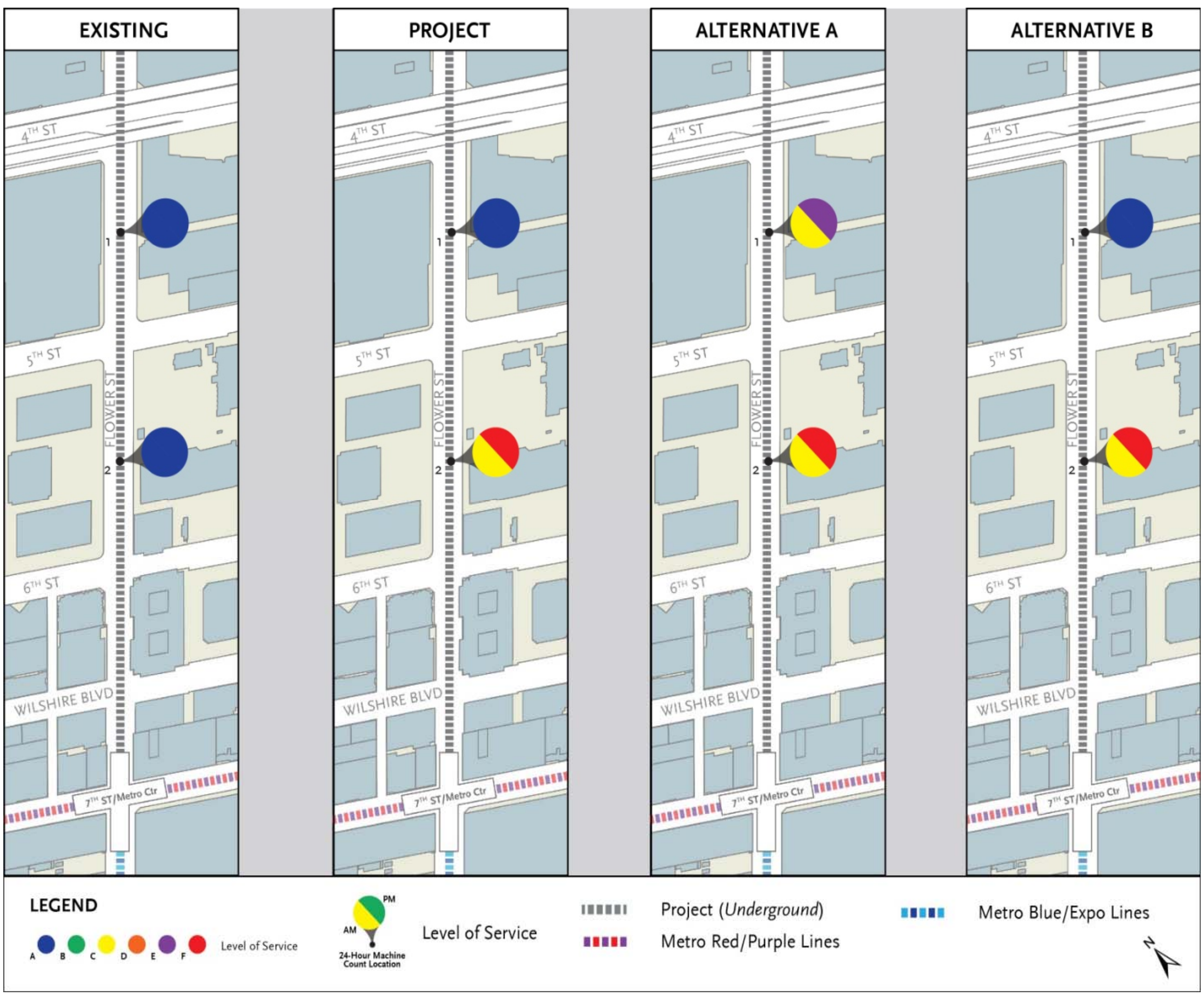
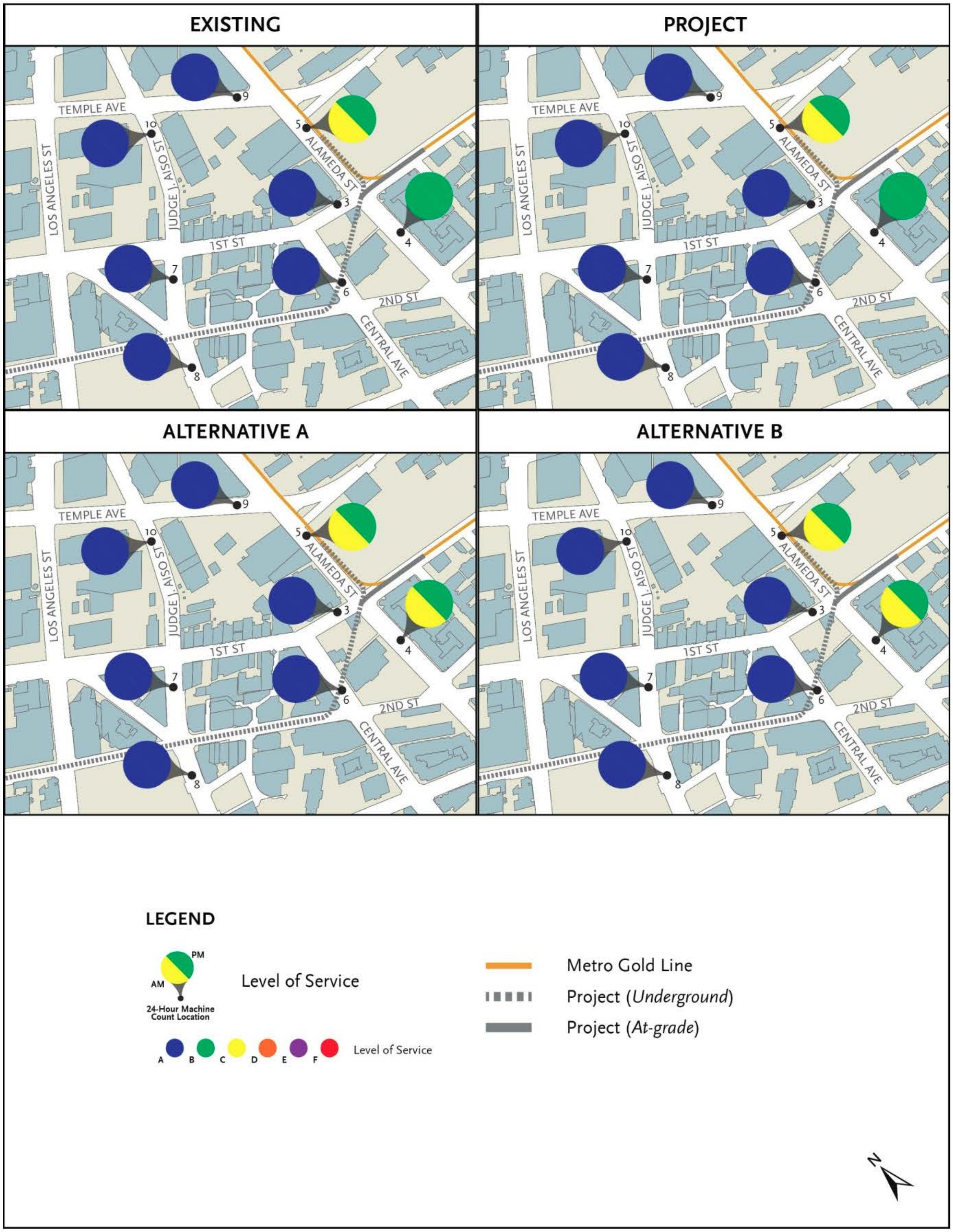


Figure 3.5: Little Tokyo LOS for Each Alternative (During Construction, 2014-2017)



Metro

Table 3.2-1: Alternative A – Level of Service Analysis (During Construction, 2014-2017)

No.	Roadway	No. of Lanes	Peak Hour Capacity[1]	AM Peak Hour			PM Peak Hour		
				Volume	V/C[2]	LOS	Volume	V/C	LOS
1	Flower St n/o 5th St	2	1,600	1,217	0.761	C	1,573	0.983	**E**
2	Flower St n/o 6th St	2	1,600	1,197	0.748	C	1,629	1.018	**F**
3	First St at Alameda St	4	3,200	1,407	0.440	A	1,778	0.556	A
4	Alameda St at First St	4	3,200	2,240	0.700	C	1,998	0.624	B
5	Alameda St at Temple St	4	3,200	2,417	0.755	C	2,199	0.687	B
6	Central St s/o First St	3	2,400	880	0.367	A	1,164	0.485	A
7	San Pedro St at First St	4	3,200	592	0.185	A	869	0.272	A
8	San Pedro St at Second St	4	3,200	1,115	0.348	A	1,321	0.413	A
9	Temple St at Alameda St	4	3,200	719	0.225	A	1,114	0.348	A
10	Temple St at Judge John Aiso	4	3,200	1,072	0.335	A	1,324	0.414	A

Notes:
[1] Capacity values of 800 vehicles per hour per through lane for arterial segment analysis based on 2010 Los Angeles Congestion Management Plan Appendix D guidelines
[2] V/C = volume to capacity ratio
Bolded and shaded intersections operate at or approaching an unacceptable LOS E or worse, per City guidelines
Source: Los Angeles City Department of Transportation, 2014; Los Angeles Congestion Management Plan (CMP); AECOM, 2014

During construction, evening peak period traffic operations along Flower Street north of 5th Street and north of 6th Street would degrade to unacceptable LOS E and F, respectively, due to the additional two lane closure required for construction activities, compared to LOS A for the Project.

While the LOS would remain unchanged with the shift in excavation truck trips from Flower Street to Little Tokyo – with only a slight increase in the volume/capacity ratio – travel times may increase for vehicles circulating along the Little Tokyo haul routes. Under Alternative A, the duration of these impacts would be 15 months longer than the Project.

Construction of Alternative A would have an adverse effect on traffic on Flower Street between 4th and 5th Streets when compared to the Project. Although the majority of the impacts identified under Alternative A would be temporary, they would be significant and unavoidable.

Parking

There is limited on-street parking along Flower Street and adjacent to the Mangrove site in Little Tokyo, and there are no changes from the conditions identified in the Final EIS. Under Alternative A, construction-related parking impacts along the Flower Street segment would be similar to those identified for the Project. As stated in the Final EIS, parking effects would be considered adverse before mitigation only in the Little Tokyo community portion of the alignment – in street segments where reduction in traffic lanes and roadway space would be utilized for street enhancements and/or underground station construction; however parking impacts would not be adverse after implementation of mitigation identified in the Final EIS.

Other Modes

Pedestrian access along Flower Street to adjoining properties and bicycle traffic movements would be maintained during construction of Alternative A. Portions of sidewalks may be temporarily closed for decking construction at cut and cover shaft locations similar to the Project. Bicycle riders could be affected by uneven roadway surfaces, cracks, metal surfaces, or other dangerous conditions, due to the different construction methods proposed under this alternative.

Temporary closures of sidewalks and crosswalks may be necessary. Lane reductions and street closures could inhibit the flow of bicycle traffic during construction, particularly along Flower Street during grouting activities on the central and eastern sides of the street. Although temporary, the identified potential impacts during construction on pedestrian and bicycle movements would be significant and unavoidable similar to the Project.

3.2.1.2 Operational Impacts

There would be no operational impacts from implementation of Alternative A on traffic circulation, transit, parking, or other modes beyond those identified for the Project.

There would be a reduction in the light rail transit (LRT) operational speed in the Flower Street segment for Alternative A, which would be reduced to 35 mph from 55 mph under the Project and identified as required by Metro Rail Design Criteria, Section 10 Operations. The speed reduction would have impacts on rail headway and runtimes compared to the Project, and Alternative A would offer less travel time savings than the Project. Increased travel times may result in a reduction in project ridership, and a corresponding decrease in air quality and climate change benefits as SOV drivers are not attracted to shift to rail service.

3.2.2 Alternative B – EPBM/SEM Low Alignment Alternative

3.2.2.1 Construction Impacts

Alternative B would result in an increase in the level and duration of excavation-related activity in Little Tokyo over the Project, as previously presented in Table 2.3-1, and would have corresponding construction-related transportation impacts. Even though surface-related excavation activities along Flower Street under Alternative B are reduced in comparison to conditions under the Project, the required grouting operations would result in the closure of two additional travel lanes at a time to provide space for grouting equipment and staging areas for the two phases of grouting activity. Alternative B would decrease the share of excavation materials handled on Flower Street from 81 percent under the Project to 20 percent. Correspondingly, it would increase the quantity of Flower Street excavation materials handled in Little Tokyo from 19 percent under the Project to 80 percent, and would increase the duration of those activities and impacts by seven months. It should be noted that these percentages reflect the volume of excavated materials from the Flower Street segment only, not of the entire Regional Connector project.

For Alternative B, a minor amount of cut and cover construction would be required for two shafts: an emergency exit south of 5th Street, and a train control room vent shaft north of the 7th Street/Metro Center Station tail tracks structure. The excavated materials of these shafts would be handled along Flower Street. The excavated materials of these shafts would be primarily handled along Flower Street.

In order to stabilize the ground for SEM and extension of EPBM tunneling further south on Flower Street, extensive jet grouting will be required from 5th Street to 6th Street. Construction of Alternative B would require the closure of two travel lanes at a time for approximately eight months to accommodate the two phases of grouting activities. Grouting activities could extend up to approximately 16 months due to unforeseen underground conditions. Figures 3.2 and 3.3 illustrate the grouting area, as well as the equipment staging areas, required along Flower Street for Phases I and II. During Phase I, construction of Alternative B would require the closure of two lanes on the east side for construction and grouting equipment staging , as well as closure of the two center travel lanes for grouting activities. During Phase II, the lanes on the west side of Flower Street would be used for grouting activities along with the two lanes on the east side for equipment staging. A total of four lanes would be temporarily closed when grouting is taking place for approximately for a total of eight months, possibly up to 16 months.

Transit

Alternative B may require relocation of one major Flower Street bus stop between 5th and 6th Streets due to Phase II grouting activities along the eastern side of the street. Although construction would occur during nighttime and weekend hours, under the two phased grouting scenario (shown in Figures 3.2 and 3.3), construction would require the use of two traffic lanes at a time for grouting equipment during weekday hours. Additionally, bus service may need to be rerouted in the case of night closures of Flower Street in its entirety.

Alternative B would have an adverse transit effect on Flower Street between 5th and 6th Streets due to the need for additional lane closures compared to the Project.

Traffic Circulation

Under Alternative B, handling of Flower Street segment excavation materials on Flower Street would be decreased from 81 percent under the Project to 20 percent, with a corresponding increase in the amount of Flower Street segment materials handled through the Mangrove portal site in Little Tokyo. The number of excavation trucks using the Flower Street route would decrease by 24 trucks to eight trucks per day, while the number of trucks using the Little Tokyo haul routes would increase to 32 trucks per day versus eight for the Project.

Table 3.2-2 shows the effect of the shift in excavation truck trips from Flower Street to Little Tokyo on study area roadway segments. Table 3.2-2 also reflects the reduction in capacity on Flower Street from six lanes to two lanes to accommodate the two-phased construction and grouting equipment staging, as previously shown in Figures 3.2 and 3.3.

Traffic operations along Flower Street between 5th and 6th Streets would degrade to unacceptable LOS F during the PM peak due to the two lane closure required to accommodate construction and grouting equipment. In Little Tokyo, although the LOS would remain relatively unchanged with the shift in excavation truck trips from Flower Street to Little Tokyo – with only a slight increase in the volume/capacity ratio – travel times may increase for vehicles circulating along the Little Tokyo haul routes. Under Alternative B, the duration of these traffic impacts would be seven months longer than the Project.

Construction of Alternative B would have an adverse effect on traffic on Flower Street between 5th and 6th Streets when compared to the Project. Although the majority of the impacts identified under Alternative B would be temporary, they would be significant and unavoidable.

Parking

There is limited on-street parking along Flower Street and adjacent to the Mangrove site in Little Tokyo, and there are no changes from conditions identified in the Final EIS. Under Alternative B, construction-related parking impacts would be similar to those identified for the Project. As stated in the Final EIS, parking effects would be considered adverse before mitigation only in the Little Tokyo community portion of the alignment, in portions where reduction in traffic lanes and roadway space would be utilized for street enhancements and/or underground station construction; however parking impacts would not be adverse after implementation of mitigation identified in the Final EIS.

Other Modes

Pedestrian access along Flower Street to adjoining properties and bicycle traffic movements would be maintained during construction of Alternative B; however, portions of sidewalks may be temporarily closed for decking construction at cut and cover shaft locations similar to the Project. Bicycle riders could be affected by uneven roadway surfaces, cracks, metal surfaces, or other dangerous conditions, due to different construction methods.

Table 3.2-2: Alternative B – Level of Service Analysis (During Construction, 2014-2017)

No.	Roadway	No. of Lanes	Peak Hour Capacity[1]	AM Peak Hour			PM Peak Hour		
				Volume	V/C[2]	LOS	Volume	V/C	LOS
1	Flower St n/o 5th St	4	3,200	1,215	0.380	A	1,571	0.491	A
2	Flower St n/o 6th St	2	1,600	1,195	0.747	C	1,627	1.017	**F**
3	First St at Alameda St	4	3,200	1,409	0.440	A	1,780	0.556	A
4	Alameda St at First St	4	3,200	2,242	0.701	C	2,000	0.625	B
5	Alameda St at Temple St	4	3,200	2,419	0.756	C	2,201	0.688	B
6	Central St s/o First St	3	2,400	882	0.368	A	1,166	0.486	A
7	San Pedro St at First St	4	3,200	594	0.186	A	871	0.272	A
8	San Pedro St at Second St	4	3,200	1,117	0.349	A	1,323	0.413	A
9	Temple St at Alameda St	4	3,200	721	0.225	A	1,116	0.349	A
10	Temple St at Judge John Aiso	4	3,200	1,074	0.336	A	1,326	0.414	A

Notes:
[1] Capacity values of 800 vehicles per hour per through lane for arterial segment analysis based on 2010 Los Angeles CMP Appendix D guidelines
[2] V/C = volume to capacity ratio
Bolded and shaded intersections operate at or approaching an unacceptable LOS E or worse, per City guidelines
Source: Los Angeles City Department of Transportation, 2014; Los Angeles CMP; AECOM, 2014

Temporary closures of sidewalks and crosswalks may be necessary. Lane reductions and street closures could inhibit the flow of bicycle traffic during construction, particularly along Flower Street during grouting activities on the central and eastern sides of the street. Although temporary, the identified potential impacts during construction on pedestrian and bicycle movements would be significant and unavoidable similar to the Project.

3.2.2.2 Operational Impacts

There would be no operational impacts from implementation of Alternative B on traffic circulation, transit, parking, or other modes beyond those identified for the Project.

There would be a reduction in the resulting LRT operational speed in the Flower Street segment for Alternative B, which would be reduced to 35 mph from 55 mph under the Project and identified as required by Metro Rail Design Criteria, Section 10 Operations. This speed reduction would have permanent negative operational impacts on headway and runtimes compared to the Project, and Alternative B would offer less travel time savings than the Project. Increased travel times may result in a reduction in project ridership, and a corresponding decrease in air quality and climate change benefits as SOV drivers are not attracted to shift to rail service.

3.3 Mitigation Measures

Mitigation measures to reduce potential transportation impacts during construction were identified in the Final EIS. Implementation of mitigation measures TR-1 through TR-13 from the Final EIS for the Project would apply for Alternatives A and B. Below is a summary of these mitigation measures, and a detailed description can be found in Appendix G:

- TR-1: Prior to construction, traffic management and construction mitigation plans shall be devised outlining access routes, haul truck activity, street closures, etc
- TR-2: Haul truck routes confirmed during final design and all haul truck activity
- TR-3: Construction worker parking and designated contractor designated areas
- TR-4: Implementation of safe pedestrian detours and crosswalks with ADA compliance
- TR-5: Proper signage for bicyclists of detours, travel lanes, and alternate routes
- TR-6: Permanently restriping Flower Street at the 4th Street intersection
- TR-7: Permanently restriping Flower Street at the 5th Street intersection
- TR-8: Permanently restriping Flower Street at the 6th Street intersection
- TR-9: Continued shuttle service and bus drop-off areas at City National Plaza
- TR-10: Design and implementation of linkages to the proposed Broadway Streetcar
- TR-11: Enhanced pedestrian walkways along Flower Street to better connect Financial District
- TR-12: Maintaining access to bus stops whenever possible and adequate signage
- TR-13: Temporary relocation of bus stops to nearby alternative locations

As with the Project, potentially adverse construction-related effects to traffic, transit, bicycle, parking, and pedestrian circulation would remain after implementation of these mitigation measures for Alternative A and B, which would have additional transportation impacts along Flower Street and in Little Tokyo beyond those identified for the Project.

4.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

The following sections discuss the impacts associated with environmental resources for the tunneling method Alternatives A and B. The construction methods described in Chapter 2.0, Alternatives Considered have varying construction impacts along the focused Flower Street segment and Little Tokyo area analyzed in this SEIS. For some environmental resource areas, operational impacts are not changed from those identified in the Final EIS and are not discussed further. Resource areas with no additional operational impacts beyond those identified for the Project in the Final EIS include:

- Visual Quality
- Air Quality
- Climate Change
- Geotechnical
- Energy Resources
- Historical Resources
- Cumulative

In order to identify potential impacts during construction of the tunneling method alternatives, possible effects from construction activities along Flower Street and in Little Tokyo were analyzed. Impacts from construction activities for other portions of the Project Area from the Final EIS were not analyzed because they would be the same for these alternatives as for the Project.

4.1 VISUAL QUALITY

This section summarizes the existing visual and aesthetic environment within the Study Area for this SEIS and evaluates the potential visual and aesthetic impacts resulting from construction of Alternatives A and B. Potential visual impacts to historic resources are summarized in Section 4.7 Historic Resources of this SEIS.

4.1.1 Affected Environment

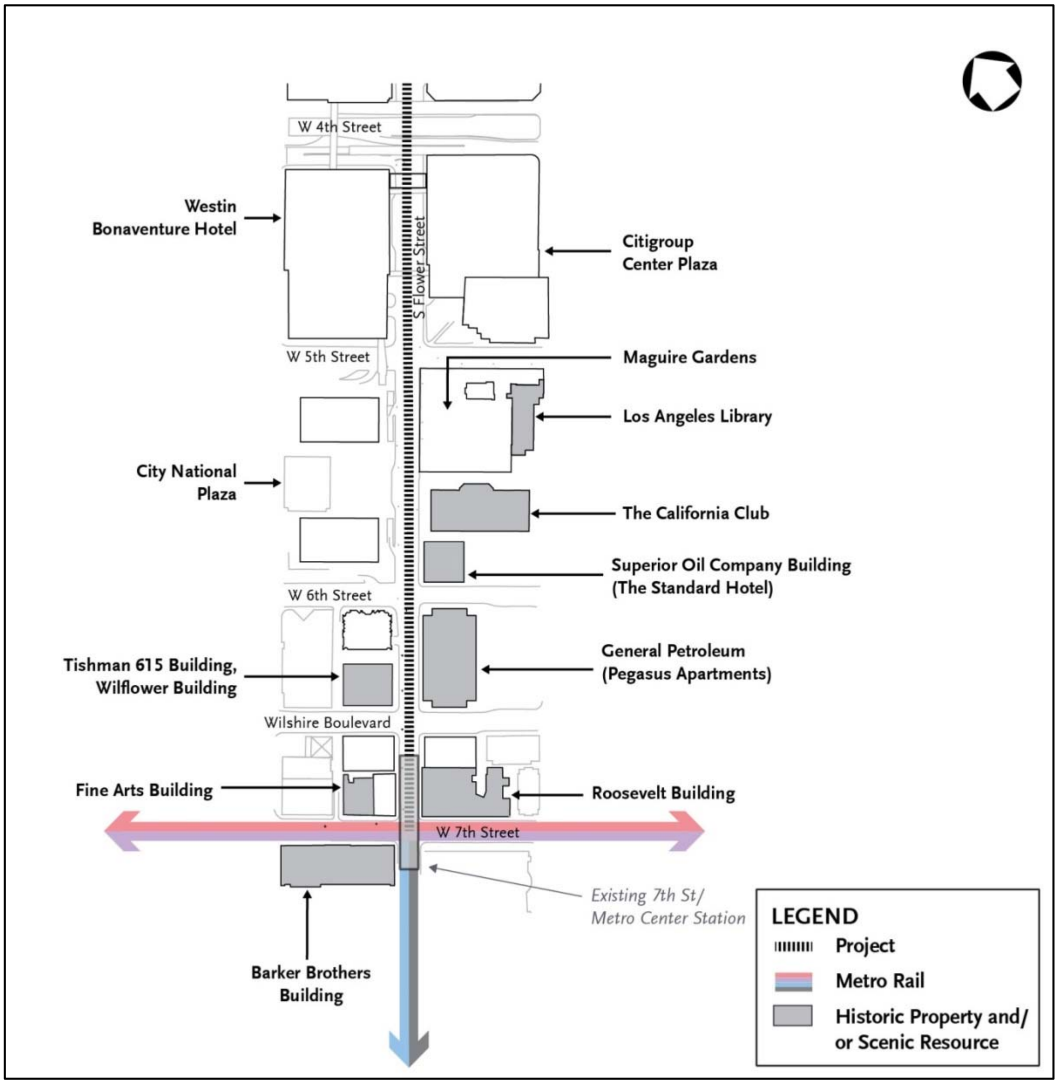
As identified in Section 4.4 Visual and Aesthetic Impacts of the Final EIS, the area for the visual impact analysis consists of the area one city block adjacent to each side of the two tunneling method alternatives along the Flower Street segment between 4th Street and 7th Street/Metro Center Station in the Financial District, and the Mangrove portal site in Little Tokyo.

4.1.1.1 Visual Resources

The existing visual and aesthetic environment is characterized by an established urban landscape. Research was completed to locate visual and aesthetic resources. These resources include, but are not limited to, structures of architectural or historic significance or visual prominence; public plazas, art, and gardens; heritage oaks or other trees or plants protected by the City of Los Angeles; consistent design elements (such as setbacks, massing, height, and signage) along a street or district; pedestrian amenities; and landscaped medians or park areas. Based on site reviews, the predominant visual resources along Flower Street and in Little Tokyo are recognized historic buildings. Figures 4.1-1 and

4.1-2 illustrate identify Flower Street and Little Tokyo buildings respectively that are recognized as historic or visual resources adjacent to the proposed Alternative A and B alignments.

Figure 4.1-1: Historic Properties and Scenic Resources along Flower Street



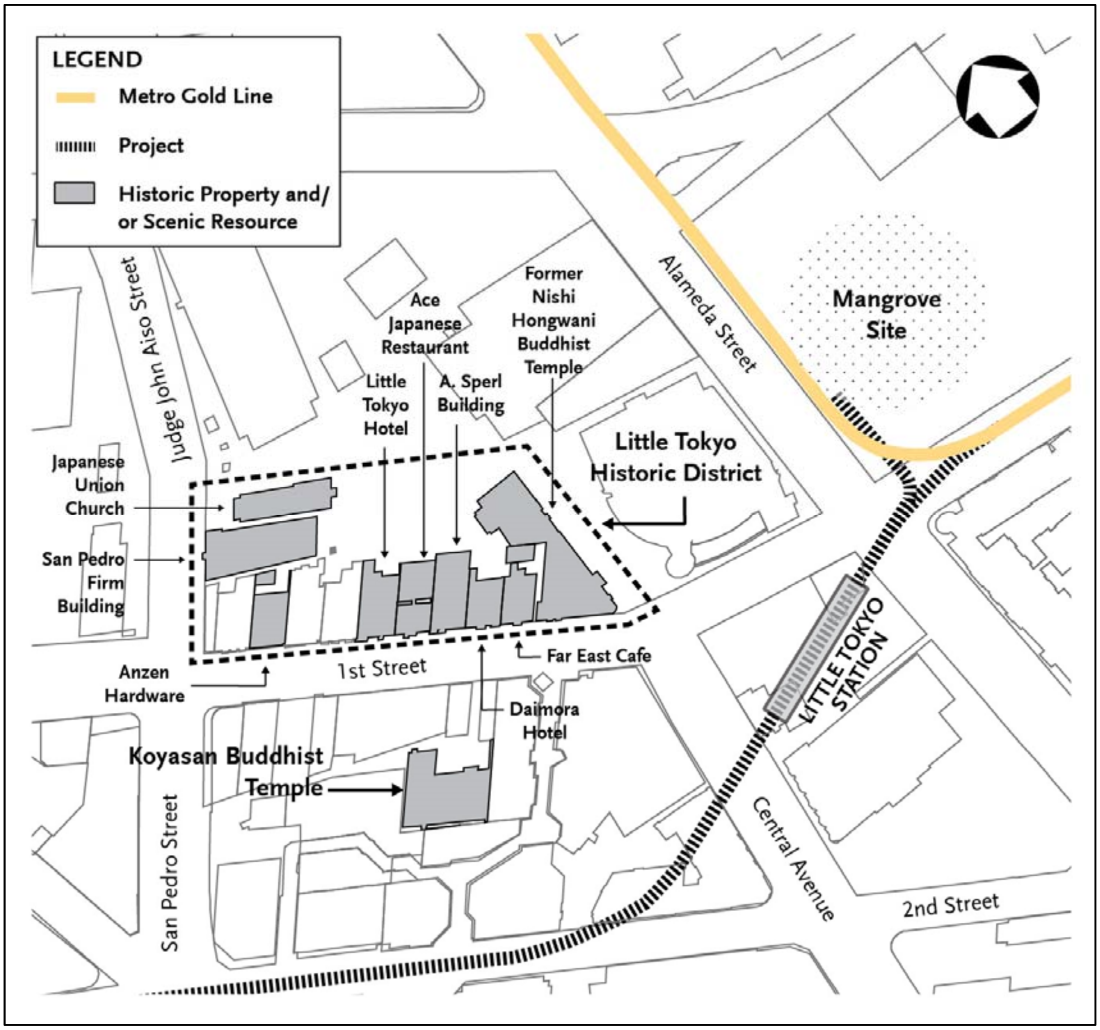
Along Flower Street:

- Pegasus Apartments, 612 South Flower Street
- The Standard Hotel, 550 South Flower Street
- The California Club, 538 South Flower Street
- Los Angeles Central Library and Maguire Gardens, 630 West 5th Street
- Tishman 615 Building , 811 Wilshire Boulevard
- Roosevelt Building, 727 West 7th Street
- Barker Brothers Building, 818 West 7th Street

In the Little Tokyo Area:

- Little Tokyo Historic District
- Los Angeles Hompa Hongwanji Temple
- Union Center Arts

Figure 4.1-2: Historic Properties and Scenic Resources in Little Tokyo



4.1.1.2 Scenic Vistas

The City of Los Angeles General Plan and the Scenic Highways Plan within the General Plan's Circulation Element state that there are no scenic highways in downtown Los Angeles. Although Objective 11 of the General Plan's Circulation Element is to "preserve and enhance access to scenic resources and regional open space," there are no such features adjacent to the alternatives under evaluation along Flower Street or in the Little Tokyo area.

4.1.2 Environmental Consequences

Potential impacts to historic resources are evaluated in Section 4.7 Historic Resources of this SEIS. Scenic byways, scenic vistas, and protected public view corridors are not located along the Flower Street segment or Mangrove portal site in Little Tokyo, the Study Area for this SEIS. Therefore, the two tunneling method alternatives would neither impede views from any nationally recognized scenic highways, designated scenic routes, corridors, or parkways nor would they affect any otherwise recognized or valued public viewing locations.

Methodology

The extent of the potential impact from a particular visual change is subjective and depends upon the degree of alteration, the scenic quality of the area disturbed, and the sensitivity of the viewers. The degree of alteration refers to the extent of change, including changes to a structure height, landscaping, and setback, as well as the introduction of construction equipment. Scenic quality is often indicated by a city's special zoning and planning overlay zones, but can also be assessed based on memorability of the view, and unity of the elements within the view.

Due to the location of the tunneling method alternatives in downtown Los Angeles, construction activities would be visible to several different groups of people. To assess their potential responses to the tunneling method alternatives, it is important to identify and categorize different types of viewers depending on their sensitivity to change in the landscape. Viewer groups who currently experience the Study Area include local residents of downtown Los Angeles; patrons and employees of businesses and public facilities in the Financial District and Little Tokyo, and motorists passing through the Study Area. Viewer sensitivity varies depending on the location of the viewer at the time the view is experienced, the duration of that view, the typical activities being undertaken while the view is experienced, and the number of viewers in the sensitive viewer group. A description of each viewer group follows, in order from the most to least sensitive.

The Pegasus Apartments and Roosevelt Building are multi-family residences located directly adjacent to the project alignment along Flower Street and currently have views of the project site in the Financial District. In addition, a multi-family residential complex (Savoy Community Association) is located at the southeast corner of the intersection of Alameda and 1st Streets, directly across the street from the Mangrove site in Little Tokyo.

Patrons and employees of Los Angeles Central Library and Maguire Gardens, California Club, Standard Hotel, City National Plaza, Citigroup Center Plaza, and 811 Wilshire Boulevard currently have direct views of the project site along Flower Street. In addition, patrons and employees of businesses and community facilities currently have direct and indirect views of the Mangrove site in Little Tokyo. Patrons and employees are typically considered less sensitive viewers because they would generally continue to patronize and work in the area despite negative impacts and aesthetics of the area and project site. Patrons and employees at these locations would have a moderate sensitivity to changes in the Study Area.

Motorists pass through the project site along the Flower Street segment in the Financial District, as well as the Mangrove site in Little Tokyo. Motorists are generally considered to be the least sensitive of the viewers identified here as views are fleeting and temporary. However, motorists traveling in the Study Area during peak traffic periods may have a longer duration of views while waiting at traffic signals.

4.1.2.1 Alternative A – EPBM/Open Face Shield/SEM Project Profile

4.1.2.1.1 Construction Impacts

Scenic Resources

There would be no impact from Alternative A to either Flower Street or in the Little Tokyo area as there are no adjacent scenic resources within view from a scenic highway. Potential impacts to visual character and setting, including the setting of historic resources are discussed below.

Construction of Alternative A would not result in adverse effects to scenic resources. Therefore, construction of this alternative would not contribute to a cumulative scenic resource impact

Visual Quality/Visual Character

During construction of Alternative A, activities occurring aboveground in roadways and along sidewalks would temporarily alter the existing visual character and views along Flower Street and in the vicinity of the Mangrove property in Little Tokyo. Construction equipment and staging locations would be visible to nearby land uses and passersby; however, the construction sites themselves would be screened from public view by temporary construction barriers to the extent possible.

Flower Street Impacts

As previously mentioned, highly visible jet grouting and mixing equipment, with certain pieces over 100 feet tall, are of a size, type, and quantity that could not be entirely screened. The proposed grouting rigs to be used for construction of Alternative A are similar in size to the drill rigs and cranes to be used for cut and cover construction under the Project. The difference is due to the number of grouting rigs and supporting equipment, and the duration of grouting compared to cut and cover construction. Grouting rigs are supported by cement and water silos that are similar in size to the rigs, and require mixing and electrical generation equipment to facilitate the mixing and flow of the grouting material.

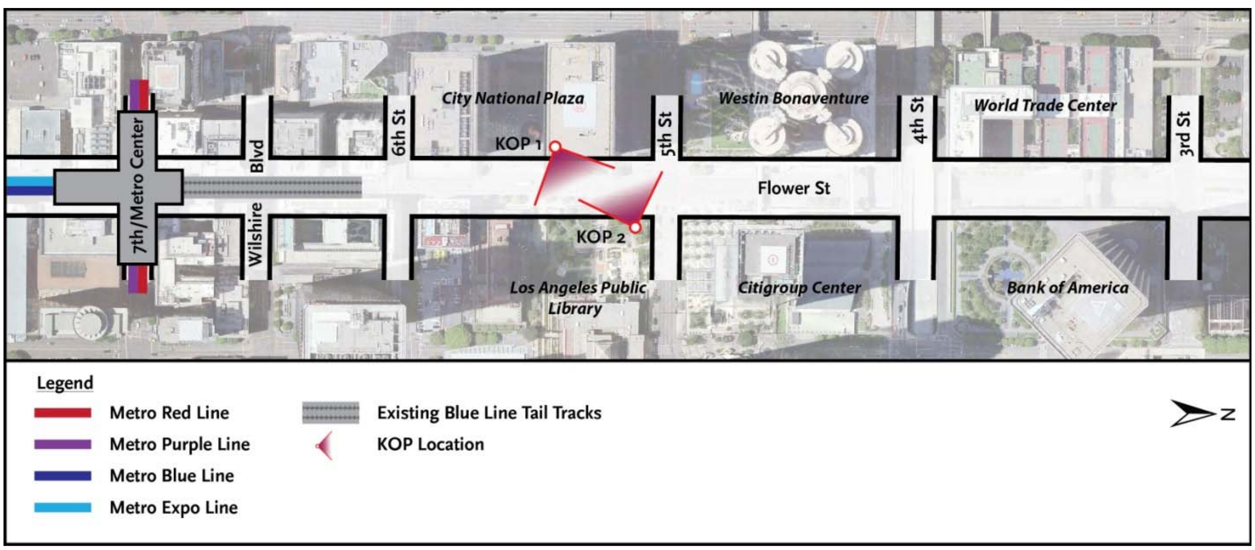
The construction and grouting staging sites are proposed to be located generally in the travel lanes along the east side of Flower Street, from south of 4th Street to 6th Street as discussed and illustrated in Chapter 2, Alternatives Considered. Staging locations were not located on east-west streets such as 5th Street as they typically provide access to the north-bound and south-bound I-110 Freeway two blocks to the west of Flower Street. In the case of 5th Street, while the street is five lanes in width, taking two lanes for equipment storage would significantly reduce the peak period carrying capacity and operations of the street, while Flower Street serves only south-bound downtown traffic and has more capacity to store equipment. In addition, locating construction and grouting activities on 5th

Street would result in significant access impacts to the Los Angeles Central Library and a restaurant business that would need to be closed for the duration of construction due to equipment blocking both views of the business and parking/valet access for the building.

On Flower Street, grouting equipment would be located directly adjacent to the previously identified visual resources, including the Los Angeles Central Library and Maguire Gardens, California Club, The Standard Hotel, and the Pegasus Apartments. As a result of the numerous types, amount, and scale of the equipment associated with grouting, this segment of Flower Street would exhibit an altered visual environment.

As part of a visual character analysis, several viewpoints or key observation points (KOPs) were selected that represented valued views along this segment of Flower Street. The two KOPs, KOP 1 and KOP 2, are located along Flower Street, between 5th and 6th Streets. Each of these KOPs represents public pedestrian, transit rider, and vehicle driver views along Flower Street of nearby valued visual resources such as the Los Angeles Central Library and Maguire Gardens, and the California Club. Figure 4.1-3 shows the locations of KOP 1 and KOP 2.

Figure 4.1-3: Location of Flower Street Key Observation Points (KOPs) 1 and 2

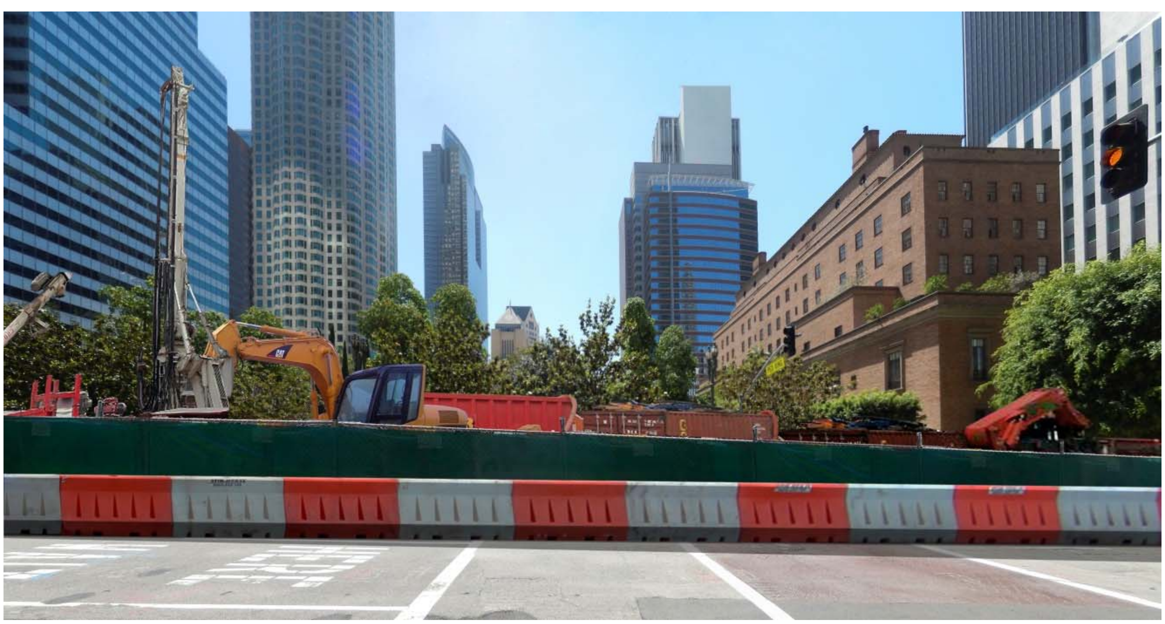


Figures 4.1-4 through 4.1-7 illustrate "before and after" visual simulations, which compare the existing affected environment (before) to the visual character of the use of jet grouting and mixing and other construction equipment (after). The "after" representations of the construction equipment to be used under Alternative A are considered to be conceptual at this time and may not represent the exact construction equipment and/or conditions that would occur if Alternative A were to be constructed.

The view from KOP 1, illustrated in Figures 4.1-4 and 4.1-5, includes an east-facing view of the Los Angeles Central Library and Maguire Gardens, and the California Club along Flower Street from City National Plaza on the west side of Flower Street. The Los Angeles Central Library building is not clearly visible in the view; however, the associated Maguire Gardens includes the mature trees on the left side. The California Club building includes a historic red-brick building toward the right side of the view. This view is representative of the experience of local residents, patrons, and employees, and passing motorists and pedestrians. Both the Los Angeles Central Library and the California Club and Maguire Gardens are considered to be visual resources.

Figure 4.1-4: Before View of Flower Street Facing East Between 5th and 6th Streets

Figure 4.1-5: After View of Flower Street with Construction and Grouting Equipment Facing East Between 5th and 6th Streets



The before and after views from KOP 2, shown in Figures 4.1-6 and 4.1-7, includes a west-facing view of City National Plaza from within the Maguire Gardens grounds on the east side of Flower Street. The angular orange sculpture is visible within the center of the plaza and is the Plaza's iconic artwork.

This view is representative of the experience specifically of patrons and employees, and passing pedestrians of Maguire Gardens. City National Plaza is considered to be a visual resource.

Figure 4.1-6: Before View of Flower Street Facing West Between 5th and 6th Streets

Figure 4.1-7: After View of Flower Street with Construction and Grouting Equipment Facing West Between 5th and 6th Streets

Although it is not uncommon to have construction activities in a heavily urbanized environment consisting of high- and mid-rise buildings, construction of Alternative A would require the use of large-scale jet grouting and mixing equipment along Flower Street that would noticeably reduce the visual quality or alter viewing context from the perspective of KOP 1 and KOP 2. From KOP 1, views of the mature trees and garden setting of Maguire Gardens, as well as the California Club would be significantly disrupted and blocked by construction activities. Similarly, from KOP 2, west-facing views from within Maguire Gardens toward City National Plaza would be blocked. The visual intrusion of the construction and grouting equipment from the perspective of both KOPs would dominate views for all viewer groups. Temporary construction impacts on visual character along Flower Street would be adverse. Mitigation may not be available to reduce these impacts due to the size, type, and quantity of the construction and grouting equipment.

Little Tokyo Impacts

For Alternative A, construction activities proposed for the Mangrove site would result in an increased number of muck trucks driving through the Little Tokyo area. Although the trucks would not directly impact the visual environment, view of the truck would be temporary and fleeting. Views of the Mangrove site during construction may alter the visual environment for residents, area patrons and employees, as well as passing motorists. Temporary construction impacts on visual character near the Mangrove site would not be reduced with screening to not adverse.

In summary, unlike the Project which does not require the use of grouting, construction of Alternative A would alter the visual quality of the street due to major equipment being located adjacent to historic properties during the entire duration of grouting, approximately 12 months and possibly up to 24 months. Overall, Alternative A would result in more intense, but temporary impacts to the visual character along Flower Street as compared to the Project. Therefore, it would contribute to a temporary cumulative visual impact. All other visual and aesthetic effects from construction of this alternative would not be substantially adverse. Alternative A would result in temporary construction-related adverse effects on the visual character of Flower Street between 4th and 6th Streets that could not effectively be mitigated. Therefore, it would contribute to a temporary cumulative visual character impact. There would be no impacts beyond those identified for the Project, in Little Tokyo.

Nighttime Lighting/Shade and Shadow

During construction of Alternative A, nighttime lighting would predominantly consist of security lighting that would be directed on-site. Construction is expected to occur in two shifts per day, while grouting activities are currently anticipated to take place in one ten-hour, daytime shift per day. Depending on the final contractor work schedule, which may include a second nighttime grouting shift, there would be a potential for nighttime lighting impacts on hotels and businesses along Flower Street. Lighting from construction activity would be limited to the street level, which is currently highly lighted during the night. These construction impacts would be temporary.

The construction of Alternative A would not result in adverse nighttime lighting or shade and shadow impacts along Flower Street based on a single daytime grouting shift. While there would be an increase in truck activity level and duration in Little Tokyo, the trucks would only be operated during the day. Therefore, this alternative would not contribute to cumulative nighttime lighting or shade and shadow impacts.

4.1.2.2 Alternative B – EPBM/SEM Low Alignment

4.1.2.2.1 Construction Impacts

Scenic Resources

There would be no impact from Alternative B to either Flower Street or in the Little Tokyo area as there are no adjacent scenic resources within view from a scenic highway. Potential impacts to visual character and setting, including the setting of historic resources are discussed below.

Construction of Alternative B would not result in adverse impacts to scenic resources. Therefore, construction of this alternative would not contribute to a cumulative scenic resource impact.

Visual Quality/Visual Character

During construction of Alternative B, activities occurring aboveground in roadways and along sidewalks would temporarily alter the existing visual character and views along Flower Street and adjacent to the Mangrove property in Little Tokyo in similar ways to those identified for Alternative A.

Flower Street Impacts

As previously discussed for Alternative A, highly visible jet grouting and mixing equipment, with certain pieces over 100 feet tall, are of a size, type, and quantity that could not be entirely screened. While the proposed grouting rigs to be used for construction of Alternative B are similar in size to the drill rigs and cranes to be used for the Project's cut and cover construction, the number of grouting rigs and supporting equipment, and the duration of the grouting compared to cut and cover construction would have significant impacts over those of the Project.

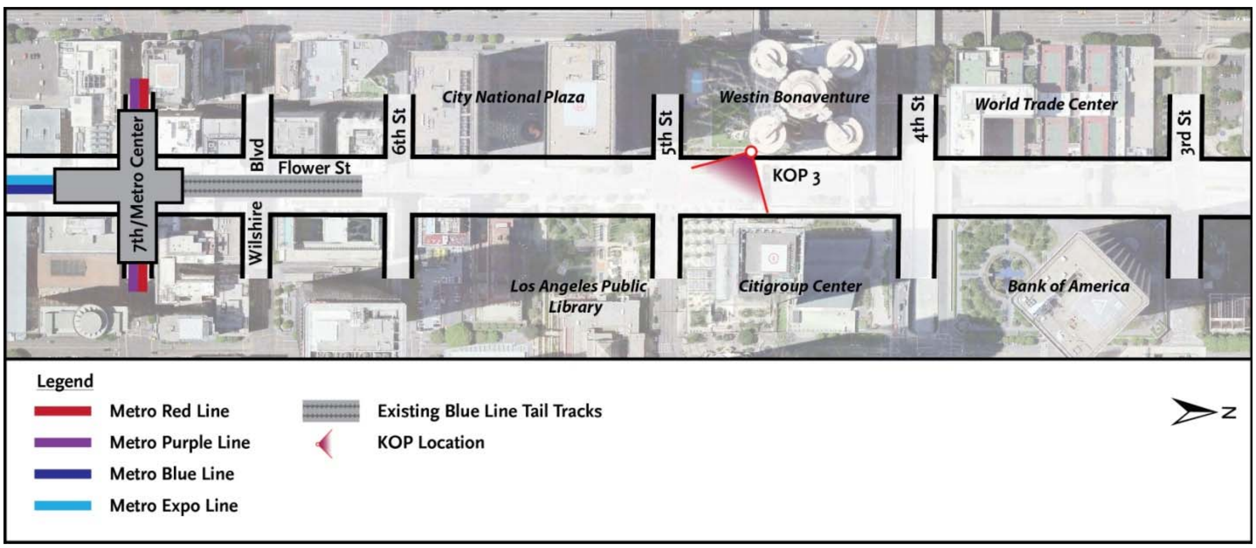
For Alternative B, the single construction and grouting staging site required for this alternative is proposed to be located generally in the travel lanes along the east side of Flower Street between just south of 5th Street to 6th Street as discussed and illustrated in Chapter 2, Alternatives Considered. Staging locations were not located on east-west streets such as 5th Street as they typically provide access to the north-bound and south-bound I-110 Freeway two blocks to the west of Flower Street. Taking of two lanes on east-west streets for equipment storage would significantly reduce the peak period carrying capacity and operations of the street, while Flower Street serves only south-bound downtown traffic and has more capacity to store equipment. Similar to Alternative A, locating construction and grouting activities on 5th Street would result in significant access impacts to the Los Angeles Central Library and a restaurant business that would need to be closed for the duration of construction.

On Flower Street, grouting equipment would be located directly adjacent to the previously identified visual resources, including the Los Angeles Central Library and Maguire Gardens, California Club, The Standard Hotel, and the Pegasus Apartments. As a result of the numerous types, amount, and scale of the equipment associated with grouting, this segment of Flower Street would exhibit an altered visual environment.

Construction staging locations would be visible to nearby land uses and passersby; however, the construction sites themselves would be sheltered from direct public view by temporary construction barriers. As previously mentioned, highly visible jet grouting equipment, with certain pieces over 100 feet tall that could not be screened, would be located in travel lanes along the east side of Flower Street, from south of 5th Street to just south of 6th Street. As a result of the numerous types, amount, and scale of the equipment associated with jet grouting and mixing, this segment of Flower Street would exhibit an altered visual environment.

As part of the visual character analysis for Alternative B, one KOP was selected that represented a valued view along this segment of Flower Street, and the location where construction conditions along the street would change versus those of the Project. Construction activities in/around the Little Tokyo area remain unchanged, with the exception being the increased length of time of associated construction haul activities due to changes in construction along Flower Street. Figure 4.1-8 illustrates the location of the KOP 3, which is located along Flower Street between 5th and 6th Streets.

Figure 4.1-8: Location of Flower Street KOP 3



The before and after views from KOP 3, illustrated in Figures 4.1-9 and 4.1-10, represents public pedestrian, transit rider, and vehicle driver views along Flower Street of valued visual resources such as the Los Angeles Central Library and Maguire Gardens, and the California Club. The figures compare the existing affected environment (before) to the visual character of the use of jet grouting, mixing, and other construction equipment (after). The "after" representation of the construction equipment to be used under Alternative B are considered to be conceptual at this time and may not represent the exact construction conditions that would occur if Alternative B were constructed.

Figure 4.1-9: Before View of Flower Street Facing Southeast North of 5th Street

Figure 4.1-10: After View of Flower Street Facing Southeast North of 5th Street

Although it is not uncommon to have construction activities in a heavily urbanized environment consisting of high- and mid-rise buildings, the construction of Alternative B, including the use of large-scale jet grouting equipment, would noticeably reduce visual quality or alter viewing context from the perspective of KOP 3. Views of the mature trees of the Citigroup Center Plaza, and Maguire Gardens, as well as the California Club would be significantly disrupted and blocked by construction activities. The visual intrusion of the construction equipment would dominate views for all viewer groups. Furthermore, temporary construction impacts on visual character would be adverse. Mitigation may not be available to reduce these impacts due to the size of the equipment.

Little Tokyo Impacts

For Alternative B, construction activities proposed for the Mangrove site would result in an increased number of muck trucks driving through the Little Tokyo area. Although the trucks would not impact the visual environment, as views of the truck would be temporary. Views of the Mangrove site during construction may alter the visual environment for residents, area patrons and employees, as well as passing motorists. Temporary construction impacts on visual character near the Mangrove site would not be adverse with mitigation similar to the Project. All other visual and aesthetic effects from construction of this alternative would not be substantially adverse.

In summary, unlike the Project which does not require the use of grouting, construction of Alternative B would alter the visual quality of the street due to major equipment being located adjacent to historic properties during the entire duration of grouting, approximately 8 months and possibly up to 16 months. Overall, Alternative B would result in more intense, but temporary impacts to the visual character along Flower Street during construction as compared to the Project. Alternative B would result in temporary construction-related adverse effects on the visual character of Flower Street between 5th and 6th Streets that could not effectively be mitigated. Therefore, it would contribute to a temporary cumulative visual character impact. There would be no impacts, beyond those identified for the Project, in Little Tokyo.

Nighttime Lighting/Shade and Shadow

During construction of Alternative B, nighttime lighting would predominantly consist of security lighting that would be directed on-site. Construction is expected to occur in two shifts per day, while grouting activities are currently anticipated to take place in one ten-hour, daytime shift per day. If the contractor adds a second nighttime grouting shift were added, there would be a potential for nighttime lighting impacts on hotels and businesses along Flower Street. Lighting from construction activity would be limited to the street level, which is currently highly lighted during the night. These construction impacts would be temporary.

The construction of Alternative B would not result in adverse nighttime lighting or shade and shadow impacts along Flower Street based on a single daytime grouting shift. While there would be an increase in truck activity level and duration in Little Tokyo, the trucks would only be operated during the day. Therefore, this alternative would not contribute to cumulative nighttime lighting or shade and shadow impacts.

4.1.3 Mitigation Measures

Mitigation measures to reduce potential visual quality impacts during construction were identified in the Final EIS for the Project. Implementation of mitigation measures VA-1 through VA-5 from the Final EIS would apply for Alternatives A and B. Below is a summary of the identified mitigation measures and a detailed description can be found in Appendix G:

- VA-1: Co-ordination with station area communities
- VA-2: Appropriate integration of urban design elements for the LRT at the street level
- VA-3: Minimizing lighting impacts during construction through shielding
- VA-4: Appropriately locating stockpiles in less visually sensitive locations
- VA-5: Placement of construction sheds and barricades to avoid obstructing views

As with the Project, potentially adverse effects during construction would remain after implementation of these mitigation measures for Alternatives A and B, which would have additional visual quality impacts along Flower Street beyond those identified for the Project due to the type, size, and quantity of grouting and support equipment required for construction of these alternatives.

4.2 AIR QUALITY

This section describes the existing air quality conditions in the Project Area from the Final EIS or Study Are for the SEIS, and the potential impacts from construction of the tunneling method alternatives compared to the Project. This section focuses on the evaluation of the tunnel method alternatives compared to what was previously analyzed as part of the Final EIS. The analysis focuses on potential short-term impacts of emissions during construction of the tunneling method alternatives compared to the Project. While short-term construction impacts associated with the Project, Alternative A and Alternative B could result in potentially adverse air quality impacts, operation of the new transit project would result in a long-term air quality benefit compared to existing conditions due to decreased regional vehicle miles travelled.

4.2.1 Affected Environment

NEPA does not contain air quality thresholds specific to construction or require regional conformity analysis for construction activities expected to last less than five years. Therefore, this analysis uses South Coast Air Quality Management District's (SCAQMD) regional CEQA thresholds of significance and Localized Significance Thresholds (LST's) to analyze potentially adverse regional and localized construction air quality impacts pursuant to NEPA, consistent with the Final EIS.

The air quality area of analysis includes the four-county region covered by the South Coast Air Basin (SoCAB), which includes all of Orange County and the urban, non-desert portions of Los Angeles, Riverside, and San Bernardino Counties. The SoCAB area has high levels of air pollution, particularly from June through September. Pollutant concentrations in the SoCAB vary by location, season, and time of day. Concentrations of O_3, for example, tend to be lower along the coast and in far inland areas of the basin and adjacent desert and higher in and near inland valleys.

Over the past 30 years, substantial progress has been made in reducing air pollution levels in Southern California. Previously, the Environmental Protection Agency (EPA) designated SoCAB as a non-attainment area for all National Ambient Air Quality Standards (NAAQS) except sulfur dioxide (SO_2) (the SoCAB was designated as an attainment/maintenance area for SO_2 in 1979). The EPA now designates SoCAB as in attainment for nitrogen dioxide (NO_2), SO_2, and CO. Particulate matter (PM_{10} and $PM_{2.5}$), Pb (lead), and ozone (O_3) levels, while reduced substantially from their peak, remain above relevant NAAQS and California Ambient Air Quality Standards (CAAQS), and PM_{10} levels also remain above the CAAQS.

4.2.2 Environmental Consequences

In order to compare potential impacts during construction of the tunneling method alternatives to the Project, impacts from construction activities along Flower Street and Little Tokyo were analyzed. Impacts from construction activities for other portions of the Project Area were not analyzed because they would be the same for these alternatives as for the Project. The construction methods that would be employed for each of the alternatives are described in Chapter 2, Alternatives Considered.

Construction emissions from the two tunneling method alternatives were estimated using the same methodology that was used for the Final EIS, which is described in more detail in the Air Quality Impacts and Health Risk Assessment Technical Memorandum, which is incorporated into the Final EIS as Appendix Q. The emission calculations include reductions from the mitigation measures listed in Chapter 4.5, Air Quality, of the Final EIS.

4.2.2.1 Alternative A – EPBM/Open Face Shield/SEM Project Profile

Short-term regional and localized air quality impacts generated during construction were evaluated by comparing estimated peak daily emissions to SCAQMD's regional CEQA thresholds of significance and LST's, consistent with the Final EIS. The emissions estimate includes the following sources: off-road construction equipment, fugitive dust, construction worker commuting, and haul truck transport.

4.2.2.1.1 Construction Impacts

The estimated construction equipment use, soil excavation quantities, number of daily haul truck trips (for removal of excavation materials) and number of construction workers for each phase of Alternative A is listed in Table 4.2-1.

Air Quality Plan Consistency

Because construction of Alternative A would not result in a population increase, Alternative A would not conflict with the growth projections used to develop the 2012 Air Quality Management Plan (AQMP). Growth projections from local general plans adopted by cities in the SoCAB and VMT projections developed by the SCAG are some of the inputs used to develop the AQMP. Construction of Alternative A would not conflict with the implementation of the AQMP, and there would be no impact.

Ambient Air Quality Standard Violation

Peak daily emissions from activities along Flower Street during construction of Alternative A are compared to SCAQMD's CEQA significance thresholds to evaluate potential regional air quality impact significance, as presented in Table 4.2-2. The emissions estimate includes the following sources: off-road construction equipment, construction worker commuting, haul truck trips, and fugitive dust from earthmoving activities.

As presented in Table 4.2-2, peak daily emissions for construction activities along Flower Street exceed the SCAQMD's regional CEQA significance threshold for NOx of 100 pounds per day. With implementation of proposed mitigation measures, mass daily emissions of NOx would be reduced but would remain adverse. Therefore, emissions of NOx generated during construction of Alternative A have the potential to contribute substantially to an existing or projected air quality violation. Regional air quality impacts related to emissions of NOx remain adverse and unavoidable.

Table 4.2-1: Estimated Construction Equipment, Soil Excavation, and Vehicle Trips for Alternative A

Construction Phase	Construction Equipment	Soil Excavation (cubic yards)	Daily Haul Truck Trips	Construction Workers
Alternative A				
Earth Pressure Boring Under Flower Street, West Bound	2 dozers (357 hp) 4 excavators(168 hp) 2 cranes (399 hp) 5 flatbeds (479 hp)	13,917	20	20
Earth Pressure Boring Under Flower Street, East Bound	2 dozers (357 hp) 4 excavators(168 hp) 2 cranes (399 hp) 5 flatbeds (479 hp)	13,917	20	20
Jet Grouting on Flower Street	4 drill/injection rigs (755 hp) 4 generators (689 hp) 4 compressors (207 hp) 5 flatbeds (479 hp)	0	0	40
Open Face/Shield Tunneling Under Flower Street	2 dozers (357 hp) 4 excavators(168 hp) 2 cranes (399 hp) 5 flatbeds (479 hp)	17,373	20	20
Sequential Excavation Method Tunneling Under Flower Street	2 dozers (357 hp) 4 excavators(168 hp) 2 cranes (399 hp) 5 flatbeds (479 hp)	19,097	20	20
Cut and Cover Along Flower Street	2 dozers (357 hp) 4 excavators(168 hp) 2 cranes (399 hp) 1 drill rig (291 hp) 5 flatbeds (479 hp)	20,925	20	30

Source: The Connector Partnership, 2014

With implementation of mitigation measures, construction of Alternative A, similar to the Project, would still result in a cumulatively considerable contribution to regional air quality. Therefore, regional air quality impacts under NEPA would be adverse.

Peak daily on-site emissions during each construction phase for Alternative A were also compared with the emissions from the SCAQMD Localized Significance Thresholds (LST) look-up tables, as presented in Table 3-4 of the Air Quality Appendix. The emissions used from the SCAQMD look-up tables were for a one-acre site and a distance of 25 meters to the closest receptor, because these were the smallest size and shortest distance available in the LST look-up tables. Peak daily on-site emissions from construction of Alternative A did not exceed the values from the look-up tables.

Therefore, on-site construction emissions from Alternative A would not be anticipated to cause an LST to be exceeded.

Table 4.2-2: Peak Daily Construction Emissions (Mitigated), lb/day – Alternative A

Emission Source	VOC	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$
Construction Equipment[1]	45.5	**307.7**	360.4	1.7	7.4	0.1
Construction Worker Commuting	0.2	0.6	7.0	0.0	3.3	0.0
Haul Trucks	1.7	7.4	7.6	0.0	0.7	0.7
Total =	47	**316**	375	2	11	1
SCAQMD Significance Threshold	75	100	550	150	150	55

Note: Values that exceed significance threshold are in **bold** and shaded.
[1] Fugitive dust emissions generated during earthmoving activities are included in the daily PM10 and PM2.5 emissions for construction equipment.
Source: AECOM, 2014

Cumulatively Considerable Air Quality Impact

The SoCAB is classified as nonattainment for O_3, PM_{10} and $PM_{2.5}$. Table 4.2-2 shows that peak daily emissions of NOx, which is an O_3 precursor, exceed the SCAQMD's CEQA significance threshold. Therefore, construction of Alternative A could result in a cumulatively considerable net increase of O_3 precursor emissions. These impacts would occur over the duration of construction and would be temporary. Mitigation measures including use of model year 2014 off-road equipment would be implemented, which would reduce NOx construction emissions, but impacts would remain adverse. Thus, the cumulative impact from these emissions is expected to remain adverse and unavoidable.

Sensitive Receptor Exposure to Substantial Pollutant Concentrations

Construction activities would include operation of diesel-fueled off-road equipment, resulting in emissions of diesel particulate matter (DPM), a recognized toxic air contaminant (TAC). However, because carcinogenic DPM health risk is estimated using the annual average concentration over long exposure periods (40 to 70 years), the Office of Environmental Health Hazard Assessment (OEHHA) does not suggest estimating carcinogenic health risk for exposure periods less than nine years. Construction of Alternative A, over an estimated duration of approximately 4 years, would be less than the nine-year exposure period indicated by OEHHA. The most conservative distance to evaluate exposure to sensitive receptors is 25 meters (80 feet). As discussed above, emissions generated during construction of Alternative A would not exceed the LSTs and, therefore, would not substantially affect nearby receptors. The impact would not be adverse.

Objectionable Odors

Construction of Alternative A would not result in any major sources of odor, and would not involve operation of any of the common types of facilities that are known to produce odors (e.g., landfill, coffee roaster, wastewater treatment facility). Diesel exhaust, which could be considered an objectionable odor source, would be associated with construction equipment operation, but it would be intermittent and temporary and would dissipate rapidly from the source with an increase in distance. Thus, Alternative A construction would not expose sensitive receptors to significant odorous impacts, and this impact would not be adverse.

4.2.2.2 Alternative B – EPBM/SEM Low Alignment

As described in Section 4.2.2.3, short-term regional and localized air quality impacts generated during construction were evaluated by comparing estimated peak daily emissions to SCAQMD's regional CEQA thresholds of significance and LST's, are consistent with the Final EIS.

4.2.2.2.1 Construction Impacts

The estimated construction equipment use, soil excavation quantities, number of daily haul truck trips and number of construction workers for each phase of Alternative B is listed in Table 4.2-3.

Table 4.2-3: Estimated Construction Equipment, Soil Excavation, and Vehicle Trips for Alternative B

Construction Phase	Construction Equipment	Soil Excavation (cubic yards)	Daily Haul Truck Trips	Construction Workers
Alternative B				
Earth Pressure Boring Under Flower Street	2 dozers (357 hp) 4 excavators (168 hp) 2 cranes (399 hp) 5 flatbeds (479 hp)	44,292	20	20
Jet Grouting on Flower Street	2 drill/injection rigs (755 hp) 2 generators (689 hp) 2 compressors (207 hp) 5 flatbeds (479 hp)	0	0	20
Sequential Excavation Method Tunneling Under Flower Street	2 dozers (357 hp) 4 excavators (168 hp) 2 cranes (399 hp) 5 flatbeds (479 hp)	22,487	20	20
Cut and Cover Along Flower Street	2 dozers (357 hp) 4 excavators (168 hp) 2 cranes (399 hp) 1 drill rig (291 hp) 5 flatbeds (479 hp)	16,231	20	30

Source: Regional Connector Partnership, 2014

Air Quality Plan Consistency

Because construction of Alternative B would not result in a population increase, Alternative B would not conflict with the growth projections used to develop the 2012 AQMP. Growth projections from local general plans adopted by cities in the SoCAB and VMT projections developed by the SCAG are some of the inputs used to develop the AQMP. Construction of Alternative B would not conflict with the implementation of the AQMP, and there would be no impact.

Ambient Air Quality Standard Violation

Peak daily emissions from activities along Flower Street during construction of Alternative B were compared to SCAQMD's regional CEQA significance thresholds to evaluate potential air quality impacts, as presented in Table 4.2-4. Peak daily emissions include the following sources: off-road construction equipment, construction worker commuting, haul truck trips, and fugitive dust from earthmoving activities.

Table 4.2-4: Peak Daily Construction Emissions (Mitigated), lb/day – Alternative B

Emission Source	VOC	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$
Construction Equipment[1]	37.0	**186.8**	256.3	1.2	4.4	4.0
Construction Worker Commuting	0.1	0.4	5.3	0.0	0.1	0.3
Haul Trucks	1.1	7.4	4.5	0.0	2.9	0.3
Total =	38	**195**	266	1	7	5
SCAQMD Significance Threshold	75	100	550	150	150	55

Note: Values that exceed significance threshold are in **bold** and shaded.
[1] Fugitive dust emissions generated during earthmoving activities are included in the daily PM10 and PM2.5 emissions for construction equipment.
Source: AECOM, 2014

As presented in Table 4.2-4, peak daily emissions for construction activities along Flower Street exceed the CEQA significance threshold for NOx of 100 pounds per day. With implementation of proposed mitigation measures, mass daily emissions of NOx would be reduced but would remain adverse Therefore, emissions of NOx generated during construction of Alternative B have the potential to contribute substantially to an existing or projected air quality violation. Regional air quality impacts related to emissions of NOx remain adverse and unavoidable.

With implementation of mitigation measures, emissions of peak daily NOx would not be reduced below a level of significance. With implementation of mitigation measures, construction of Alternative B, similar to the Project, would still result in a cumulatively considerable contribution to regional air quality. Therefore, regional air quality impacts under NEPA would be adverse.

Peak daily on-site emissions during each construction phase for Alternative B were also compared with the emissions from the SCAQMD LST look-up tables, as presented in Table 3-5 of the Air Quality Appendix. The emissions used from the SCAQMD look-up tables were for a one-acre site and a distance of 25 meters to the closest receptor, because these were the smallest size and shortest distance available in the LST look-up tables. Peak daily on-site emissions from construction of Alternative B would not exceed the values from the look-up tables. Therefore, on-site construction emissions from Alternative B would not be anticipated to cause an LST to be exceeded.

Cumulatively Considerable Air Quality Impact

The SoCAB is classified as nonattainment for O_3, PM_{10} and $PM_{2.5}$. Table 4.2-4 shows that peak daily emissions of NOx, which is an O_3 precursor, exceed the SCAQMD's CEQA significance threshold. Therefore, construction of Alternative B could result in a cumulatively considerable net increase of O_3 precursor emissions. These impacts would occur over the duration of construction and would be temporary. Mitigation measures including use of model year 2014 off-road equipment would be implemented, which would reduce NOx construction emissions, but would remain adverse. Thus, the cumulative impact from these emissions is expected to remain adverse and unavoidable.

Sensitive Receptor Exposure to Substantial Pollutant Concentrations

Construction activities would include operation of diesel-fueled off-road equipment, resulting in emissions of DPM, a recognized TAC. However, because carcinogenic DPM health risk is estimated using the annual average concentration over long exposure periods (40 to 70 years), OEHHA does not suggest estimating carcinogenic health risk for exposure periods less than nine years. Construction of Alternative B, over an estimated duration of approximately 4 years, would be less than the nine-year exposure period indicated by OEHHA. The most conservative distance to evaluate exposure to sensitive receptors is 25 meters (80 feet). As discussed above, emissions generated during construction of Alternative A would not exceed the LSTs and, therefore, would not substantially affect nearby receptors. The impact would not be adverse.

Objectionable Odors

Construction of Alternative B would not result in any major sources of odor, and would not involve operation of any of the common types of facilities that are known to produce odors (e.g., landfill, coffee roaster, wastewater treatment facility). Diesel exhaust, which could be considered an objectionable odor source, would be associated with construction equipment operation, but it would be intermittent and temporary and would dissipate rapidly from the source with an increase in distance. Thus, Alternative B construction would not expose sensitive receptors to significant odorous impacts, and this issue would not be adverse.

4.2.3 Mitigation Measures

Mitigation measures to reduce the potential regional air quality impacts during construction were identified in the Final EIS. Implementation of mitigation measures AQ-1 through AQ-22 from the Final EIS for the Project would apply for Alternatives A and B. Below is a summary of these mitigation measures and a detailed description can be found in Appendix G:

- AQ-1: Adherence to SCAQMD standards for off-road engine emissions
- AQ-2: Requirement to use equipment that meets current standards for criteria pollutant emissions
- AQ-3: Adherence to SCAQMD Rule 403 for fugitive dust
- AQ-4: Dirt at construction sites to not exceed 25 feet and street sweeping shall be co-ordinated with local businesses

- AQ-5: Requirement of contractor to utilize SCAQMD Rule 403 Section(d)(5) for material removal
- AQ-6: Haul trucks shall not fill materials all the way to the top during removal of sand, soil, etc
- AQ-7: Haul trucks shall be covered during removal of sand, soil, etc
- AQ-8: Traffic speeds on unpaved roads to be restricted to 15 mph
- AQ-9: Proper implementation of SCAQMD Rule 403 when gusts exceed 25 mph
- AQ-10: Suspension of heavy equipment operations during second stage smog alerts
- AQ-11: Watering and/or covering of on-site debris, dirt, or rusty materials
- AQ-12: Utilization of LADWP electricity rather than diesel or gas generators
- AQ-13: Heavy-duty trucks shall not idle and regular inspections shall be performed
- AQ-14: Construction worker parking shall be configured to minimize traffic interference
- AQ-15: Construction activity that affects traffic flow shall be limited to off-peak hours
- AQ-16: Ongoing maintenance and adherence of specifications of construction equipment
- AQ-17: Dedicated turn lanes for movement of trucks where appropriate
- AQ-18: Requirement of construction equipment to meet EPA standards
- AQ-19: Maintenance and cleanliness of all trucks and construction equipment
- AQ-20: Use of low-sulfur fuel where possible
- AQ-21: Stations and project to be constructed consistent with Energy and Sustainability Policy
- AQ-22: Appropriate detour routes for minimal idling

As with the Project, potentially adverse construction related air quality effects would remain after implementation of these mitigation measures for Alternatives A and B.

4.3 CLIMATE CHANGE

This section evaluates the existing climate change conditions and greenhouse gas (GHG) emission levels in the project area, and the potential impacts from construction of the tunneling method alternatives compared to the Project. The analysis only addresses GHG emissions during construction as operations and the associated climate change impacts would be nearly identical under the Project and the tunneling method alternatives.

Regional vehicle miles travelled (VMT) reductions from implementation of the Project and the tunneling method alternatives would result from increased transit ridership and a corresponding reduction in miles travelled from single occupancy vehicles. These reductions in regional VMT would not be substantially impacted by implementation of either of the tunneling method alternatives, which represent variations in construction method only. For the two tunneling method alternatives, the regional reduction in GHG emissions due to traffic congestion relief is greater than the new emissions associated with operation of the Project and the tunneling method alternatives. The environmental analysis assumes a conservative, worst-case, condition when determining potential impacts. Section 4.6, Climate Change, of the Final EIS describes GHG emissions from existing regional transportation sources in the Project Area and analyzes the potential climate change impacts of the Project. The Final EIS determined that no adverse climate change impacts would be associated with the Project since a regional decrease of GHG emissions will result from its implementation.

4.3.1 Affected Environment

The following analysis identifies existing GHG emission levels generated by the transportation sector based on 2014 forecasted VMT within the Los Angeles region. Data on VMT in the region and emission factors from the EMFAC2007 model were used to estimate emissions of GHG. Since the EMFAC model only generates emissions of carbon dioxide (CO_2) and methane (CH_4), the California Climate Action Registry (CCAR) General Reporting Protocol was used to estimate emissions of nitrous oxide (N_2O). Table 4.3-1 summarizes the results of existing, regional GHG emissions from the transportation sector.

Table 4.3-1: Existing (2014) Conditions – GHG Emissions from Regional Traffic

Regional Vehicle Miles Travelled (VMT/yr)[1]	GHG Emission Factor (grams per mile)			GHG Emissions (Metric Tons per year)			Total ($MTCO_2e$/Yr)
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	
147,037,695,000	365.21	0.028	0.173	53,699,637	4,117	25,438	53,729,191
Global Warming Potential =				1	21	310	61,671,726

Note:
[1] Regional VMT data obtained from the SCAG's 2012-2035 Regional Transportation Plan, Transportation Conformity Analysis Appendix Table 11 (2014 data for SCCAB and SCAB). Available at: http://rtpscs.scag.ca.gov/Documents/2012/final/SR/2012fRTP_TransportationConformityReport.pdf .
Source: AECOM, 2014

4.3.2 Environmental Consequences

The following discussion summarizes the evaluation of potential climate change adverse effects for each of the tunneling method alternative. Construction of the alternatives and the Project would result in GHG emissions predominately in the form of carbon dioxide (CO_2) during operation of construction equipment, excavation materials haul trucks, and worker commuting. Construction emissions were estimated using the California Air Resources Board's (CARB's) OFFROAD and EMFAC emissions model, for diesel and gasoline mobile source emission factors, respectively, and the proposed construction schedule. The GHG emissions from construction are presented for the construction duration of the tunneling method for Alternative A and Alternative B compared to the Project and amortized over the operational lifetime of the project assumed to be 30-years in duration as recommended by the SCAQMD.

4.3.2.1 Alternative A – EPBM/Open Face Shield/SEM Project Profile

4.3.2.1.1 Construction Impacts

Analysis of potential climate change and GHG-related construction impacts from Alternative A was based on estimated GHG emissions from operation of construction equipment, excavation material haul trucks, and workers commuting to and from the project site. Estimated GHG emissions that may occur during construction of Alternative A are presented in Table 4.3-2.

Table 4.3-2: Alternative A – Construction GHG Emissions (2014-2017)

GHG Emission Source	Annual GHG Emissions (MTCO2e/yr)				Total Project (MTCO2e/Project)	Amortized Emissions (MTCO2e/30-yr Project Lifetime)
	2014	2015	2016	2017		
Construction Equipment	2,373	16,277	7,663	8,658	34,971	1,166
Construction Worker Commuting	20	148	86	94	348	11
Excavation Materials Haul Trucks	0	119	288	305	712	24
Total =	**2,393**	**16,544**	**8,037**	**9,057**	**36,031**	**1,201**

Source: AECOM, 2014

Note: SCAQMD recommends for construction-related GHG emissions to be amortized over the operational lifetime of the project, which is recommended by SCAQMD as 30-years in duration

Construction of Alternative A along the Flower Street segment would result in a net increase in GHG emissions over a finite period (less than four years). For this analysis, amortized construction-related GHG emissions were compared to SCAQMD's proposed threshold for industrial projects of 10,000 $MTCO_2e$/yr to determine impact significance. As presented in Table 4.3-2, construction of Alternative A would result in approximately 36,031 metric tons of carbon dioxide equivalent ($MTCO_2e$), which would result in an amortized value of 1,201 $MTCO_2e$. Therefore, GHG emissions generated during construction of Alternative A would not have an adverse effect on climate change.

In addition, the CEQ recommends a reference point of 25,000 MT per year of direct GHG emissions as a "useful indicator" of when federal agencies should evaluate climate change impacts in their NEPA documents. The amortized construction emissions for Alternative A would also not exceed the GHG emissions threshold by the CEQ for evaluation of climate change impacts. Therefore, this impact would not be adverse.

In summary, operation of Alternative A would result in a net decrease in regional GHG emissions. Temporary construction-related GHG emissions, as presented in Table 4.3-2, would be offset by long-term reductions in regional VMT and associated GHG emissions, as presented in Section 4.6, Climate Change, of the Final EIS. Furthermore, amortized construction-related GHG emissions for Alternative A would be less than the SCAQMD's proposed threshold for industrial projects of 10,000 $MTCO_2e$/yr. Therefore, project-related GHG emissions resulting from implementation of Alternative A would not have an adverse effect on climate change.

4.3.2.2 Alternative B – EPBM/SEM Low Alignment

4.3.2.2.1 Construction Impacts

Analysis of potential climate change and GHG-related construction impacts from Alternative B was based on estimated GHG emissions from operation of construction equipment, excavation material haul trucks, and worker commuting to and from the project site. Estimated GHG emissions that may occur during construction of Alternative B are presented in Table 4.3-4.

Table 4.3-3: Alternative B Construction GHG Emissions (2014-2017)

GHG Emission Source	Annual GHG Emissions (MTCO2e/yr)				Total Project (MTCO2e/Project)	Amortized Emissions (MTCO2e/30-yr Project Lifetime)
	2014	2015	2016	2017		
Construction Equipment	0	9,093	10,058	4,383	23,534	784
Construction Worker Commuting	0	81	335	262	678	23
Excavation Materials Haul Trucks	0	118	508	305	931	31
Total =	**0**	**9,292**	**10,901**	**4,950**	**25,143**	**838**

Source: AECOM, 2014

Note: SCAQMD recommends for construction-related GHG emissions to be amortized over the operational lifetime of the project, which is recommended by SCAQMD as 30-years in duration

Construction of Alternative B along the Flower Street segment would result in a net increase in GHG emissions over a finite period (three years). For this analysis, amortized construction-related GHG emissions were compared to SCAQMD's proposed threshold for industrial projects of 10,000 $MTCO_2e$/yr to determine impact significance. As presented in Table 4.3-3, construction of Alternative B would result in approximately 25,143 metric tons of carbon dioxide equivalent ($MTCO_2e$/), which would result in an amortized value of 838 $MTCO_2e$. Therefore, GHG emissions generated during construction of Alternative B would not have an adverse effect on climate change.

In addition, the CEQ recommends a reference point of 25,000 MT per year of direct GHG emissions as a "useful indicator" of when federal agencies should evaluate climate change impacts in their NEPA documents. The amortized construction emissions for Alternative B would also not exceed the GHG emissions threshold by the CEQ for evaluation of climate change impacts. Therefore, this impact would not be adverse.

operation of Alternative B would result in a net decrease in regional GHG emissions. Temporary construction-related GHG emissions, as presented in Table 4.3-3, would be offset by long-term reductions in regional VMT and associated GHG emissions, as presented in Section 4.6, Climate Change, of the Final EIS. Furthermore, amortized construction-related GHG emissions for Alternative B would be less than the SCAQMD's proposed threshold for industrial projects of 10,000 $MTCO_2e$/yr. Therefore, project-related GHG emissions resulting from implementation of Alternative B would not have an adverse effect on climate change

4.3.3 Mitigation Measures

Mitigation measures identified in the Final EIS, under air quality, including use of newer, more efficient off-road vehicles during construction would result in GHG emission reductions. As described in the analysis above, the long-term reduction in GHG emissions and regional VMT from implementation of the Regional Connector project would result in a net benefit to the regional GHG emissions inventory and associated climate change impacts. Therefore, potential construction-related impacts from the Project or the tunneling method alternatives would not be adverse.

4.4 NOISE AND VIBRATION

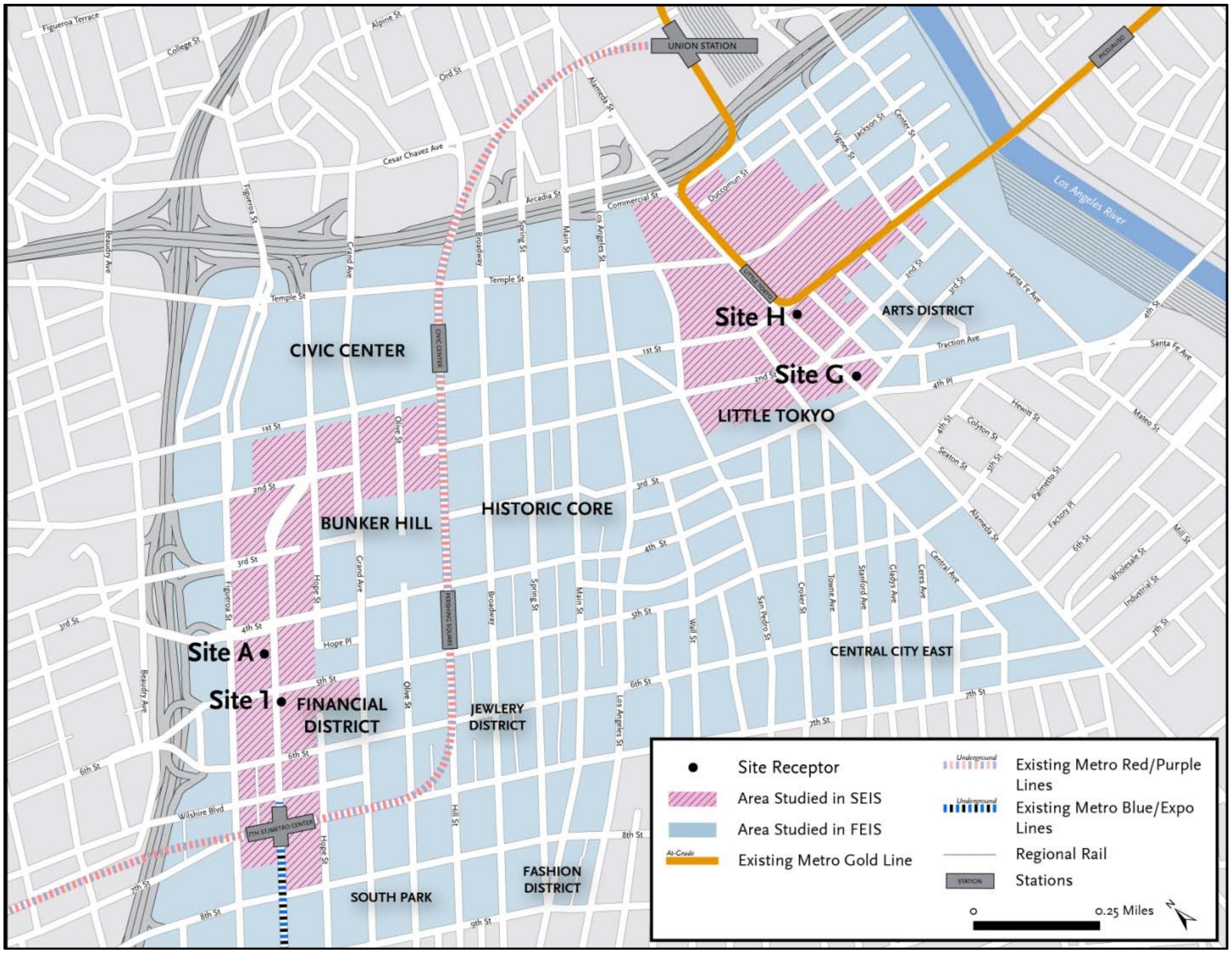
This section discusses the existing noise and vibration environment within the Study Area for the SEIS and evaluates the potential noise and vibration impacts resulting from construction of Alternatives A and B. The construction methods that would be employed for each of the tunneling method alternatives are described in Chapter 2, Alternatives Considered. Operation and operational impacts of Alternatives A and B would be the same as the Project; therefore no operational noise analysis was performed. Noise and vibration conditions and analytical information related to the Project and the entire project alignment is described in Chapter 4.7, Noise and Vibration of the Final EIS.

4.4.1 Affected Environment

During the Final EIS analysis efforts, noise levels were measured at two locations along Flower Street (Sites 1 and A) and two locations in Little Tokyo at the Savoy apartment building (Sites G and H), as shown in Figure 4.4-1. Although the changes in construction methods on Flower Street are the focus of this noise and vibration analysis, an evaluation of potential impacts to Little Tokyo as a result of increased muck truck activity, was also conducted. Measurements included the following:

- Site 1: A short-term (10-minute) measurement was conducted at Maguire Gardens at the Los Angeles Central Library on Flower Street. A one-hour Leq of 67 dBA was measured at 2:00 PM. and a peak-hour Leq of 68 dBA was estimated at this location based on the 24-hour measurement obtained at the Westin Bonaventure. Noise levels at this location are dominated by traffic noise from Flower and 5th Streets.
- Site A: A 24-hour measurement was conducted on the pool deck of the fourth floor of the Westin Bonaventure on Flower Street. An Ldn of 71 dBA and a peak-hour Leq of 68 dBA was measured at 6:00 AM.
- Site G: A 24-hour measurement was conducted at ground level to approximate noise in certain units of the Savoy Condominium in Little Tokyo where traffic noise levels are dominated by street traffic on Alameda Street. An Ldn of 73 dBA and a peak hour Leq of 75 dBA were measured at 7:00 PM.
- Site H: A 24-hour measurement was conducted at ground level to approximate noise in certain condo units in the Savoy Condominium building where noise levels are dominated by the traffic on 1st Street and train noise from Metro Gold Line operations. An Ldn of 72 dBA and a peak hour Leq of 72 dBA were measured at 7:00 PM.

Figure 4.4-1: Noise Measurement Locations Evaluated in the Final EIS and this SEIS



4.4.2 Environmental Consequences

Noise and vibration effects during construction of Alternatives A and B were evaluated using the FTA's detailed guidance manual on *Transit Noise and Vibration Impacts Assessment (May 2006).* No operational impacts analysis was included in the SEIS as operations under both alternatives would remain the same as the Project.

Mitigation measures for construction were identified, evaluated, and documented as part of the detailed assessments conducted as part of the Final EIS. In general, any impact resulting from the construction of Alternatives A and B would require the same or similar mitigation measures as was identified and recommended as part of the Final EIS. Therefore, where impacts are predicted during construction, the mitigation measures proposed are based on the control measures identified in the Final EIS, and other supplementary documents prepared in support of the Project.

Methodology

The various noise and vibration modeling assumptions, source reference levels for each of the proposed construction equipment and other operating characteristics (such as equipment usage factors) are described below. These data are based on FTA data, as well as information included in the Final EIS and other supplemental support documents. Qualification of a receptor as "sensitive" under FTA standards depends on the distance of the receptor from the proposed facility, and on the type of facility. Detailed information on significant thresholds is found in Appendix B – Regulatory Framework. In this SEIS effort, the following evaluation parameters were used:

- For each construction scenario, worst case or conservative parameters were applied:
  - All equipment was applied to the closest distance from each of the receptors;
  - Construction activities and phases were evaluated when all potential pieces of equipment were active (Source: Final EIS, Appendix K: Description of Construction); and receptors;
  - All construction scenarios included drilled holes rather than pile driving.

- Construction equipment noise reference levels and usage factors from both the FTA and the Federal Highway Administration (FHWA) guidelines were used for all noise sources except:
  - Grouting Plant – applied maximum usage of 100 percent; and,
  - Grouting Drill Rigs – applied maximum usage of 100 percent.

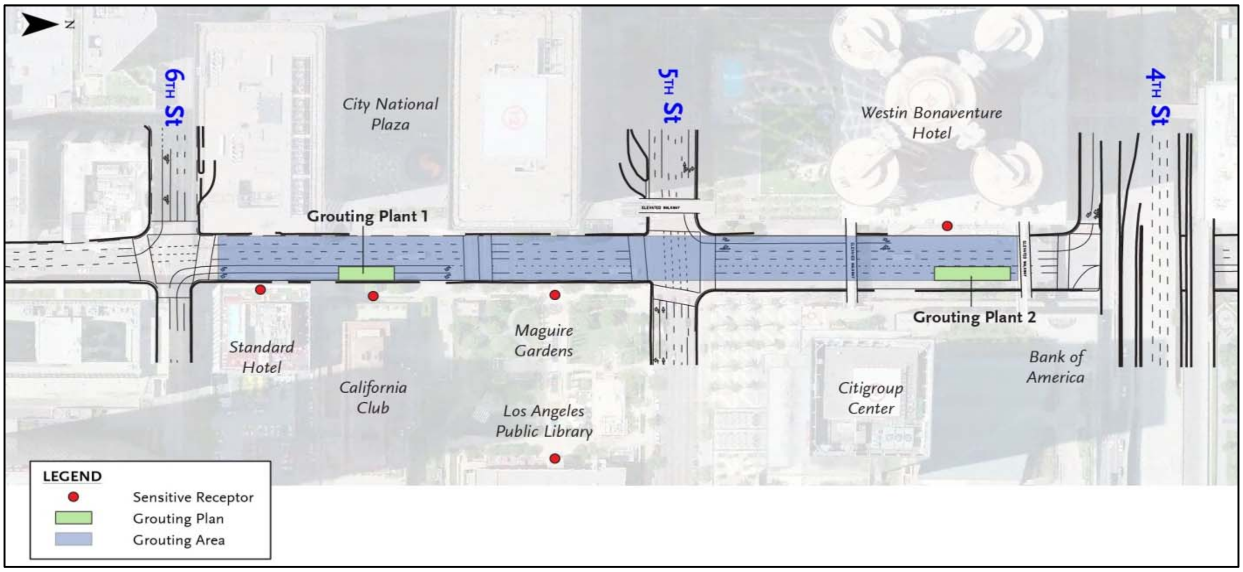
Additionally, the analysis considered impacts to historic resources along Flower Street and in Little Tokyo, as identified from the National Historic Register, from the Final EIS and confirmed in the SEIS.

In the grouting activity scenarios, two grouting plants were assumed for Alternative A and one for Alternative B. These plants were modeled to include compressors, pumps, generators, a mixing plant, and two grouting drill rigs per plant as discussed in Section 2.3.1, Construction Methods and Staging for Tunneling Method Alternatives, and Figures 2.3-2 and 2.3-3.

Figure 4.4-2 illustrates the Flower Street segment with identified sensitive receptors and construction scenarios which were assumed for this SEIS analysis. Construction detail considered in the analysis also included muck removal truck volumes developed by taking total trips per day and dividing by the estimated work day. Additionally, the TBM was assumed to be 22-feet in diameter, and was modeled at the shallowest point of each alternative's vertical alignment in order to capture the maximum predicted noise and vibration caused by the TBM operations at the street level.

Similar to the Project, Alternatives A and B would have two construction staging areas located on the east side of Flower Street: 1) just south of 4th Street; and 2) just south of 5th Street. In addition to the two construction staging sites, and as shown in Figure 4.4-2: Alternative A would have two grouting plants located on the east side of Flower Street: 1) between 5th and 6th Streets (Grouting Plant 1); and 2) just south of 4th Street (Grouting Plant 2). Alternative B would have a single grouting plant located between 5th and 6th Streets (Grouting Plant 1).

Figure 4.4-2: Representative Sensitive Receptors and Grouting Areas along Flower Street – Alternatives A and B



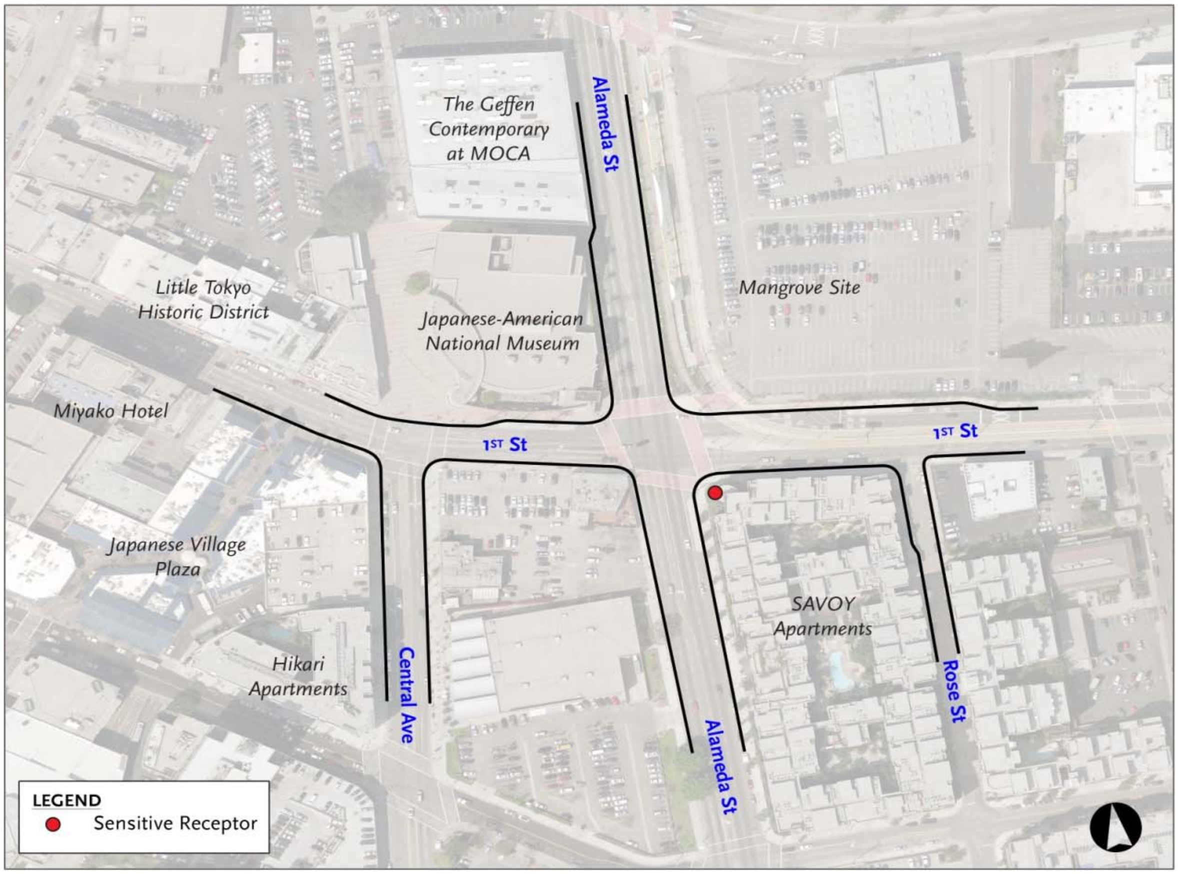
Little Tokyo

The Mangrove property in Little Tokyo, shown below in Figure 4.4-3, was identified under the Project and remains the location for the removal of the tunnel excavation materials by truck for Alternatives A and B. For purposes of the noise and vibration analysis, the duration of the construction methods identified for Alternatives A and B was taken into account for identifying impacts to sensitive receptors in the Little Tokyo area, due to extended construction and haul truck activities. Alternatives A and B would shift a majority of muck truck activities from Flower Street to this site in Little Tokyo and for a longer duration than the Project resulting in increased exposure to truck noise and vibration. As shown in Table 4.4-1, the construction duration for Alternative A would be 15 months longer than the Project and 7 months longer for Alternative B.

Table 4.4-1: Summary of Construction Impacts

Alternative	Muck Truck Activity		Excavation Duration
	Flower Street	Little Tokyo	Difference over Project (Months)
Project	81%	19%	--
Alternative A	25%	75%	15
Alternative B	20%	80%	7

Figure 4.4-3: Representative Sensitive Receptor at the Staging Area in Little Tokyo



4.4.2.1 Alternative A – EPBM/Open Face Shield/SEM Project Profile

4.4.2.1.1 Construction Impacts

Under Alternative A, maximum cumulative noise levels (L_{eq}) from street and surface construction activities along Flower Street are predicted to occur from the construction and grouting staging sites that would be located in front of the Maguire Gardens and the Los Angeles Central Library, and between 4th and 5th Streets adjacent to the Citigroup Center and The Westin Bonaventure Hotel.

The construction noise levels under Alternative A are anticipated to be 3 to 6 dBA greater than the levels predicted under the Project. The increase in noise levels is due to the use of four grouting rigs required by this alternative to provide ground stabilization. Grouting activities would operate from: 1) a joint construction and grouting staging site located between 4th and 5th Streets; and 2) a grout plant located adjacent to the construction staging area between 5th and 6th Streets. Construction is expected to occur in two shifts per day, while grouting activities are currently planned to take place in one ten-hour, daytime shift per day for a 12 month time period, possibly extending up to 24 months due to unforeseen underground conditions. Depending on the final contractor work schedule, a second nighttime grouting shift may be added.

Except for Maguire Gardens, all of the identified sensitive receptors include indoor land uses. Although the noise levels predicted at the exterior facade of the Flower Street buildings would be reduced for interior spaces due to the buildings' transmission loss of 20 to 25 dBA, implementation of the control measures identified in the Final EIS are recommended to minimize any exceedances of the FTA construction noise criteria. Mitigating noise generated by grouting equipment would be challenging due to the size of the equipment, with the grouting rigs more than 100 feet in height.

Implementation of mitigation measures identified for the Project would reduce adverse noise effects to sensitive or historic buildings to not substantially adverse, though impacts would remain due to the size of the grouting equipment. Due to daytime-only grouting operations, construction of Alternative A is expected to result in noise levels below the "severe" impacts level identified by FTA noise criteria, and would not result in adverse noise effects on sensitive land uses under NEPA.

Under Alternative A, maximum vibration levels from both surface and tunneling construction activities are predicted to range from 0.003 in/sec PPV at the Los Angeles Central Library to 0.118 in/s PPV at the Westin Bonaventure Hotel. The higher vibration level at the Westin Bonaventure Hotel is due to the TBM operations, which are estimated to occur approximately 45 feet from the hotel's Flower Street building edge, and at a higher depth than that of the Project at approximately 30 feet below street level. Overall, the construction vibration levels under Alternative A are predicted to be essentially equal to the levels predicted under the Project. No exceedances of the vibration damage threshold of 0.5 in/sec for sensitive properties or 0.2 in/sec for fragile historic properties are predicted. Similarly, most of the identified receptors include indoor land-uses, except for Maguire Gardens. With regard to the physical structure of the gardens, Alternative A would not result in any adverse effects or damage due to construction-related activities. Therefore, the ground-borne vibration levels predicted at the Los Angeles Central Library's exterior façade would not be adverse due to the coupling loss at the building's foundation of approximately 10 VdB.

In summary, adverse noise or vibration effects from construction of Alternative A to sensitive land uses or historic resources are not anticipated. The Little Tokyo alignment remains unchanged; however the duration of construction noise would be extended.

4.4.2.2 Alternative B – EPBM/SEM Low Alignment

4.4.2.2.1 Construction Impacts

Under Alternative B, the construction noise levels are predicted to be 6 to 7 dBA greater than the noise levels predicted under the Project. The increase in noise levels is due to the use of two grouting rigs required by this alternative to provide ground stabilization. Grouting activities would operate from a single joint construction and grouting staging site located on the east side of Flower Street between 4th and 5th Streets. Construction is expected to occur in two shifts per day, while grouting activities are currently planned to take place in one ten-hour, daytime shift per day for an 8 month time period, possibly extending up to 16 months due to unforeseen underground conditions. Depending on the final contractor work schedule, a second nighttime grouting shift may be added.

Except for Maguire Gardens, all of the selected receptors include indoor land uses. Similar to Alternative B, Although the noise levels predicted at the exterior facade of the Flower Street buildings would be reduced for interior spaces due to the buildings' transmission loss of 20 to 25 dBA, implementation of the control measures identified in the Final EIS are recommended to minimize any exceedances of the FTA construction noise criteria. Mitigating noise generated by grouting equipment would be challenging due to the size of the equipment, with the grouting rigs more than 100 feet in height. With daytime operation of the grouting equipment, noise effects would be below "severe" impact levels identified under FTA criteria.

Implementation of mitigation measures identified for the Project would reduce adverse noise effects to sensitive or historic buildings to not substantially adverse, though impacts would remain due to the size of the grouting equipment. Due to daytime-only grouting operations, construction of Alternative B is expected to result in noise levels below the "severe" impacts level identified by FTA noise criteria, and would not result in adverse noise effects on sensitive land uses under NEPA.

Under Alternative B, the construction vibration levels from both surface and tunneling construction activities are predicted to be essentially equal to the levels predicted under the Project. No exceedances of the vibration damage threshold of 0.5 in/sec for sensitive properties or 0.2 in/sec for fragile historic properties are predicted. Similarly, most of the selected receptors include indoor land-uses (except Maguire Gardens at Site R5). Therefore, the ground-borne vibration levels predicted at the exterior facade of the Los Angeles Central Library would not be adverse due to the coupling loss at the building's foundation of approximately 10 VdB.

In summary, adverse noise or vibration effects from construction of Alternative B to sensitive land uses or historic resources are not anticipated. The Little Tokyo alignment remains unchanged; however the duration of construction noise would be extended.

4.4.3 Mitigation Measures

Mitigation measures to reduce potential noise and vibration impacts during construction were identified in the Final EIS. Implementation of mitigation measures NV-1 through NV-29 from the Final EIS for the Project would apply for Alternatives A and B. Below is a summary of these mitigation measures, and a detailed description can be found in Appendix G:

- NV-1: Monitoring for sensitive and/or historic structures within 21 feet of construction
- NV-2: Preparation of vibration monitoring plan for sensitive buildings
- NV-3: Appropriate distances maintained during construction to vibration-sensitive locations
- NV-4: Use of less vibration-sensitive equipment near sensitive locations
- NV-5: Heavy construction vehicles routed away from vibration-sensitive locations
- NV-6: Earthmoving equipment to be operated far from vibration-sensitive locations
- NV-7: Sequencing of vibration producing construction activities
- NV-8: Avoidance of nighttime construction near vibration-sensitive locations
- NV-9: Use of minimal impact devices
- NV-10: Use of non-impact demolition methods near vibration-sensitive locations

- NV-11: Use of building protection measures to prevent deterioration
- NV-12: Use of pavement breakers, vibratory rollers, and packers far from sensitive locations
- NV-13: Appropriate procedures for noise complaints and measures to reduce construction noise below FTA criteria
- NV-14: Temporary noise barriers around construction sites and equipment
- NV-15: Use of back-up alarms/warning procedures where feasible
- NV-16: Use of mufflers for construction equipment near sensitive land uses
- NV-17: Portable noise sheds for smaller construction equipment
- NV-18: Specific requirements in/around vicinity of the Walt Disney Concert Hall
- NV-19: Maintenance and operation of TBM by contractor to minimize vibration impacts
- NV-20: Coordination and notification of TBM use in/around vicinity of Disney Concert Hall, Colburn School, and Broad Art Foundation Museum
- NV-21: Delivery train speed in/around Disney Concert Hall, Colburn School, and Broad Art Foundation Museum
- NV-22: Use of resilient system to support and fasten delivery train tracks
- NV-23: Use of conveyor system on delivery train if exceedances of FTA annoyance criteria
- NV-24: Coordination of delivery train during vacancies at Disney Concert Hall, Colburn School, and Broad Art Foundation Museum
- NV-25: Coordination and notification of tunneling activities prior to commencement
- NV-26: Appropriate notification strategies in/around Little Tokyo and monitoring ground borne noise (GBN)/ground borne vibration (GBV) levels during TBM activity
- NV-27: Implementation of measures around Disney Concert Hall and Colburn School as needed to reduce GBN
- NV-28: During final design, conduct engineering studies to verify GBN and implement appropriate measures if needed, in/around Hikari Lofts and Nakamura Tetsujiro Building
- NV-29: During final design, conduct engineering studies to verify GBN and implement appropriate measures if needed, in/around the Japanese Village Plaza and Broad Art Foundation Museum.

As with the Project, potentially construction-related adverse effects would remain after implementation of these mitigation measures for Alternatives A and B. The alternatives may have additional noise impacts along Flower Street beyond those identified for the Project due to the size and type of grouting and support equipment required for ground stabilization. Additionally, Alternative A and B would increase the muck truck activity in Little Tokyo for a longer duration than the Project.

4.5 GEOTECHNICAL, SUBSURFACE, AND SEISMIC HAZARDS

This section discusses the geology, soils, seismicity, hazardous materials, and subsurface obstructions along Flower Street, and evaluates their potential impacts on the construction and operation of Alternatives A and B. The information presented in this section is based on the following documents that provided the basis for the Final EIS:

1. Geotechnical-Subsurface-Seismic-Hazardous Materials Technical Memorandum (Appendix U) in the Metro Regional Connector Transit Corridor Final EIS.
2. Final Geotechnical Data Report, Rev. 1 (GDR), Regional Connector Transit Corridor Project, March 30, 2013.
3. Geotechnical Baseline Report, Rev. 1a (GBR), Regional Connector Transit Corridor Project, August 1, 2013.

4.5.1 Affected Environment

Generally, conditions related to geologic, subsurface, seismicity, and hazardous materials along the Flower Street portion of the Project and two tunneling method alternatives have remained unchanged from those discussed in the Final EIS Chapter 4.09 Geotechnical/Subsurface/Seismic/Hazardous Materials and in Appendix U in the Final EIS. This section provides a more focused discussion on the Flower Street conditions, and the construction techniques considered for the two tunneling method alternatives and evaluation of potential impacts. There are no construction changes to the Little Tokyo portion of the project due to the two tunneling method alternatives.

4.5.1.1 Geology

Along the Flower Street segment of the alignment, alluvium and fill materials overlie the Fernando Formation consisting primarily of weak to very weak clayey siltstone. The alluvial deposit consists of interlayered silty clays, sandy silts, clayey sands, and silty sands with some sand layers containing variable gravel and few cobbles. The fill materials consist of a mixture of gravel, sand, silt, and clay mixed with construction debris. The depth of fill material varies along Flower Street with the maximum fill depth estimated to be about 40 feet below ground surface. Occasional boulders are also present in the alluvium. The principal geologic conditions on Flower Street that control tunneling risk are: groundwater, geologic interface of different soil or weak rock strata, and hazardous gases.

Groundwater seepage at relatively shallow depths (ranging from approximately 15 to 35 feet below ground surface) was encountered in geotechnical borings drilled for the many building sites lining Flower Street between 5th and 7th Streets. Within the lower portion of the alluvial deposits adjacent to Flower Street between 2nd and 5th Streets, groundwater (most probably perched above the Fernando Formation) has been reported at depths from approximately 18 to 27 feet below ground surface, which is close to or within the tunnel vertical alignment horizon. Groundwater problems would be magnified at the alluvium-Fernando interface.

Along Flower Street, the geologic interface of alluvial soils over the weak rock of Fernando Formation, as illustrated in Figure 4.5-1, is a geologic tunneling hazard. If tunneling is located fully below the geological interface, and there is some Fernando Formation between the tunnel and interface, there exists a reduced potential hazard. If the interface is located just above the tunnel, or within the face of the tunnel being excavated, the hazard is that the alluvial materials would run uncontrolled into the tunnel during construction. With the presence of ground water, this condition would cause an uncontrolled flow into the tunnel under construction. Tunneling through alluvium conditions with open face or SEM techniques has a high risk of losing control of the tunneling face due to the lack of face support, which can result in an uncontrolled flow of alluvium and other soils into the tunnel. The uncontrolled flow of soils into the tunnel creates a void in front of and above the tunnel heading causing substantial subsidence of the ground surface including possible sink holes open to the surface. Additionally, the void created in an uncontrolled flow of material into the tunnel can cause significant settlement and damage to existing utilities and adjacent structures. Most importantly, an uncontrolled flow of ground into the tunnel creates a serious safety hazard with a potential for serious injuries or death to the underground construction workers and public on the surface.

Geologic conditions may be mitigated by grouting to create non-running/non-flowing ground conditions, or by using another method, such as use of earth pressure balance machines (EPBMs), which inherently can safely address with Flower Street segment geotechnical conditions. The *Draft Flower Street Tunneling Method Alternatives Report (2014)* identified that even when jet grouting is used, substantial risks of utility damages would remain due to the grouting operation, along with risks of excessive settlement and tunnel failures due to incomplete coverage of the grouted mass or migration of groundwater along abandoned tie-backs located under Flower Street.

Methane and hydrogen sulfide (H_2S) are anticipated to be encountered as described in the Geotechnical Baseline Report (GBR) prepared for the Final EIS, and experienced on recent construction projects in the project area (Wilshire Grand Plaza at 7th Street/Figueroa Street). Several sections of the tunnels are to be constructed through Methane Buffer Zones. Cal/OSHA has classified all of the underground construction for the Regional Connector project as "potentially gassy." Geotechnical investigations performed during Advanced Conceptual Engineering, Preliminary Engineering, and Advanced Preliminary Engineering indicate the various presence of methane gas (CH_4) and hydrogen sulfide (H_2S) in the ground along Flower Street. For example, a maximum field H_2S reading of 5 parts per million (ppm) was detected in Boring E2-2, which is located near the intersection of Flower Street and 3rd Street. Close to this location, a methane gas concentration of 1,000 ppm was detected in Boring MB2. In addition, a methane gas concentration as high as 87 percent was detected during the basement excavation of the Los Angeles Central Library located on the southeast corner of Flower Street and 5th Street. Hydrogen sulfide is highly toxic and could result in human health effects to individuals who are exposed, particularly construction workers. Methane is explosive if allowed to accumulate to a range of five to twelve percent at atmospheric oxygen level.

Metro Rail Design Criteria (MRDC) requires specific underground designs where gassy conditions are present. In order to prevent the entry of gases into the tunnel and underground stations, a gas barrier must be incorporated into the design either with the use of EPBMs, and installation of a double-gasket, segmental precast tunnel lining, or encasing the station and tunnel cast-in-place structures with a high density polyethylene (HDPE) membrane.

4.5.2 Environmental Consequences

The following sections summarize the evaluation of potential impacts of geotechnical conditions, soils, seismicity, hazardous materials, and subsurface obstructions that would occur with construction of Alternatives A and B.

4.5.2.1 Alternative A – EPBM/Open Face Shield/SEM Project Profile

In this alternative, EPBM-bored tunnels would be constructed following the Project alignment to south of 4th Street, with open-face shield tunnel excavation from 4th Street to 5th Street, and SEM tunnel construction from 5th Street to the 7th Street/Metro Center Station tail tracks structure.

Sequential Excavation Method (SEM) tunneling for the segment south of 4th Street would allow for removal of tie-backs through the face of the shield or within the SEM excavation. However, without the undertaking of special mitigating measures, such as complete ground stabilization, Alternative A would have a high level of risk of tunnel face instability with the potential for soil runs during tunneling by open-face shield or SEM, particularly when dealing with the tie-backs under Flower Street. The open-face shield section of the alignment would occur in the diminishing thickness of the Fernando Formation above the shield. There would be approximately five feet of Fernando Formation cover above the open-face shield section.

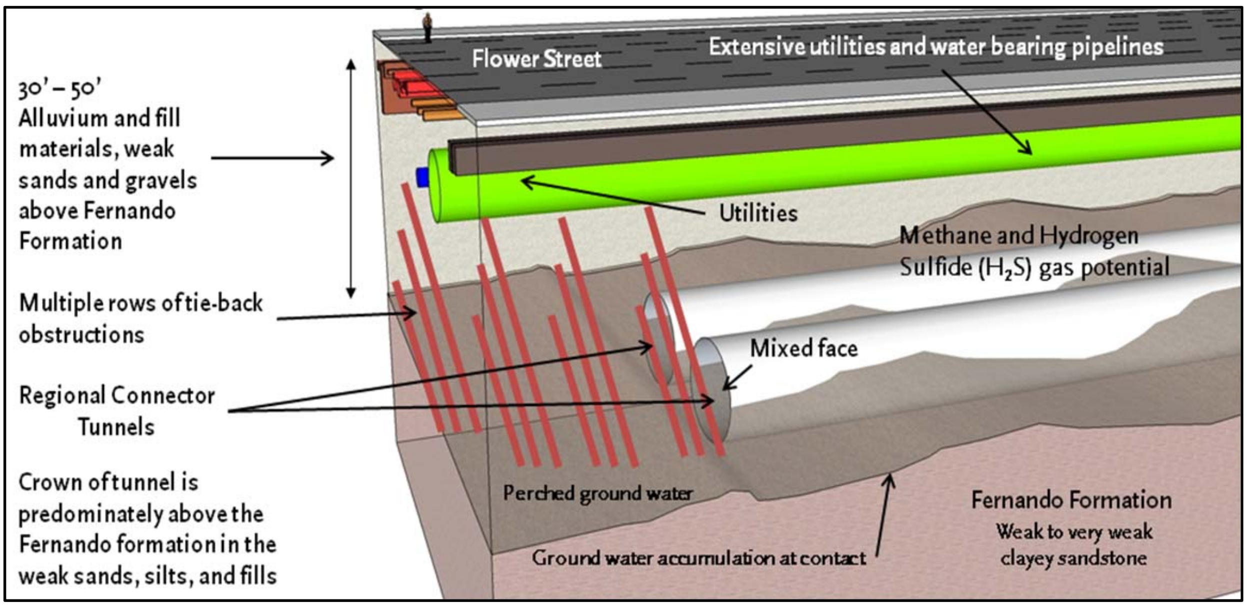
In addition, the top of the Fernando Formation is an erosional surface, and the geologic profile is based on a limited number of borings. Thus the thickness of the Fernando Formation above the tunnel has uncertainty and the stability of the ground surface on Flower Street is not guaranteed. Significant ground improvement would be required as previously discussed in Chapter 2, Alternatives Considered. For the SEM portion of the tunneling, the single twin-track tunnel diameter is very large and the tunnel would have varying amounts of mixed face geologic conditions in the tunnel heading. In this situation, there would be a high risk of creating sinkholes or subsidence on Flower Street. Ground improvement by jet grouting would be required for Alternative A. Mitigation of impacts may not be successful given the complexity and severity of the Flower Street underground conditions.

The jet grouting for the SEM portion of this alternative would require drilling grout holes on a six-by-six foot pattern throughout the area to be grouted as illustrated in Figure 2.3-1. Grout holes would extend from the ground surface through weak fill and alluvial soils to just into the relatively stronger Fernando Formation. A 50-foot-wide zone in Flower Street would be grouted and requires setting up a grout plant on Flower Street. Depending on the number of required grout holes, two to four drill rigs would be utilized to drill and grout. For Alternative A, a total of approximately 1,900 grout holes would be drilled and grouted.

Although jet grouting would improve the ground conditions for ground control during SEM tunneling, significant risk of ground loss and excessive settlement due to SEM would remain, and these risks cannot be mitigated. This is primarily because grouting must be done through a series of borings designed to have overlapping grout columns. Given mixed face soil conditions, ground water inflows and ground loss can still occur which would damage utilities and existing buildings, basements, and other structures and pose a safety threat to workers, the public, and construction operations. Also, with the significant number of existing utilities under the street and with a dense grout pipe pattern required, the existing utilities would have a high risk of being damaged by the high pressure grouting operation, which could result in adverse impacts or interruption of utility services even before the tunneling starts.

Due to the potential gassy conditions under Flower Street, using SEM tunneling, or open-shield TBM, would increase risks of hazardous gas for construction and likely require significant additional measures to mitigate these safety issues. An open face shield allows hazardous gasses into the tunnel at the tunnel face. SEM has greater safety risk of gas on account of greater exposure to the excavated ground. Whereas hazardous gas can be safely handled in a cut and cover excavation, a SEM-mined cavern would need significant ventilation to meet Cal/OSHA standards.

Figure 4.5-1: Flower Street Subsurface Conditions



In summary, construction of Alternative A would require ground improvement along Flower Street utilizing jet grouting for mitigation of mixed face instability and potential excess ground settlements associated with Open Face Shield and SEM tunneling. The risk assessment provided in *Draft Flower Street Tunneling Method Alternatives Report (2014)* identified that even when jet grouting is used, a high level of risk resulting in utility damages would remain due to the grouting operation, along with the high level risks of excessive settlement and tunnel failures due to incomplete coverage of the grouted mass or migration of groundwater along abandoned tie-backs located under Flower Street.

Implementation of Alternative A would result in high risk of adverse effects due to mixed face instability and potential excess ground loss, settlement, and sinkholes.

4.5.2.2 Alternative B – EPBM/SEM Low Alignment

For this alternative, EPBM-bored tunnels would be constructed on a deep alignment to south of 5th Street transitioning to SEM tunneling from south of 5th Street to the 7th Street/Metro Center Station tail tracks. The EPBM-bored tunnels would be extended to south of 5th Street in a deeper alignment to avoid abandoned tie-backs. The EPBM would be disassembled and removed through the tunnel to the Mangrove portal site with the EPBM shield left in place. For the SEM tunneling section, the single twin-track tunnel has a larger diameter and the tunnel will have varying amounts of mixed face geologic conditions in the tunnel heading. In this situation, there would be a high risk of creating sinkholes or subsidence on Flower Street. Ground improvement by jet grouting would be required for Alternative B, with approximately 1,000 grout holes required as illustrated in Figure 2.3-1.

With extension of tunneling further south to the 7th Street/Metro Center Station tail tracks structure through the use of SEM, there would be a significant increase in the amount of excavated materials being handled through the Mangrove site in Little Tokyo over the Project conditions. Cut and cover excavation materials would be handled from locations along Flower Street under the Project, while tunnel muck from the EPBM and SEM operations would be handled through Little Tokyo.

In addition, due to the potential gassy conditions under Flower Street, using SEM tunneling would have a high level of construction risks related to hazardous gas and likely require significant additional measures to mitigate these safety issues. SEM would also have a higher level of safety risk for workers due to gas conditions from the greater exposure to excavated ground. Whereas hazardous gas can be safely handled in a cut and cover excavation, a SEM-excavated cavern would require significant ventilation to meet Cal/OSHA standards.

In summary, construction of Alternative B would require ground improvement along Flower Street utilizing jet grouting for mitigation of mixed face instability and potential excess ground settlements associated with SEM tunneling. The risk assessment provided in the *Draft Flower Street Tunneling Method Alternatives Report (2014)* identified that even when jet grouting is used, a high level risk of utility damages would remain due to the grouting operation, along with the risks of excessive settlement and tunnel failures due to incomplete coverage of the grouted mass or migration of groundwater along tie-backs located under Flower Street.

Implementation of Alternative B would result in a high risk of adverse effects due to mixed face soils instability and potential excess ground loss, settlement, and sinkholes.

4.5.3 Mitigation Measures

Mitigation measures to reduce potential geotechnical impacts during construction were identified in the Final EIS for the Project; implementation of mitigation measures GT-1 through GT-21 would apply for Alternatives A and B. Below is a summary of these mitigation measures and a detailed description can be found in Appendix G:

- GT-1: Before construction, survey of structures and geotechnical/ settlement monitoring plans in place as well as gathering of soil data during and after final design
- GT-2: Use of ground improvement methods such as grouting where potential settlement during excavation
- GT-3: Grouting of tunnel alignment prior to construction to minimize settlement

- GT-4: Monitoring of settlement and leveling surveys prior to tunneling to monitor ground movement
- GT-5: Description of tunneling monitoring requirements in contract documents and soil documentation of soils encountered during construction in Geotechnical Baseline Report
- GT-6: Preparation of a Contaminated Soil/Groundwater Management Plan
- GT-7: Notification to appropriate agencies if contaminated soil or groundwater is encountered
- GT-8: Sampling of soil and/or groundwater if impacted by hazardous materials
- GT-9: Procedures for proper handling of contaminated soil and/or groundwater with regulatory agencies
- GT-10: Use of dust control measures shall be implemented for contaminated soil
- GT-11: Proper collection, treatment, and discharge of groundwater per applicable standards
- GT-12: Preparation of a Worker Health and Safety Plan
- GT-13: Appropriate measures, such as impermeable grout, to avoid spreading of contaminated groundwater
- GT-14: Testing for subsurface gases conducted along all portions of underground alignment
- GT-15: Construction will be consistent with City of Los Angeles Methane Mitigation Standards
- GT-16: Specialized excavation methods shall be implemented to protect workers and public
- GT-17: Surveying of asbestos prior to demolition and appropriate removal
- GT-18: Implementation by contractor of Best Management Practices (BMPs)
- GT-19: Consistency with municipal code requirements for structures within methane/buffer zones
- GT-20: Development by Metro of an Environmental Site Assessment program
- GT-21: Development and implementation of plans by Metro for pre-demolition and demolition abatement of hazardous building materials

The mitigated impacts of Alternatives A and B are expected to be greater than those of the Project, as even when jet grouting is used, the possibility of substantial risk of utility damages due to the grouting operation and excessive settlement would remain high.

Table 4.5-1: Summary of Benefits and Challenges of Alternative A and B

Alternative	Description	Advantages	Disadvantages
Alternative A	• EPBM to 4th Street • Open face shield TBM to 5th Street • SEM from 5th to 7th Street/Metro Center Station • Depth to top of rail: 40' • 2nd/Hope Station depth: 96'	• Total amount of excavation materials is reduced due to replacement of cut and cover section.	• High risk of excessive settlement on Flower Street due to removal of existing tie-backs encountered by digger shield and SEM. • Removal of tie-backs encountered by digger shield and SEM would be time consuming and result in a significant delay to the project schedule. • Jet grouting is required to mitigate ground instability for digger shield and SEM excavations. • High risk of sinkholes and subsidence on Flower Street exists because of the large SEM cross section and potential imperfection of grouted ground mass; risk of tunnel collapse cannot be mitigated. • High risk of existing utilities being damaged due to jet grouting operations. • High risk of hazardous gas impacts due to open face shield and SEM excavations. • Major increase in tunnel spoils handled through Mangrove Site; would result in higher level of environmental impacts in Little Tokyo.
Alternative B	• EPBM to south of 5th Street • SEM from 5th Street to 7th Street/ Metro Center • Depth to top of rail: 40' to 105' (at sag) • 2nd/Hope Station depth: 128'	• Total amount of excavation materials is reduced due to replacement of cut and cover section. • Conflicts with existing tie-backs between 3rd and 4th Streets would be minimized.	• Jet grouting is required to mitigate ground instability for SEM section. • High risk of sinkholes and subsidence on Flower Street exists because of the large SEM cross section and potential imperfection of grouted ground mass; risk of tunnel collapse cannot be mitigated. • High risk of existing utilities being damaged due to jet grouting operation • High risk of hazardous gas impacts due to SEM excavations. • 2nd/Hope Station depth increase of 32 feet would increase project construction cost. • Major increase in spoils handled through Mangrove Site; would result in higher level of environmental impacts in Little Tokyo.

Note: EPBM – earth pressure balance tunnel boring machine; SEM – sequential excavation method

4.6 ENERGY RESOURCES

This section evaluates the existing energy resources in the Project Area, and the energy usage impacts from construction of the tunneling method alternatives compared to the Project. The analysis only addresses energy usage during construction because operations of the Project and the evaluated alternatives would have nearly identical associated energy resource impacts. The environmental analysis assumes a conservative, worst-case, condition when determining potential impacts. Section 4.11, Energy Resources of the Final EIS describes energy demand of existing transportation sources in the project area and analyzes the potential energy resource impacts of the Project. This section focuses on the evaluation of construction methods along Flower Street compared to what was previously analyzed for the Project in Final EIS.

4.6.1 Affected Environment

This section identifies existing annual energy usage by the transportation sector within the Los Angeles region. Transportation in Los Angeles County continues to be dominated by single-occupancy automobiles. In 2010, 72.3 percent of all people in the Southern California region drove alone to work (US Census Bureau). High percentages of single-occupancy vehicles result in higher vehicle miles travelled (VMT) throughout the state. In turn, high VMT translates into high energy use and increased air pollutants throughout the Southern California Association of Government (SCAG) region.

Metro's electricity use is split between powering the rail system and its transit facilities (Metro 2009). For both rail and facility electricity requirements, Metro buys power from the Los Angeles Department of Water and Power (LADWP), Southern California Edison (SCE), and Pasadena Water and Power (Metro 2009b). In 2008, Metro rail consumed 175 million kilowatt hours (kWh) of electricity (approximately 597 billion British Thermal Units [BTUs]) and Metro facilities consumed 69 million kWh (approximately 235 thousand BTUs) (Metro 2009). Metro would purchase additional electricity from its current providers to operate the proposed project. Metro's *2009 Baseline Sustainability Report* presents goals and recommendations for tracking and improving these performance measures. Appendix W, Energy Resources Technical Memorandum in the Final EIS provides detailed information regarding existing energy supplies and usage.

4.6.2 Environmental Consequences

The following discussion summarizes the evaluation of potential energy resource impacts for the tunneling method alternatives. Energy impact conclusions for each alternative are based on the significance criteria identified in Appendix B – Regulatory Framework.

In order to compare potential energy resource impacts during construction of the tunneling method alternatives to the Project, energy use impacts from construction activities along Flower Street and the associated construction activities at Little Tokyo were analyzed. Impacts from construction activities for other portions of the Regional Connector project were not analyzed as they would be the same for the evaluated alternatives as for the Project in the Final EIS.

Construction-related impacts from the evaluated alternatives and the Project were estimated using the Input-Output Approach developed by The California Department of Transportation (Caltrans, 1983), which is the same methodology used for the Final EIS, and is described in Appendix W of the Final EIS. This method assigns an energy-to-dollar ratio to various roadway construction activities, which converts construction dollars into energy consumption. Construction-related impacts were estimated by applying a highway construction energy factor to the total estimated direct construction cost for the evaluated alternatives and the Project; indirect cost including contractor fees and schedule delay costs were not considered in this analysis. The estimated construction costs, in 2013 dollars, were based on engineering assumptions and unit price per construction component.

4.6.2.1 Alternative A – EPBM/Open Face Shield/SEM Project Profile

4.6.2.1.1 Construction Impacts

Analysis of potential energy resource-related construction impacts was based on direct costs estimated for construction of Alternative A. Indirect costs such as contractor markup fees and schedule delay costs do not contribute to energy consumption and therefore were not considered in the analysis. Potential energy impacts that may occur during construction of Alternative A are presented in Table 4.6-1. The energy impacts for Alternative A would be temporary for the 15 month extension in duration of construction activities.

Table 4.6-1: Estimated Energy Consumption from Construction for Alternatives A and B

Construction Description	Construction Year Dollars (thousands)[1]	Energy Consumption Factor (Btu/2013$)	Total Btu Consumption[2] (billions)
Alternative A			
Flower Street: • EPBM with Open Face Shield tunnel excavation • SEM tunnel construction	$64,359	5,017	323
Alternative B:			
Flower Street: • EPBM • SEM tunnel construction	$58,726	5,017	295

Acronyms: Btu = British thermal unit; Btu/2013$ = British thermal unit per 2013 dollars; EPBM = earth pressure balance machine; SEM = sequential excavation method

Note:

1. Construction year dollars were estimated based on unit price as of 2013. Construction costs presented in the table do not include indirect costs associated with contractor markup fees and project schedule delay costs.
2. Inputs and supporting energy calculations are provided in Appendix B.

Source: AECOM 2014

In summary, construction of Alternative A would result in short-term, temporary energy usage within the project area due to fuel and electricity usage during equipment operation. The short-term energy usage would be offset by the energy resource benefits from project operation due to reduced VMT from commuter vehicles. As the long-term energy resource benefits exceed the short-term energy usage impacts during construction, the construction-related energy resource impacts would not be adverse.

4.6.2.2 Alternative B – EPBM/SEM Low Alignment

4.6.2.2.1 Construction Impacts

Analysis of potential energy resource-related construction impacts was based on direct costs estimated for construction of Alternative B. Indirect costs such as contractor markup fees and schedule delay costs do not contribute to energy consumption and therefore were not considered in the analysis. Potential energy impacts that may occur during construction of Alternative B are presented in Table 4.6-1. The energy impacts for Alternative B would be temporary for the seven month extension in duration of construction activities.

In summary, construction of Alternative B would result in short-term, temporary energy usage within the project area due to fuel and electricity usage during equipment operation. The short-term energy usage would be offset by the energy resource benefits from project operation due to reduced VMT from commuter vehicles. As the long-term energy resource benefits exceed the short-term energy usage impacts during construction, the construction-related energy resource impacts would not be adverse.

4.6.3 Mitigation Measures

Mitigation measures identified in the Final EIS, under air quality, including use of newer, more efficient off-road vehicles would result in reduced energy consumption and ensure energy resources were not consumed in an a wasteful or inefficient manner. As described in this analysis, the long-term reduction in energy use from implementation of the Regional Connector project would result in a net benefit to existing energy resources.

4.7 HISTORIC RESOURCES

This section evaluates potential impacts of Alternatives A and B to historic properties along Flower Street and in Little Tokyo. The Final EIS identified the baseline condition for historic resources within a Project Area of Potential Effects (APE). The Flower Street and Little Tokyo areas, which together comprise the APE of the two alternatives evaluated in this SEIS, were included in the Project APE. As the baseline condition is essentially unchanged since approval of the Final EIS, it is used herein for the current impact assessment. Historic resources were defined as built environment, archaeological, and paleontological resources. The affected environment for archaeological resources and paleontological resources was considered further only for potential additional impacts related to the change in the vertical limits of excavation under Alternative B (excavation under Alternative A would remain within the limits of the Project APE). In this SEIS, only built environment historic resources located in the APE of the two alternatives have been revisited for potential project impacts or effects. The current study describes the built environment historic properties within the SEIS Study Area, a subset of the Project APE located along Flower Street and in Little Tokyo.

The SEIS is intended to meet the requirements of the court order (as discussed in Chapter 1) to provide information on the construction method alternatives that were previously withdrawn from consideration. There is no change to the APE of the Project. However, information on the SEIS and the construction method alternatives and their potential impacts to historic resources will be provided to SHPO. There are no changes to the APE relating to the tunneling method alternatives nor is there potential for Alternatives A and B to have impacts on historic properties that may be different from those identified in the Final EIS for the Project. The Final EIS states that in areas where new underground tunnel boring machine segments will be constructed, mitigation for impacts to paleontological resources will not be feasible and thus construction and cumulative impact will be significant and unavoidable.

For archaeological resources, five possible resources are identified in the Project Area in the Final EIS, including the Los Angeles Zanja System which crosses Flower Street south of 9th Street. Along Flower Street segment of the Regional Connector project, possible archaeological impacts are not anticipated to occur due to the ground conditions, which consist of fill from other downtown locations to support development in this portion of the street corridor. This corridor has been heavily-developed since the early 1920s, which also would have destroyed any archeological resources that may have been located in the area. From a historic resource perspective, the former Pacific Electric tunnel will be negatively impacted by any underground project on Flower Street. However, any additional impacts on archaeological resources as identified in the Final EIS would be resolved with implementation of the established mitigation measures in the Memorandum of Agreement (MOA) between Metro and the State Historic Preservation Officer (SHPO), in the Mitigation Monitoring and Reporting Program (MMRP) for the Project (see Section 8, Mitigation Monitoring and Reporting Program, of the Final EIS/EIR), and in the Cultural Resources Mitigation Management Plan (CRMMP).

The potential impacts on historic properties that are further considered are those caused by noise and vibration generated from the construction and operation of the project. As Alternatives A and B propose different construction methods and some modifications to the vertical and horizontal alignment along Flower Street, the potential impacts of these alternatives on historic properties may be different from those identified in the Final EIS for the Project. Supplemental noise and vibration analysis for these tunneling method alternatives has been performed as discussed in Section 4.4, Noise and Vibration Technical Report. In addition, analysis for potential impacts on visual quality caused by the two tunneling method alternatives was conducted as discussed in Section 4.1, Visual Quality.

This section references the mitigation measures for historic properties under NHPA Section 106 in the MOA between Metro and SHPO, and mitigation measures carried forward and included in the MMRP for the Project (see Section 8, Mitigation Monitoring and Reporting Program, of the Final EIS) and in the CRMMP for historic properties under NHPA and NEPA.

4.7.1 Affected Environment

4.7.1.1 SEIS Study Area

FTA and Metro, with concurrence from SHPO as part of Section 106 consultation, established the original Area of Potential Effect (APE) to ensure identification of historic properties under NEPA and NHPA that may be directly or indirectly affected by the project. The APE was analyzed in the Final EIS. Changes to the APE relating to the Project and the tunneling method alternatives have been submitted to SHPO.

Because the tunneling method alternatives propose different construction methods within the same project location, the SEIS Study Area is a focused sub-area within the APE where those changed construction methods would be used. Figures 4.7-1 and 4.7-2 show the SEIS Study Area within a portion of the APE. The map illustrates the project APE with the boundaries of the "direct APE" and an "indirect APE" to show the limits of ground disturbance and adjacent areas in the project vicinity that may be impacted. This differentiation is only for informational purposes, as the established APE included both the direct and indirect areas. The direct APE is the area where resources would be physically impacted by construction activities, while the indirect APE includes the larger area where project impacts might include pollutant noise and vibration impacts to historic properties, changes to their visual or historic setting, or limitations on access during construction. The maps also show the location of built environment resources that were identified as historic properties under NEPA and NHPA in the Final EIS.

4.7.1.2 Built Environment Resources

Sixteen historic properties that were identified by the Project analysis are located within the SEIS Study Area. These were identified and evaluated through intensive survey. An analysis of the potential adverse effects to historic properties under NHPA was also conducted in support of the Final EIS. On June 1, 2010, SHPO concurred with FTA's determination of eligibility and finding of effects. The built environment technical studies and SHPO correspondence that supported these results are contained in the Final EIS. For the current analysis, because the results of the Project analysis are less than five years old, and there have been no apparent changes to the historic properties in the APE, the affected environment in the Project analysis is used as the baseline in the SEIS analysis.

The SEIS Study Area contains 16 historic properties (15 of which are individual buildings or structures) that are either listed in or determined eligible for listing in the NRHP (Table 4.7-1). This includes the Little Tokyo Historic District, of which ten contributing buildings are located within the SEIS Study Area (see Figure 4.7-2). Therefore, there are 16 historic properties composed of 25 historic buildings or structures within the analysis area.

4.7.2 Environmental Consequences

The following analysis examines potential adverse effects of the tunneling method alternatives to historic properties. The Regulatory Framework for the analysis can be found in Appendix B - Regulatory Framework. This analysis also incorporates the findings of the Section 4.7 Noise and Vibration, from the Final EIS, to inform the assessment of potential impacts and effects related to ground borne vibration (GBV) and ground borne noise (GBN) on historic properties and it also incorporates the findings of the visual quality analysis related to potential visual intrusion on historic properties.

Figure 4.7-1: SEIS Study Area – Flower Street

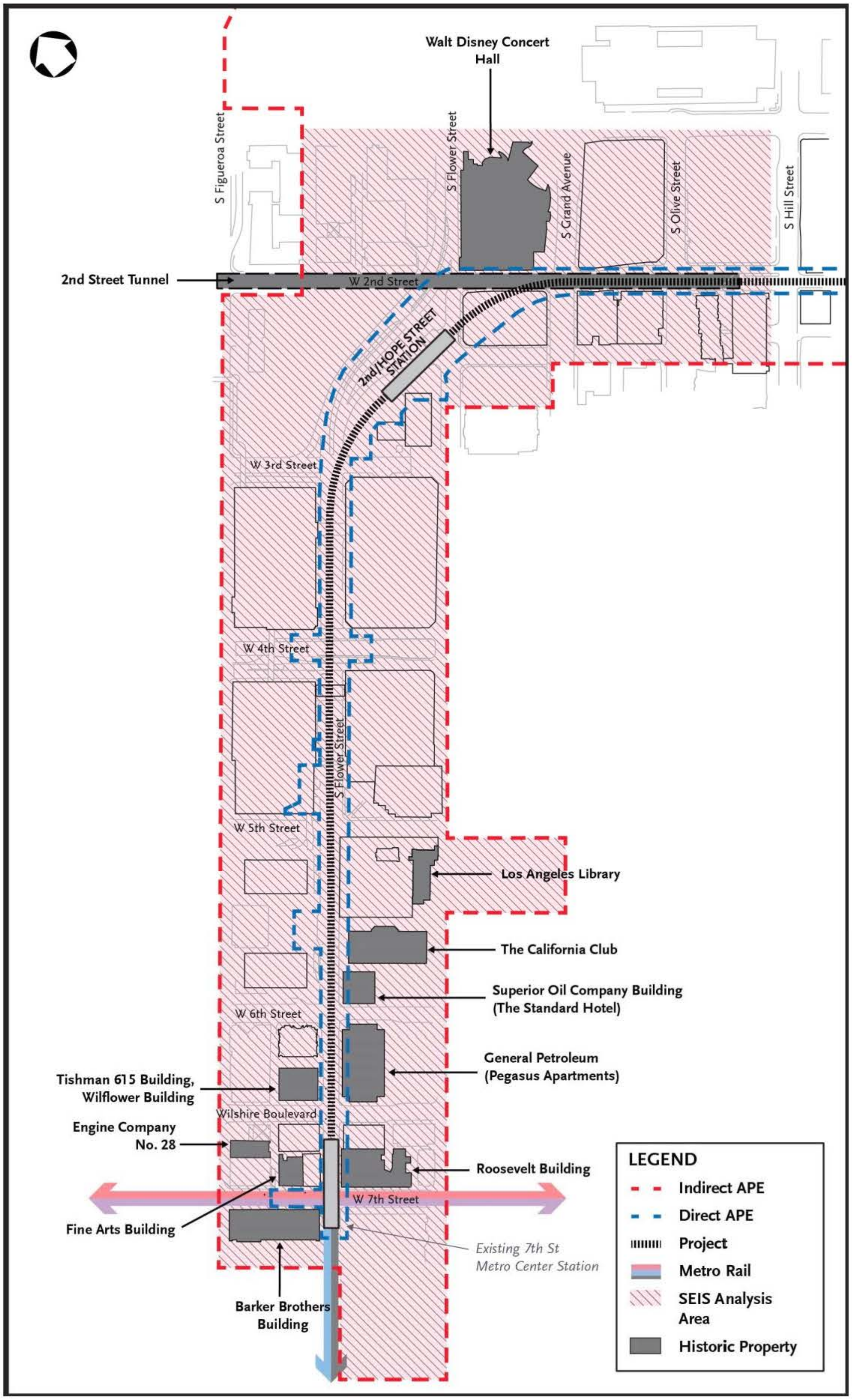


Figure 4.7-2: SEIS Study Area – Little Tokyo

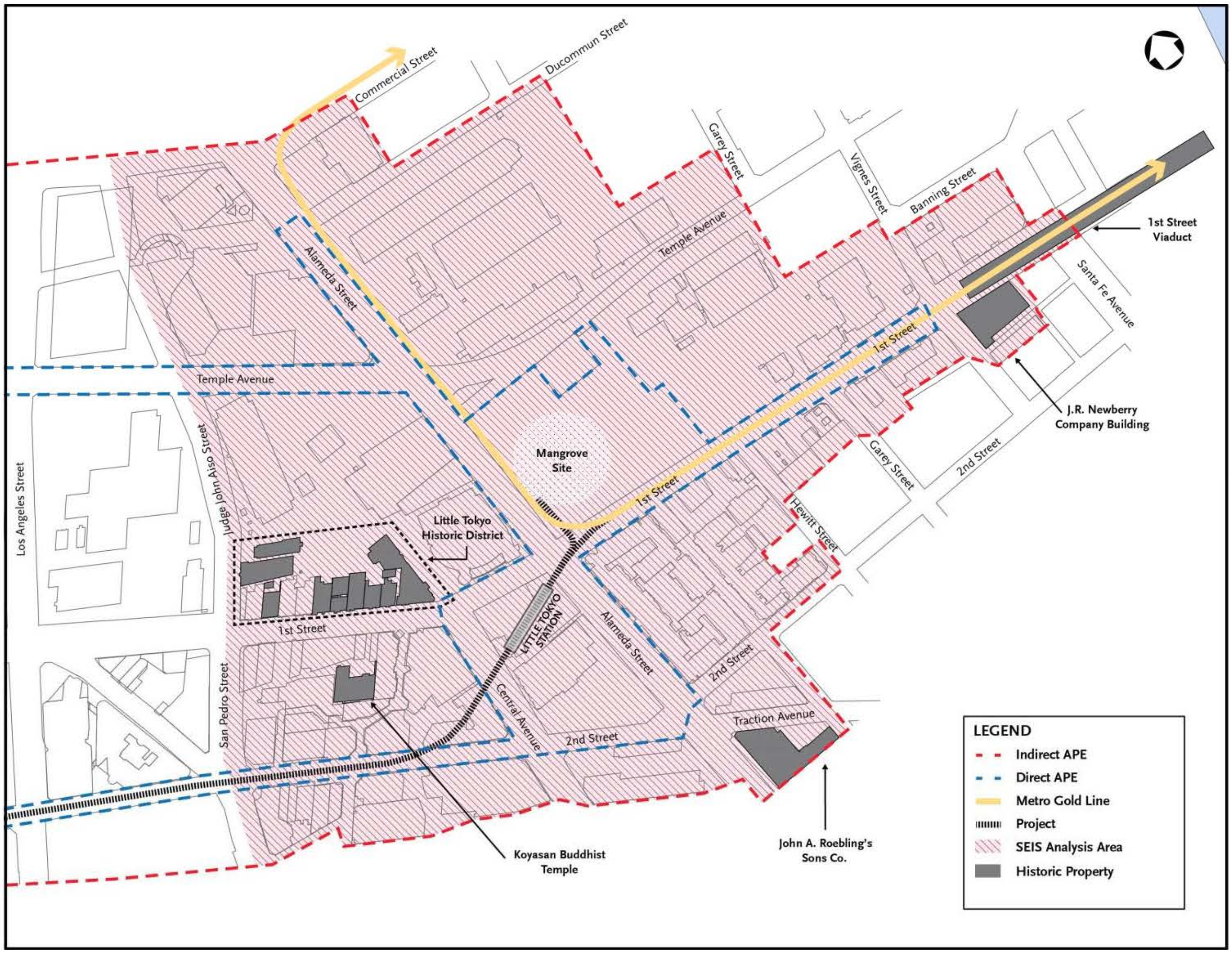


Table 4.7-1: Historic Properties within the SEIS Study Area

Resource Name	Address	NRHP Eligibility	Distance to the Alignment
Barker Brothers	818 West 7th Street	Eligible	30 ft
Fine Arts Building	811 W. 7th Street	Eligible	76 ft
Engine Company No. 28	644 S. Figueroa Street	Listed	206 ft
Roosevelt Building	727 West 7th Street	Listed	5 ft
General Petroleum-Mobil Oil Building	612 South Flower Street	Listed	10 ft
Tishman 615 Building, Wildflower Building	811 Wilshire Blvd.	Eligible	27 ft
Superior Oil Company Building	550 South Flower Street	Listed	13 ft
The California Club	538 South Flower Street	Eligible	38 ft
Los Angeles Central Library	630 West 5th Street	Listed	255 ft
2nd Street Tunnel, Bridge (tunnel) #53C 1318	2nd Street, between Grand Avenue and Figueroa Street	Eligible	Crosses over alignment
Walt Disney Concert Hall	111 South Grand Avenue	Eligible	77 ft
Little Tokyo Historic District (10 contributing buildings, below)	Various (bounded by San Pedro Street, 1st Avenue, and Central Avenue)	Listed (National Historic Landmark)	
Japanese Union Church of Los Angeles	*120 North San Pedro Street*	*Listed*	*658 ft*
San Pedro Firm Building	*108-116 North San Pedro Street*	*Listed*	*585 ft*
Mark Kuwata Real Estate	*301 East 1st Street, 104-106 North San Pedro Street, 104-106 Judge John Aiso Street*	*Eligible*	*472 ft*
1-3 story commercial building, Anzen Hardware	*309-313 East 1st Street*	*Listed*	*472 ft*
1-3 story commercial building, Little Tokyo Hotel	*325 East 1st Street*	*Listed*	*448 ft*
1-3 story commercial building, Ace Japanese Restaurant	*331-335 East 1st Street*	*Listed*	*453 ft*
A. Sperl Building	*337-339 East 1st Street*	*Listed*	*440 ft*
3+ story commercial building, Daimora Hotel	*341-345 East 1st Street*	*Listed*	*421 ft*
Far East Café Building	*347-353 East 1st Street*	*Listed*	*300 ft*
Former Nishi Hongwanji Buddhist Temple	*119 North Central Avenue*	*Listed*	*181 ft*
Koyasan Buddhist Temple	342 East 1st Street	Eligible	105 ft
John A. Roebling's Sons Co.	216 South Alameda Street	Eligible	828 ft
J.R. Newberry Company Building	900 East 1st Street	Eligible	170 ft
1st Street Viaduct	1st Street between Vignes Street and Mission Road	Eligible	1,173 ft

Note: The California SHPO concurred with FTA's determination of eligibility for these properties on June 1, 2010.

No changes to the proposed demolition, partial take, subsurface easement, or alteration of a historic property is anticipated within the SEIS Study Area under the Project and two tunneling method alternatives. Short-term impacts from construction including dirt, unintended damage, traffic congestion, limited parking and access, and visual changes are anticipated to be temporary. The Project analysis indicated that Metro would employ BMPs to minimize these changes and they should be short-term. These conditions are the same under the tunneling method alternatives. Cumulative impacts to built environment historic properties are not anticipated to change from the Project conditions, and can be found in Section 4.19 Cumulative Impacts, in the Final EIS.

Noise and Vibration

Historic properties that are close to the cut and cover construction activities and which may be affected by construction-related vibration include:

- Barker Brothers
- Roosevelt Building
- General Petroleum-Mobil Oil Building (The Pegasus Apartments)
- Superior Oil Building (The Standard Hotel)
- The California Club
- Los Angeles Central Library
- 2nd Street Tunnel
- Walt Disney Concert Hall

In the Project analysis, detailed potential GBN impacts resulting from the operation of the Project were identified at the Walt Disney Concert Hall, in addition to other sensitive historic buildings. Both "frequent" one Light Rail Transit (LRT) vehicle pass-by scenarios and "occasional/infrequent" two LRT vehicle pass-by scenarios would occur, generating GBN levels that would potentially exceed the FTA annoyance criterion for the Walt Disney Concert Hall. Project operation would result in GBV levels that would not exceed the FTA criteria for the most sensitive use at the Walt Disney Concert Hall. Mitigation measures were confirmed to reduce the GBN impact. Moderate noise effects/impacts from other project activities would not exceed the FTA criteria; therefore, no adverse effects to historic properties are anticipated from project operations in the Project analysis after implementation of confirmed mitigation measures in the MOA and MMRP.

Visual Quality

The Project analysis concluded that the construction activities occurring aboveground would only temporarily alter the visual character and setting of historic properties along Flower Street and in Little Tokyo. Temporary construction staging locations and equipment would be visible, but would not have a permanent adverse effect that would diminish the integrity of the historic properties. Therefore, there would be no adverse effects from visual intrusion related to the construction of the project.

Differential Settlement

The Project analysis identified cut and cover and TBM construction activities may have potential differential settlement impacts on historic properties/historic resources. According to the Description of Construction in the Final EIS, buildings situated near cut and cover and tunneling excavation that would be susceptible to differential settlement include:

- Superior Oil Company Building (now The Standard Hotel)
- The California Club
- 2nd Street Tunnel
- Walt Disney Concert Hall
- Former Nishi Hongwanji Buddhist Temple (Little Tokyo Historic District)

The MOA and the MMRP outline several mitigation measures related to the protection of historic properties including measures to address potential noise and vibration and differential settlement.

4.7.2.1 Alternative A – EPBM/Open Face Shield/SEM Project Profile

The two tunneling method alternatives would be built entirely with tunneling construction techniques and, based on the Final EIS findings, would have significant and unavoidable impacts on paleontological resources. Under Alternative A, which has a vertical profile similar to the Project, in areas where new underground EPBM/Open Face Shield/SEM segments would be constructed, mitigation for impacts to paleontological resources will not be feasible and thus construction impacts will be significant and unavoidable.

Nevertheless, any new impacts along the Flower Street segment Alternative A would not be adverse with the implementation of mitigation measures included in the Final EIS and the protocols defined in the project Paleontological Monitoring and Mitigation Plan.

4.7.2.1.1 Construction Impacts

Noise and Vibration

Under Alternative A, the construction noise levels are predicted to be 3 to 6 dBA greater than the levels predicted under the Project due to the presence of grouting along Flower Street (see Section 4.4, Noise and Vibration). No exceedances of the vibration damage threshold of 0.5 in/sec for sensitive properties or 0.2 in/sec for fragile historic properties are predicted.

Differential Settlement

As discussed in Section 4.5 Geotechnical, Subsurface and Seismic Hazards, significant risk of ground loss and excessive settlement due to the open-face Shield and SEM tunneling will remain even when jet grouting is employed to improve the ground conditions along Flower Street. The risk of tunnel collapse cannot be ruled out. This is because grout columns do not always overlap in practice and there is no guarantee that all of the ground within the columns will be adequately grouted. Groundwater inflows and ground loss can still occur which could damage utilities and existing buildings, basements, structures and provide a safety threat to workers, the public, and building operations.

Visual Quality

As discussed in Section 4.1 Visual Quality, although Alternative A would noticeably reduce visual quality or alter the viewing context of historic properties along Flower Street due to the presence of large and tall grouting equipment, the impact would be temporary and would not result in an adverse effect once construction equipment was removed.

4.7.2.1.2 Section 106 Effects Analysis for Historic Properties

Alternative A does not pose any additional effects to historic properties in the SEIS Study Area. The resulting impacts and effects would be essentially the same as previously analyzed. There would be no additional adverse effects with implementation of confirmed mitigation measures identified in the MMRP and MOA Implementation of the MMRP and MOA would specify the requirements for pre- and post-construction surveys, geotechnical investigations, building protection measures, and TBM specifications. Mitigation measures for noise and vibration during operation and construction would further reduce potential effects to historic properties so they fall below FTA impact threshold criteria for noise and vibration. If these mitigation measures are properly implemented, construction of this alternative would not directly alter a characteristic of these historic properties in a manner that would diminish the integrity of the historic properties' location, design, setting, materials, workmanship, feeling, or association.

Alternative A would have adverse impacts on paleontological and archaeological resources that would not be feasible to mitigate, and thus the construction and cumulative impact will be adverse and unavoidable.

4.7.2.2 Alternative B – EPBM/SEM Low Alignment

4.7.2.2.1 Construction Impacts

The two tunneling method alternatives would be built entirely with tunneling construction techniques and, based on the Final EIS findings, would have significant and unavoidable impacts on paleontological resources. Alternative B would potentially have greater impact on paleontological resources than the Project due to a deeper vertical profile that would be 45 or 65 feet deeper, respectively, along the Flower Street segment and 32 feet deeper, respectively, at the 2nd/Hope Station location. On the basis of current geologic maps, the surface geology underlying the Flower Street segment is almost entirely Younger Quaternary alluvial-fan deposits of low paleontological sensitivity. However, these deposits likely overly Older Quaternary alluvial deposits of Pleistocene age with the potential to contain significant vertebrate fossils. The potential sensitivity of these deposits increases with depth. Therefore, the potential for Alternative B to impact significant paleontological deposits is greater than that of the Project. In addition, the mapped surface geology underlying the 2nd/Hope Station location is a composite of paleontologically sensitive Puente and Fernando Formations bordered by Older Quaternary alluvium to the east. Both the Puente and Fernando Formations were identified in the Final EIS as having high paleontological sensitivity with the potential to contain marine and terrestrial mammals and other significant fossils. Deeper excavations into these formations have the potential to impact significant paleontological resources that would not be impacted by the shallower excavations planned for the Project.

Nevertheless, any new impacts along the Flower Street segment and at the planned 2nd/Hope Station location caused by the deeper vertical profile proposed for Alternative B would not be adverse with the implementation of mitigation measures included in the Final EIS and the protocols defined in the project Paleontological Monitoring and Mitigation Plan.

Noise and Vibration

Under Alternative B, the construction noise levels are predicted to be 6 to 7 dBA greater than the noise levels predicted under the Project due to the presence of grouting activity along Flower Street. . No exceedances of the vibration damage threshold of 0.5 in/sec for sensitive properties or 0.2 in/sec for fragile historic properties are predicted.

Differential Settlement

Qualitatively, EPBM-bored tunneling typically causes less differential settlement impact on adjacent buildings and structures than cut and cover construction. Therefore, the extension of the EPBM-bored tunnel to south of 5th Street under this alternative would reduce the different settlement impacts on some historic properties located adjacent to this EPBM-bored tunnel section (but would be adjacent to cut and cover section under the Project). However, significant risk of ground loss and excessive settlement due to SEM tunneling will remain even when jet grouting is employed to improve the ground conditions along Flower Street. The risk of tunnel collapse cannot be ruled out. This is because grout columns do not always overlap in practice and there is no guarantee that all of the ground within the columns will be adequately grouted. Groundwater inflows and ground loss can still occur which could damage utilities and existing buildings, basements, structures and provide a safety threat to workers, the public, and building operations.

Visual Quality

Under Alternative B, a larger amount of excavated materials from the Flower Street portion of the project would be handled from Little Tokyo. Unlike the Project, the construction of Alternative B would also include the use of jet grouting equipment associated with the SEM construction technique proposed along Flower Street from south of 5th Street to just south of 6th Street. Highly visible jet grouting equipment would be located generally along the eastern traffic lanes of Flower Street, from south of 5th Street to 6th Street. Although Alternative B construction would noticeably reduce visual quality or alter the viewing context of historic properties, it would be a temporary impact, and would not result in an adverse effect once construction equipment was removed.

4.7.2.2.2 Section 106 Effects Analysis for Historic Properties

Alternative B does not pose any additional impacts or effects to historic properties in the SEIS Study Area. The resulting impacts and effects would be essentially the same as previously analyzed and identified for the Project. There would be no additional adverse effects with implementation of confirmed mitigation measures identified in the MMRP and MOA. Implementation of the MMRP and MOA would specify the requirements for pre- and post-construction surveys, geotechnical investigations, building protection measures, and TBM specifications. Mitigation measures for noise and vibration during operation and construction would further reduce potential effects to historic properties so they fall below FTA impact threshold criteria for noise and vibration. If these mitigation measures are properly implemented, construction of this alternative would not directly alter a characteristic of these historic properties in a manner that would diminish the integrity of the historic properties' location, design, setting, materials, workmanship, feeling, or association.

Alternative B would have adverse impacts on paleontological and archaeological resources that would not be feasible to mitigate, due to the use of EPBM for a longer segment along Flower Street versus Alternative A in addition to the deeper vertical depth, and thus the construction and cumulative impact will be adverse and unavoidable.

4.7.3 Mitigation Measures

Implementation of mitigation measures CR/B-1 through CR/B-6, CR/A-1 through CR/A-6, CR/P-1 through CR/P-6, from the Final EIS for the Project would apply for Alternatives A and B. Below is a summary of these mitigation measures and a detailed description can be found in Appendix G:

- CR/B-1: Appropriate documentation and co-ordination with historic resource archives to adversely affected properties/resources
- CR/B-2: Surveying of historic properties and/or resources within 21 feet of vibration producing construction
- CR/B-3: Review of historical protection measures by qualified architectural historian
- CR/B-4: Reference to MOA and specific requirements for historic properties adversely impacted
- CR/B-5: Removal and incorporation of historic buildings for 1st/Central Station
- CR/B-6: Proper protection from dirt for adjacent historic properties
- CR/A-1: Construction personnel to be trained by qualified lead archaeologist
- CR/A-2: Presence of archaeological monitor during ground-disturbing activities
- CR/A-3: Native American cultural resources consultant to be present during ground-disturbing activities
- CR/A-4: Halting of work should human remains be found during ground-disturbing activities
- CR/A-5: Preparation of an Archaeological Resource Management Report with findings
- CR/A-6: Appropriate identification and documentation program for any disturbance of historic resources
- CR/P-1: Preparation of a Paleontological Monitoring Report by a qualified paleontologist with monitoring specifications
- CR/P-2: Monitoring of Puente Formation, Fernando Formation, and Quatemary alluvium and deposits during construction
- CR/P-3: The use of field data forms at fossil locals for samples and collections
- CR/P-4: Testing for microfossils at Puente Formation and Fernando Formation
- CR/P-5: Recovered fossils to be listed in database and repositioned at the Natural History Museum (NHM) of Los Angeles
- CR/P-6: Paleontologist to prepare final monitoring and mitigation report

4.8 ENVIRONMENTAL JUSTICE

This section describes the existing Environmental Justice communities in the Study Area for the SEIS and presents the results of the evaluation of the potential construction impacts of the tunneling method alternatives. The environmental analysis assumes a conservative, worst-case, condition when determining potential impacts. Background information in this section is based on the Environmental Justice Technical Memorandum (Appendix EE) and Section 4.17 Environmental Justice Impacts presented in the Final EIS.

4.8.1 Affected Environment

This section describes the affected environment as it relates to an analysis of environmental justice for the two tunneling method alternatives being analyzed in this SEIS. General construction activities for the Project for locations other than along Flower Street and the Mangrove site area in Little Tokyo remain unchanged from the Final EIS.

The general boundaries of the Study Area are illustrated in Figure 4.8-1. While the Study Area encompasses those census blocks within the general boundaries, the purpose of this SEIS effort is to analyze potential impacts of the two tunneling method alternatives. Environmental justice analysis conducted for the two tunneling alternatives pertains specifically to those populations located along Flower Street and in Little Tokyo.

The affected environment along Flower Street includes the alignment-adjacent areas of the Financial District and Bunker Hill in downtown Los Angeles. These areas are characterized largely by business activities with high rise office buildings, hotels, and commercial properties. A limited number of high rise apartment buildings are located on Flower Street, along with the Los Angeles Public Library, the California Club, and smaller ground floor retail businesses. The Mangrove portal site is located on the eastern edge of Little Tokyo – a thriving historic and cultural destination characterized by a mix of retail businesses, housing, and cultural institutions.

The Final EIS was based on 2008 census information. The analytical information presented and used in this SEIS has been updated to reflect 2010 census information, which has identified significant growth in downtown residential population and employment since 2008.

Minority Populations

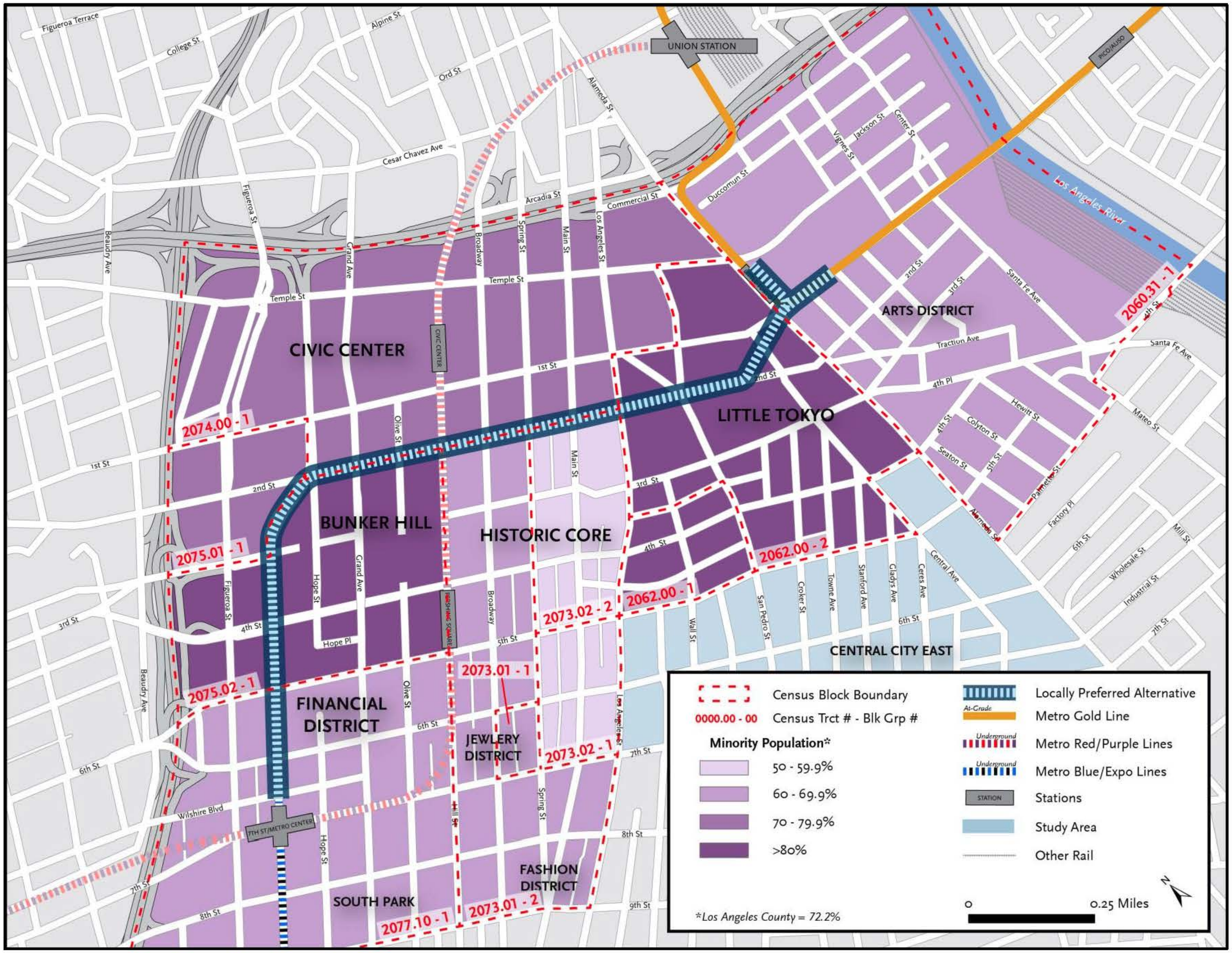
The racial and ethnic character of the populations within the Study Area by census block is listed in Table 4.8-1 (Racial and Ethnic Character by Census Block, 2008 to 2012), and shown on Figure 4.8-1 (Minority Populations in the Study Area by Census Block, 2008 to 2012). Based on U.S. Census Bureau data, all census block groups in the study area were identified as environmental justice areas due to higher minority averages in comparison to the surrounding community (i.e., Los Angeles County), or because 50 percent or more of the population was considered minority. However, census blocks are much larger than the area affected by the Project and tunneling method alternatives. Field work confirmed that the Flower Street corridor is predominantly commercial and has limited residents, while Little Tokyo is an identified environmental justice community.

Table 4.8-1: Racial and Ethnic Character by Census Block, 2008 to 2012

Census Tract	Census Block Group	Total Population	White	Black or African American	Asian	Hispanic or Latino	Amer. Indian/ Alaskan Native	Nat. Hawaiian/ Other Pacific Islander	Other Races	Two or More Races	Percent Minority
2060.31	1	2,088	31.4%	4.8%	50.1%	9.2%	0.1%	0.1%	0.6%	3.7%	**68.6%**
2062	1	1,028	16.4%	47.5%	2.4%	31.1%	0.7%	0.1%	0.1%	1.7%	**83.6%**
2062	2	2,358	10.4%	16.5%	55.8%	14.5%	0.3%	0.1%	0.2%	2.3%	**89.6%**
2073.01	1	1,115	34.5%	24.5%	10.6%	25.2%	1.0%	0.1%	0.2%	4.0%	**65.5%**
2073.01	2	3,406	38.1%	18.8%	17.5%	19.4%	0.9%	0.2%	0.3%	4.8%	**61.9%**
2073.02	1	2,209	48.7%	18.4%	8.9%	17.5%	1.0%	0.0%	0.4%	5.3%	**51.4%**
2073.02	2	1,501	45.6%	20.0%	9.6%	19.7%	1.1%	0.1%	0.6%	3.3%	**54.4%**
2074	1	1,363	20.6%	21.9%	7.3%	48.4%	0.3%	0.0%	0.2%	1.3%	**79.4%**
2075.01	1	2,218	27.6%	7.9%	46.3%	14.5%	0.3%	0.1%	0.2%	3.1%	**72.5%**
2075.02	1	2,589	19.9%	4.9%	60.0%	12.4%	0.1%	0.2%	0.2%	2.4%	**80.2%**
2077.1	1	2,490	35.0%	11.7%	34.5%	15.5%	0.2%	0.2%	0.2%	2.7%	**65.0%**
Total Study Area		**22,446**	**30.4%**	**15.6%**	**31.1%**	**18.6%**	**0.5%**	**0.1%**	**0.3%**	**3.3%**	**69.6%**
Los Angeles County		9,818,605	27.8%	8.3%	13.5%	47.7%	0.2%	0.2%	0.3%	2.0%	**72.2%**

Note: EJ – Environmental Justice; N/A – Not Applicable
Source: U.S. Census Bureau, American Community Survey 5-Year Estimate (2008-2012)

Figure 4.8-1: Minority Populations in the Study Area by Census Block, 2008 to 2012



Metro

Low-Income Households

The median household income and households living below the poverty level (i.e., low-income households) within the Study Area are listed in Table 4.8-2 (Low-Income Households by Census Block, 2008 to 2012) and shown on Figure 4.8-2 (Low-Income Households in the Project Area by Census Block, 2008 to 2012). The average median household income is $32,076. Table 4.8-2 also shows the percentage of households in each block group that are transit-dependent. All census block groups except one have greater percentages of transit-dependent households than Los Angeles County. Field work identifies that the project-adjacent areas of Flower Street and Little Tokyo do not appear to meet the criterion of being below the Los Angeles County median income level, as there is no low-income housing, rather both areas have only moderate and high rent housing.

Table 4.8-2: Low-Income Households by Census Block, 2008 to 2012

Census Tract	Census Block Group	Total Households	Median Household Income	Percent Households Living Below Poverty Level	Percent Households Transit-Dependent
2060.31	1	932	$61,042	18.9%	7.0%
2062	1	226	$4,589	76.6%	88.1%
2062	2	1,204	$17,320	36.5%	47.3%
2073.01	1	861	$7,682	65.7%	74.0%
2073.01	2	2,191	$21,753	31.5%	46.4%
2073.02	1	1,266	$32,241	24.0%	24.6%
2073.02	2	890	$30,990	37.2%	49.7%
2074	1	15	$10,795	100.0%	100.0%
2075.01	1	1,353	$56,169	8.1%	22.5%
2075.02	1	1,741	$19,698	35.8%	41.6%
2077.1	1	1,553	$51,803	19.3%	30.4%
Total Study Area		**12,232**	**$32,076**	**30.5%**	**38.9%**
Los Angeles County		3,218,511	$56,241	15.6%	9.7%

Notes: EJ – Environmental Justice; N/A – Not Applicable
Source: U.S. Census Bureau, American Community Survey 5-Year Estimate (2008-2012)

Little Tokyo

Los Angeles's Little Tokyo is one of only three remaining "Japantowns" in the US, and is a historic cultural center of national importance. Prior to World War II, Little Tokyo was the largest Japanese American community in the country. Its Japanese-American population has since decreased in size as a majority of the Japanese-American population has migrated to the suburbs, but Little Tokyo remains a historic and cultural focal point for Japanese Americans both in Los Angeles and throughout the US. It houses important cultural institutions, such as the Japanese American National Museum (JANM), and a portion of the neighborhood is designated as a historic district on the National Register of Historic Places. Impacts to Little Tokyo would affect not only local residents, but also the cultural footings of Japanese-Americans nationwide.

Throughout the planning and environmental review process for the Regional Connector project, residents of Little Tokyo have continuously expressed concern that construction of the project alternatives would negatively affect the community's cultural identity and economic viability. The Little Tokyo community has experience based on the impacts from the three-year construction effort for the Metro Gold Line Eastside Extension. This included the construction of a new Little Tokyo/Arts District Station, as well as construction along Alameda Street between US-101 and 1st Street.

4.8.2 Environmental Consequences

This section summarizes the potential construction impacts of the two tunneling method alternatives evaluated in this SEIS as compared to the Project. The mitigation measures identified in the Final EIS for the Project would apply for Alternative A and B, and are described below in Section 4.8.3.

4.8.2.1 Alternative A – EPBM/Open Face Shield/SEM Project Profile

4.8.2.1.1 Construction Impacts

Transit

Under Alternative A , there are no impacts to transit services in Little Tokyo beyond those identified for the Project. A majority of the potential construction impacts of Alternative A would be temporary and unavoidable. There would be no disproportionate adverse effect to Little Tokyo EJ populations with implementation of mitigation measures.

Traffic Circulation

Construction of Alternative A would increase the excavation truck trips in Little Tokyo from 19 percent under the Project to 75 percent, and would occur for 15 months longer than the Project. Under Alternative A, the number of trucks using the Flower Street route would decrease to approximately 10 trucks per day, while the number of trucks using the Little Tokyo haul routes would increase to approximately 30 trucks per day. Although the Level of Service (LOS) in the affected roadway segments would remain unchanged, travel times are expected to increase for vehicles traveling along the Little Tokyo haul routes. These increased travel times in and around Little Tokyo would be disproportionately borne by this community.

In summary, Alternative A would have a disproportionate adverse effect to the environmental justice population in Little Tokyo due to increased truck activity, and the longer duration of that truck activity as compared to the Project. This adverse effect would be temporary and unavoidable. This would be a disproportionate adverse effect to the Little Tokyo EJ community.

Parking

Parking impacts identified during construction of the Project would remain unchanged under construction of Alternative A. Parking would be adverse only in the Little Tokyo community portion of the alignment, but, there would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

Other Modes

Pedestrian access to adjoining properties in Little Tokyo and bicycle traffic movements would be maintained during construction of Alternative A; however, portions of sidewalks may be temporarily closed adjacent to construction locations. Temporary closures of sidewalks and crosswalks may be necessary. Lane reductions and street closures would restrict bicycle traffic flow during construction. Impacts would be reduced after implementation of proposed mitigation. There would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

Visual Quality

As described in Section 4.1, construction of Alternative A would not result in impacts to scenic resources or in nighttime lighting or shade and shadow impacts over the Project in Little Tokyo. Construction equipment and staging set ups for Alternative A would have an adverse effect, however they would be temporary. Therefore, there would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

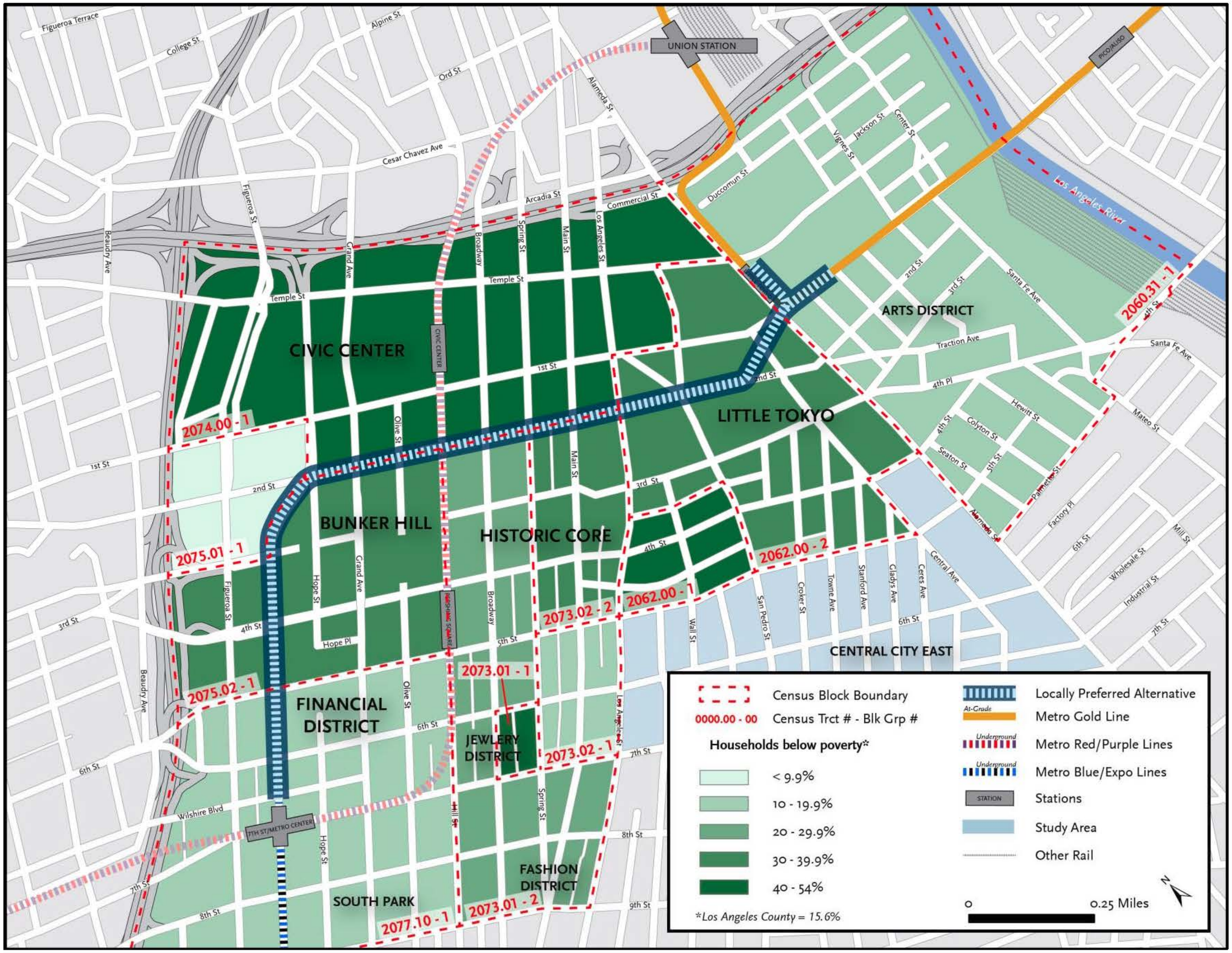
Air Quality

As described in Section 4.2, along with Sections 2.3 and 3.0, during construction of Alternative A there may be no additional truck impacts to Little Tokyo beyond those of the Project. There would be an increase in the number and duration of daily truck traffic handling tunnel muck materials from the Flower Street segment. These impacts will not be adverse or have a disproportionate adverse effect on EJ populations with implementation of mitigation measures.

Climate Change

As evaluated in Section 4.3, construction of Alternative A would result in a net increase in GHG emissions over a finite period. The increase in GHG emissions would be higher than the GHG emissions estimated for the Project. However, the amortized construction-related GHG emissions for Alternative A would be less than the proposed or adopted thresholds discussed in Section 4.3.1. The amortized construction emissions for Alternative A would also not exceed the GHG emissions threshold by the CEQ for evaluation of climate change impacts. There would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

Figure 4.8-2: Low-Income Households in the Study Area by Census Block, 2008 to 2012



Metro

Noise and Vibration

As discussed in Section 4.4, Alternative A would shift muck truck activity from Flower Street to Little Tokyo for 15 months longer than the Project. The duration of construction and excavation efforts identified for Alternative A were taken into account for identifying impacts to receptors in the Little Tokyo area, due to extended duration of construction and increased haul truck activities. Although this is a temporary construction impact, this would be adverse to an environmental justice community. There would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

Energy

Construction of Alternative A would result in a temporary energy demand of 323 billion Btu's, which would be higher than the energy demand estimated for the Project. As discussed in Section 4.6, this impact would be temporary for the short-term duration of construction activities and would be offset by the long-term, beneficial decreases in energy use associated with operations. There would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

Historic Resources

As presented in Section 4.7, Alternative A would have essentially the same impacts and effects on historic properties as identified for the Project in the Final EIS, and, therefore, the confirmed mitigation measures in the Memorandum of Agreement (MOA) and the Mitigation Monitoring and Reporting Plan (MMRP) would reduce effects to no adverse effect when implemented. There would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

4.8.2.2 Alternative B – EPBM/SEM Low Alignment

4.8.2.2.1 Construction Impacts

Transit

Under Alternative B, there would be no impacts to transit services in Little Tokyo beyond those identified for the Project. A majority of the potential construction impacts would be temporary and unavoidable. There would be no disproportionate adverse effect to Little Tokyo EJ populations with implementation of mitigation measures.

Traffic Circulation

Construction of Alternative B would increase excavation truck trips in Little Tokyo from 19 percent under the Project to 80 percent, and would occur for seven months longer than the Project. Conversely, the truck trips on Flower Street would decrease from 81 percent under the Project to 20 percent in Alternative B. Under this alternative, the number of trucks using the Flower Street route would decrease to 8 trucks (versus 32 trucks under the Project), while the number of trucks using the Little Tokyo haul routes would increase to 32 trucks (versus 8 trucks under the Project). Travel times are expected to increase for vehicles travelling along the Little Tokyo haul routes. These increased travel times in and around Little Tokyo would be disproportionately borne by this community.

In summary, Alternative B would have a disproportionate adverse effect to the environmental justice population in Little Tokyo due to increased truck activity, and the longer duration of that truck activity compared to the Project. This adverse effect would be temporary and unavoidable. This would be a disproportionate adverse effect to the Little Tokyo EJ community.

Parking

Parking impacts identified during construction of the Project would remain unchanged under construction of Alternative B. Parking would only be affected in the Little Tokyo community portion of the alignment, but, there would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

Other Modes

Pedestrian access to properties in Little Tokyo and bicycle traffic movements would be maintained during construction of Alternative B; however, portions of sidewalks may be temporarily closed adjacent to construction locations. Temporary closures of sidewalks and crosswalks may be necessary. Lane reductions and street closures could inhibit bicycle traffic flow during construction. Impacts would be reduced after implementation of proposed mitigation. There would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

Visual Quality

As described in Section 4.1, construction of Alternative B would not result in impacts to scenic resources or in nighttime lighting or shade and shadow impacts over the Project in Little Tokyo. There would be no impact to Little Tokyo. Therefore, there would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

Air Quality

As described in Section 4.2, along with Sections 2.3 and 3.0, during construction of Alternative B there may be no additional truck impacts to Little Tokyo beyond those of the Project. There would be an increase in the number and duration of daily truck traffic handling tunnel muck materials from the Flower Street segment. These impacts will not be adverse or have a disproportionate adverse effect on EJ populations with implementation of mitigation measures.

Climate Change

Construction of Alternative B would result in a net increase in GHG emissions over a finite period. The increase in GHG emissions would be lower than the GHG emissions estimated for the Project. However, the amortized construction-related GHG emissions for Alternative B would be less than the proposed or adopted thresholds discussed in Section 4.3.1. The amortized construction emissions for Alternative B would also not exceed the GHG emissions threshold by the CEQ for evaluation of climate change impacts. There would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

Noise and Vibration

As described in Section 4.4, Alternative B would shift muck truck activity from Flower Street to Little Tokyo and increase the duration of impacts by an additional 7 months over Project conditions. Although this is a temporary construction impact, this would be adverse to an environmental justice community. There would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

Energy

Construction of Alternative B would result in a temporary energy demand of 295 billion Btu's, which would be lower than the energy demand estimated for the Project. This impact would be temporary for the short-term duration of construction activities and would be offset by the long-term, beneficial decreases in energy use associated with operations of this alternative. There would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

Historic Resources

Alternative B would have essentially the same impacts and effects on historic properties as identified for the Project in the Final EIS, and, therefore, the confirmed mitigation measures in the MOA and the MMRP would reduce to no adverse effect when implemented. There would be no disproportionate adverse effect to EJ populations with implementation of mitigation measures.

4.8.3 Mitigation Measures

Mitigation measures to reduce potential environmental justice impacts during construction were identified in the Final EIS. Implementation of mitigation measures EJ-1 through EJ-35 identified for the Project would be followed for Alternatives A and B. Below is a summary of these mitigation measures and a detailed description can be found in Appendix G:

- EJ-1:Replacement of bus loading spaces on Alameda Street for JANM during construction
- EJ-2: Unmet demand for parking eliminated in Little Tokyo during construction shall be replaced within one block on reliant land uses
- EJ-3: Metro shall provide two acres of land on Mangrove property as alternative parking during construction
- Ej-4: Proper notices by Metro of traffic control plans, parking relocation, through typical communication devices
- EJ-5: Metro shall support efforts to curb non-legitimate use of disabled parking spaces
- EJ-6: Metro shall coordinate to develop a parking reservation system during construction
- EJ-7: Coordination with LADOT to open city parking lots for short-term use
- EJ-8: Coordination with the City to reduce impacts of government vehicles along 2nd Street during construction
- EJ-9: Coordination with the City and Little Tokyo Business Improvement District to facilitate financial incentives and priority parking to Little Tokyo patrons
- EJ-10: Coordination with Little Tokyo restaurants interested in curbside pickup

- EJ-11: Metro shall conduct annual parking needs assessment prior to construction and proper notification strategies to communicate parking to visitors and patrons
- EJ-12: Coordination to maintain visibility for businesses during construction
- EJ-13: Shall parcels used for construction staging be proposed for future redevelopment, Metro shall comply with the Joint Development Policy to involve the community
- EJ-14: Displaced commercial spaces in Little Tokyo shall be replaced with high quality commercial development consistent with community identity
- EJ-15: Coordination with Little Tokyo, Arts District, and City CRA to create joint development opportunities
- EJ-16: Metro shall implement various strategies to support affected services/businesses in Little Tokyo
- EJ-17: Surface level construction activities to be curtailed to extent possible during major Little Tokyo festivities and outdoor events
- EJ-18: Metro shall work with Little Tokyo Business Association to help offset neighborhood impacts associated with reduced revenue during construction
- EJ-19: Metro shall work with Little Tokyo community to minimize adverse impacts during utility relocation and protection of utilities
- EJ-20: Communication and advertising on transit buses and other means to announce construction plans and alternatives to travel and parking in Little Tokyo
- EJ-21: Avoidance of haul routes along 1st or Alameda Streets between 3rd St and US-101
- EJ-22: Publishing of safety and security information at stations in Japanese, Korean, and Spanish
- EJ-23: Publishing of project's safety education campaign in Japanese, Korean, and Spanish
- EJ-24: Involvement of Little Tokyo's Public Safety Association in development of safety and security plans
- EJ-25: Monitoring of committed mitigations designed to address safety and security concerns
- EJ-26: Appropriate orientation of system's ventilation equipment and minimizing of noise
- EJ-27: Implementation of receptor-based mitigation where needed to reduce construction-related pollutant levels
- EJ-28: maximize opportunities for enhancing access from existing land uses to new station
- EJ-29: Design of underground facilities to avoid subsurface impacts to buildings
- EJ-30: Proper monitoring of newly planted trees to ensure healthy growing
- EJ-31: Providing Little Tokyo and Arts District opportunities for input on 1st/Central design processes
- EJ-32: All information to be made available in Japanese and Korean
- EJ-33:TBM operations to be performed by contractor in 48 months
- EJ-34: Appropriate procedures for rapid shut-down should vibration thresholds be reached
- EJ-35: Preparation of a cost-benefit analysis of using one versus two TBMs

Adverse effects would remain after implementation of these mitigation measures for the tunneling method alternatives, which would have additional adverse effects beyond those identified for the

Project primarily due to the increased level and duration of the construction impacts on the Little Tokyo community.

Impacts after Mitigation and Environmental Justice Determination

For the Project, there would be no disproportionately high and adverse effects to Environmental Justice populations after mitigation measures identified in the Final EIS are implemented for construction effects.

Little Tokyo would experience expanded traffic congestion and travel times due to an increase in truck activity handling a greater proportion of the tunneling excavation materials. Construction of both Alternatives A and B would have a longer duration than that of the Project, which would be disproportionately experienced in the Little Tokyo community and would be considered disproportionately high and adverse to residents of Little Tokyo. With the longer construction and the increase in truck activity resulting from the tunneling method alternatives, and the associated impacts to Little Tokyo residents and businesses, the potential off-setting benefits of improved access and connectivity that the community could experience during operations may not be of value to the community, which would be significantly affected by the disproportionately adverse construction impacts associated with Alternatives A and B.

4.9 CUMULATIVE IMPACTS

This section summarizes potential cumulative impacts that would result from the Regional Connector Transit Corridor project in combination with identified past, present and reasonably foreseeable projects. The information presented in this SEIS provides an update to prior reports developed as part of Final EIS including the Cumulative Impacts Technical Memorandum prepared for the project contained in Appendix GG, Cumulative Impacts Technical Memorandum.

Updated information in this section includes new renovation, construction, institutional/public facility, and transportation projects. Since completion of the Final EIS, eight new renovation, construction, and institutional/public facility projects are now anticipated to be completed by 2014, and 13 new projects will be under construction during 2014 to 2020. While all of these projects are located in the Project Area, only two projects will impact the Flower Street and Little Tokyo areas affected by the two tunneling methods alternatives: renovation of the former mixed-use Macy's Plaza, now known as the Bloc, located at 7th Street and Flower Street; and the new Wilshire Grand Hotel under construction at 7th Street and Figueroa Street.

Both projects will increase pedestrian activity and contribute to higher Metro Rail ridership in the Flower Street portion of the Project. From a transportation project perspective, there have been significant changes to rail transit project implementation schedules since completion of the Final EIS. In addition, with the anticipated operation of the Regional Connector project, Metro has identified future operational changes such that Gold Line service will provide a one-seat ride for travel from East Los Angeles to Santa Monica, and the Blue Line from Azusa to Long Beach. Reflecting this future operational change, information on other rail lines to be served by the Regional Connector Transit Corridor project has been added to this cumulative section. These lines include the Gold Line Foothill Extension, Crenshaw/LAX, and Purple Line Extension projects.

4.9.1 Affected Environment

The cumulative context includes the geographic area, timeframe, and/or type of projects that would contribute to the potential cumulative effect. This context differs for each discipline. Each discipline identifies a relevant geographic area for evaluation of direct, indirect, and cumulative impacts. The geographic range considered for the cumulative analysis can vary based on the resource area. For example, the geographic range over which air quality impacts would occur would not necessarily be the same as the geographic range considered for traffic impacts.

In addition, for some disciplines the scope of analysis for cumulative impacts is based on a list of reasonably foreseeable related projects while for others it is be based on general trends in demographics or other regional forecasts. The forecast approach was used in the analysis of cumulative operational impacts for the transportation and air quality disciplines. This approach was also used in the analysis of cumulative impacts for the climate change discipline, which combined construction and operational emissions per the South Coast Air Quality Management District's recommendation. The general geographic range used to forecast cumulative conditions for these three disciplines was the Southern California Association of Government (SCAG) region, which also assumed operation of the rail projects identified in Figure 4.9-2. All other disciplines used the list of reasonably foreseeable related projects as the scope of analysis for cumulative impacts, including the cumulative construction impacts analysis for the transportation and air quality disciplines for the Final EIS.

The purpose of this SEIS is to study the potential environmental consequences associated with construction and operation of the tunneling method alternatives as compared to the Project. Therefore, the evaluation of cumulative impacts is focused on specific disciplines identified as potentially being impacted by proposed construction method changes to the Flower Street segment of the Regional Connector project. For these disciplines, the general geographic range considered for the cumulative analysis are shown in Figure 4.9-1, along with the rail projects identified in Figure 4.9-2.

4.9.1.1 Project Time Frames

The following project-related time frames were used to identify project-related cumulative impacts.

Construction Period: 2014 – 2020

The project construction period has been identified as extending from initiation of construction to 2020. A worst-case (i.e., maximum potential impact) scenario was assumed for each resource area. For example, it is assumed that all other related projects for which there is no current construction schedule will be under construction during the project construction period. Related projects within the general project area that may be under construction during this project's proposed construction period of 2014 to 2020, which were not previously analyzed as part of the Final EIS are listed in Tables 4.9-3 through 4.9-6.

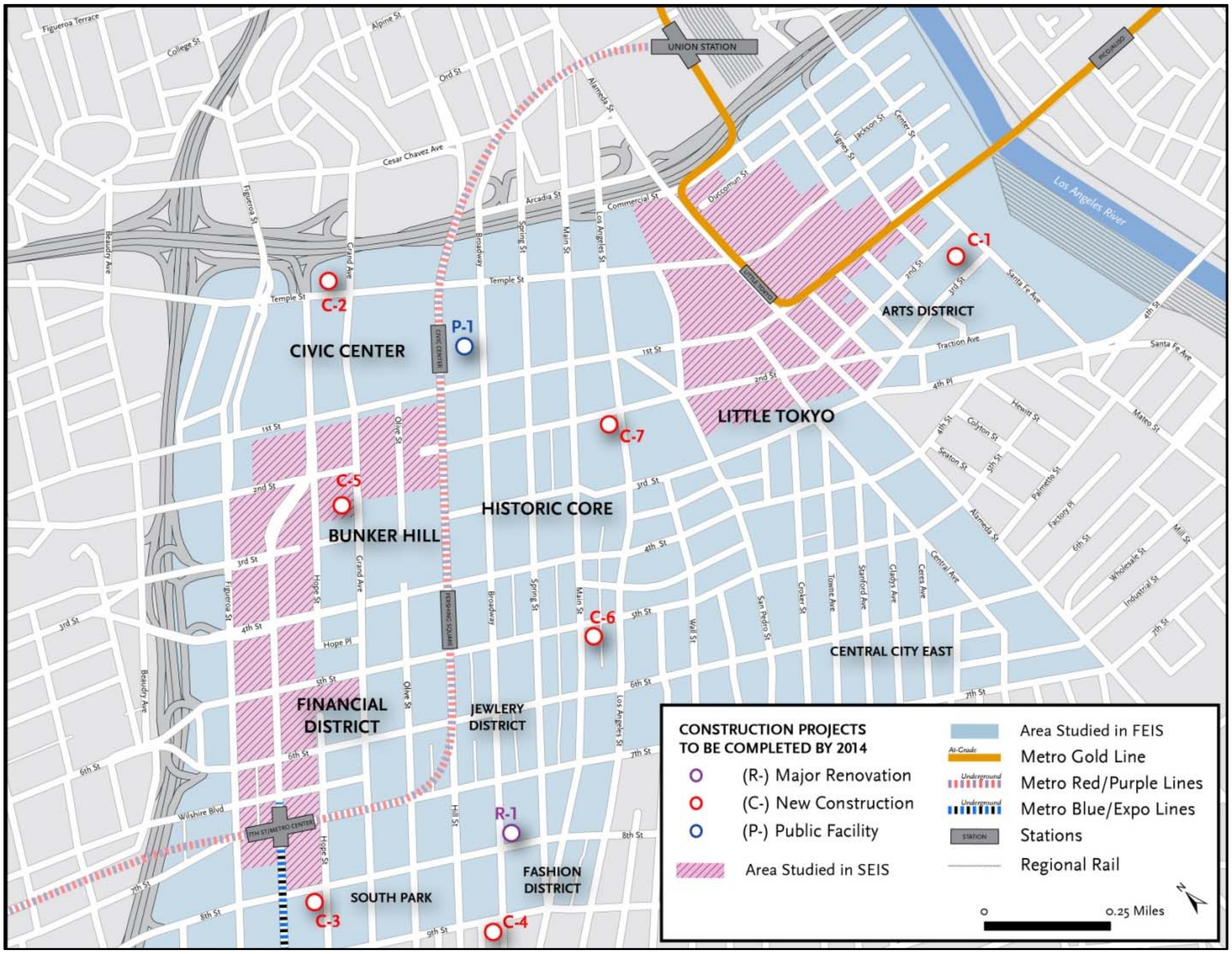
Year of Opening: 2020

With initiation of Project revenue operations anticipated in 2020, potential effects from operation of the Project would begin to be seen. The planning horizon identified for the project is 2035, reflective of the planning horizon used in the two documents that guide Los Angeles County transportation investment decisions – Metro's adopted 2009 Long Range Transportation Plan (LRTP) and SCAG's adopted 2012 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS).

4.9.1.2 Current and Reasonably Foreseeable Related Actions

There are two ways to address the question of what is reasonably foreseeable within the Project Area. The first is to evaluate the project effects in combination with a summary of projections contained in an adopted local, regional, or statewide plan, or related planning document, that describes or evaluates conditions contributing to the cumulative effect. The second method is to generally review a list of past, present, and probable future projects within the Project Area that are expected to be under construction or in operation during the same time frames as the Project. The most appropriate method may vary by discipline.

Figure 4.9-1: Projects Anticipated to be Completed Prior to 2014



Source: SCAG, 2012 Regional Transportation Plan

Forecasts for elements such as population, employment, land use, air quality, and transportation from regional plans were used in the analysis. Regional plans prepared by SCAG and general plans prepared by the City and County of Los Angeles and other nearby cities provided information on trends and forecasts relevant to the impact analysis for specific disciplines.

The following tables identify projects within the general Project Area that are either anticipated to be completed prior to start of construction in 2014, or which may be under construction during this project's proposed construction period of 2014 to 2020. The projects identified in this section include additional projects not previously analyzed as part of the Draft and Final EIS. There are several subcategories identified, including major renovations, new construction, transportation, and utility projects. The locations of the new additional construction projects are also identified in Figure 4.9-3.

The project lists were developed from information available from the Los Angeles Downtown Center Business Improvement District's (DCBID) fourth quarter 2014 project database and the City of Los Angeles' utility district Capital Improvements Program (CIP). The Community Redevelopment Agency (CRA) of the City of Los Angeles was dissolved per Assembly Bill 1x-26 which took effect in February

2012. Therefore, updated lists of potential projects in the Downtown Los Angeles and Little Tokyo CRA study areas are no longer available. However, it would appear that the projects listed in the DCBID database better meet the definition of "reasonably foreseeable". Many of these potential projects are only in the conceptual planning stages and the timing of construction or operations are unknown. Projects that do not have reported completion dates have been compiled in the tables of projects assumed to be under construction or completed between 2014 and 2020 as a worst-case scenario.

4.9.1.3 Projects Anticipated to be Completed Prior to 2014

Many of the projects identified in Tables 4.9-1, 4.9-2, and 4.9-3 are currently under construction and have identified completion dates prior to 2014. These lists may also include some projects which have recently been completed. The locations of related projects anticipated to be completed prior to 2014 are illustrated in Figure 4.9-1. The following projects listed below include capital improvements which were not previously included or have been modified since the release of the Final EIS.

Transportation

The following transportation capital improvements within the Project Area are currently identified as funded under Metro's 2009 LRTP and SCAG's 2012 RTP/SCS. The transit projects listed in this section have been or are anticipated to be completed prior to 2014, and are shown in Figure 4.9-2. The project listed below was included in the Final EIS, but its construction and operational schedule has been modified since the release of the document.

- Metro Exposition Transit Corridor, Phase 1 to Culver City. The first phase of this project, a nine mile light rail transit (LRT) line extending from the 7th Street/Metro Center Station to downtown Culver City, opened in 2012. In addition, Phase 2 extending service to Santa Monica started construction in 2012.

Major Renovations

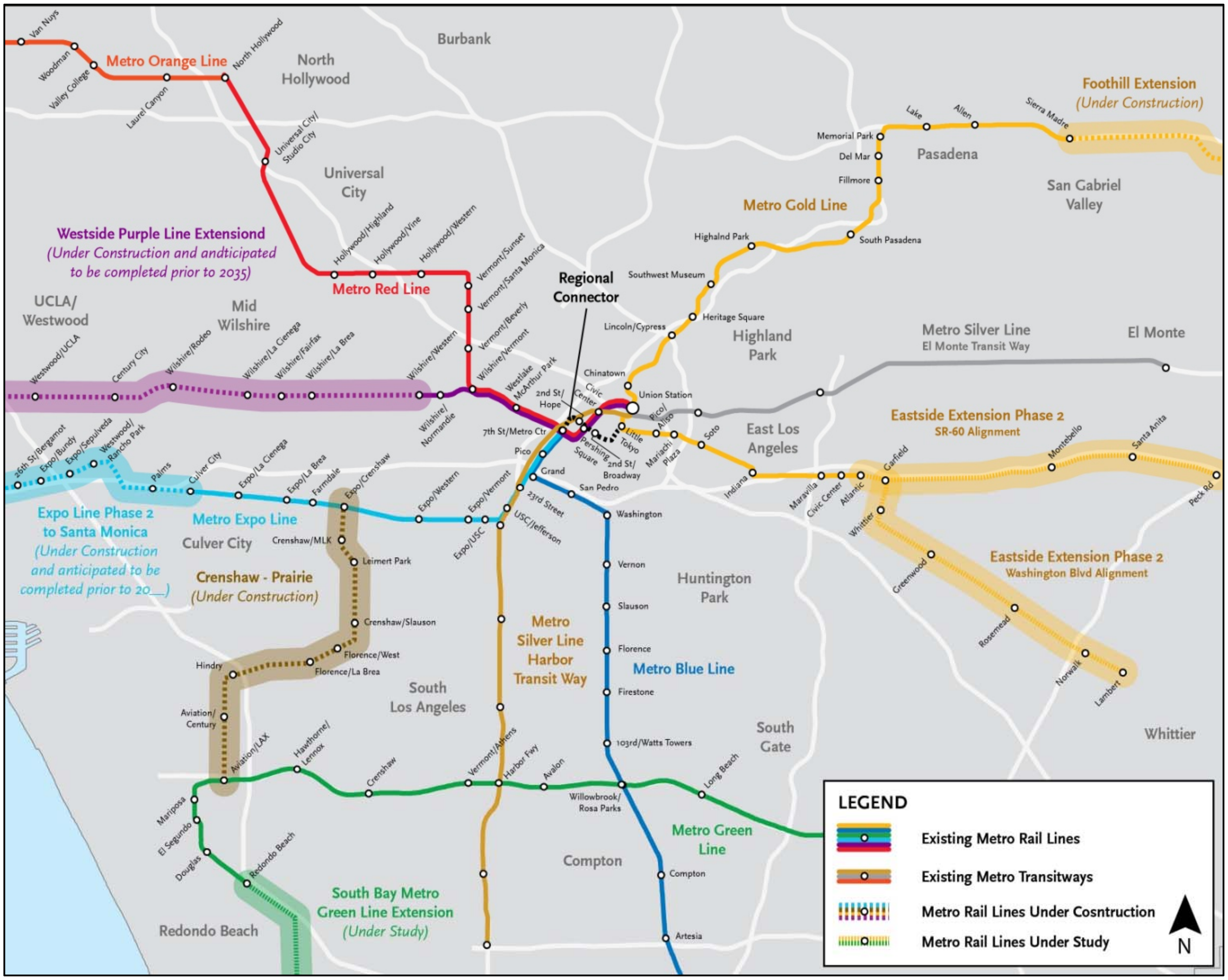
As listed in Table 4.9-1, there is one project located within the Project Area that proposes to convert offices to residential housing and/or which involve a major renovation of an existing structure.

Table 4.9-1: Major Renovation Project Anticipated to be Completed Prior to 2014

Number	Project Name	Address	Land Use	Units	Completion
R-1	Singer Sewing Building	806 S. Broadway	Mixed Use	9	Late 2014

Note: All projects are located within the City of Los Angeles
Source: DCBID project list, 4th quarter 2014

Figure 4.9-2: Year 2035 Rail Transit Projects



Source: Metro, 2014

New Construction

Table 4.9-2 lists new potential construction projects in the Project Area. New construction encompasses building new structures on vacant lots, as well as any demolition of older structures needed to clear the lots for construction. None of these projects are located along Flower Street or in Little Tokyo.

Table 4.9-2: New Construction Estimated to be Completed Prior to 2014

Number	Project Name	Address	Land Use	Units	Completion
C-1	One Santa Fe	1 N. Santa Fe Ave	Mixed Use	4	Completed
C-2	Da Vinci	909 W. Temple St	Mixed Use	630	Late 2014
C-3	8th & Hope	801 S. Hope St	Mixed Use	290	Late 2014
C-4	Olympic & Hill	915 W. Hill St	Mixed Use	281	Late 2014
C-5	The Emerson	225 S. Grand Ave	Mixed Use	271	Completed
C-6	Pershing Apartments	502 S. Main Street	Mixed Use	69	Late 2014
C-7	Ava Phase 2	210 E. 2nd St	Mixed Use	280	Late 2014

Note: All projects are located within the City of Los Angeles
Source: DCBID project list, 4th quarter 2014

Utility Projects

The City of Los Angeles maintains an extensive project list of public works projects. No additional major utility projects have been identified for completion by 2014, and there do not appear to be any planned within the Project Area. Most of the planned projects within the City are related to ongoing maintenance or replacement in-kind of existing infrastructure.

Institutional and Public Facility

Institutional and public facility projects located within the project area are listed in Table 4.9-3. This project is not located in the study areas covered by this SEIS.

Table 4.9-3: Institutional and Public Facility Projects to be Completed Prior to 2014

Number	Project Name	Address	Land Use	Completion
P-1	1st & Broadway Civic Center Park	1st & Broadway	Public	Fall 2014

Note: All projects are located within the City of Los Angeles
Source: DCBID project list, 4th quarter 2014

4.9.1.4 Projects Potentially Under Construction 2014 to 2020

Tables 4.9-4, 4.9-5, and 4.9-6 list projects which are currently in some stage of conceptual planning, but which do not have a defined schedule. Given the uncertainties of project development, the probability that these projects will occur is unknown. It may be reasonable to assume that this compilation of projects represents a worst-case condition for the construction period. The locations of these related projects are shown in Figure 4.9-3. The listed and illustrated projects include capital improvements which were not previously included, or have been modified since the release of the Final EIS.

Transportation

The following transportation capital improvements, while not located within the Project Area, will have significant impacts to the Regional Connector Transit Corridor Project. They are all currently identified as funded under Metro's 2009 LRTP and SCAG's 2012 RTP/SCS. The projects listed below were either not previously included in the Final EIS, or their construction schedule has been modified since the release of the document. In addition, as mentioned above, Metro's future LRT system operational plans call for Gold Line service to provide one-seat travel from East Los Angeles to Santa Monica, and the Blue Line from Azusa to Long Beach.

- Exposition Transit Corridor, Phase 2 to Santa Monica. The second phase of this project, extending service from the Culver City station to downtown Santa Monica, initiated construction in 2012 and is scheduled for completion by 2015.
- Crenshaw/LAX Transit Project. This line, extending LRT service from the Exposition Line at Crenshaw and Exposition Boulevards to the existing Green Line Aviation/LAX station, started construction in 2014 and has a planned completion date of 2018.
- Gold Line Foothill Extension, Phase 2A Pasadena to Azusa. This project will extend existing Gold Line service east from its current Pasadena terminus to Montclair in two phases. The first phase (Phase 2A), extending service to Azusa, began construction in 2011 and is projected to open for service in 2016. Engineering design and environmental clearance for the second phase (Phase 2B) is underway and a construction schedule will be established.
- Purple Line Westside, Section 1 to Wilshire/La Cienega. Extension of the Purple Line to the Westside from the existing Wilshire/Western Station is scheduled to be built in three phases. Section 1 to Wilshire/La Cienega started construction in 2014 with revenue service operations anticipated for 2023. Pre-construction activities for Section 2, continuing the Line further west to Century City, are planned to start in 2017 and be completed in 2026.

Institutional and Public Facility

The single institutional and public facility project located in the Project Area is listed in Table 4.9-3.

Table 4.9-4: Institutional and Public Facility Projects Potentially Under Construction 2014-2020

Number	Project Name	Address	Land Use	Completion
P-1	110 Freeway Overcrossing Art Phase II	Los Angeles & Main St. between Arcadia and Aliso St.	Public	N/A

Note: Project located within the City of Los Angeles
Source: DCBID project list, 4th quarter 2014

Major Renovations

The project located within the Project Area, The Bloc (former Macy's Plaza), involves a major renovation of an existing retail, hotel, and office structure, including an underground pedestrian linkage to the 7th Street Metro Station.

Table 4.9-5: Major Renovation Projects Anticipated Potentially Under Construction 2014-2020

Number	Project Name	Address	Land Use	Completion
R-1	The Bloc	7th & Flower	Retail, Hotel, Office, Underground Pedestrian Linkage	Late 2015

Note: All projects are located within the City of Los Angeles
Source: DCBID project list, 4th quarter 2014

New Construction

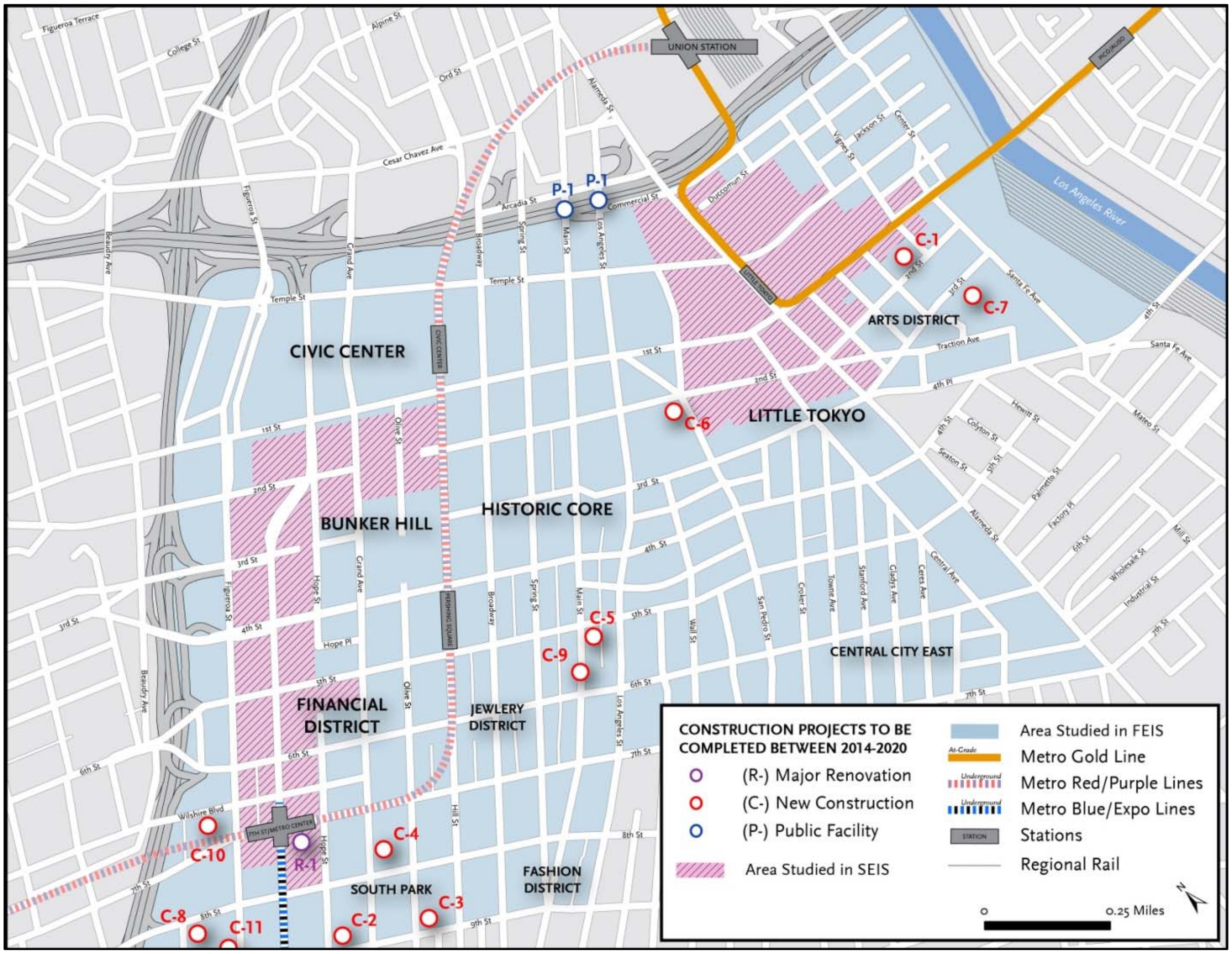
Figure 4.9-3 provides a map of the location of new potential construction projects in the project area. New construction encompasses building new structures on vacant lots, as well as any demolition of older structures needed to clear the lots for construction. Table 4.9-6 includes a list of additional new projects which are identified to be in construction from 2014-2020. The list only includes those projects with identified construction schedules or in the entitlement process which were not previously included in the Final EIS, or where modifications to the project have been made. The list does not include projects in early conceptual planning phases where construction schedules are not identified.

Table 4.9-6: New Construction Projects Potentially Under Construction 2014-2020

Number	Project Name	Address	Land Use	Units	Completion
C-1	Megatoys/Garey Building	905 E. 2nd St	Mixed Use	320	Fall 2015
C-2	Valencia/888 Hope	888 Hope St	Mixed Use	218	2016
C-3	Onni Tower	888 Olive St	Mixed Use	283	Q1 2015
C-4	8th & Grand	770 S. Grand Ave	Mixed Use	700	Fall 2015
C-5	Metropolis Phase I	502 S. Main Street	Mixed Use	69	Fall 2016
C-6	Sares-Regis Little Tokyo/Block 8-D	2nd & San Pedro St	Mixed Use	240	Fall 2015
C-7	950 E Third St	950 E Third St	Residential	472	N/A
C-8	Metropolis Phase 2	8th & Francisco	Mixed Use	1020	N/A
C-9	Topaz	550 S. Main	Mixed Use	159	N/A
C-10	Wilshire Grand Hotel	930 Wilshire Blvd	Hotel, Retail, Office	900	2017
C-11	Metropolis Hotel	9th and Francisco	Hotel, Retail, Office	350	2016

Note: All projects are located within the City of Los Angeles
Source: DCBID project list, 4th quarter 2014

Figure 4.9-3: Projects Potentially Under Construction 2014 to 2020



Source: SCAG, 2012 Regional Transportation Plan

Utility Projects

The City of Los Angeles maintains an extensive list of public works projects. No major utility projects have been identified within the Project Area during the construction period of 2014 to 2020. However, there do not appear to be many projects planned after 2014 within the City and there do not appear to be any planned within the project area. Most of the planned projects within the City are related to ongoing maintenance or replacement of in-kind of existing infrastructure.

4.9.1.5 Projects Potentially Under Construction Post-2020

Transportation

The following transportation capital improvements within the Project Area and/or interfacing with the Project are funded under Metro's 2009 LRTP and SCAG's 2012 RTP/SCS project list. The projects listed below were: not previously included in the Final EIS, the construction schedule has been modified since the release of the document, or have increased importance to the Regional Connector Transit Corridor project due to Metro's future LRT system operational plans.

Metro

- Gold Line Eastside Transit Corridor Phase 2 – Extension of Gold Line Eastside service from its current terminus in East Los Angeles to communities farther east is being studied through preparation of a Draft EIS report planned for completion in 2014. The study evaluates two LRT alternatives along two service alignments, along SR-60 to Peck Road in South El Monte, and Washington Boulevard to Lambert Road in Whittier. The selected alternative is anticipated to be operational by 2035. The SCAG 2012 RTP/SCS includes implementation of one branch alternative in the Financially-Constrained RTP project list, and construction of the second alternative in the Strategic Plan, which represents projects for which the region would pursue additional funding.
- Gold Line Foothill Extension, Phase 2B to Montclair. Construction of the second phase from Azusa to Montclair is anticipated to be completed and in operation post-2020.
- Purple Line Westside, Section 1, service to Wilshire/La Cienega is planned to start operation in 2023. Section 2 to Century City is planned for revenue service in 2026. Building Section 3, west to a future Westwood/VA Hospital Station, will commence with pre-construction activities in 2025 and revenue service operation slated for 2035.

4.9.2 Environmental Consequences

Impact conclusions for all of the alternatives are based on the thresholds identified in Appendix B (Regulatory Framework) of this SEIS. Appendix GG, Cumulative Impacts Technical Memorandum of the Final EIS, summarizes the potential cumulative impacts that could result from the Regional Connector Transit Corridor project in combination with the identified past, present and reasonably foreseeable projects. The cumulative impacts analysis includes positive impacts as well as adverse effects, particularly with respect to the enhancements in regional mobility.

Additional analysis conducted for this SEIS includes analysis of the following resource areas:

- Transit, Traffic, Circulation, Parking, Pedestrian, and Other Modes
- Visual Quality
- Air Quality Impacts
- Climate Change
- Noise and Vibration
- Geotechnical
- Energy
- Historic Resources
- Environmental Justice

Cumulative impacts were analyzed in more detail for each of the resource areas within the Study Area for the SEIS. Alternatives A and B would have increased truck activity, reduction in lane capacities, transit rerouting, increased construction duration and intensity compared to the Project. Cumulatively, these adverse effects would be unavoidable under traffic, transit, and environmental justice communities.

Although construction activities are temporary, under cumulative conditions, Alternatives A and B would affect vehicle travel times and traffic operations. The impacts would also cumulatively effect construction of development projects from 2014 to 2020 though none are located on Flower Street. Mitigation measures were identified; however the impacts would be unavoidable.

During operation with Alternatives A and B, the Project would have reduced operating speeds and increased travel times. Cumulative impacts from Alternatives A and B would result in decreased benefits of improved access and connectivity when compared to the Project.

Cumulative impacts and mitigation for the Project are provided in the Final EIS. Technical Memoranda prepared for the Final EIS provides additional analysis detail on Project cumulative effects. Cumulative impacts and related mitigation measures for each of the resource areas identified above that would occur with implementation of the alternatives are described in Chapter 2, Alternatives Considered of this SEIS. The following provides a summary of the cumulative adverse effects/impacts for the Project with Alternatives A and B.

4.9.2.1 Alternative A - EPBM/Open Face Shield/SEM Project Profile

As presented in Chapter 2, Alternatives Considered, Alternative A would be constructed with a combination of EPBM and SEM construction methods, and with a similar vertical alignment profile to that of the Project.

With implementation of mitigation, construction of Alternative A would contribute to cumulative effects associated with bus transit, traffic circulation, and environmental justice communities based on the increase truck activity, reduction in lane capacities, transit rerouting, and increased construction duration and intensity compared to the Project. All other cumulative effects would not be adverse, or not adverse after mitigation.

4.9.2.2 Alternative B – EPBM/SEM Low Alignment

Alternative B would be built with a combination of EPBM and SEM construction methods with a lower vertical alignment profile than the Project. Chapter 2 provides detailed information on Alternatives Considered for this SEIS.

With implementation of mitigation, construction of Alternative B would contribute to cumulative effects associated with bus transit, traffic circulation, and environmental justice communities based on the increase truck activity, reduction in lane capacities, transit rerouting, and increased construction duration and intensity compared to the Project. All other cumulative effects would not be adverse, or not adverse after mitigation.

4.9.3 Mitigation Measures

Mitigation measures listed for the Project contained within the specific Final EIS section for each environmental resource have been carried forward and included in the MMRP for the Project. They are the final committed mitigation measures for the Project and apply to results of this SEIS.

5.0 COMPARISON OF THE TUNNELING METHOD ALTERNATIVES VERSUS THE PROJECT

This chapter presents a summary of the consequences associated with the construction and operation of the two tunneling method alternatives, Alternatives A and B. Information provided includes an overview of the construction descriptions of the two alternatives, and their resulting construction risk considerations, operational impacts, cost and schedule impacts, and environmental effects as valuated and documented in the SEIS.

5.1 Introduction

A summary discussion of the resulting information from the *Draft Flower Street Tunneling Method Alternatives Report (2014)* and the SEIS is provided to allow for informed decision-making. The viability of a transportation system investment typically is based on the following planning, operational, and environmental factors, which are discussed in the following sections:

- **Purpose and Need** – Meeting the project purpose and need as identified in the project study efforts leading up to the Final EIS and summarized in Chapter 1, Background, Purpose and Scope of the SEIS.
- **Construction and Risk Considerations** – Identifying appropriate construction methods and associated risks, and resulting project schedule impacts.
- **Operational Considerations** – Meeting Metro's operational goals for light rail transit service from a customer and rail system operational perspective.
- **Cost and Funding Considerations** – Developing cost estimates to reflect the construction methods and risks of the two alternatives.
- **Environmental Considerations** – Identifying and assessing environmental and community impacts and benefits.

5.2 Description of the Project And Tunneling Method Alternatives

Within the urban and densely built setting along the Flower Street portion of the Regional Connector project alignment, the Project proposes a combination of cut and cover from the 7th Street/Metro Center Station tail tracks structure to 4th Street, and EPBM tunneling north from 4th to 3rd Street. Two tunneling method alternatives (Alternatives A and B) were identified and evaluated in the SEIS that propose different combinations of underground construction as options to the cut and cover method planned for the Project. These alternatives were developed using a variety of tunneling techniques to assess opportunities to reduce the use of cut and cover.

The SEIS is a limited-scope document that provides additional detail on tunneling methods not selected for construction along Flower Street, specifically Open-Face Shield and SEM tunneling for the Flower Street portion of the Regional Connector project alignment between 4th Street and the 7th Street/Metro Center Station. The two tunneling method alternatives identified and evaluated in the

SEIS propose different combinations of underground construction as options to the cut and cover method planned for the Project:

- Alternative A – a combination of Earth Pressure Balance Tunnel Boring Machine (EPBM), Open-Face Shield, and SEM construction methods; and with similar horizontal and vertical alignment profiles to that of the Project.
- Alternative B – a combination of EPBM and SEM construction methods with a similar horizontal alignment profile, but a lower vertical alignment profile, than that of the Project.

Table 5.2-1 summarizes and compares the descriptions for the Project and Alternatives A and B.

5.3 Effectiveness in Meeting Purpose and Need

As discussed in Chapter 1, Purpose and Need in the Final EIS, the purpose of the Regional Connector project is to improve the region's public transit service and mobility by improving travel times and connecting the light rail transit (LRT) service of the Metro Gold Line and the Metro Blue Line. As identified in the Final EIS, this rail link would serve communities across the region, allowing greater accessibility while serving population and employment growth in downtown Los Angeles. With operation of the Regional Connector, Gold Line service will provide a one-seat ride for travel from East Los Angeles to Santa Monica, and the Blue Line from Azusa to Long Beach.

The Project and tunneling method alternatives would improve the region's public transit service and mobility, and improve service to the growing population and employment in downtown Los Angeles; however, the transit service provided by the Project versus the tunneling method alternatives is superior. Construction and implementation of the Project would result in 55 miles per hour (mph) operations in the Flower Street segment meeting the requirements of Metro Rail Design Criteria (MRDC), Section 10 Operations as discussed below in Section 5.6, Operational Considerations. Alternatives A and B would result in a speed reduction in this key LRT system to 35 mph as discussed in Chapter 2, Alternatives Considered. Due to the slower speeds provided by the tunneling method alternatives, passengers would have a longer travel time of approximately 1.2 minutes per one-way trip over the travel time provided by the Project, and may not be as attractive in encouraging auto travelers to transfer to the Regional Connector project.

5.4 Construction and Risk Considerations

There are a significant number of surface and underground constraints combined with the requirements of the MRDC and desired future operations of the Project that have framed the design and construction of the Flower Street section. Flower Street surface constraints to future subway construction include possible impacts to vehicular, bus, and shuttle traffic, impacts to pedestrian and bicycle circulation, and restricted access to off-street parking and adjacent properties.

As discussed in Section 2.2.1 of the SEIS, underground constraints that the design and construction of a tunnel along the Flower Street segment must address include:

Table 5.2-1: Comparison of Project and Tunneling Method Alternatives

	The Project	Alternative A EPBM/Open-Face Shield/SEM Project Profile	Alternative B EPBM/SEM Low Alignment
Construction Description[1]	• EPBM to south of 4th Street • C&C from 4th Street to 7th Street/Metro Center Station tail tracks	• EPBM to 4th Street • Open-face shield TBM to 5th Street • SEM from 5th to 7th Street/Metro Center Station tail tracks	• EPBM to south of 5th Street • SEM from 5th Street to 7th Street/Metro Center Station tail tracks
Horizontal Alignment	Baseline	Slight shift to west of Project alignment	Slight shift to west of Project alignment
Depth To Top of Rail	40'	40'	40' to 105' (at sag)
Mucking Locations	• Flower Street • Mangrove site in Little Tokyo	• Flower Street (for emergency exit and train control room only) • Mangrove site in Little Tokyo	• Flower Street (emergency exit and train control room only) • Mangrove site in Little Tokyo
Handling of Flower Street Segment Excavation Materials (by location)	Flower Street Site: 81% Mangrove Site: 19%	Flower Street Site: 25% Mangrove Site: 75%	Flower Street Site: 20% Mangrove Site: 80%
Corresponding Excavation Materials/ Construction Trucks Per Day	On Flower Street segment: 32 In Little Tokyo: 8	On Flower Street segment: 18 In Little Tokyo: 22	On Flower Street segment: 8 In Little Tokyo: 32
Construction Shaft	TBM retrieval shaft at 4th Street (part of cut and cover construction)	TBM retrieval shaft south of 4th Street	EPBM removed thru Mangrove portal
Permanent Shafts	• Emergency exit south of 4th Street • Emergency exit south of 5th Street • Train control room vent shaft 7th Street/ Metro Center Station tail tracks structure	• Emergency exit south of 4th Street • Emergency exit south of 5th Street • Train control room shaft 7th Street/ Metro Center Station tail tracks	• Emergency exit south of 5th Street • Train control room shaft 7th Street/ Metro Center Station tail tracks
2nd/Hope Station Depth	96'	96'	128'
Maximum Design Speed	55 mph	35 mph	35 mph
Double Track Crossover Before 7th Street/Metro Center Station	Yes	Yes	Yes
Future 5th/Flower Station	Center platform with mezzanine	Side platform with no mezzanine	Side platform with mezzanine Requires tunnel reconstruction
Project Delivery Duration (months) • Construction • Pre-Construction Activities[2] • Total Duration (difference)	78 -- 78	93 (+ 15 months) 29 122 (44 months or 3.7 years longer)	85 (+ 7 months) 29 114 (36 months or 3 years longer)
Project Cost (Millions, YOE)[3]	$171	$295-332[4] (+$124 to $161 more than the project)	$238-266[4] (+$67 to $95 more than the project)

Notes: [1] **Construction Techniques** include C&C - Cut and cover; EPBM- earth pressure balance tunnel boring machine; SEM- sequential excavation method. [2] **Pre-Construction Activities** include engineering design revisions and re-procurement of the design-build construction contract. [3] **Project Cost YOE** is the year of expenditure using 2017 as the mid-point of construction. [4] **Project Costs** Range for two alternatives provides a low and high cost estimate based on risk. The range does not include increased costs resulting from procurement delay, construction delay, or escalation due to delays.

- **Physical operational challenges**, including connecting to the existing narrow and shallow rectangular 7th Street/Metro Center Station tail tracks structure, providing a new double track crossover before the tail tracks connection, and accommodating a future 5th/Flower Station.
- **Significant underground constraints**, including: a large number of abandoned steel tie-backs ranging from 30 to 90 feet in length and extending across the street right-of-way from both sides; existing utilities and sewer lines ranging in size up to an 84-inch diameter reinforced concrete pipe approximately 18 feet below the ground surface; and 4th Street Bridge foundations and piles that extend 64 feet below the surface on the west side of Flower Street and 83 feet on the east side.
- **Challenging geologic ground conditions,** which require thorough consideration in the evaluation of tunneling feasibility within acceptable risks. Flower Street geologic conditions include the presence of groundwater, unstable soils, a challenging geologic interface between different soil or rock strata (mixed face), and hazardous gases. Before development of downtown Los Angeles, Flower Street served as a natural drainage path which became a stream during rainfall with seasonal variations of groundwater below ground. Groundwater is anticipated to follow the historic underground water course and pose problems for the stability of open-face tunnel excavation. Borings made for building sites along Flower Street between 5th and 7th Streets have encountered water seepage at relatively shallow depths ranging from 15 to 35 feet, which is close to or within the proposed tunnel envelope. Groundwater within the lower portion of the alluvial deposits, most likely perched above the Fernando Formation, has been reported at depths of 18 to 27 feet on sites adjacent to the Flower Street right-of-way between 2nd and 5th Streets. All of these factors result in conditions that are difficult to tunnel through without risking ground instability, ground loss, and settlement if not addressed by the tunneling construction method and/or ground stabilization techniques. Both alternatives would require the use of jet grouting to stabilize soil conditions in the Flower Street segment to allow for tunneling construction.

The construction methods identified for the Project represent the tunneling methods that best address the significant underground constraints and lessen the construction risk along Flower Street, and have proven to be successful on other Metro projects, such as for the Gold Line Eastside Extension tunneling effort.

5.5 Summary of Impacts of Alternatives versus the Project

The SEIS analysis identified that Alternatives A and B would have the following major impacts when compared to the project:

1. Delay of Regional Connector Project completion;
2. Increased construction impacts to the Little Tokyo community and increased duration of those impacts;
3. Increased risks of excessive settlement, sinkholes and utility service disruption along Flower Street; and
4. Increased construction risks along the Flower Street segment.

Project Completion Delay

It is estimated that both tunneling method alternatives would delay the project completion schedule by a minimum of 3.0 years beyond the Project's schedule. Under the Project, the cut and cover construction along Flower Street would require only minimal ground improvement and could be carried out concurrently with construction of the remainder of the project. The Open-Face Shield and SEM tunneling methods proposed by Alternatives A and B would require a substantial jet grouting program prior to open face TBM and SEM construction due to Flower Street geologic conditions. The grouting activities would delay construction of the project's other underground stations until the tunneling is completed as excavated materials from the Flower Street segment would be transported to the Mangrove site in Little Tokyo using conveyors through the tunnels.

Increased Construction Impacts to Little Tokyo

Under the Project conditions, a majority of excavated materials from the Flower Street segment would be handled through construction sites on Flower Street and only muck from EPBM-bored tunnels would be handled through the Mangrove site. For Alternatives A and B, all of the muck generated from open-face shield and SEM tunneling would be transported to the Mangrove site through the tunnel, and only a minor quantity of excavated materials from shafts along Flower Street would be handled from construction sites on Flower Street. This would result in a significant increase in the quantity of spoils handled through the Mangrove site.

Alternative A would increase excavation-related truck activity in Little Tokyo and would extend the duration of those impacts by 15 months. Alternative B would increase the excavation-related truck activity in Little Tokyo and would extend the duration of those impacts by 7 months. The increased quantity and duration of the muck handling activities would increase construction impacts to Little Tokyo, which is an environmental justice community.

Increased Risks along Flower Street

As discussed in Chapter 2, Alternatives Considered, there are significant underground constraints which pose challenges to the design and construction of the future rail tunnel on the Flower Street segment of the Regional Connector Project. These constraints include: 1) connecting with the existing narrow, shallow rectangular tail tracks structure of the 7th Street/Metro Center Station; 2) numerous abandoned underground tie-backs (used to support the excavation of building foundations) extending into the path of the future rail tunnel from adjacent building foundations along both sides of Flower Street south of 3rd Street; 3) unstable soil conditions; 4) many utilities; and 5) the 4th Street Bridge foundations which restrict the location of a future rail tunnel to a narrow vertical and horizontal corridor between the foundation piers.

The tunneling method alternatives would increase construction risks related to excessive ground surface settlement, sinkholes, and utility service interruption along Flower Street. These risks are mainly associated with the open-face shield and SEM tunneling in an area with significant underground infrastructure constraints and poor ground conditions.

5.6 Operational Considerations

With operation of the Regional Connector project, Gold Line service will provide a one-seat ride for travel from East Los Angeles to Santa Monica, and the Blue Line from Azusa to Long Beach. The Regional Connector will serve as the trunk section for these two Metro LRT corridors. As identified by MRDC operating criteria, the required operational speed for the Flower Street segment is 55 mph. The Project provides a 55 mph operating speed in the Flower Street segment, meeting Metro's operating criteria, while Alternatives A and B would result in a speed reduction in this key LRT system segment to 35 mph, as shown in Table 5.2-1. Reduction of the maximum operating speed in this key system link would decrease rail service headways, operational efficiency, and operating capacity for the entire Metro LRT system. These impacts would be permanently adverse.

Due to the slower speeds provided by Alternatives A and B, passengers would have a longer travel time of approximately 1.2 minutes per one-way trip over the travel time provided by the Project. While this may appear minor based on individual perception, the cumulative impact for the forecast 90,000 daily boardings would be significant – approximately 1,800 hours of daily delay. Slowing rail operations makes rail transit a less attractive option for potential riders and may impact LRT line and system ridership, and reduce air quality and climate change benefits compared to the Project.

This slower speed in the heart of the region's LRT system would result in permanent operational constraints, including slower operations providing less capacity and the need for Metro to operate more trains to provide the same capacity as the Project. For Alternatives A and B, the additional trip time is estimated to require an increase in the fleet size of six vehicles with a corresponding increase in capital and operating costs.

It should be noted that the Project and Alternatives A and B have designed to allow for a future 5th/Flower Station. Construction of this station would result in slower operating speeds in the Flower Street segment for the Project and Alternatives A and B as the closer station spacing would not allow the LRT vehicles to reach the desired 55 mph operational speed. While there currently is no funding for this station, construction funding priorities may change in the future and implementation of this station would be evaluated as a separate project.

For Alternative B, the resulting 5.9 and 4.6 percent gradients due to its "sag" to avoid underground obstructions would result in increased maintenance requirements from the resulting increase in friction between the rail tracks and train wheels. The Flower Street segment of the alignment would require more frequent track maintenance efforts to ensure operations remain below the desired noise threshold.

A key element in designing the Flower Street segment of the project is to allow for future provision of a 5th/Flower Street Station. While Alternatives A and B are designed to accommodate construction of a future station, the resulting stations would be substandard and not as convenient for passengers. Under the Project, a central platform is provided allowing for ease of cross-platform transfers for passengers. For Alternatives A and B there is insufficient room between the twin tunnels to allow for a future center platform, and side platforms would be provided. Under Alternative B, passengers desiring to travel in the reverse direction would need to circulate up to the mezzanine level, and then take an escalator or elevator down to the platform to complete their transfer. Alternative A would not have a mezzanine and passengers desiring to transfer would need to circulate up to the ground level and then back down again to complete their transfer. Alternatives A and B would result in a significant decrease in passenger convenience, especially for visitors and infrequent users who may not know the Metro LRT system well.

Table 5.6-1: Operational Summary of the Project and the Tunneling Method Alternatives – Flower Street Segment

	The Project	Alternative A	Alternative B
Maximum Speed (miles per hour)	55 mph	35 mph	35 mph
Travel Time[1]	2.1	3.3	3.3
Double Track Crossover	Yes	Yes	Yes
Future 5th/Flower Station	Center platform with mezzanine	Side platform with no mezzanine	Side platform with mezzanine

Note: [1] minutes to travel between 7th Street/Metro Center and 2nd/Hope stations

5.7 Schedule Impacts

A detailed discussion of the Project schedule impacts resulting from the tunneling method alternatives was developed in the *Draft Flower Street Tunneling Method Alternatives Report (2014)*. Table 5.7-1 presents a summary of the resulting implementation schedules for Alternatives A and B.

Table 5.7-1: Comparison of Schedules for the Project and Tunneling Method Alternatives

	Construction Duration	Change in Construction Duration (Over Project)	Required Pre-construction Activities	Total Project Delivery Duration	Revenue Service Date	Total Project Delivery Delay	
Alternative	Months	Months	Months	Months	Date	Months	Years
The Project	78	--	--	78	Mid-2020	--	--
Alternative A	93	15	29	122	Early-2024	44	3.7
Alternative B	85	7	29	114	Mid-2023	36	3.0

Source: *Draft Flower Street Tunneling Method Alternatives Report (2014)*

Table 5.7-2, on the following page, provides an overview of the construction and risk factors that would contribute to the lengthening of the total project delivery schedules for Alternatives A and B and correspondingly the Revenue Service Date (RSD), when compared to the Project.

Table 5.7-2: Overview of Construction and Risk Factors Impacting the Construction Schedules for the Project and Tunneling Method Alternatives

	Project	Alternative A	Alternative B
Construction Factors	• Cut and cover section along Flower Street can occur concurrently with excavation of bored tunnels and other construction activities, including station construction.	• Requires extensive jet grouting along Flower Street between 4th and 6th Streets. • Higher level of muck truck activity in Little Tokyo than the Project • Extends duration of muck truck impacts in Little Tokyo. • Delays station construction. Removal of excavation materials through the tunnel to the Mangrove portal would delay start of station construction work until after tunneling is complete. • With extension of tunneling further south on Flower Street, longer tunnel runs would be required for excavated materials than the Project, and would extend construction duration.	• Requires extensive jet grouting along Flower Street between 5th and 6th Streets. • Higher level of muck truck activity in Little Tokyo than the Project and Alternative A. • Extends duration of muck truck impacts in Little Tokyo. • Delays the start of station construction work and 2nd/ Broadway SEM cavern/cross passages until tunneling is complete. • Removal of excavation materials through the Mangrove portal via the westbound tunnel would continue until SEM work is complete. • SEM can occur concurrently with one of the EPBM tunnels.

Alternative A Schedule Impacts

Implementation of Alternative A would require 44 months over the Project's project delivery schedule. The increased duration is due to: 1) an additional 29 months for pre-construction activities; and 2) a longer construction duration by 15 months. Pre-construction activities for this alternative would include the preparation of detailed engineering design plans; re-procurement activities for the existing design-build contract; and re-permitting efforts. As the Project is currently under construction, implementation of either tunneling method alternative would require stopping current construction activities, and initiation of re-procurement and follow-on-mobilization efforts for the new project configuration using different construction techniques and equipment than the Project. Given the design-build contract currently in place, Metro evaluated what would be required contractually to accommodate the construction changes identified by the two alternatives. Based on the magnitude in the difference of the Flower Street segment construction contract value, ranging between approximately $276 and $403 million for the two alternatives over the awarded Project cost for the same segment (as presented below in Table 5.8-1, re-procurement of the project design-build contract was recommended.

Alternative A would have a longer construction duration as the identified tunneling excavation and construction activities would need to be performed sequentially, rather than concurrently as under the Project. Additional construction time would be required for the jet grouting activities that must be performed prior to and during tunneling efforts to provide needed ground stabilization. The estimated construction duration reflects 12 months of grouting activities with the caveat that grouting work may increase up to 24 months due to unforeseen underground conditions.

In summary, the total project schedule impact for Alternative A would be 44 months or 3.7 years longer than the Project from initiation of construction to start of revenue service. As discussed in Section 2.3.1.1, the duration of construction activities for this alternative along the Flower Street segment would be reduced, while the duration of construction-related activities in Little Tokyo would increase.

Alternative B Schedule Impacts

Implementation of Alternative B would require 36 months over the Project's project delivery schedule. Similar to Alternative A, the increased duration is due to required pre-construction activities and an increased construction duration by seven months over the Project's schedule. Pre-construction activities would include preparation of detailed engineering design plans; re-procurement activities for the existing design-build contract; and re-permitting efforts. During construction of the Project, cut and cover excavation and construction work would occur concurrently with the excavation of the bored tunnels and other construction activities throughout the alignment. For Alternative B, the primarily tunneling work would be performed sequentially as the tunnel boring machine bores one tunnel towards the 7th Street/Metro Center station box, and then is turned back towards Little Tokyo to bore the second parallel tunnel, which would increase the construction schedule. Due to the need to remove all Flower Street segment tunnel spoils through the Mangrove portal, the tunneling operation would continue until the SEM work is complete. This would hold the start of station construction work for the cavern and all cross passages until after the Flower Street segment tunneling is complete. Start of station construction work would be delayed for the 2nd/Hope and 2nd/Broadway stations, and of the 2nd/Broadway SEM cavern and all cross passages until after the Flower Street segment tunneling is complete. Additional construction time would be required for the jet grouting activities that must be performed prior to and during tunneling efforts to provide needed ground stabilization. The estimated construction duration reflects eight months of grouting work with the caveat that grouting work may increase up to 16 months due to unforeseen underground conditions.

In summary, the total schedule impact would be 36 months or 3.0 years longer than the Project from initiation of construction to start of revenue service. As discussed in section 2.3.1.1, the duration of construction activities along the Flower Street segment would be reduced under this alternative, while the duration of construction-related activities in Little Tokyo would increase.

5.8 Cost and Funding Considerations

Capital cost estimates for the Flower Street portion of the two tunneling method alternatives were identified based on the efforts discussed below and documented in the *Draft Flower Street Tunneling Method Alternatives Report (2014)*. Capital costs are the expenses associated with the design and construction of a proposed transit system, with the project costs falling in one of two areas:

1. Construction Costs – including track and guideway elements, stations, and vehicle control and power system equipment.

2. Non-construction Costs – including engineering, environmental, agency, and construction management services; permits; surveying, geotechnical, and other testing; vehicles; and insurance.

Capital cost estimates were developed for the two tunneling method alternatives using cost information identified for the Project as documented in Metro Contract No. C0980 Design Build contract as it represented the most current cost information available from a design-build project similar in scope and location. Construction of the two alternatives would be substantially similar to the Project, except for the Flower Street segment south from 4th Street to the 7th Street/Metro Center Station. New cost information was developed for the revised tunneling construction techniques proposed by each alternative by estimating the quantities for the individual line items required to build the two alternatives along the Flower Street segment. The costs applicable to the estimated quantities were derived from the bid information in Contract C0980. New construction costs, such as for SEM tunnel construction and grouting activities, were identified and alternative-specific quantities and costs were developed. Non-construction costs, similar to those identified for the Project, were included in the cost estimates for the two alternatives.

The resulting cost estimates were compiled in the Standardized Cost Categories (SCC) analytical format developed by the FTA. The SCC format identifies total project costs through nine project line item categories with the first five (10-50) detailing construction costs; the second set (60 ROW, Land, Existing Conditions; 70 Vehicles; and 80 Professional Services) delineating non-construction costs; and Line Item 90 identifying the Unallocated Contingency provision. Each line item has separate allocated contingency amounts.

The cost estimates for the two tunnel method alternatives included contingency factors similar to those identified for the Project. Contingency is a necessary part of the budget for this type of project in order to account for unknowable costs, based on project construction experience on similar projects. Contingency addresses risks including market volatility, unforeseen conditions, and outside influences to the successful progression and completion of a project within the forecasted budget and schedule. It is expected that a portion of the budgeted contingency will be required to cover costs incurred during construction of the project. Contingency factors (percentages) were identified by Metro based on agency experience on similar tunneling projects. Similar to the Project cost estimate, allocated contingencies were applied to each of the SCC construction cost line items based on the risk profile associated with each SCC classification. An overall project cost provision for unallocated contingency was captured in SCC Line Item 90. The unallocated contingency percentages used for the two tunneling method alternatives were the same as those identified for the Project in the C0980 cost estimate.

The cost estimating effort for the two alternatives took into consideration schedule delays and higher risks related to the tunneling methods proposed by the two alternatives. As the Project is currently under construction, implementation of either tunneling method alternative would require stopping current construction activities and pursuing a new contract procurement process to incorporate the new tunneling construction techniques.

Construction of either tunneling method alternative would require new pre-construction services, including preparation of detailed engineering design plans for the selected tunneling method alternative, revised environmental documentation based on the final plans, re-permitting, and re-mobilization of construction staff and equipment. These pre-construction activities were estimated to delay re-initiation of construction activities by approximately 29 months for either tunneling method alternative. The increased construction duration for the two alternatives is due to the identified tunneling excavation and construction method activities having to be performed sequentially, rather than concurrently, as included in the Project's construction plan described in detail in Section 2.1.2 and summarized above in Section 5.7. The increased construction duration would have related delay and escalation costs due to the suspension of construction activities and the typical inflationary increase in construction costs during the extended project period.

In addition, as presented above in Table 5.7-2, the construction methods proposed by the two tunneling alternatives would have higher risks related to the significant number of underground constraints and the unstable geologic conditions along Flower Street. Underground constraints include tunneling activities encountering the hundreds of tie-backs that anchor existing building and parking structure foundations which form a "mesh" within the proposed Flower Street segment tunnel alignment. The geologic conditions include the presence of groundwater, unstable soils, a challenging geologic interface between different soil or rock strata (mixed face), and hazardous gases, which would present less risk with cut and cover construction for the Project.

The cost estimates for each alternative, presented in Table 5.8-1, were prepared taking into account the tunnel construction method changes and related schedule delays and risks. Cost adjustments addressed the proposed SEM and Open Face Shield construction methods, which would require extensive jet grouting for ground stabilization. A schedule analysis was performed to identify the construction schedule for each alternative, with extended construction for Alternatives A and B taking into account the proposed construction techniques, along with pre-construction activities. An initial risk assessment resulted in the re-assessment of allocated and unallocated contingency percentages to address increased risk conditions presented by the two alternatives. A range of costs was identified for the two alternative, with a low and high cost estimates, to reflect the higher risk associated with construction of the two alternatives due to challenging subsurface conditions and obstructions.

Costs related to the identified pre-construction and construction schedule delays resulting from implementation of either of the two alternatives were identified and included in the project cost estimates presented in Table 5.8-1:

1. Additional Construction Duration Cost – reflecting the design-build contractor's increased overhead costs due to an extended construction duration by a minimum of 3.0 years.
2. Cost of Procurement Delay – costs for the engineering re-design, environmental review, re-procurement, re-permitting, and re-mobilization activities required for the two alternatives.
3. Escalation Costs due to Redesign and SEIS Delay – escalation costs for construction materials, equipment, and labor due to a minimum of a 3.0 year delay from the current Project schedule.

4. Construction Delay Cost to Overall Project – agency costs for the added delay to complete the overall project.

The cost estimating effort resulted in the identification of both baseline construction only and total project cost estimates for the two tunneling method alternatives. The total Flower Street segment cost ranges between $510 and 575 million for Alternative A, and $447 and 503 million for Alternative B, as compared to $171 million for the Project.

Table 5.8-1: Year of Expenditure[1] Dollar Cost Estimate for the Flower Street Segment for the Tunneling Method Alternatives ($Million)

SCC Category	SCC Line Item	Project	Alternative A		Alternative B	
			Low	High	Low	High
10.06	Guideway – Underground Cut and Cover	93.1	9.9	9.9	7.0	7.0
10.07	Guideway – Underground Tunnel SEM	--	50.0	68.3	57.1	77.9
10.07	Guideway – Underground EPBM	31.5	46.6	46.6	50.1	52.5
10.07	Guideway – Underground Tunnel Open Face TBM	--	41.8	56.9	--	--
20.03	Underground station, stop, platform	--	--	--	30.6	32.0
40.02	Site Utilities, Utility Relocation	9.6	7.5	7.5	7.5	7.5
40.04	Environmental mitigation	0.1	0.4	0.4	0.5	0.5
40.07	Auto, bus, van access, including roads, parking lots	0.6	0.2	0.2	0.2	0.2
40.08	Temporary Facilities and other indirect costs during construction	0.4	0.1	0.1	0.1	0.1
	Total SCC 10-50	135.3	156.5	189.9	153.1	177.7
80.02	Final Design	11.2	19.0	19.4	15.4	15.7
80.04	Project & Construction Management	6.8	11.5	11.7	9.3	9.5
80.06	Legal Permits, Survey, Testing, Inspection	1.3	2.3	2.3	1.8	1.9
	Total SCC 10-80	154.7	189.3	223.3	179.6	204.8
90.00	Unallocated Contingency	16.7	20.5	24.2	19.5	22.1
	Total SCC 10-90	171.4	209. 8	247.5	199.1	226.9
	Additional Construction Duration Cost (Contractor's extended overhead)	--	84.7	84.7	39.0	39.0
	Subtotal[2]	**171.4**	**294.5**	**332.2**	**238.1**	**265.9**
	Cost for Procurement Delay	--	47.0	47.0	47.0	47.0
	Escalation Costs due to Redesign/SEIS Delay	--	139.9	139.9	134.2	134.2
	Construction Delay Cost to Overall Project	--	27.8	55.7	27.8	55.7
	Total	**$171.4**	**$509.2**	**$574.8**	**$447.1**	**$502.8**

Notes: [1] YOE – Year of Expenditure: 2017, as the mid-point of construction for the Project, was used to calculate the SCC 10- 50 line item costs

[2] Range for two alternatives provides a low and high cost estimate based on risk. The range does not include increased costs resulting from procurement delay, construction delay, or escalation due to delays.

Source: *Draft Flower Street Tunneling Method Alternatives Report, Appendix B: Cost Risk Analysis Model for Baseline and Each Alternative (2014)*

5.9 Environmental Consequences

Based on guidance provided in NEPA, this SEIS provides an analysis of the environmental consequences associated with construction and operation of the tunneling method alternatives. The following environmental impact areas were studied in the SEIS:

- Transportation and Circulation
- Visual Quality
- Air Quality
- Climate Change
- Noise and Vibration
- Geotechnical
- Energy Resources
- Historic Resources
- Environmental Justice
- Cumulative

In summary, the environmental analysis documented in the SEIS shows that construction of either of the two tunneling method alternatives would have adverse environmental effects, many of which could not be mitigated. These include shifting of a majority of the truck handling of tunnel excavation materials from the Flower Street segment, a high-rise commercial district with wide streets, to Little Tokyo, a low to mid-rise, mixed use district with visitor and cultural destinations, and identified as an environmental justice community. Implementation of Alternatives A and B would extend the duration of construction impacts in Little Tokyo by a minimum of 3.0 years over the Project.

Construction of Alternatives A and B would require the use of jet grouting for ground stabilization with extensive equipment requirements, including jet grouting rigs and mixing plants more than 100 feet in height, along with mixers, compressor, generators, and related support equipment. The grouting equipment would require use of the two travel lanes on the east side of Flower Street between 4th and 6th Streets for Alternative A, and between 5th and 6th Streets for Alternative B, for the duration of the grouting activities. Grouting efforts would require the use of two travel lanes for eight to 16 months further reducing street capacity. The construction impacts on Flower Street would result in significant traffic and circulation, visual, air quality, climate change, and noise impacts that would be difficult to mitigate or could not be mitigated. Alternatives A and B do not provide reduced environmental impacts during construction to those identified for the Project. In addition, the tunneling method alternatives would have higher and longer construction-related adverse environmental justice effects on Little Tokyo, as shown in Table 5.9-1.

Table 5.9-1: Comparison of Environmental Effects During Construction in Little Tokyo

Impact	The Project	Alternative A	Alternative B
Hauling of Excavated Materials from Flower Street			
- On Flower Street • Percentage of total Flower Street materials • Duration of hauling activities	 81% 9 Months	 25% 1 Month	 20% 1 Month
- In Little Tokyo • Percentage of total excavation activities • Duration of hauling activities	 19% 2.5 Months	 75% 19 Months	 80% 17 Months
Excavation/Construction Trucks Per Day			
- On Flower Street	32	18	8
- In Little Tokyo	8	22	32
Duration of Truck Impacts (for hauling excavated materials)	9 Months	19 Months 10 months longer	17 Months 8 months longer

Source: *Draft Flower Street Tunneling Method Alternatives Report (2014)*

5.10 Summary of Findings

Based on the environmental analysis in the SEIS and the engineering analysis documented in the *Draft Flower Street Tunneling Methods Alternatives Report*, the construction method alternatives would not perform as well as the Project in meeting purpose and need, would impact Metro operations, would pose construction and safety risks, and would result in environmental impacts, as summarized below, and presented in Table 5.10-1.

- **Purpose and Need** – Alternatives A and B would not perform as well as the Project in meeting the purpose and need identified for the Regional Connector project. While they would provide an improved regional connection, implementation of these options would result in reduced operating speeds on the Flower Street segment – 35 mph compared to 55 mph provided by the Project. There would be a corresponding increase in travel times for Gold, Blue, and Exposition Line passengers, as well as for passengers transferring from the Red and Purple Lines. The speed reduction resulting from the tunneling method alternatives would have permanent adverse operational effects over the Project due to increased travel times for the operational life of the Regional Connector project.

- **Construction and Risk Considerations** – Construction along the Flower Street segment must address significant challenges including physical operational challenges, difficult surface and underground conditions, and challenging geologic conditions. The geologic conditions include the presence of groundwater, unstable soils, a challenging geologic interface between different soil and rock strata (mixed-face), and hazardous gases. The Project was defined to address those constraints given the segment's high risk and challenges. The tunneling methods proposed by Alternatives A and B would result in significantly higher construction risks, a longer construction schedule, and a higher project cost. The higher construction risks include increased risks of ground instability, loss, and settlement which could threaten public and worker safety.

Table 5.10-1: Overview of Environmental Impacts Due to Construction of the Tunneling Method Alternatives

Resource Area	The Project	Alternative A	Alternative B
Transportation/ Circulation Flower Street Impacts	• 3 to 4 travel lanes available on Flower Street during construction • Even with mitigation, the intersections of 4th, 5th and 6th and Flower Streets would be adversely affected during the AM peak hour. With mitigation, the resulting effect would not be adverse under NEPA.	• 2 travel lanes available on Flower Street during grouting and construction. • Longer duration of traffic lane closure due to 12 months (possibly up to 24 months) of grouting activities.	• 3 travel lanes available on Flower Street: 4th to 5th Streets; 2 travel lanes 5th to 6th Streets. • Longer duration of traffic lane closure due to 8 months (possibly 16 months) of grouting activities.
Little Tokyo Impacts		• Increases and extends construction truck impacts on Little Tokyo by 15 months.	• Increases and extends construction truck impacts on Little Tokyo by 7 months.
Visual Quality	• Construction staging area along the east side of Flower Street would have negative impacts on the visual quality/character that can be screened.	• Construction and grouting staging areas along east side of Flower Street would have adverse impacts on visual quality/character. • Impacts cannot be mitigated due to size of grouting and plant equipment (over 100 feet tall). • With two grouting areas, this alternative would have a more adverse effect than Alternative B.	• Construction and grouting staging areas along east side of Flower Street would have adverse impacts on visual quality/character. • Impacts cannot be mitigated due to size of grouting and plant equipment (over 100 feet tall). • With only one grouting area, this alternative would have less impact than Alternative A, but more than the Project.
Air Quality Peak daily emissions	• During construction, regional construction emissions of VOC, NO_x, and CO will be adverse, significant and unavoidable under NEPA. With mitigation, localized construction emissions will be reduced to less than significant.	• Higher emissions during construction due to use of grouting equipment. • Longer duration of construction emissions by 12 months (up to 24 months) on Flower Street; and by 15 months over the Project.	• Higher emissions during construction due to use of grouting equipment. • Longer duration of construction emissions by 7 months (up to 16 months) on Flower Street; and by 7 months in Little Tokyo over the Project. • With only one grouting area, this alternative would have less impact than Alternative A.
Climate Change MTCO2e/year	• 2017[1] GHG emissions would be 4,870.	• 2017[1] GHG emissions would be 8,040. • Higher GHG emissions than the Project due to use of grouting equipment.	• 2017[1] GHG emissions would be 4,950. • Higher GHG emissions than the Project due to use of grouting equipment. • Less GHG emissions than Alternative A due to need for only one grouting area.
Noise and Vibration Flower Street Impacts	• Noise may inadvertently exceed FTA significance criteria during construction; mitigation measures will control exceedances.	• Results in increased construction noise level over the Project due to use of grouting equipment. • Possible minor increase in vibration impacts due to TBM use further south on Flower Street.	• Results in some noise level increases over the Project due to use of grouting equipment. • Results in lower noise level than Alternative A due to need for only one grouting area.

Note: [1] Mid-point of construction

- **Operational Considerations** – The speed reduction resulting from Alternatives A and B would have negative impacts on rail service headways, run times, and operations over the Project. With a slower operating speed – one-third slower than Metro operational requirements – Alternatives A and B would negatively impact passengers using the Gold, Blue, and Exposition Lines, as well as passengers transferring from the Red and Purple Lines at the 7th Street/Metro Center Station. Metro would be required to operate additional trains and increase the fleet size by approximately six vehicles with a corresponding increase in capital and operational costs. It should be noted that the Project and Alternatives A and B have been designed to allow for a future 5th/Flower Station. Construction of this station would result in slower operating speeds in the Flower Street segment as the closer station spacing would not allow the LRT trains to reach the desired 55 mph speed. While both alternatives would allow for a future 5th/Flower Street Station, the resulting station configuration for Alternatives A and B would not allow for cross-platform transfers negatively impacting passenger convenience, especially for visitors and infrequent users. Implementation of Alternatives A and B would result in a permanent, substandard operating segment in the heart of the region's LRT system.

- **Schedule Impacts** – Implementation of Alternatives A and B would delay start of revenue service by a minimum of 3.0 years beyond the Project's schedule. The increase in schedule is partially due to longer construction timeframes – 15 and 7 months for Alternatives A and B respectively. In addition, both alternatives would require an additional 29 months over the Project's schedule for pre-construction activities required to revise the engineering design and re-procure the design-build construction contract. A longer construction time would increase the project cost and delay operation of this much needed segment in the region's LRT system.

- **Cost and Funding Considerations** – Based on a cost analysis similar to that performed for the Project, the higher risk for Alternatives A and B translates to $67 to $123 million more for the baseline Year of Expenditure (YOE) cost for the Flower Street segment beyond the cost identified for the Project. Given the higher risk level along this segment, a range of total project costs identified an additional $276 to $403 million would be required for the construction of Alternatives A and B beyond that identified for the Project. Funding for these additional costs will need to be identified among limited federal, state, and local sources.

- **Environmental Considerations** – The two tunneling method alternatives shift a majority of the effects resulting from the handling of excavation materials from the Flower Street segment, a high-rise commercial district with wide streets, to Little Tokyo, a low to mid-rise mixed use district with visitor and cultural destinations, and identified as an environmental justice community. Use of grouting equipment, required for Flower Street segment ground stabilization for construction of the two alternatives would result in adverse visual, noise and vibration, air quality, and traffic effects that may not be mitigated.

Based on the above conclusions, it was determined that the proposed tunneling method alternatives in Alternatives A and B would result in a higher safety risk, would cost more money, would take longer to construct, and would result in additional adverse environmental effects than the Project. Even with the proposed methods to reduce construction risk associated with tunneling in the weak ground conditions under Flower Street, the tunneling method alternatives have a high chance of ground settlement problems and thus, were not carried forward as part of the Regional Connector project. While implementing Alternatives A and B may be technically possible, for the reasons stated in this paragraph and above, those alternatives were considered infeasible as a matter of sound public policy, and thus were withdrawn from further consideration.[i]

[i] *See Res. Ltd. v. Robertson, 35. ,3d 1300, 1307 (9th Cir. 1997)*

6.0 PUBLIC AND AGENCY OUTREACH

6.1 Introduction

The Regional Connector Transit Corridor Project approval and certification of the Final EIS was the culmination of prior planning and environmental studies and projects completed in the past two decades. Per court order (Submitted pursuant to the National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321-4370h, 23 CFR 771, and the Order re Plaintiffs' Combined Motion for Summary Judgment and Defendants' Motion and Cross-Motion for Summary Judgment, dated May 29, 2014 and Order re Plaintiff Today's IV, Inc. and 515/555 Flower Associates, LLC's Motion for Injunctive Relief, dated September 12, 2014 issued by the U.S. District Court in *Today's IV. Inc. v. FTA et. al.* (*Today's IV*), Case No. LA CV13-00378 JAK (PLAx), *Japanese Village, LLC v. FTA et al.* (*Japanese Village*), Case No. LA CV13-00396 JAK (PLAx), *515/555 Flower Assoc., LLC v. FTA* (*Flower Assoc.*), Case No. LA CV00453 JAK (PLAx) and the Judgments issued on October 24, 2014 by the U.S. District Court in *Today's IV* and *Flower Assoc.*), this SEIS is intended to provide more information on tunnel construction alternatives not pursued and to provide additional detail on tunneling methods not selected for use along Flower Street, specifically Open Face Shield and SEM tunneling for the Flower Street portion of the Regional Connector project alignment between 4th Street and the 7th Street/Metro Center Station.

Public Outreach for this SEIS will be focused on the two areas affected by the construction tunneling alternatives, Flower Street and Little Tokyo. Public notice of the availability of the Draft SEIS, a 45-day public review period and notification of the completion of the Final SEIS will be provided in compliance with the National Environmental Policy Act (NEPA)(23 CFR 771.130).

6.2 Highlights of Previous Outreach Efforts

The Regional Connector Transit Corridor Project has garnered considerable stakeholder interest throughout the environmental process during including the AA, Draft EIS, and Final EIS phases. Recognizing the unique challenges and opportunities of the proposed project, as well as its potential benefits beyond the immediate downtown Los Angeles area, Metro developed a creative approach to ensure an inclusive, engaging and transparent outreach process. The community outreach effort was designed to build awareness and understanding of the project, provide opportunities for ongoing stakeholder involvement, and assist in the identification of potential mitigation measures.

Outreach included the engagement of a wide diversity of stakeholders and opinion leaders including business organizations, chambers of commerce, business improvement districts (BIDs), neighborhood councils, community councils, arts organizations, and residents groups in downtown Los Angeles. Particular outreach was done in the Little Tokyo community, located within the Project Area, one of the only three remaining "Japantowns" in the United States, and an environmental justice community. The Little Tokyo Working Group (LTWG) was created and included Metro staff and leaders of the Little Tokyo Community Council (LTCC), which represented over 100 business and community organizations.

A collaborative effort, the group developed alternatives acceptable to the Little Tokyo community and appropriate mitigation measures to address construction and operational impacts. This collaboration led to the development of the Fully Underground LRT as the only acceptable alternative for the community. In 2010 the Metro Board approved the addition of the Fully Underground LRT Alternative to the DEIS for full environmental evaluation. Following the completion of the Draft EIS public review period, the Metro Board of Directors designated the Fully Underground LRT Alternative as the Locally Preferred Alternative (LPA) at the October 28, 2010 meeting.

Metro published a Supplemental Environmental Assessment (EA) document to introduce refinements made to the LPA in July 2011. The preparation of the Final EIS was completed in January 2012, and the Metro Board of Directors approved the Project on April 26, 2012. A Record of Determination (ROD) was issued by the FTA on June 29, 2012.

The formation and success of the LTWG, accompanied by Metro's desire to implement a transparent and proactive process in engaging this community, collectively provided an extraordinary opportunity for stakeholder engagement to defuse potentially volatile environmental justice issues, and in the process build trust, widespread enthusiasm, and support for a critical transit project.

Additionally, in April 2014 Metro was nominated for the Public Involvement/Partnership Award by the Environmental Protection Agency (EPA), an award given by the National Association of Environmental Professionals (NAEP), recognizing the community outreach efforts and proactive engagement of the Little Tokyo community in a focused and collaborative dialogue during the NEPA process in order to address their concerns.

6.3 Alternatives Evaluated

This SEIS is to provide additional detail on tunneling methods not selected along Flower Street, specifically Open Face Shield and SEM tunneling for the Flower Street portion of the Regional Connector project alignment between 4th Street and the 7th Street/Metro Center Station.

The northern limit for the Flower Street segment was identified as 4th Street as this is the location where construction of the Project and the two tunnel construction alternatives changes from tunnel boring machine to various construction techniques to connect south with the existing tail tracks structure of the 7th Street/Metro Center Station. Alternative A and B essentially have the same horizontal alignment as the Project, with Alternative B having a slightly lower vertical alignment than that of the Project.

This SEIS evaluation effort also addresses the corresponding impacts on the Mangrove portal site, the former Nikkei property, in Little Tokyo as the tunneling alternatives would result in both an intensification and increase in duration of construction-related truck activity in Little Tokyo. There is no change in the location of the Project or the Project Area studied, which remains as presented in the Final EIS.

6.4 Public Participation Plan (PPP)

A detailed Public Participation Plan (PPP) was developed at the commencement of the environmental effort, and included a stakeholder database, communications protocols, public input tracking, and a schedule for interfacing with the public, and recommendations for how meetings should be conducted. All elements of the PPP will be applicable to this SEIS effort. The full PPP is provided in the Final Scoping Report as Appendix G in the Final EIS.

Project notifications, mailers, and updates will follow the specification outlined in the PPP, including newspaper ads, media outreach, and in appropriate languages. Public meeting notifications will be published in local newspapers and held in the Study Area.

6.5 Public and Agency Comment

This SEIS is being distributed for public review and comment prior to the issuance of a Final SEIS. Comments may be returned during the 45-day Draft SEIS review period to FTA or Metro. FTA and Metro will hold two public meetings on the content and findings of this Draft SEIS during the 45-day public review period.

Any comments on this SEIS should be limited to the scope of analysis of the SEIS. All substantive comments on the content of this Draft SEIS will be addressed in the Final SEIS. A Notice of Availability (NOA) will be published in the Federal Register for the Final SEIS, allowing 30 days for public comments.

6.6 Section 106 Consultation

The extensive consultation process with various cultural groups and agencies to identify traditional cultural properties and cultural practices was conducted during all phases of the environmental planning process has been documented for the Section 106 consultation process and detailed information can be found in Chapter 7, Public and Agency Outreach, of the Final EIS. This co-ordination has continued through this SEIS phase. Communication with the State Historic Preservation Office (SHPO) was undertaken by FTA staff. FTA will prepare a letter to SHPO explaining the purpose of the SEIS, court order, and the alternatives under evaluation. The letter will include discussion of anticipated impacts and explain if there are no new impacts.

APPENDIX A

DRAFT FLOWER STREET TUNNELING METHOD ALTERNTIVES REPORT

REGIONAL CONNECTOR TRANSIT CORRIDOR PROJECT

Draft Flower Street Tunneling Method Alternatives

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August 19, 2014

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1.0 PREFACE

The Connector Partnership Joint Venture (CPJV), engaged by Los Angeles County Metropolitan Transportation Authority (LACMTA), conducted a tunnel feasibility and environmental assessment for Flower Street construction methods and alignment alternatives for the Regional Connector Transit Corridor Project. This effort was undertaken to evaluate feasibility of tunneling along Flower Street in response to community concerns about cut-and-cover construction impacts in this area.

This report builds on previous analysis to evaluate tunneling alternatives along Flower Street and supports preparation of a Supplemental Environmental Impact Statement (SEIS) for the Regional Connector Transit Corridor Project. The environmental assessment of the tunneling alternatives is conducted and discussed in the SEIS.

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2.0 EXECUTIVE SUMMARY

In an effort to address concerns from the Financial District, regarding the potential construction impacts along Flower Street, the LACMTA Board, in April 2012, directed staff to examine various value engineering and cost saving methods to determine if certain specific construction methods and design features could be incorporated, to mitigate potential construction impacts along Flower Street, without causing an increase to the Life of Project (LOP) budget. The Board further directed staff that, if the analysis determined that the methods exceeded the LOP budget, the construction methods and design features should be included, as bid options, during the construction procurement to allow design-build proposers a process to include each feature and determine if it could be accomplished within the LOP budget.

At the time of the April 2012 Board Meeting, the Flower Street mitigation method under consideration was referred to as the “Low Alignment.” This alignment, with a deeper segment between 4th and 5th Streets, would extend pressurized-face TBM tunneling from the Baseline termination, at south of 4th Street, to a point south of 5th Street, which would subsequently reduce the length of the cut-and-cover section with street decking system along Flower Street. The Low Alignment was considered as Alternative B in this study.

The Baseline and two alternatives have been evaluated in this study in order to fully respond to stakeholders concerns for tunneling alternatives along Flower Street. The Baseline consists of earth pressure balance machine (EPBM) tunneling to south of 4th Street and the cut-and-cover with street decking system to the 7th/Metro Center Station along the Locally Preferred Alternative (LPA) vertical profile. Alternative A would extend tunneling south to the 7th/Metro Center Station along the LPA profile through the use of a combination of EPBM, open-face shield tunneling, and sequential excavation method (SEM) construction techniques in series. Alternative B would extend tunneling south toward the 7th/Metro Center Station along a lower profile (Low Alignment) through the use of a combination of EPBM and SEM construction technique. Both Alternatives A and B would minimize cut-and-cover construction, limiting it to the tie-in with the 7th/Metro Center tail tracks and street-surface exit shafts.

It was determined based on this study that it is not feasible to use pressurized-face tunnel boring machines (Earth Pressure Balance Machines [EPBM]) for tunneling where tiebacks are present. Unacceptable risks of excessive subsidence from ground loss are associated with open-face shield and SEM tunneling in mixed face geologic conditions with the tieback obstructions. The substantial amount of drilling from the ground surface for ground improvement by grouting that would be required to mitigate the hazard of mixed-face conditions and tiebacks would negate the benefit intended of avoiding street surface impacts by tunneling.

This study supports the environmental assessment presented in the Supplemental Environmental Impact Statement (SEIS). Based on this environmental assessment, no changes to the Project are being recommended. The assessment demonstrates that there are a variety of construction, operation, cost, and schedule concerns that make the tunneling alternatives infeasible, and that while some environmental impacts may be reduced along Flower Street, other impacts are similar along Flower Street and/or shifted to the other end of the alignment, in Little Tokyo area, which is an environmental justice community.

3.0 DEVELOPMENT OF PROJECT CONFIGURATION

The project configuration on Flower Street between 2nd/Hope Station and the existing Blue Line tail tracks at 7th/Metro Center Station has progressed from preparation of the Draft Environmental Impact Statement/Draft Environmental Impact Report (DEIS/DEIR) through the Final Environmental Impact Statement/Final Environmental Impact Report (FEIS/FEIR). From the engineering perspective, the work encompassed Conceptual Engineering, Advanced Conceptual Engineering, and Preliminary Engineering.

3.1 Conceptual Engineering and DEIS/DEIR October 2010

The project went through a number of design iterations, which have been significantly influenced by mitigation measures in the environmental process. This section presents the design and construction methods carried in the project at the conclusion of Conceptual Engineering and preparation of the DEIS/DEIR.

The DEIS/DEIR alignment under Flower Street included a pocket track between 3rd and 4th Streets and an underground station between 4th and 5th Streets. Both elements would require large cut-and-cover excavation over long sections of the alignment along Flower Street. The combined length and arrangement of these major structures and the cut-and-cover connection to the existing 7th/Metro Center structure left only short construction sections deemed not practical or cost effective to construct by tunneling. This left no practical section of the alignment to be constructed by tunneling, either by conventional tunneling techniques or pressurized-face Tunnel Boring Machines (TBM). See Sections 4.3, 4.4, and 4.6 for the descriptions of different tunneling techniques. Therefore, a cut-and-cover construction scheme was developed for this part of the Regional Connector project as has been typical for the underground station sites on the Los Angeles Metro system, including the existing 7th/Flower Street Blue Line tail tracks.

An additional construction consideration along Flower Street at the time of the DEIS/DEIR preparation is the existence of tiebacks that were abandoned in place after construction of many of the adjacent buildings along the Flower Street portion of the alignment. Use of tiebacks that extend into the public right-of-way was permitted upon approval by the City of Los Angeles for construction of the buildings. The tiebacks were used to temporarily support the ground for excavations required to construct the building foundations, or other underground structures, such as the ARCO Plaza (505 and 515 South Flower Street), 444 South Flower Street, Bank of America, Westin Bonaventure Hotel, and the Library Parking Garage.

Cost of transit structure is minimized by having the stations and tunnels deep enough to avoid existing utilities and to permit construction of the station in accordance with LACMTA standards with a concourse (mezzanine). However, in the case of Flower Street, the tunnel profile (depth below street) was dictated by the tie-in elevation to existing track at 7th/Metro Center Station and the minimum depth required for the 5th/Flower Station to be under the existing utilities. Also, the foundations for 4th Street ramps (bridge structures) placed a limit on tunnel depth to avoid impacting the existing drilled shaft bridge foundations. Alternative construction methods were not credible for this area, i.e. tunneling by pressurized-face TBMs at this shallow depth would encounter numerous tieback obstructions; and tunneling by SEM (see Section 4.4) would have greater risks.

Tunnel construction using a pressurized-face TBM was identified in conceptual engineering to be used only between the 2nd/Hope Station and the 1st/Central Station. Direction of tunneling and associated environmental impacts had not been determined at that time. The direction of the tunnel drive would be either from west to east from 2nd/Hope Station or east to west from a shaft in 2nd Street between Central and San Pedro Streets.

In summary, during the conceptual engineering, the cut-and-cover method was considered to facilitate removal of existing tiebacks that are known to be present on Flower Street with the least cost and schedule impacts. Alternative construction methods, such as open face shield tunneling, were reviewed but rejected. See Section 4.8 for more description of tiebacks and their relevance to feasible construction methods on Flower Street. Cut-and-cover was determined to be the most appropriate construction method for the alignment between 3rd Street (2nd/Hope Station) and the tie in to the 7th/Metro Center Station.

On October 28, 2010, the LACMTA Board accepted the Draft EIS/EIR for the Regional Connector Transit Corridor and designated the Locally Preferred Alternative (LPA) as the Fully Underground LRT Alternative, which was used in the Baseline and Alternative A alignments described in this report. At that time the 5th/Flower Street Station was eliminated from the project definition due to cost considerations. However, the Board further stipulated the design and alignment should not preclude future construction of a 5th/Flower Street station.

3.2 Advanced Conceptual Engineering March 30, 2011

Implementing LACMTA Board direction, the Advanced Conceptual Engineering design was revised to eliminate the 5th/Flower Street Station, but did not preclude its construction in the future. The track alignment through the 2nd/Hope Station was refined to use larger radius curves that would improve rail operations and also allow for TBM tunneling through the station area. At the same time, the pocket track was moved to south of 4th Street. This allowed the TBM tunneling to be extended south to 4th and Flower Streets, thereby reducing the amount of cut-and-cover construction and increasing tunneling to reduce cost by optimizing usage of the pressurized-face TBM.

The continuation of pressurized-face TBM construction south of 4th Street was precluded by the presence of abandoned tiebacks south of 4th Street, the need for a box structure for a crossover, and the fixed elevation of the existing rail at the 7th/Metro Center tail tracks. As was the case for Conceptual Engineering (Section 3.1), the combined length and arrangement of these major structures left only short construction sections deemed not practical or cost effective to construct by tunneling.

During Advanced Conceptual Engineering, the presence of tiebacks on Flower Street continued to be recognized as a hazard for pressurized-face tunneling. As stated above, extending pressurized-face TBM tunnel to just south of 4th/Flower Streets was limited by the presence of tiebacks associated with construction of the Westin-Bonaventure Hotel. Had there been no tiebacks, or if tiebacks would have not been encountered by pressurized-face TBM tunneling (the tiebacks being either below or above the tunnel), the tunnel would have been extended. Such was not the case. See Section 4.8 for the full discussion of tiebacks and how their presence negatively affects the feasibility of tunneling and the great risks if attempting to tunnel through tiebacks.

In summary, a result of the refinements during Advanced Conceptual Engineering, major project configuration changes were:

- No station at 5th/Flower (but did not preclude future station construction)
- Pocket Track moved to south of 4th Street
- 2nd/Hope Station track geometry revised (horizontally and vertically) for operations and tunneling
- Pressurized-face TBM tunneling extended to south of 4th Street bridge (south of 4th and Flower Street intersection)

3.3 Draft (June 29, 2011) and Pre-Final (September 29, 2011) Preliminary Engineering (PE) Submittals

Project advancements and value engineering (VE) further refined the project configuration. As a specific VE recommendation to reduce costs, the rail elevation and station platform were raised at the 2nd/Hope Station by approximately 14 ft. The station depth reduction saved construction cost with shorter construction time, less excavation support, and significantly less station structure with one less flight of long escalators for this deep station.

LACMTA also determined that a pocket track for car storage was not required within the subsurface area of the project alignment. A possible storage track location was identified at Division 21, which is located north of the Metro Gold Line Chinatown Station. Eliminating the pocket track narrows the width of cut-and-cover construction from 4th Street to the 7th/Metro Center Blue Line tail tracks by several feet thus reducing potential construction impacts on Flower Street. LACMTA considered reducing construction impacts further by eliminating the underground cross over. However, crossovers are still required within the Flower Street section of the project to mitigate service delays to allow LACMTA to manage the operational impacts of disabled trains and track maintenance.

During this time, to address the cost, construction duration, and impact on the community, a raised deck over the cut-and-cover excavation was reviewed to minimize relocations of existing utilities. In addition in response to community concerns, LACMTA limited the height to approximately 10 inches that the “raised deck” could be constructed above the existing roadway. The low raised deck has less impact to adjacent properties and maintenance of street use. At the same time, design development eliminated construction work areas on private properties and work staging was restricted to the public right-of-way. Some work on adjacent properties would be needed to construct and maintain access at driveways and entryways, but by temporary easements, or rights of entry, rather than permanent “takes.”

The Pre-Final PE Submittal of September 29, 2011 was the project configuration that LACMTA issued for Industry Review on October 20, 2011.

In summary, changes incorporated in the Pre-Final PE September 29, 2011 were as follows:

- Pocket track no longer on Flower Street
- Crossover (previously part of pocket track) on Flower Street located south of 5th Street
- Raised 2nd/Hope Station by 14 ft

- "Raised decking" along Flower Street limited in height, which reduced overall Flower Street construction impact and activity, while maintaining significant reduction in utility relocations and associated impacts.

- Modified construction staging areas to reduce private property easement requirements

3.4 Draft Final PE December 20, 2011

Station designs were refined to site-specific conditions, which included establishing street and traffic layouts in the 2nd/Hope Street Station area. Design/build technical requirements (performance specifications) were drafted. Characterization of existing utilities and utility relocations were refined. No changes were made to the project configuration on Flower Street.

3.5 Final PE March 30, 2012

The Final documents submitted March 30, 2012 did not change the configuration on Flower Street from the December 20, 2011 Draft.

3.6 PE and FEIS/FEIR

During Preliminary Engineering and preparation of the FEIS/FEIR, four major changes established the project configuration and tunneling limits. LACMTA's actions listed below document the fact that LACMTA considered and implemented changes that fine tuned the project configuration to further mitigate the construction impact to the public. This would result in the least public impact possible within the available budget.

First, the tunnel alignment was refined through Little Tokyo, resulting in a relocated station at 1st/Central Avenue. This new station site was initially proposed for the pressurized-face TBM tunnel shaft. In parallel with preparation of the FEIS/FEIR, the "Mangrove Site" at the northeast corner of 1st and Alameda Streets became available for a TBM tunnel work shaft when a development rights lease expired. As a mitigation of impact on the Little Tokyo community, the commitment was made by LACMTA that the Mangrove Site would be the main site for staging of tunneling operations. The pressurized-face TBMs would be assembled and launched from that site and tunneling would proceed to the west.

Second, two major structures, 5th/Flower Street Station and the pocket track, were not included in the preliminary design. As cost saving actions, the LACMTA Board eliminated the 5th/Flower Street Station when approving the Locally Preferred Alternative (LPA) (with the stipulation to not preclude future construction) and the pocket track was eliminated during PE. Deletion of these major structures reduced construction impact with a much narrower structure and reduced property takes or temporary construction easements along Flower Street.

Third, tunneling was extended south from the 2nd/Hope Street Station to 4th and Flower Streets where the TBMs would be removed through a shaft south of 4th Street. In addition to the mitigation of less construction impact, cost savings resulted from efficiencies with longer length of tunneling and avoiding the deep cut-and-cover construction between 3rd and 4th Streets. Tunneling also eliminated the impact of cut-and-cover construction to the community and reduced the construction impact to the 4th Street bridge foundations.

Fourth, during PE, LACMTA continued to search documentation of all tiebacks on Flower Street. LACMTA confirmed that hundreds of tiebacks currently exist in Flower Street that are obstructions to tunneling, especially pressurized-face TBM tunneling. Existing records show the number of tiebacks along this segment as over 500 and potentially up to 800. (See Section 4.8 for more description of tiebacks and their relevance to feasible construction methods on Flower Street.) The major impacts from tieback obstructions for tunneling south of 4th Street were avoided by specifying construction by cut-and-cover. Due to the confirmed presence of numerous existing (abandoned) tiebacks along Flower Street south of 4th Street, the need for a box structure for a crossover, and the fixed elevation of the existing rail at the 7th/Metro Center tail tracks, pressurized-face TBM tunneling could not be extended farther south under Flower Street for the FEIS/FEIR alignment. This profile is presented in the FEIS/FEIR and in the Preliminary Engineering documents.

3.7 Record of Decision/ Procurement Documentation Pre-Construction Activities

In June 29, 2012, the FTA issued a Record of Decision (ROD) for the project. The ROD includes further commitments to mitigate adverse effects of the project as it proceeds and are described in the Mitigation Monitoring and Reporting Plan (MMRP). Contract documentation was initiated to procure a design build contractor. Subsequent to the ROD, three parties along Flower Street submitted challenges to the EIS/EIR for the Regional

3.8 Procurement and Start of Construction

Metro started procurement for a Request for Qualifications (RFQ) in 2012. Qualified teams were issued a Request for Proposals (RFP) on January 7, 2013. Construction Contract No. C0980 was Awarded May 6, 2014 and Notice to Proceed was July 7, 2014 and has started Final Design. Current construction activities include utility relocation by Contract No. C0981R along the project alignment. Mitigations are being implemented as appropriate per the MMRP to help minimize construction impacts.

4.0 MAJOR CONSIDERATIONS FOR CONSTRUCTION METHOD

This section presents several engineering and practical construction topics addressed during development of the Regional Connector Transit Corridor Project configuration in general and specifically on Flower Street. Mitigation of environmental impacts is addressed in the FEIS/FEIR/SEIS.

Major factors considered were:

- Geologic Conditions (Section 4.1)
- Transit Structure Configuration (Operations) (Section 4.7)
- Underground Obstructions to Tunneling – Tiebacks (Section 4.8)
- Schedule (Section 6.0)
- Cost (Section 7.0)
- Risk (Section 8.0)

4.1 Geologic Conditions

Along Flower Street, alluvium and fill materials overlie the Fernando Formation consisting primarily of weak to very weak clayey siltstone. The alluvial deposit consists of interlayered silty clays, sandy silts, clayey sands, and silty sands with some sand layers containing variable gravel and few cobbles. The fill consists of mixtures of gravel, sand, silt, and clay with construction debris. The depth of fill material varies along Flower Street with maximum fill depth estimated to be about 40 ft below ground surface. Occasional boulders are also present in the alluvium. The principle geologic conditions on Flower Street that control tunneling feasibility and risk are groundwater, geologic interface of different soil or weak rock strata, and hazardous gases.

Groundwater seepage at relatively shallow depths that ranged from approximately 15 to 35 ft below ground surface was encountered in historical borings drilled for many building sites adjacent to Flower Street between 5th and 7th Streets. Groundwater within the lower portion of the alluvial deposits, most probably perched above the Fernando Formation, has been reported at depths from approximately 18 to 27 ft below ground surface adjacent to Flower Street in the area between 2nd and 5th Streets, which is close to or within the tunnel horizon. Groundwater problems will be magnified at the Alluvium–Fernando interface. Before development of downtown Los Angeles, Flower Street was more recognizable as a natural drainage path (stream during rainfall) with seasonal variations of groundwater in the Alluvium. In present day, development has affected the groundwater regime as a result of cuts and fills altering the topography, paving streets, and constructing buildings with deep basements. However, groundwater is still anticipated to follow the ancient underground water course and pose problems for stability of open-face tunnel excavations.

Along Flower Street, the geologic interface of alluvial soils over the Fernando Formation (weak rock) is a recognized geologic tunneling hazard. If tunneling is fully below the geological interface and there is adequate Fernando Formation (one tunnel diameter, which is about 22 ft) between the tunnel and interface, there exists a reduced potential hazard. On the other hand, if the interface is just above the tunnel or within the face of the tunnel being excavated, the major hazard is the alluvial materials running uncontrolled into the tunnel. In the presence of ground water, this could cause an uncontrolled flow into the tunnel under construction. Both conditions are unacceptable risks that must be mitigated by grouting to create non-running/non-flowing ground conditions, or mitigated by using another method, such as pressurized-face TBM, which inherently can safely deal with such conditions.

Methane and hydrogen sulfide (H2S) are expected as described in the Geotechnical Baseline Report (GBR). Several sections of the tunnels are to be constructed through Methane Buffer Zones. Cal/OSHA has classified all of the underground construction for the Regional Connector as “potentially gassy.” Metro requires specific designs where gassy conditions are present. The use of EPBMs for tunneling and installation of a double gasketed segmental precast tunnel lining provides a robust barrier to resist entry of methane into the tunnels. SEM or open-shield tunneling would increase risks of hazardous gas for construction and likely require significant additional measures to mitigate these safety issues. An open-face shield allows hazardous gasses into the tunnel at the tunnel face. SEM has greater safety risk of gas on account of greater exposure to the excavated ground. Hazardous gases in a cut-and-cover excavation also need to be safely handled, but open excavation allows easier control of hazardous gases.

4.2 Cut-and-Cover Construction Method

Cut-and-cover is the usually preferred method of constructing relatively large underground transit structures such as stations, crossovers, and pocket tracks. Becoming less so in current times, cut-and-cover has also been used extensively to construct relatively shallow running tunnels. The type of cut-and-cover construction along Flower Street is recognized to be a suitable method and has extensive precedent with construction of all major modern buildings in downtown Los Angeles, as well as transit stations.

On past LACMTA rail projects, the excavation support system consisted of braced soldier piles and lagging which minimized settlement of adjacent ground and facilities and accommodates utilities and traffic control requirements. An additional benefit of this method, which installs soldier piles in drilled holes at 6 to 8 ft spacing, is that the system can be revised to adapt to circumstances during construction, for instance, by changing soldier pile spacing. Cut-and-cover is the basis of construction on Flower Street in the FEIS/FEIR and for Preliminary Engineering.

The soldier piles are structural steel members placed in pre-bored (vertical) holes, which are than filled with concrete such that piles are encased in concrete. As excavation takes place, lagging is placed horizontally between the soldier piles. Traditional local Los Angles practice is to use timber lagging. Lateral support is either by tiebacks where real estate conditions permit or by structural steel struts across the excavation.

Regardless of type of excavation support system, to minimize public disruption on the street surface, a precast concrete deck is installed over the excavation to maintain street traffic and allow construction activities beneath. The excavation support system provides temporary support for the adjacent ground until the permanent structure is constructed. After the permanent cast-in-place concrete structures are completed, the deck beams are removed, the excavation is backfilled and the street is restored.

Cut-and-cover is relatively unaffected by the variations and uncertainty regarding the presence of man-made and natural obstructions and geologic conditions. Obstructions, in the form of abandoned tiebacks, can be dealt with directly as they are encountered during excavation. The geologic conditions along Flower Street are known to have perched groundwater and a distinct change in geologic strata consisting of fill and alluvium over weak rock. For cut-and-cover construction, past experience in downtown Los Angeles indicates groundwater can be managed by pumping from sumps in the excavation or, in rare instances, from dewatering wells. The presence of “weak rock,” which is generally stiffer than the alluvium, can be considered a positive condition for excavation stability where soldier piles would be founded within the relatively stiff Fernando Formation (the “weak rock”).

In summary, the existing tiebacks and geologic conditions pose no extraordinary challenges for cut-and-cover construction, whereas for tunneling, the variations and uncertainty regarding the presence of man-made obstructions (tiebacks) and geologic conditions pose substantial construction hazards as elaborated subsequently in this document.

4.3 Open-Face Shield Tunneling

Tunnel construction with open-face machines (also called a “digger shield”) was considered for the Regional Connector but was rejected as not being a satisfactory method of construction to mitigate risks of uncontrolled settlement in this mixed face geologic profile (condition) along Flower Street (and anticipated in Little Tokyo).

Ground control hazards are always present when an open tunnel face is in alluvium and where water is present, or where a mixed face heading is present (alluvium over Fernando Formation). The ground at the heading of the open-face shield could become unstable and subject to unacceptable loss of ground, raveling, running, or flowing of disturbed soil uncontrolled into the tunnel face, all of which could result in surface subsidence. This was the case during the construction of the Metro Red Line A146 contract when the tunnel was constructed using the digger shield shown in Figure 4-1. In much of the alignment, the upper part of the tunnel encountered cohesionless sand which ran uncontrolled into the tunnel face and created a void ahead of and over the tunnel shield. A number of ground losses occurred during tunneling with volumes as great as 36 cubic yards, or more than the size of a full-size automobile. Significant surface settlement was avoided by a soil stabilization program consisting of holes drilled from the ground surface to backfill with concrete the voids created by the ground losses. The Red Line case serves as an example of what methods and risks LACMTA will not accept for future projects: Open-face tunnel shields and any project that would have to rely upon grouting from inside the tunnel for safe construction are now deemed to have unacceptable risk. To avoid this geologic hazard, ground improvement by grouting from the ground surface (“preconditioned ground” in the Tunnel Advisory Report) would be required as a risk mitigation measure. Such grouting is costly, time consuming to undertake, and would create substantial construction impacts at the surface (street level) that were intended to be avoided with tunneling.

Figure 4-1: Digger Shield Used to Construct Metro Red Line Contract A146 Tunnels

A characteristic of a digger shield is that, when an obstruction such as a tieback is encountered during tunneling, the tunnel face is accessible and the tieback can be removed in pieces manually by torch cutting or metal cut-off saw. Special powered equipment operated remotely by miners would likely be used to assist in tieback removal to some extent. Regardless of possible mechanized assistance, manual labor would be required and job-specific safety hazards would exist for tieback removal.

The heading of an open-face shield would need to remain stable for sufficient time without sloughing and raveling into the tunnel face to permit workers to safely remove some tiebacks. Generally, tiebacks are installed on a downward angle and are expected to run downward across the face of the tunnel shield. Where the tunnel face is in uniform ground conditions, a portion of a tieback that intersects in the upper part of the tunnel would be relatively easy to remove, compared to tiebacks at lower depth, on the basis there being the least amount of soil to excavate. On the other hand, any part of the tieback that intersects the open-face shield at the lower part of the tunnel would be buried; gaining safe access for miners would be difficult. To do so would require stopping tunneling and then manually excavating and supporting the tunnel face until the tieback can be manually dug out. The tunnel shield would be about 22 ft in diameter and the tunnel face requiring support would be as high as a two-story building.

A very difficult condition would exist where an open-face shield encounters the mixed-face conditon of the Alluvium-Fernando geologic contact with perched water in the face of the tunnel. In this case an attempt to remove a tieback that intersects in the upper part of the tunnel would likely lead to an uncontrolled loss of disturbed soil and water into the tunnel, settlement, and possibly a sinkhole at the ground surface. Tunneling safely in such conditon requires mitigation by ground improvement of the Alluvium by grouting or other measures to create firm ground conditions. See Section 4.8.3 Tieback Hazard for Open Face Shield or SEM Tunneling.

Although open-face shield construction may be technically feasible, this method likely require soil stabilization from the street surface causing major disruption along Flower Street to locate a grout plant and manage (control) the grouting spoils. This would further complicate traffic management, have major impact on existing utilities, and potentially limit building access and have impacts similar to cut-and-cover construction.

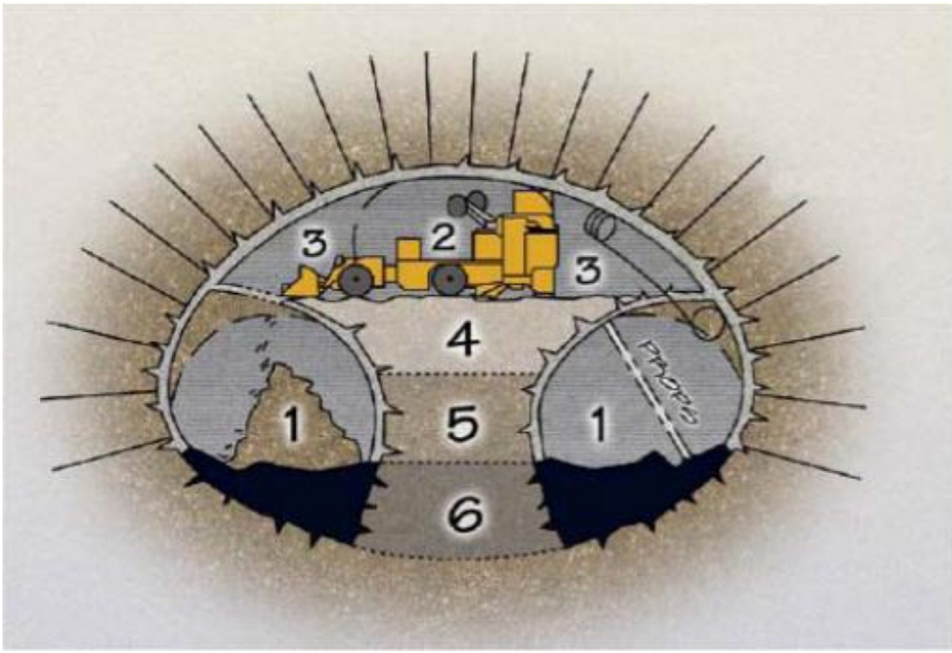
Grouting from inside the tunnel is much more costly and is not considered to be a viable alternative to pre-grouting from the ground surface along Flower Street. Moreover, grouting from the tunnel face could not reliably provide the needed ground improvement beneath utilities, particularly the large storm drain, leaving “windows” of ungrouted soil which would become potential zones of unstable soil. Grouting from the tunnel face (from inside of the tunnel) will simply not provide the adequate ground improvement to ensure control of settlement for utilities and roadway surface.

The above describes difficulties typically experienced when the soil in the face of the TBM is mostly loose water-bearing alluvium. Generally a mixed face condition (water bearing alluvium over Fernando Formation) is even more difficult to control because the alluvium tends to ravel and flow into the face on top of the more stable Fernando Formation. However, a much more risky situation is created when any unfavorable soil condition is encountered unexpectedly because the ground control measure being implemented cannot be changed quickly enough. It should be noted that the crown of the tunnel alignment discussed in this report is very close to the alluvium/Fernando interface creating a significant risk of hazardous conditions with uncontrolled soils coming into the tunnel resulting in excessive settlement and possibly creation of a sinkhole at the ground surface.

4.4 Sequential Excavation Method (SEM)

Another tunneling technique is the Sequential Excavation Method (SEM), which is used globally for underground construction. The excavation is performed by mechanical excavators in a prescribed sequence with the initial ground support typically consisting of sprayed-on concrete (shotcrete). Figure 4-2 shows a typical SEM excavation sequence.

Figure 4-2: Sequential Excavation Method (SEM) Tunneling



For safe SEM operations, it is desirable to have a competent layer of good ground as thick as the width of the tunnel over the tunnels, i.e., 20 ft of good ground above a 20 ft diameter transit (running) tunnel. Less cover and weaker soils greatly increase the risk of settlement and large ground loss resulting in runs and flowing of ground that rapidly rise to the surface and form sinkholes. In order to mitigate this risk, tunneling would require more ground modification and a greater number of excavation sequences with slower advance rates. Such situations typically also require the use of extensive pre-support measures, which include ground improvement and/or forepoling or spiling. Forepoling is a conventional, ground pre-support method to advance tunnels in loose, caving, or running ground by driving pipes, timbers, steel sections, or concrete slabs ahead of the tunnel excavation. Similarly, spiling is a ground pre-support method by installing untensioned reinforcement (spiles) in drilled holes. Spiles consist of deformed steel reinforcing bars, steel pipe, or self-drilling bars, grouted in place. They are typically installed without end hardware in a row or multiple overlapping rows above the tunnel crown at a low angle to the longitudinal axis of the tunnel. See Figure 4-6 showing an SEM excavation with a canopy of spiles created by jet grouting.

As shown in cross-section in Figure 4-9, Flower Street SEM excavation for the crossover may be as wide as 60 ft but will only have about 20 ft thickness or less of poor soil cover combined with close proximity to utilities and ground water in potentially gassy conditions making it a very high risk for excessive settlement, uncontrolled subsidence, or collapse. SEM relies upon the natural arching effect of the ground. Not much arching can be expected in Flower Street because of the low ground cover, poor ground, and existing utilities. Use of SEM would require major ground improvements and/or forepoling or spiling work, which would have major impacts on both Flower Street and the construction schedule.

Compared to constructing the Metro guideway tunnels by cut-and-cover on Flower Street, SEM construction has more risk. It is preferable to use SEM in deep alignments with adequate ground cover and favorable ground conditions, and where extensive ground modification is not required. Typically, machine bored tunneling is chosen because of its rapid advance rates and efficiency in long runs; whereas, the slower SEM method is considered for short runs and excavation of non-circular shapes. In another area of the Regional Connector project along 2nd Street, the track crossover cavern is fully within the Fernando Formation (with Fernando cover of approximately 35 ft above the tunnel crown), which makes use of SEM for construction at that location possible with acceptable risk.

4.5 Ground Improvement and Tunneling

Ground improvement is the general term used for the construction methods that make poor soil conditions stronger and/or less pervious. Poor soils include pervious soils below the ground water table and weak or loose soils. Where poor soils conditions are present, successful tunneling often relies on various methods to “improve the ground” in order to reduce or eliminate many risks associated with tunneling in such conditions. Implemented before tunneling, the ground improvement methods are either grouting or freezing:

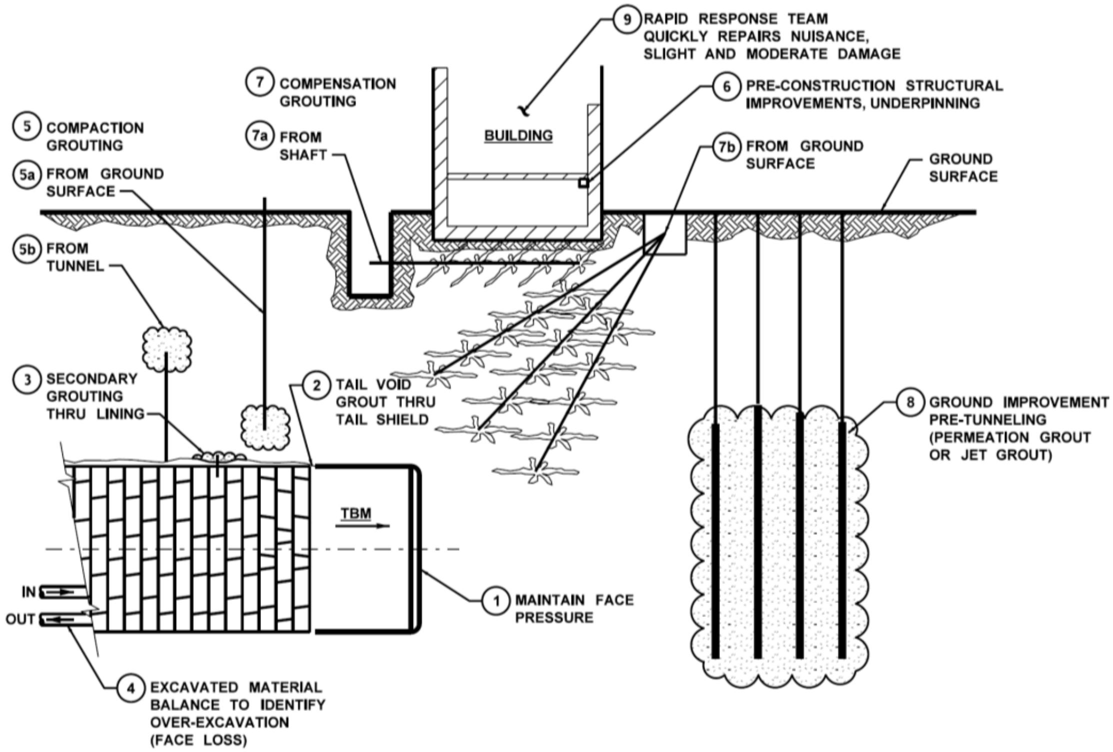
- Permeation Grouting
- Jet Grouting
- Ground Freezing

Grouting techniques implemented during tunneling are:

- Compensation Grouting
- Compaction Grouting

As a guide to where and how ground improvement is implemented for tunneling, Figure 4-3 shows various methods. As can be seen on the figure, some methods are done well in advance of tunneling and some during tunneling. A closed, pressurized-face TBM is shown. In the detailed descriptions of each method below, use of various grouting techniques associated with open-faced TBMs and SEM tunneling are addressed, where applicable.

Figure 4-3: Grouting Methods for Tunneling



In the broad scope of geotechnical engineering and ground improvement, other methods exist that are not typically used in tunneling or the Regional Connector site conditions, such that they are not remotely applicable. They are mentioned here for the record, but are not elaborated further in this report. These other methods include vibro-compaction (insertion of vibrating probe in sands below water table, commonly used in marine construction), dynamic compaction (dropping very large weight to compact loose soils), wick drains (insertion of geotextile filters to increase rate of consolidation of poorly consolidated soils below the ground water table), and use of explosives to density loose soils. Dewatering is often considered a type of ground improvement where tunneling is below the ground water table. However for the Regional Connector, much of the tunnel alignment has little to no groundwater or groundwater is perched groundwater. Any tunneling scheme will have to accommodate groundwater. On its own, dewatering in the absence of other mitigating measures would not result in an improvement of site conditions that would make a specific tunneling method constructible, where it was not constructible before.

4.5.1 Permeation Grouting: Chemical or Cement

Permeation grouting involves filling the soil pore spaces with chemicals or fine cement, while individual soil grains are not disturbed or moved. The structure and dimension of the soil pore spaces dictate the type of grout that can be effectively used. Generally, permeation grouting is suitable for sandy soils containing less than 10 to 20% silt or clay.

For tunneling application, permeation grouting is done from the ground surface or, when unusual or extreme conditions dictate, from the tunnel face. Permeation grouting performed from the ground surface in most cases is the only practical scheme compared to grouting at the tunnel face. Permeation grouting requires drilling and injecting grout to the targeted ground. The drilling pattern depends on the soil pore space structure. Typical spacing of the drilling pattern is two to six feet between grout holes. See Figure 4-4 for a drill hole pattern for grouting from the ground surface. Working from the ground surface permits control of the grouting and provide substantial assurance of the targeted tunneling ground being improved. The inherent and unavoidable impact is the ground surface disturbance by grouting from surface.

Figure 4-4: Permeation Grouting from Surface

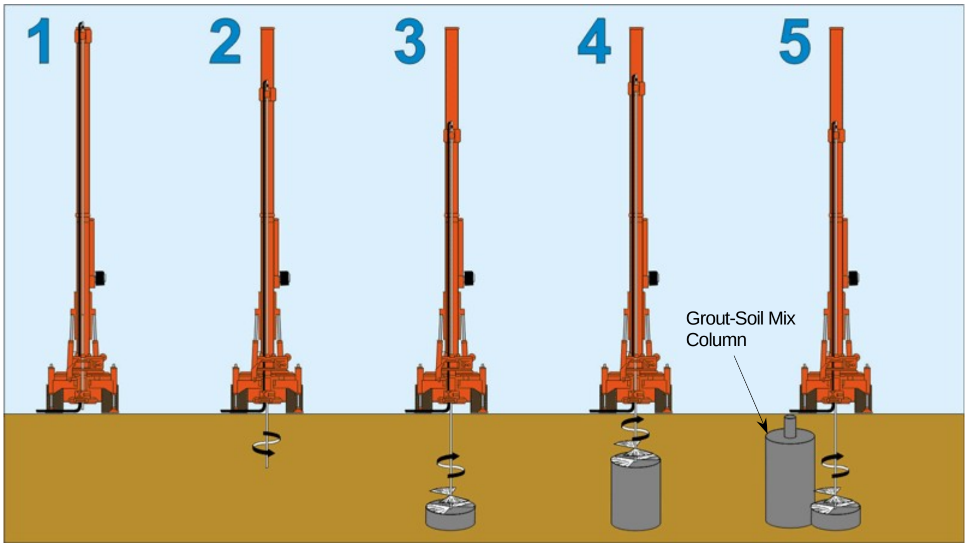
On the other hand, permeation grouting from tunnel will have essentially no impact on the ground surface; however, working from the confines of the tunnel face, it is difficult to assure satisfactory improvement of the soils targeted for ground improvement. In addition, when grouting from the tunnel face, the tunnel advance rate will be significantly reduced with the introduction of the drilling and grouting operations to the tunneling cycle. Grouting from the tunnel face is only possible with open-face TBMs or SEM tunneling.

Regardless of where the permeation grouting is done, the alluvial deposits along South Flower Street would be difficult to be improved by permeation grouting. The content of fines (silt and clay) would limit the extent of grout permeation and would require closer drill hole spacing. The interlayered nature of the sands and fine soils would also make it difficult to achieve a uniformly grouted condition. Some zones would be not groutable or marginally groutable. Particularly, the horizontal and sub-horizontal grout holes drilled from tunnel face could easily miss the targeted pervious layers and would not be able to achieve the ground improvement intended. Overall for grouting from the tunnel face, it would be difficult to control the quality of a zone intended to be grouted, which in turn creates a tunneling hazard.

4.5.2 Jet Grouting

Jet grouting mixes cement grout with the in-situ soil to result in a mixed grout-soil material. With jet grouting, weak soils would be changed to a stronger grout-soil mixture and create “firm” ground conditions. Figure 4-5 shows the jet grouting procedure creating series of grout-soil mix columns in the ground.

Figure 4-5: Jet Grouting Sequence



The technique requires drilling grout holes on a 5 to 10 ft spacing throughout the area to be grouted such that the neighboring grout-soil mix columns would overlap or touch each other. Grout holes would typically extend from the ground surface creating vertical grout-soil mix columns. In rare cases, horizontal jet grouting is used to create grout-soil material canopy over a tunneling course to provide pre-supported tunneling ground in front of the face (see Figure 4-6). On account of its brute-force approach of replacing weak soils with grouted soil, jet grouting is a method that has control over achieving a high degree of improvement of the targeted ground, and achieving the required strength of the soils. However, the surface disturbance would be significant requiring a large staging area and a messy grouting operation. Figure 4-7 shows the jet grout plant set up on the street, and Figure 4-8 shows a jet grouting operation on urban streets.

Figure 4-6: Jet Grouting Canopy by Horizontal Drilling

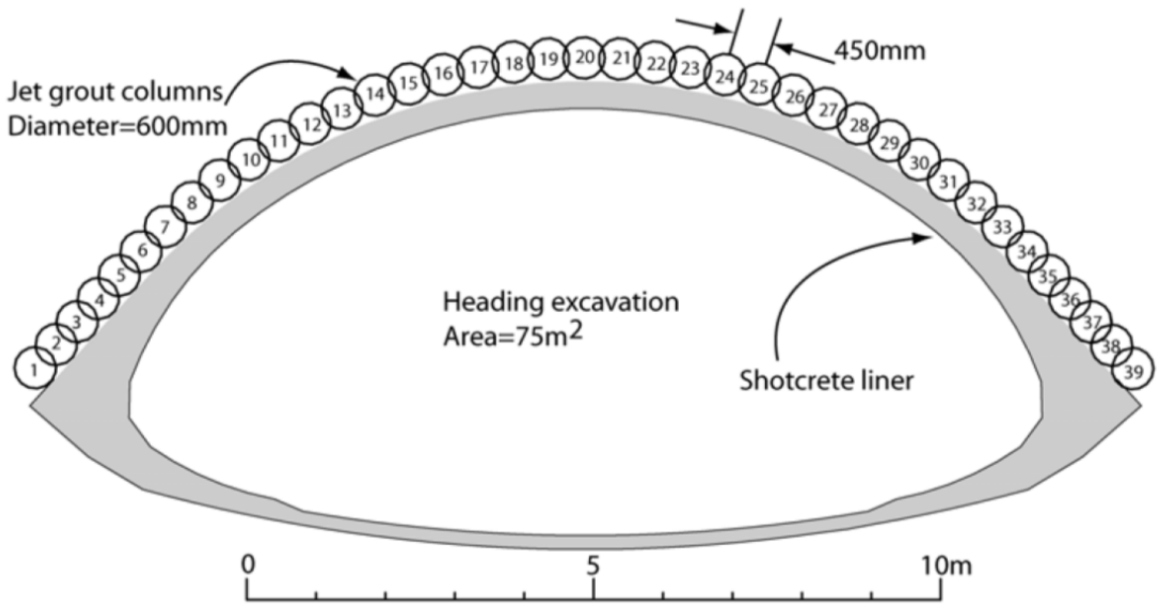


Figure 4-7: Staging for Jet Grouting Operation

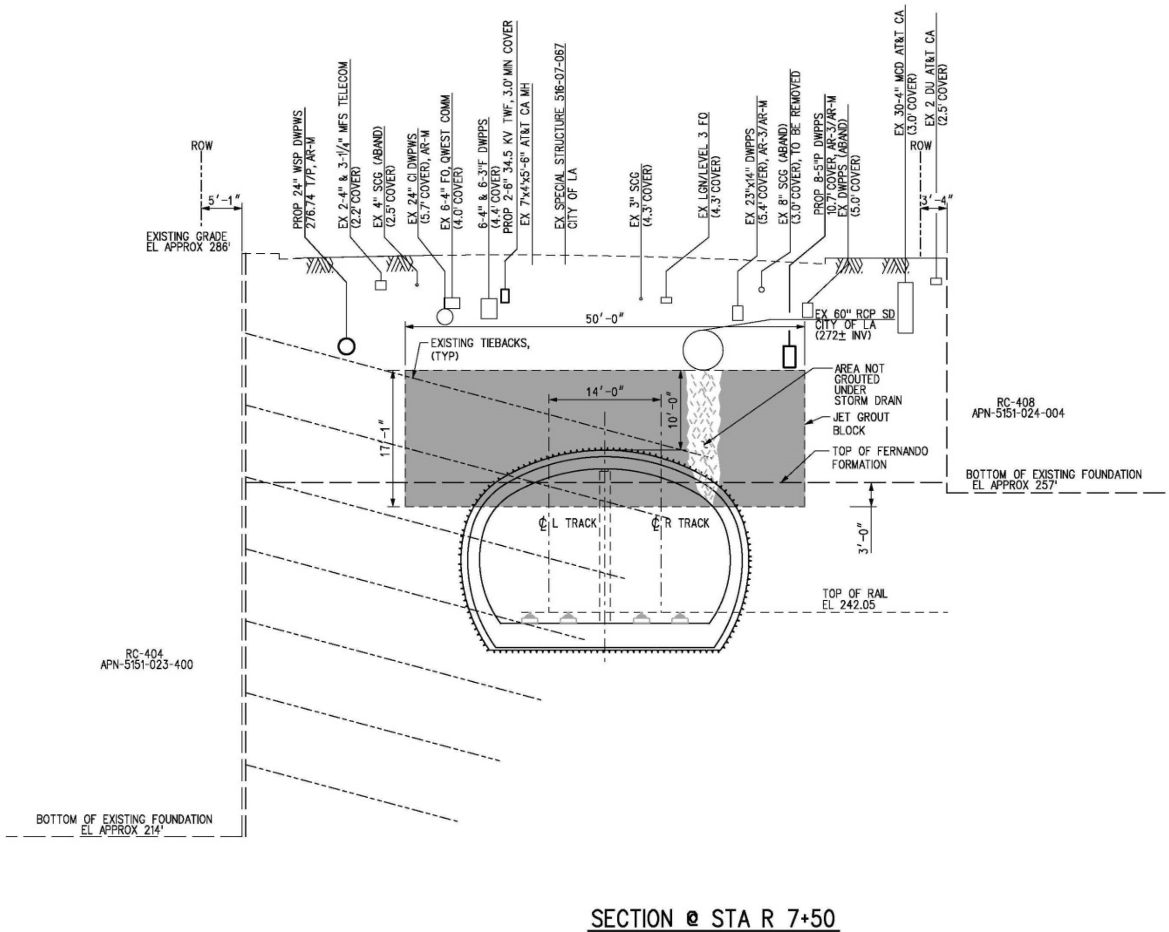
Figure 4-8: Surface Jet Grouting Operation

Along the Flower Street, vertical jet grouting would be the most effective technique to improve the ground conditions to permit tunneling with open-face shields or SEM. Jet grouting is considered the most suitable for the soil conditions in this area and would provide adequate strength and size of the grout-soil mix block above the tunnel crown. The method has relatively good control over assuring the quality of grouted soil blocks. Yet, the extensive environmental impacts on the street, the risk of utility damages, and the risk of incomplete ground improvement remain. Figure 4-9 shows typical jet grout zone that could be installed from the street above SEM tunneling section with abandoned tiebacks intersecting the tunnel and various utilities within the subsurface. A major risk is the interference created by utilities that prevent full coverage by jet grouting. As can be seen in Figure 4-9, it would not be possible to fully jet grout below the 60 inch diameter storm drain and a "window" of ungrouted ground would be present above the tunnel. The ungrouted ground would tend to transmit groundwater, and if intersected by the tunneling, would be the point where an uncontrollable run or flow of soil into the tunnel would start, which in turn can progressively lead to a sinkhole at the street surface.

The use of jet grouting canopy by horizontal drilling alone (see Figure 4-6). would not be considered feasible for the tunnel under the Flower Street. This technique is rarely used in North

America. As tunneling takes place, it would be necessary to drill the holes out at an angle from the heading every few rounds over the length of the tunnel drive. This process is a very slow and difficult operation in order to achieve and ensure adequate coverage and full support of the ground.

Figure 4-9: Jet Grout Zone above SEM Tunnel on Flower Street



4.5.3 Ground Freezing

Ground freezing is based on withdrawing heat from the soil. The process converts in-situ pore water into ice. The ice binds the soil particles imparting strength to the frozen soil mass. For the creation of a frozen soil body, a pattern of vertical (in very special instances horizontal or inclined) freeze pipes have to be installed in drill holes. Each freeze pipe (or freeze "pile: as referred to in the industry) consists of the open-end inner pipe and the closed-end freeze pipe. The inner pipe is used for the supply of a cooling medium, usually brine, or liquid nitrogen. The inner pipe is connected to the supply line and the outer pipe to the return line (when brine is used) or the exhaust line (when liquid nitrogen is used). The coolant flows through the inner pipe. On its way back through the annulus, the coolant picks up heat from the soil. The freeze takes place over time as the frost penetrates the soil and a ring of frozen soil grows around the pipes. Figure 4-10 shows the individual freeze pipe arrangement.

The freeze pipes are arranged to achieve the required shape of frozen soil mass. The initial setup and freezing time of ground freezing operation must be considered for significant schedule impact. Figure 4-11 and Figure 4-12 show freeze pipe installation and ground freezing operation in an urban area. Setting up for the freeze, establishing the freeze, tunneling, and finally demobilizing the freeze would take months of time and occupy at least two to three traffic lanes.

Along the Flower Street section of the Regional Connector, feasibility of ground freezing has a fatal flaw of the being substantially dry and, in a sense, “not freeze-able,” and thus not suitable to mitigate unstable ground conditions during tunneling. The groundwater within the alluvium along the Flower Street is perched groundwater. Once the limited perched groundwater is frozen, the freeze would not continue. In this situation, the freeze would be incomplete as non-uniform and discontinuous, and would not provide the sufficient ground stability for tunneling under Flower Street. Also, as can be seen in Figure 4-13, ground freezing would block off several lanes of the traffic for months of time in order to set up for the freeze, tunnel, demobilized, and restore the street. In addition, were there enough groundwater present, ground freezing from the surface would have extensive surface impacts and problems getting full coverage with utilities in the way. To freeze from underground, pipes installed horizontally would need to be drilled large distances from a large excavation (shaft) in order to position them properly around the tunnel.   Such a scheme is impractical and ineffective.

Figure 4-10: Individual Freeze Pipe Arrangement

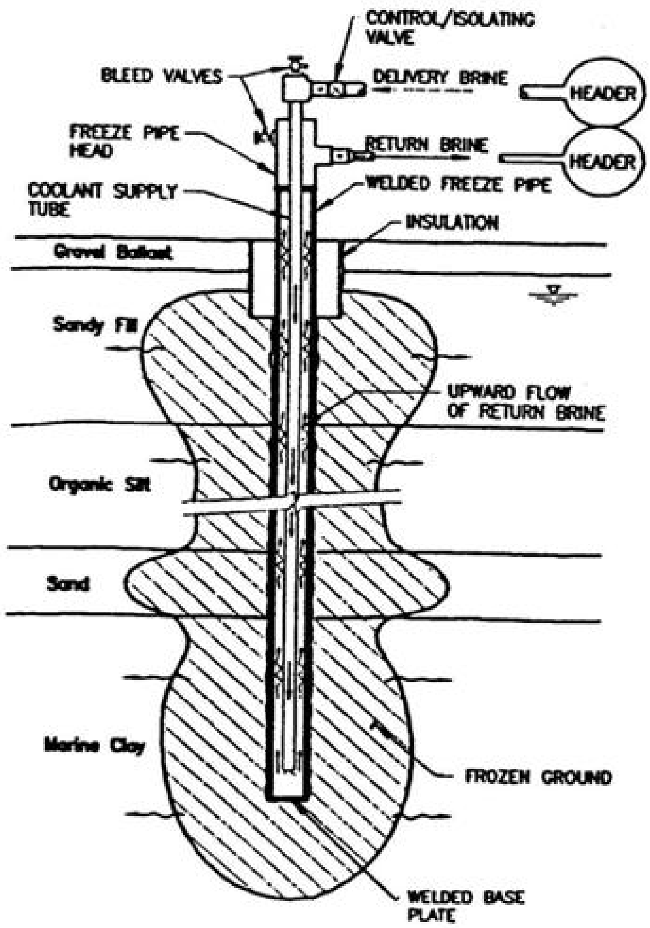


Figure 4-11: Ground Freezing Pipe Installation in New York City, Prior to Starting Freeze

Figure 4-12: Ground Freezing Operation

Figure 4-13: Freeze Pipe Array

4.5.4 Compensation Grouting

Compensation grouting is known as correctional measures, rather than a preventive measure to mitigate ground settlement due to the excavation or tunneling. For compensation grouting, steel or plastic grout pipes with sleeve ports are installed in the holes drilled from the ground surface or grout pits prior to tunneling. Typical application for protection of buildings is shown in Figure 4-3, items 7a and 7b. Compensation grouting displaces the surrounding soils at grouting points along the grout pipe to compensate for settlement caused by construction activities, such as tunneling. A fluid grout mix is used to hydro-fracture the ground, and fills any pre-existing discontinuities and the fractures created in the process. As the grout penetrates the ground it forms a network of wedges and displaces/heaves the ground, “compensating” for settlement. As tunneling advances and settlement occurs, compensation grouting is activated to keep the settlement within the acceptable limit. Once the ground movement is stabilized, the grouting pipes and equipment are typically abandoned in place. Grout pipes are typically limited to a maximum length of 200 ft. Compensation grouting would be only suitable for mitigation of settlement of utilities by open-faced TBM tunneling or SEM tunneling along Flower Street. Implementation would require shafts in the street required to install grout pipes. Compensation grouting would be completely ineffective in avoiding excessive ground loss and collapse of the tunnel face leading to a sinkhole in the street.

4.5.5 Compaction Grouting

Compaction grouting involves injection of very stiff grout with low mobility at high pressure creating grout columns and densifying surrounding soils at the injection points. Grout holes are usually vertical and spaced on a grid of 6 to 12 ft. The grout bulbs are not designed to overlap or contact with each other, as the soils left in place between grout columns are presumed to be densified. Inclined holes if required to avoid utilities, should be no more than about 20 degree from the vertical line. An inclined or horizontal hole provides a greater horizontal effective area resulting refusal at low grout pressure due to surface/utility heave and resulting incomplete ground improvement. In general, a vertical column of grout and the resulting compacted soil provide the better support than inclined. Key to successful compaction grouting is deposition of the grout in such a manner that it remains in a globular mass at the injection point such that the surrounding soil can be radially densified.

Compaction grouting is a technique developed in the 1970's and has had limited use. Subsequent development of compensation grouting provided a more manageable and effective technique for tunneling applications. Compaction grouting is seldom a preferred choice in today's practice, or even considered at all, as a tunneling settlement mitigation method. Also, the advent of pressurized face tunneling, which has reduced tunneling ground losses, has decreased the need. Compaction grouting is shown in Figure 4-3 for completeness to illustrate the various methods. For the specific case shown, use from inside a very large tunnel (54 foot diameter Alaskan Way Tunnel) is proposed to mitigate settlement for a very specific situation where grouting from the ground surface would not be possible (under existing railway tunnel at depth of over 100 ft). However, the compaction grouting for the referenced tunnel has not yet taken place.

The alluvial deposits along South Flower Street would be difficult to improve by compaction grouting. Keeping the deposition of the grout in a globular mass would be difficult because of the interlayered nature of the soils. The high pressure grout may just crack the weak soil layers creating thin lenses of grout. Also, trying to grout effectively at high pressures above a wide SEM excavation cannot be done ahead of the face, and would not prevent running ground. Essentially, compaction grout would only be used at low pressures to fill voids that have already developed. The SEM tunnel depth along the Flower Street is too shallow and there is no arresting layer above the tunnel that would stop a void so that the void could be filled before it reached the surface. Thus this technique is considered to be not effective for preventing large ground loss and reducing the risk of surface subsidence if Flower Street were to be tunneled.

4.5.6 Summary and Conclusions on Ground Improvement for Tunneling

Ground improvement using jet grout, compaction grout, permeation grout, compensation grout, or ground freezing would have to be employed from the ground surface for tunneling with an open face shield or by SEM under the Flower Street. However, as was the case on LACMTA's construction along Lankershim Street for the Red Line, the grouting operations will create extensive environmental impacts involving lane closures and multiple equipment operations. There is also significant possibility for damage to utilities, basements, and at the street level due to grout pressure and grout flowing into unplanned or undesirable locations. Similarly, the ground freezing operations will also create extensive environmental impacts on the street and may cause damage to utilities, basements, and at the street level. In fact, the numerous utilities will be obstructions to the grouting and ground freezing operations increasing the risk of incomplete ground improvement. The existing utilities along the Flower Street include an 84-in diameter reinforced concrete storm drain which has the invert level as deep as 18 ft below ground surface. Additionally, extensive geotechnical instrumentation and monitoring points will need to be installed and monitored for any ground improvement operation.

4.5.7 Summary of Feasible Ground Improvement Methods

The following Table 4-1 summarizes the evaluation of various ground improvement methods discussed above.

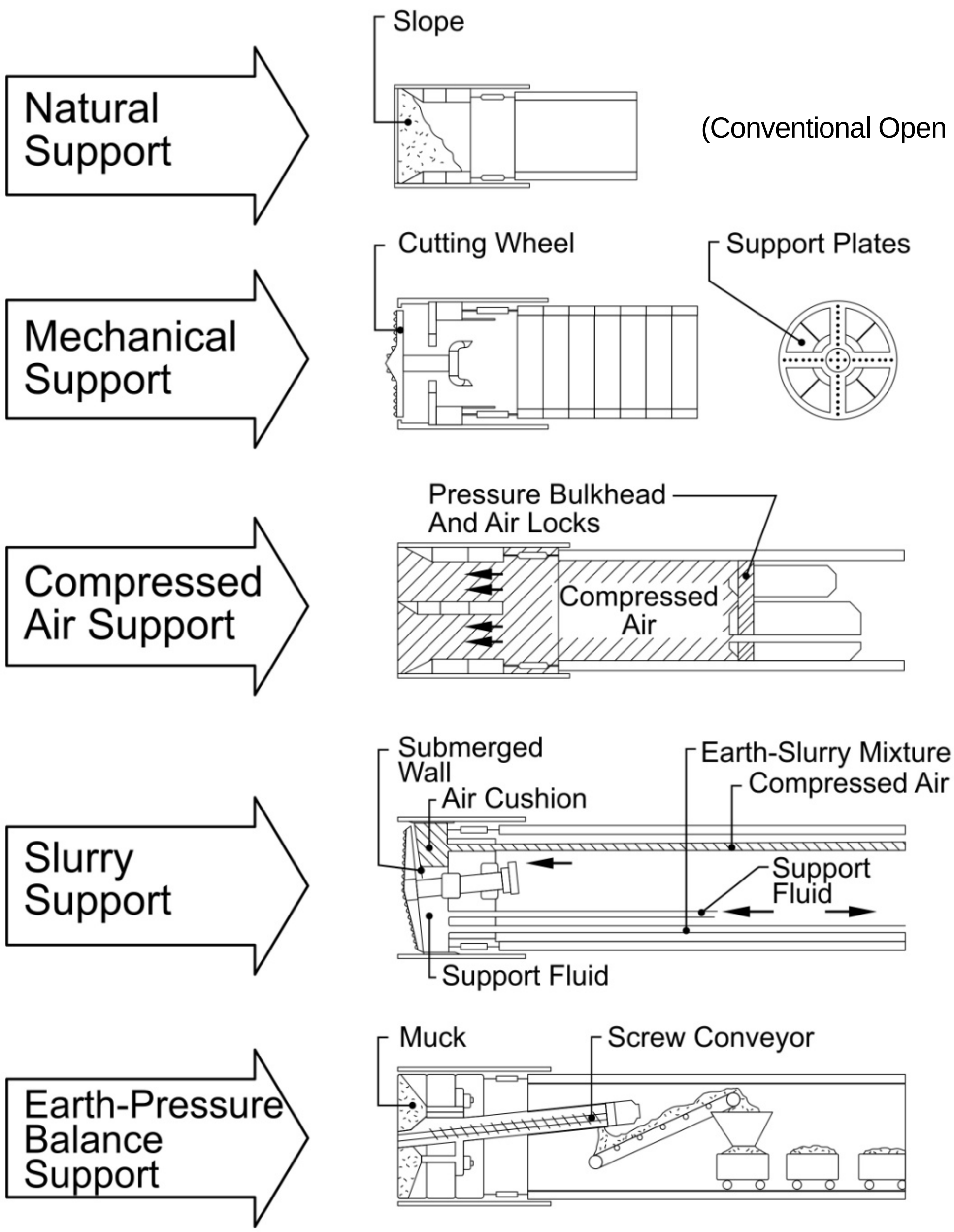
Table 4-1: Summary of Evaluation of Ground Improvement Techniques

Ground Improvement Technique	From Ground Surface	From Inside Tunnel
Permeation Grouting	• Difficult to permeate grout through the soil because of fine contents • Non-uniform grout block because of the interlayered soil structure • Difficult to control QAQC • High surface disturbance • Low tunneling schedule impact	• Difficult to permeate grout through the soil because of fine contents • Non-uniform grout block because of the interlayered soil structure • Very difficult to control QAQC • Low surface disturbance • High tunneling schedule impact
Jet Grouting	• Widely applicable for soil conditions • Relatively uniform grout block • Better control on QAQC • High surface disturbance • Low tunneling schedule impact	• Widely applicable for soil conditions • Insufficient grout block size • Better control on QAQC • Low surface disturbance • High tunneling schedule impact
Ground Freezing	• Insufficient quantity of groundwater • Non-uniform frozen mass because of the interlayered soil structure and perched groundwater condition • Difficult to control QAQC • High surface disturbance • High tunneling schedule impact	• Insufficient quantity of groundwater • Non-uniform frozen mass because of the interlayered soil structure and perched groundwater condition • Difficult to control QAQC • Low surface disturbance • High tunneling schedule impact
Compensation Grouting	• Extensive set up before tunneling • Correctional measures rather than prevention measures • Not recommended for high riser buildings • High surface disturbance • Low tunneling schedule impact	• Not applicable: Must be prepared and ready prior to tunneling.
Compaction Grouting	• Correctional measures rather than prevention measures • Difficult to control QAQC • High surface disturbance • Low tunneling schedule impact	• Difficult to control QAQC • Moderate surface disturbance (heave) • High tunneling schedule impact

4.6 Pressurized-Face (Closed-Face Shield) Tunneling

Tunneling with a shield refers to use of a circular tunnel shield with either an open face or a closed face (“pressurized face”). Types of tunnel shields are shown in Figure 4-14.

Figure 4-14: Types of Shield Machines

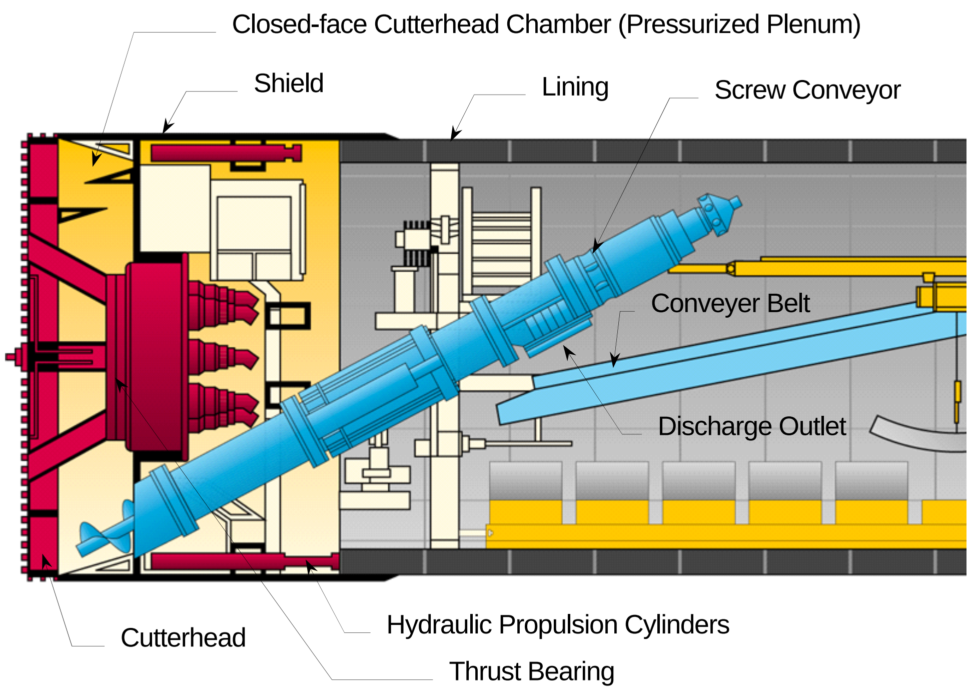


The cylindrical shield provides ground support and permits safe installation of a tunnel lining. Open-face shield tunneling is discussed in Section 4.3 of this report. Closed-face tunnel shields are the modern-day evolution of a tunnel shield that once used compressed air to stabilize the ground and control groundwater. A closed-face tunnel boring machine, also generically termed “pressurized-face,” has a rotating cutter head inside a sealed chamber at the front of the machine. There are two general types: slurry type, where the excavated soil is removed by mixing with slurry injected into the cutterhead chamber and pumped out of the tunnel as slurry, and earth pressure balance type, where pressure is maintained on the soil itself and the soil is removed as a semi-solid in muck cars by rail or by a conveyor. These two types of machines are known as Slurry Machines and Earth Pressure Balance Machines (EPBM).

In recent decades, pressurized-face TBMs have become the tunneling method of choice for projects in the Los Angeles area. The recent Eastside Extension project was successfully constructed using pressurized-face TBMs. The use of pressurized-face TBMs for LACMTA projects follows the recommendation in the 1995 report of a specially convened Tunneling Advisory Panel (TAP) entitled “Report on Tunneling Feasibility and Performance,” wherein it is recommended that “…[LACMTA] for future tunneling, consideration be given to application of earth pressure balance tunnel boring machines….” The report further states “The choice of whether to permit an open face shield in preconditioned ground or require an earth pressure balance machine will depend on the degree of risk [Metro] wishes to share and on the overall cost.” Preconditioned ground assumes the use of specific grouting techniques whereby soil stabilizing material such as cement is injected to reinforce the strength of the earth where tunneling may occur. Such preconditioning is used where ground conditions are less than desirable for TBM activity such as open face tunneling. The LACMTA Board accepted TAP’s recommendation and LACMTA has instituted the policy to reduce or avoid construction risk of excessive settlement with open face tunnel shields by requiring pressurized-face tunneling. Since the Eastside Extension project, LACMTA’s practice for soft ground tunneling has been to use pressurized-face tunneling equipment to control ground and prevent subsidence. Figure 4-15 shows the EPBMs used for tunneling of the LA Metro Eastside Extension Project Contract No. CO800. Figure 4-16 shows a typical EPBM in cross section.

Figure 4-15: EPBMs Used for Constructing Los Angeles Eastside LRT Tunnels

Figure 4-16: Cross-Section of Typical EPBM



4.7 Transit Structure Configuration

The design of underground structures along Flower Street has gone through various design iterations including double-track box for line track sections (close track centers of 14 ft), double crossover for operational purposes, 5th/Flower Street Station, and a pocket track. As stated in Section 4.2, practical construction of these structures is by cut-and-cover. Although the pocket track has been eliminated, a crossover is still needed between 2nd/Hope and 7th/Metro Center Station and is located at 6th & Flower Street, immediately North of the existing Blue Line tail tracks.

4.7.1 Deferred 5th/Flower Street Station

The DEIS/DEIR alignment included the underground 5th/Flower Street Station between 4th and 5th Streets under Flower Street. According to Metro's Design Criteria, the future station should be constructed on a 370 ft long tangent alignment with maximum vertical grade of one percent. The 5th/Flower Street Station, however, was eliminated due to cost considerations with LACMTA Board's direction for the design and alignment not to preclude future construction of a 5th/Flower Street station. The Advance Conceptual Engineering and the FEIS/FEIR documented the Locally Preferred Alternative (LPA) and the elimination of the future station with LACMTA Board's direction. Deletion of the future station resulted in a reduction of construction impact along Flower Street. The Baseline alignment using cut-and-cover construction allows the construction of a station in the future from the street surface. Discussion on each alternative with respect to the future 5th/Flower Street station is presented in Section 5.

4.7.2 Pocket Track

LACMTA Rail Operations at the onset of the project indicated a need to have a pocket track within the Regional Connector system to accommodate trains going out of service, systems disruption, or peak service. A pocket track permits a managed, quick recovery of the system when a train has to be taken out of service, so the required level of service can be maintained. The pocket track was deleted from the subsurface project area configuration and will be provided elsewhere in the system. The elimination of the pocket track enabled narrowing the width of cut-and-cover along Flower Street, thereby reducing construction impacts.

4.7.3 Profile Requirements for Rail Operations

Metro Design Criteria limits the grade of the track profile for 3-car trains. The ruling (maximum) grade is 5% for grade length of 500 to 1,000 ft between vertical points of intersection and 6% for grade length of less than 500 ft between vertical points of intersection. Simultaneous horizontal and vertical curves further reduce the maximum allowable grades, as can other operational considerations. Also the track profile can result in a reduced design speed that may not meet Metro Design Criteria requirement for operating headway. The grade constraints limit the track profile and the depth that can be considered for tunneling.

4.7.4 Crossovers

LACMTA Rail operations require a double crossover on Flower Street for operational flexibility. The project includes a double crossover with standard No. 10 turnouts, which will allow higher operating speed through the crossover during single track operations.

4.7.5 Tie-in at 7th/Metro Center Station

The Regional Connector must meet the existing tail tracks at the north end of the 7th/Metro Center Station. The existing tail track location and elevation is a control point for the project. The end wall of the existing 7th/Metro Center Station structure has a "knock-out panel" (a section of wall with minimal or no steel reinforcing). The knock-out panel facilitates extending the transit line by making it easy to demolish the panel without compromising the integrity of the structural tunnel walls. With the shallow cover over the existing structure, of about 20 ft, the future connection was expected to be made from a cut-and-cover excavation.

It is not possible to change the existing tail track elevation without reconstructing the entire existing structure, significantly and unacceptably impacting the active rail operations of the Blue and Expo Lines and likely closing down 7th/Metro Center Station. When the Expo Line is extended to Santa Monica in late 2015, LACMTA will operate two of the heaviest ridership LRT lines in the country. Re-configuration of 7th/Metro Center Station on a long-term basis of a year or more would not be acceptable. Reconstruction of the existing tail track was not addressed in the EIR and is outside the limits of the Regional Connector project. If this were proposed it would have major environmental, cost, and schedule impacts.

4.7.6 2nd/Hope Street Station

The 2nd/Hope Street Station in the northern end of the Flower Street section of the project is fixed in its horizontal plan location. The alignment proposed at this station has physical and right-of-way constraints. The minimum radius of curvature at both ends of the station is 583 ft for both right and left track centerline, which is the minimum radius a tunnel boring machine can operate. Curve radii cannot be increased because of the horizontal alignment and right-of-way constraints. Within certain limitations, vertical adjustments are possible.

4.7.7 4th Street Bridge Foundations

The existing 4th Street bridge foundations are on both sides of Flower Street, beneath the sidewalks and partially within the street footprint. It is understood that a seismic retrofit has been performed on the bridge structure.

In the LPA, the tunnels pass between the bridges' drilled shaft and battered pile foundations. During Preliminary Engineering an analysis was performed to evaluate the Regional Connector's pressurized-face TBM tunnel impact to the bridge foundations. As a result of this analysis, it was determined that there would be no significant impact to the bridge foundations.

The Low Alignment, discussed in details in Section 5.0, requires the pressurized-face TBMs to pass beneath the pile foundations. Further engineering analysis would be required to assess the impacts and design requirements for possible temporary support of the bridge foundations during construction, for example installation of foundation underpinning. The structure may also require permanent foundation modifications due to possible changes in foundation soil support. Temporary and permanent bridge modifications would require extensive coordination with and approvals by the City of Los Angeles. It is concluded based on the above discussions that there is substantial risk of mitigations being more costly with the Low Alignment than with LPA.

4.8 Underground Obstructions to Tunneling – Tiebacks

4.8.1 Tiebacks on Flower Street

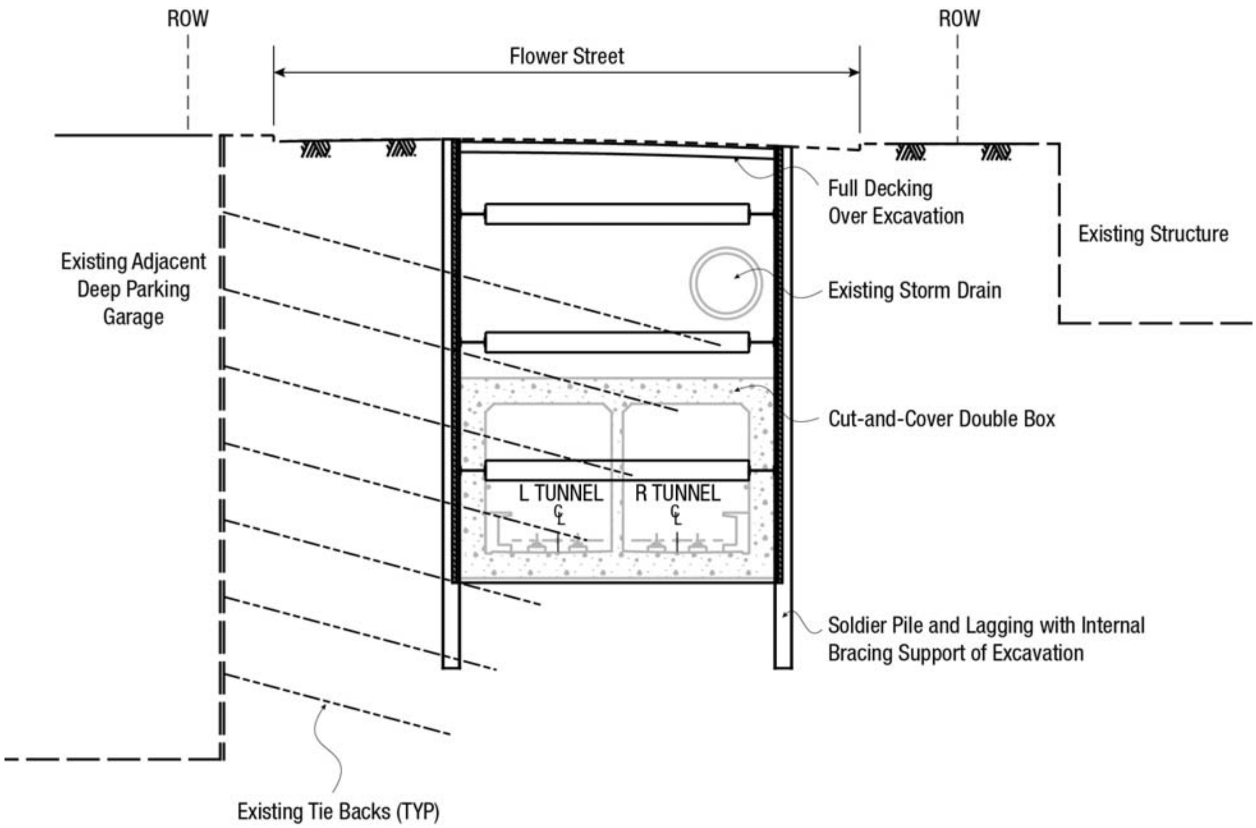
The existing deep basement/parking garages along Flower Street used tiebacks (steel bars or cables grouted in the ground) to laterally support the original excavations during construction. The steel tiebacks extend deep below ground across the width of Flower Street from both sides along the alignment and have been abandoned in place. Tiebacks exist every six to eight feet in this reach of the project. There are hundreds of tiebacks that impact the alignment, particularly south of 4th Street and even more so south of 5th Street. Existing records show the number of tiebacks along Flower Street segment of the Regional Connector as over 500 and potentially up to 800. Figure 4-17 shows a typical arrangement of existing tiebacks under the Flower Street.

It is commonly considered an unnecessary effort to remove the tieback and industry practice is that tiebacks are left beneath the streets but untensioned. Also, where removal is intended for construction reasons or required by regulations, removal is not assured since the force required for removal has to overcome the tieback bond with the ground. Failure of the tieback tendon can occur, leaving the tieback irretrievably in the ground.

Use of tiebacks for temporary support of excavations came into practice in Los Angeles in the 1970's. The initial method of construction was to drill a large-diameter drill hole (12 inches, possibly larger), similar to that used to construct drilled-shaft foundations with or without an enlarged end, commonly called a belled end. In Los Angeles, the "Old Alluvium" and Fernando Formation constitute firm ground conditions, and resulted in stable drill holes without casing. The tieback tendon was cast in the concrete filled drill hole. Later developments in the construction industry led to smaller diameter drill holes (6 inch or less) and a pressure-grouted anchorage.

It has been found that exposed tiebacks can be pathways for water to flow into excavations or tunnels. Also, it should be noted that many of the existing tiebacks were installed relatively soon after tieback technology developed when quality control of drilling and concreting the holes was likely not well developed, thus adding to the numbers of leaky tiebacks. When encountered during tunneling, groundwater seepage along the periphery of the tieback could erode the soil, bringing soil and water into the tunnel. If uncontrolled, this can progressively lead to excessive settlement, which if allowed to continue can create a sinkhole at the ground surface.

Figure 4-17: Existing Tiebacks on Flower Street



4.8.2 Tieback Hazard for Pressurized-face Tunneling

In either the tensioned or untensioned state, tiebacks are a hazard to closed-face (pressurized-face) tunneling as the cutter head will be entangled in the tiebacks which can damage the machine, stall advancement of the excavation, and create excessive ground loss. Uncontrolled efforts to extract the tiebacks would lead to excessive ground loss (more soil excavated than tunnel size), which in turn leads to unacceptable settlements beneath utilities, roadway surfaces and overlying structures. If tiebacks were entangled with the cutterhead, the entangled and displaced tiebacks could disturb surrounding soils and raveling of the adjacent ground could occur, causing settlement and potential damage to overlying structures.

The TBM cutterhead is not capable of “chewing-up” or otherwise processing a steel tieback. The TBM will need to stop advancing and substantial down time will be required to work within or ahead (in front) of the TBM cutterhead to manually remove a tieback which could lead to ground loss. As can be seen in the photo of typical pressurized-face TBMs in Figure 4-15, the cutterhead is a huge barrier between tunnel workers and a tieback that would have to be removed. The pressurized-face machine is designed to control excavation of the soils, which in reverse, practically prohibits tunnel worker access ahead of the machine. The machines are designed with sectional doors in the cutterhead and/or a man-way hatch that can be used to access the ground and cutterhead interface to find, cut and remove a tieback. This design feature is to make access possible, but does not make the process easy or automatically safe.

Working through the spokes of the cutterhead (see Figure 4-15) or ahead of the cutterhead will add significant delay to the construction schedule, even if firm ground conditions are present. If ground water is present and soils are unstable, grouting would be required to create firm ground conditions or the work would have to be done under compressed air (hyperbaric conditions) with appropriate safety cautions instituted. Removal of one tieback would likely have to be done in several sections to free the steel tendon from the ground and cutterhead. Dealing with one or two tiebacks in this manner might be practical. The result would still be a substantial delay and significant cost increase. Encountering hundreds of tiebacks, which is the case here in this section of Flower Street, renders the use of a pressurized-face TBM not viable.

4.8.3 Tieback Hazard for Open Face Shield or SEM Tunneling

Tiebacks in the face of an open-face shield can be removed in a more direct manner compared to the pressurized-face TBM since the ground is directly accessible. However, instability of the face and potential for soil runs poses unacceptable risks and makes the method unsuitable for use in alluvial and fill materials without complete soil stabilization or ground treatment. An open-face shield to get access to tiebacks requires removing the soil from the tunnel face in the shield, thus there is no protection from the hood and breasting or from the excavated soils sloping on the breast tables or in the pan at the front of the shield. This can lead to runs in the sandy silty soils. Another complication is that the tiebacks would cross the tunnel face at an angle. Removal of a tieback in the top heading (upper part of the tunnel face) would be relatively straight forward in comparison to the remaining portion of the tieback that went fully across the tunnel face. In the latter case, the tunnel heading would have to be excavated; the ground would have to be supported to exhume the tieback; and the tieback would be cut off at the tunnel shield periphery. A time consuming effort, including ground improvement for the unstable soil conditions, will be required. During construction of the Seattle Bus Tunnel, hundreds of tiebacks were removed from an open shield but there was substantial loss of ground and two sinkholes. See also discussion of risks associated with open-face shield tunneling in Section 4.3.

For SEM construction, tiebacks would be directly removable from the tunnel face. Absence of a shield, however, has consequences of increased risk of creating unstable conditions, where mixed-face soil conditions are present and any complications resulting from removal of tiebacks.

4.8.4 Advance Tieback Removal to Mitigate Tunneling Hazard

Removal of tiebacks in advance of tunneling can be done by constructing tieback removal pits or trenches to mitigate the tieback hazard. In practice, the location of tiebacks would need to be identified. Where their location is fairly well known, a few tiebacks encountered by TBM tunneling can be removed in advance where the value of more tunneling greatly outweighs the cost of proactive advance removal. This situation exists along Flower Street next to the Bank of America building (tunnel reach between Sta 19+00 and Sta 28+00). In this area, up to twenty tiebacks can be extracted by trenching, which allows tunneling a block further to the south. In this specific instance, mitigation by excavation and removal in advance of tunneling is planned.

A complicating condition is that as-built records may not be available or not reliably documented to be able to plan and execute such temporary works for advance tieback removal. Geophysical techniques, such as a magnetometer survey performed in the tunnel might be able to find some tiebacks, but if used in drilled holes, would be like "looking for a needle in a haystack." A geophysical method at the ground surface is not known to exist that can reliably and simply find the tiebacks at depths of possibly 40 to 80 ft below the ground surface. Thus even with rigorous study of records and field investigation, the risk of not finding and removing all the tiebacks to eliminate the tieback hazards would remain. Also, even if the tunnel profile were to be established to avoid existing tiebacks with a specific clearance of several feet, there would still be the risk of encountering during tunneling a tieback that was installed longer than indicated by available records. The only feasible direct method to remove tiebacks for the substantial extent that are known to exist for safety on Flower Street would require an independent excavation, a trench with suitable ground support to explore, cut, and remove tiebacks. The task of digging trenches along Flower Street would have significant impacts to traffic and pedestrian disruption and may require utility relocations. In effect, it would have impacts like cut-and-cover construction.

5.0 ALTERNATIVE ALIGNMENTS AND TUNNELING METHODS

In February 2012, stakeholders on Flower Street requested LACMTA to investigate extending the bored tunnels further south, along Flower Street, and reduce the length of the cut-and-cover construction. To address the stakeholder concerns, an alternate lower tunnel profile ("Low Alignment") was developed to allow continuation of tunneling south of 4th Street, to a point south of 5th Street, which simultaneously reduced the overall length of the cut and cover construction. Based on then available existing building tieback information, the lower profile was developed to permit the extension of bored tunnels, at a Low Alignment, avoiding potential conflict with these tiebacks.

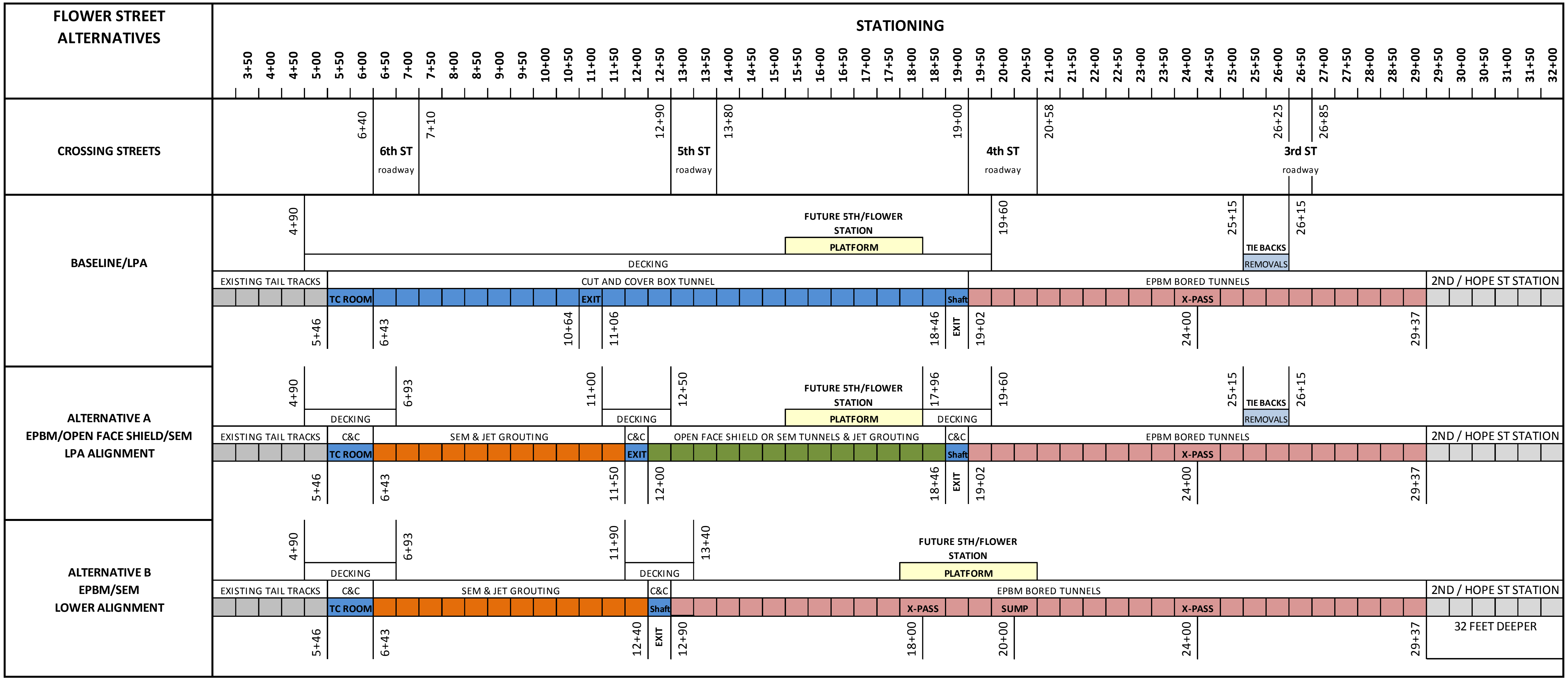
In the April 2012 LACMTA Board meeting, the Board approved the Project definition (the "Base Design" referred to herein as "Baseline") for the Regional Connector Transit Corridor Project. At this meeting, the Board directed staff to examine various value engineering and cost saving methods to determine if certain specific construction methods and design features could be incorporated to mitigate potential construction impacts along Flower Street, without causing an increase to the Life of Project (LOP) budget. If it can be completed within the current LOP budget then amend the Locally Preferred Alternative (LPA) of the Regional Connector Transit Corridor Project to include the design features. The Board further directed staff that if the analysis determined that the methods exceeded the LOP budget, the construction methods and design features shall be included during construction procurement, as bid options, to allow design-build proposers a process to include each feature and determine if it could be accomplished within the LOP budget.

At the time of the April 2012 Board Meeting the Flower Street mitigation method under consideration was the "Low Alignment". This alignment would extend tunneling from the termination of tunneling at south of 4th Street, to a point south of 5th Street, and would subsequently reduce the length of the cover and cut section along Flower Street. Construction impacts in the block between 4th and 5th Streets would be further mitigated by limiting the construction ingress and egress to points south of 5th Street.

Two tunneling Alternatives, A and B, have been advanced to determine if they reduce or mitigate construction impacts or lower the risks to construction safety, cost, and schedule compared to the Baseline. The Baseline consists of EPBM tunneling to south of 4th Street and the cut-and-cover with street decking system to the 7th/Metro Center Station along the LPA profile. Alternative A ("EPBM/Open Face Shield/SEM LPA Profile") would extend tunneling south to the 7th/Metro Center Station through the use of a combination of EPBM, open-face shield, and SEM tunneling along the LPA profile. Alternative B ("EPBM/SEM Low Alignment") would extend tunneling south of the 7th/Metro Center Station through the use of a combination of EPBM and SEM tunneling along the Low Alignment. Both Alternatives A and B would minimize cut-and-cover construction, limiting it to the tie-in with the 7th/Metro Center tail tracks and street-surface exit shafts.

In summary, the types of construction for the Baseline and these two tunneling alternatives are shown in Figure 5-1.

Figure 5-1: Baseline and Tunneling Alternatives



5.1 Baseline Alignment and Profile

The Baseline alignment is as presented in the Final Preliminary Engineering design. The Baseline alignment profile is presented in Figure 5-2.

This configuration assumes EPBM construction between the 2nd/Hope Street Station and 4th Street where a reception pit allows for the extraction of the EPBM for reuse on the second tunnel drive. In conformance with LACMTA's policies, and the ground conditions along the alignment, a pressurized closed-face TBM would be designated for the bored tunnel construction. Per the EIS/EIR, material excavated through the use of pressurized face TBM through 4th Street will be transported back along the alignment within the newly constructed tunnels and removed at the TBM insertion site in Little Tokyo at the northeast corner of 1st and Alameda. The depth of the tunnel was selected to avoid direct conflicts with and adverse impacts on the existing 4th Street bridge foundations, avoid most existing tiebacks between 3rd and 4th Streets, and provide sufficient ground cover over the tunnel at the reception pit south of 4th Street. Refer to Section 4.8 for discussion of tunneling and tiebacks.

Cut-and-cover methods of construction are assumed between 4th Street and the existing 7th/Metro Center Station interface. This will require the relocation of some utilities, and the installation of soldier piles which will begin to create the alignment structure box in Flower Street from 4th to 6th Street. In addition, the existing Pacific Electric tunnel will be encountered in the cut-and-cover section. Its portion within the cut-and-cover excavation will be demolished by top-down excavation. Excavation of the top portion of the street and a temporary concrete decking system between the soldier piles will take place using a phased approach to minimize impacts to traffic by allowing at least three lanes to remain open during the day time period. The Baseline alignment uses two locations within the cut-and-cover excavation along Flower Street to remove soil and construct the temporary and permanent structures. The alignment allows for construction of a track crossover, does not preclude the construction of a future station at 5th and Flower Streets, and allows for simple extraction of the existing tiebacks. An additional open cut excavation pit will be required for removal of existing abandoned tiebacks in the course of approximately 100 ft of EPBM tunneling south of 3rd Street along Flower Street.

The alignment is designed for light rail operating speed of 55 miles per hour (mph) along the Flower Street portion.

Metro Rail Design Criteria (MRDC) Section 10-Operations state the following requirements:

a. Light Rail operational headway to be no greater than 5-minute interval for single-line normal operations at the branch line, and 2-1/2 minute at the trunk segment and through junctions.

b. Light Rail design headway to be no greater than 200 seconds for single-line normal operations, and no greater than 100 seconds for trunk segments and through junctions.

The Baseline alignment satisfies the operational requirements listed above.

5.2 EPBM/Open Face Shield/SEM LPA Profile Alternative (Alternative A)

This alternative extends tunneling south to the 7th/Metro Center Station through the use of a combination of EPBM, open-face shield tunnel boring, and sequential excavation method (SEM) construction techniques in series.

Alternative A, as shown in Figure 5-3 is defined as follows: EPBM-bored tunnels are constructed following the Baseline/LPA alignment to south of 4th Street, then open face shield tunnel excavation from 4th Street to 5th Street (abandoning the shields underground), and SEM tunnel construction from 5th Street to the 7th/Metro Center Station tail tracks structure.

Without taking special mitigating measures, this alternative has substantial risk of instability of the tunnel face with the potential for soil runs during tunneling by open-face shield or SEM, particularly when dealing with tiebacks. The open-face shield section of the alignment has diminishing thickness of the Fernando Formation above the shield. There would be about 1 to 7 ft of Fernando Formation cover over the open-face shield section as shown on Figure 5-3. However, the top of the Fernando Formation is an erosional surface and the geologic profile is based on a limited number of borings. Thus the thickness of the Fernando Formation above the tunnel has substantial uncertainty and stability of the open-face shield tunnel face is not guaranteed. Ground improvement by jet grouting would be required.

The open-face shield tunneling in this alternative would encounter the Pacific Electric tunnel which may include pea gravel backfill between its final lining and the surrounding ground as commonly used in earlier tunneling methods. As the open-face shield tunnel approaches, this backfill may run into the new tunnel creating large voids around the Pacific Electric tunnel directly underneath Flower Street. Backfill will be necessary under this alternative at the location of the Pacific Electric tunnel to permit practical tunneling and minimize this risk.

For the SEM portion of the tunneling, the single twin-track tunnel is larger. The tunnel will have varying amounts of mixed geologic conditions in the tunnel face, and at portion of the tunnel crown will be in the alluvium. In this situation, there would be an unacceptable risk of creating subsidence or even sinkholes on Flower Street (see Section 4.1). Mitigation by jet grouting would be required, however it would encounter difficulties as discussed in Section 4.5.2. In addition significant risks are associated with the construction schedule and cost for this alternative. Switching among three tunneling techniques (EPBM, open-face shield, and SEM) for the relatively short tunnel drive in difficult ground conditions would cause significant schedule delay and cost increase due to equipment, labor, and procedure adjustments.

The jet grouting for the open-face shield and SEM portions would require drilling grout holes on a 6 foot by 6 foot pattern throughout the area to be grouted. Grout holes would extend from the ground surface through weak fill and alluvial soils to just into the relatively stronger Fernando Formation. A 50-foot-wide zone in Flower Street would be grouted and requires setting up a grout plant on Flower Street. Depending on the number of required grout holes, two to four drill rigs would be utilized to drill and grout. For Alternative A, approximately 1,900 grout holes would be drilled and grouted, and approximately 12 months (with risk of doubling to 24 months) would be anticipated to complete using two drill rigs as a feasible mitigation effort.

Although the jet grouting would improve the ground conditions for ground control during SEM tunneling, significant risk of ground loss and excessive settlement due to SEM will remain. The risk of tunnel collapse cannot be ruled out. This is because grouting must be done through a series of borings designed to have overlapping grout columns which do not always overlap in practice and there is no guarantee that all of the ground within the columns will be adequately grouted. Ground water inflows and ground loss can still occur which could damage utilities and existing buildings/basements/structures and provide a safety threat to workers, the public, and building operations. Before tunneling, utility services may also be adversely impacted and interrupted by pressure grouting.

The vertical alignment for this alternative would be the same as that of the Baseline/LPA with the tunnel alignment located at a depth of approximately 40 ft to top of rail below street surface. The proposed horizontal alignment would differ from the Baseline/LPA and reduce the operational speed in the Flower Street section between 5th Street and the 7th/Metro Center Station from 55 mph under the Baseline/LPA to 35 mph for this alternative. The speed reduction in this segment is due to the constraints of the horizontal and vertical alignments to accommodate a future 5th/Flower Station and to miss the bridge foundation piles under 4th Street. The short distance available for transition from the wider track centers of the open-face shield tunnels at 5th Street to a narrower track center spacing to connect with the proposed double crossover north of the 7thMetro Center Station limits the design speed to 35 mph. The speed reduction will have negative operational impacts on headway and runtimes. Under Alternative A, the 2nd/Hope Street Station would be at the same depth (96 ft) as the Baseline/LPA.

Configuration of a future 5th/Flower Street Station would have to be as a side platform station without a concourse. The center to center spacing of the tunnels do not permit construction of the center platform. The relatively shallow depth does not give sufficient distance for a concourse. Transit service would have to be interrupted for substantial lengths of time to permit some elements of construction to take place. Deviations would be required from Metro standards for the site-specific conditions.

There would be four separate cut-and-cover excavation sites: 1) for the train control room construction and connection at the end of the existing tail track tunnel south of 6th Street; 2) for emergency exit construction located south of 5th Street; 3) for emergency exit construction and EPBM retrieval south of 4th Street, and 4) an open cut excavation pit for removal of existing abandoned tiebacks in the course of approximately 100 ft of EPBM tunneling south of 3rd Street along Flower Street. Similar to the Baseline/LPA, cut-and-cover excavation materials would be handled from locations along Flower Street, while tunnel muck from the EPBM, open-face shield, and SEM operations would be handled through the Mangrove site in Little Tokyo. With a lengthening of tunneling further south on Flower Street using open face shield and SEM tunneling, there would be a corresponding increase in the excavated materials handled through Little Tokyo, an environmental justice community, over the Baseline/LPA conditions, and a corresponding decrease in excavated materials handled on Flower Street.

5.3 EPBM/SEM Low Alignment Alternative (Alternative B)

Alternative B extends tunneling south to the 7th/Metro Center Station through the use of a combination of EPBM and SEM construction techniques.

Alternative B, as shown in Figure 5-4, is defined as follows: EPBM-bored tunnels are constructed on a deep alignment to south of 5th Street and then when the track centers are too close to permit use of EPBMs, construction changes to SEM tunneling the remaining distance to the 7th/Metro Center Station tail track structure.

This alternative's horizontal alignment along Flower Street would be similar to the Baseline/LPA with the vertical alignment designed with a "sag" resulting in an alignment depth varying from 40 ft at the shallowest point to 105 ft to top of rail below street surface at the low point. This sag provides for a flat spot at a one percent grade to accommodate the future 5th/Flower Station. Based on the provision of a double crossover north of 6th/Flower, a future 5th/Flower Street Station, and the maximum operational grades required at the approach/departure of a crossover, there is insufficient distance to provide horizontal and vertical alignments that support 55 mph operations. Therefore this segment's design speed of 55 mph under the Baseline/LPA is reduced to 35 mph under this alternative, which will have negative operational impacts with increased runtimes. Due to this alternative's greater depth, the alignment will not intersect the Pacific Electric tunnel but the 2nd/Hope Street Station would need to be lowered by 32 ft from the Baseline alignment and would have a depth to top of rail of 128 ft.

For the SEM portion of the tunneling, the single twin-track tunnel is larger and the tunnel will have varying amounts of mixed geologic conditions in the tunnel face. At some locations, the tunnel crown will be in the alluvium. In this situation, there would be an unacceptable risk of creating subsidence or even sinkholes on Flower Street. Mitigation by jet grouting would be required, however would encounter difficulties discussed in Section 4.5.2. Refer to the discussion on jet grouting in Section 4.5. For Alternative B, approximately 1,000 grout holes would be drilled and grouted, and approximately 8 months (with risk of doubling to 16 months) would be anticipated to complete using two drill rigs.

The EPBM would be disassembled and removed through the tunnel to the Mangrove portal site with the EPBM shield left in place. With the extension of the tunneling further south to the 7th/Metro Center Station through the use of SEM, there would be a significant increase in excavated materials being handled through the Mangrove site in Little Tokyo over the Baseline/LPA conditions. Cut-and-cover excavation materials would be handled from locations along Flower Street, while tunnel muck from the EPBM and SEM operations would be handled through the Mangrove site in Little Tokyo. With a lengthening of tunneling further south on Flower Street using the EPBM and then SEM tunneling, there would be a corresponding increase in the excavated materials handled through Little Tokyo, an environmental justice community, over the Baseline/LPA conditions, and a corresponding decrease in excavated materials handled on Flower Street.

Configuration of a future 5th/Flower Street Station would have to be as a side platform station since the center to center spacing of the tunnels do not permit construction of the center platform. The tunnels are sufficiently deep such that a concourse can be constructed The tunnel profile would need to be flattened, which will mean demolishing the previously constructed tunnels and establishing the invert of the new station. Transit service would have to be interrupted for substantial lengths of time (years) to permit this major construction work to take place. Deviations would be required from Metro standards for the site-specific conditions.

Figure 5-2: Baseline/Locally Preferred Alternative Alignment Profile

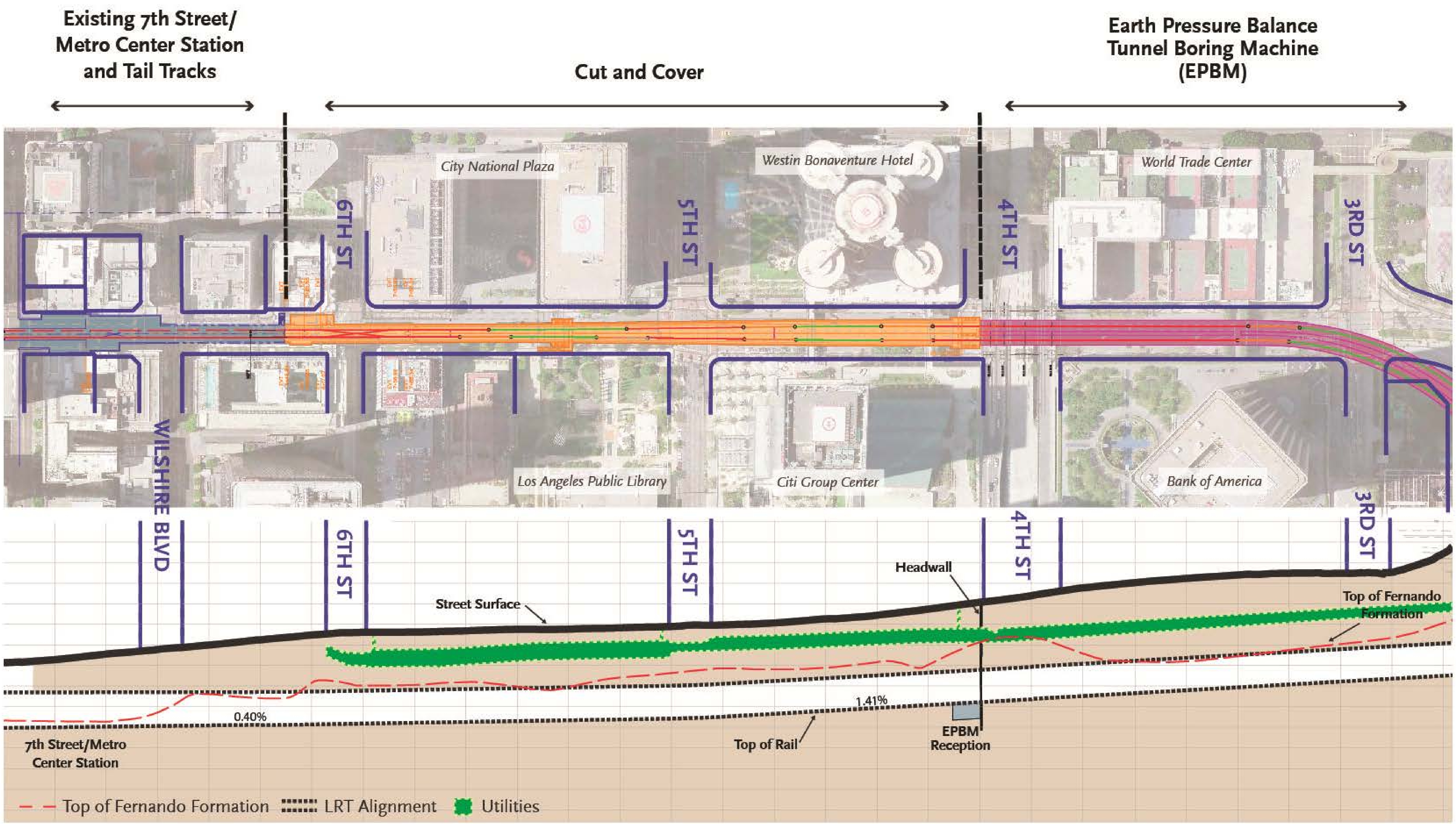


Figure 5-3: EPBM/Open Face Shield SEM LPA Profile (Alternative A)

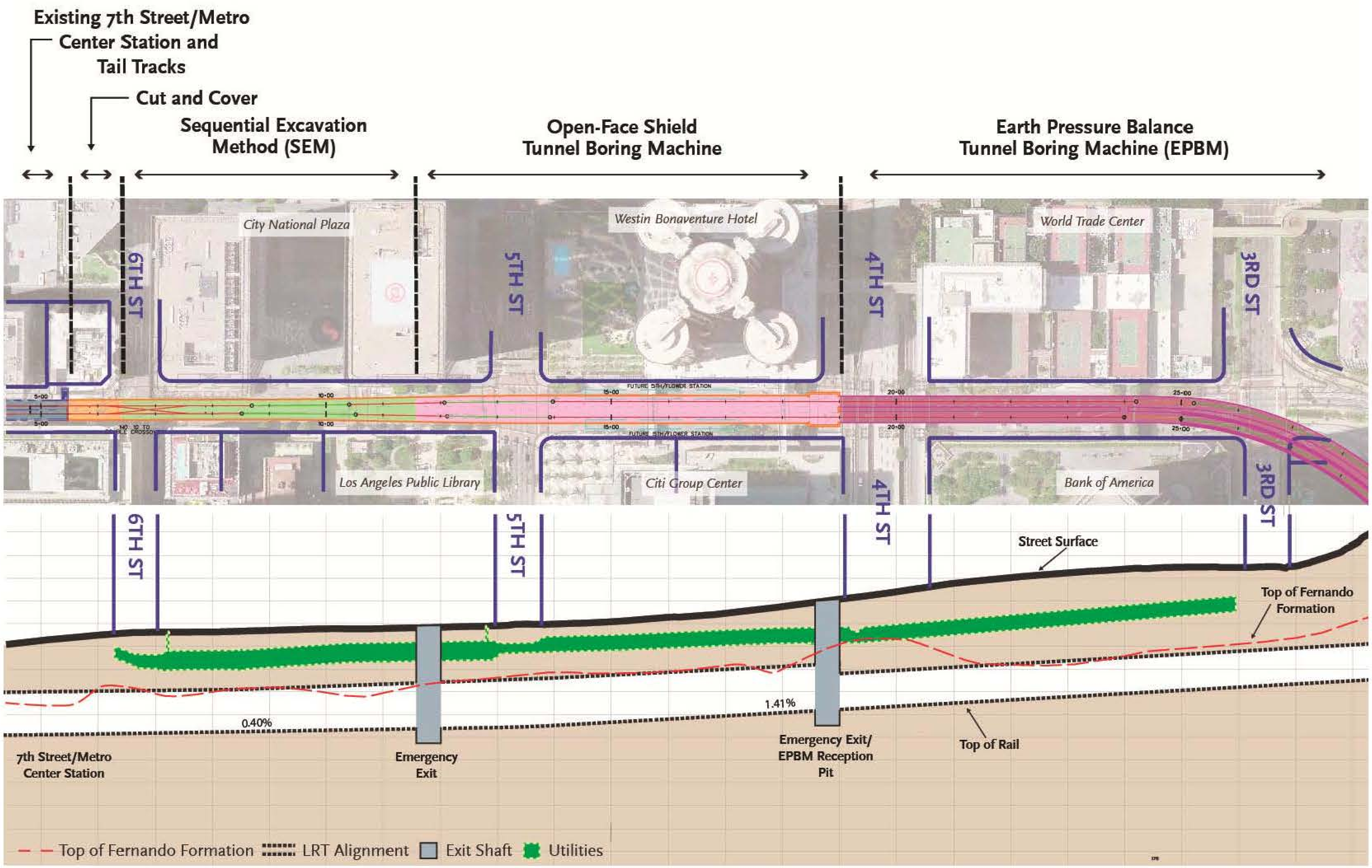
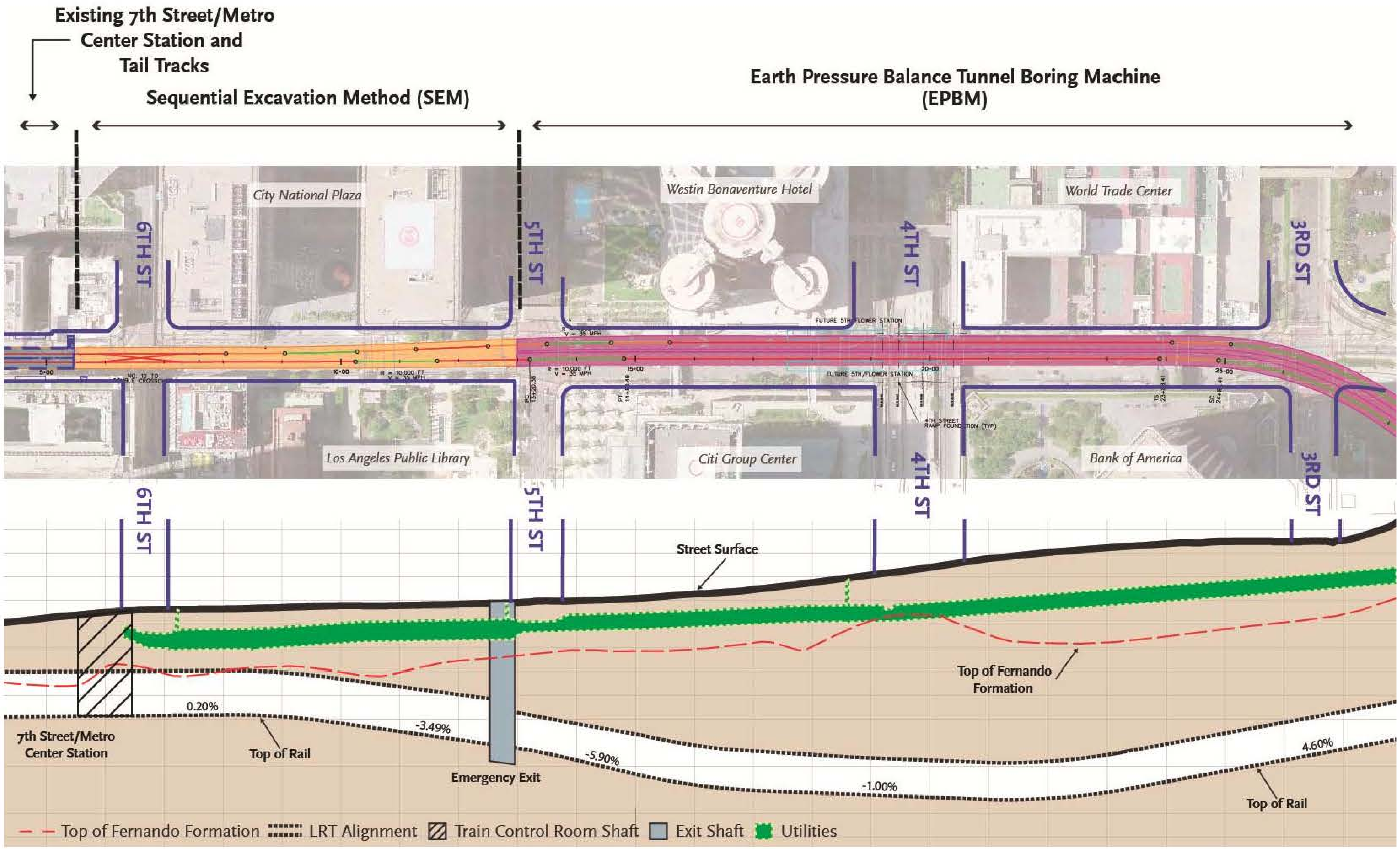


Figure 5-4: EPBM/SEM Low Alignment Alternative (Alternative B)



6.0 SCHEDULE

6.1 General

The following key dates have been used in the development of the alternative schedules:

- NTP Construction – 21 March 2014
- Start of Tunneling – 22 June 2015 (about 15 months after NTP)

Schedules were developed for each alignment and compared against the Baseline schedule. In all cases, it was assumed the contractor would utilize one EPBM and, for Alternative A only, one Open-Face Shield. To facilitate direct comparison of the construction schedules among Baseline, Alternative A, and Alternative B, the schedules are presented in this report with a common date for start of tunneling. As will be shown below, Alternative A and Alternative B have longer construction durations than the Baseline by 15 months and 7 months, respectively. These schedules are "as if" the alternative were being constructed instead of the Baseline without a delay and are not intended to match actual Metro Contract No. C0980 project status.

The schedules shown in Sections 6.3 through 6.4 encompass only the actual construction activities and do not include allowances for any potential schedule delays for, amongst others, any environmental process or resolutions of existing or potential future legal challenges. Influencing the cost and schedule impacts is the delay to the project due to any required environmental clearance documentation needed to allow LACMTA to incorporate any of these alternatives into construction. Cancellation of the current procurement and a reopening of the environmental documents would result in large delays to the project.

6.2 Environmental Process Schedule

Assuming that LACMTA is required to conduct a SEIS/SEIR in order to evaluate one or more of these alignment and construction method alternatives, a Notice of Preparation and Notice of Intent (NOP/NOI) per NEPA and CEQA would be developed in parallel with the decision making process to conduct the SEIS/SEIR. Effectively as of May 29, 2014, Metro started this process in advance of a firm determination of need for a SEIS/SEIR. Once provided a notice to proceed by the LACMTA Board of Directors, the NOP/NOI would be immediately filed with Federal, State and local agencies for public notice. There are a number of Regional Connector public meetings currently being held on a monthly basis. A scoping meeting could be held within the first month after the NOP/NOI is published. In parallel, a number of environmental technical studies can be initiated. This report contains sufficient detail and description of the alignment and construction methods to determine which technical studies need to be developed and what potential impacts need to be evaluated. It is anticipated that the studies would include Transportation/Traffic, Air Quality, Noise/Vibration, and Environmental Justice. These studies can be completed in approximately three months.

Post completion of the technical studies, an Administrative Draft SEIS/SEIR would be developed over a month and reviews by LACMTA and FTA would take approximately two months. FTA normally requires at least six weeks review for environmental documents. Upon completion of the review, the Draft SEIS/SEIR would be released for public circulation and comment for a 45 day period. A selection of one of the alignment and construction method alternatives would be made considering public comment and a Final SEIS/SEIR would be developed in order to respond to the comments. The Final SEIS/SEIR would require up to three months to complete, again assuming at least a six week review by FTA before completion. After review by LACMTA and FTA, the document would be completed and available to the public. The Final SEIS/SEIR would go to the LACMTA Board, a two month process, in order to certify the SEIS/SEIR and approve the final project.

The SEIS/SEIR process (assuming no new major public issues) will take about 13 months from preparation to approval by LACMTA Board. After the SEIS/SEIR approval, LACMTA can begin to initiate design of the selected alignment and construction method alternative in preparation for a new procurement process. In parallel, the FTA will review the SEIS/SEIR and prepare a Record of Decision on the SEIS/SEIR. The design and procurement processes are estimated to take 16 months.

The total potential delay is 29 months (13 + 16 months) due to the time required for SEIS/SEIR, design, and procurement processes for Alternatives A and B described below in Sections 6.4 and 6.5. This delay has been included in the cost analysis described in Section 8.0 of this report.

6.3 Baseline Schedule

The Baseline schedule is based on the Final Preliminary Engineering design alignment (plan and profile) with a scheduled NTP Date of 21 March 2014. The schedule anticipates that the construction of the cut-and-cover section, along Flower Street, would occur concurrently with the excavation of the bored tunnels and other construction activities throughout the alignment. See Figure 6-1**.**

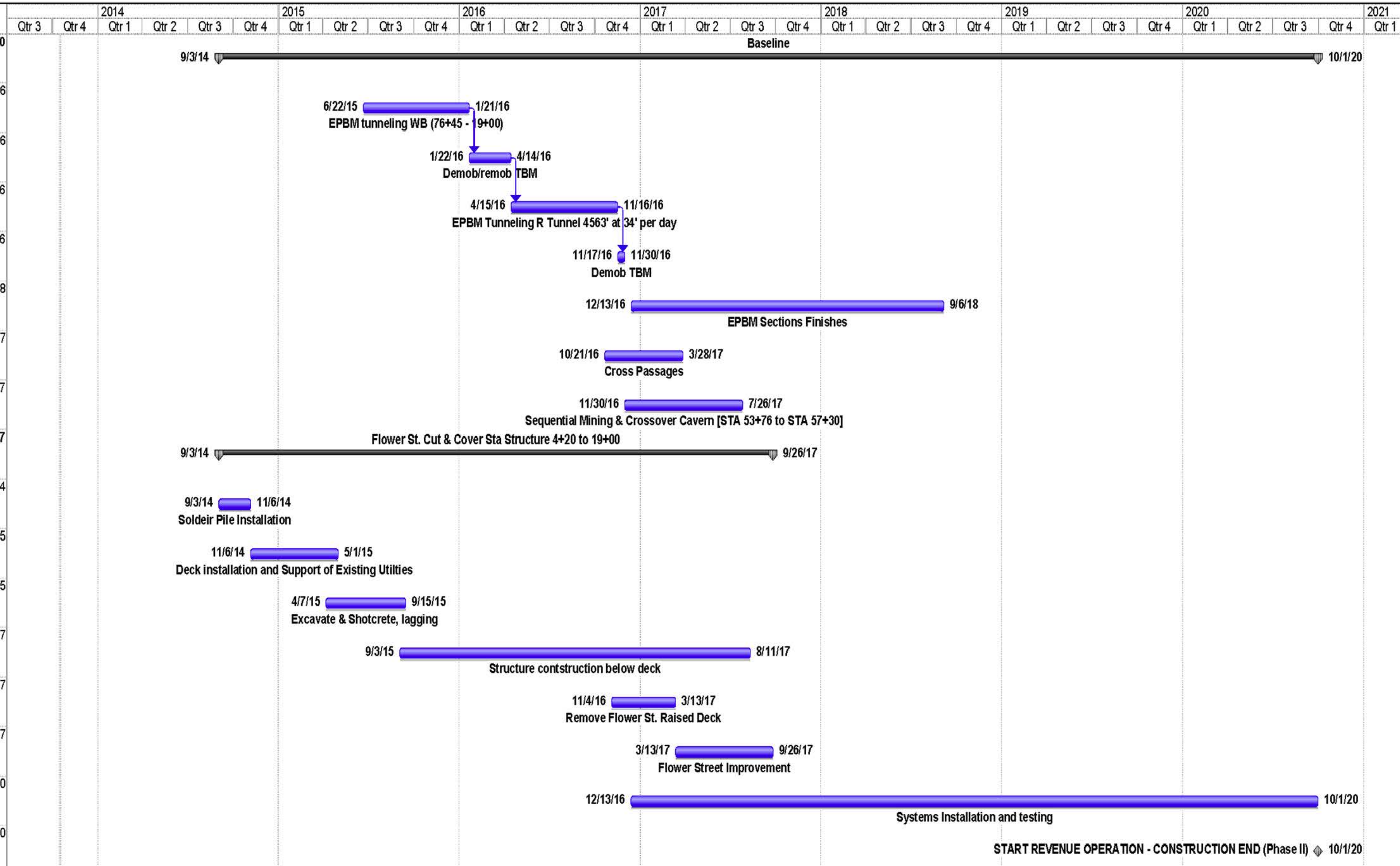
For the Flower Street segment of the Project, the schedule is based on the construction of 1,035 ft of twin bored tunnel between the 2nd and Hope Street Station and immediately south of the 4th Street Bridge, where a reception pit would be constructed for the extraction of the TBM. The balance of the segment is 1,356 ft of cut-and-cover construction between the TBM reception pit and the existing 7th/Metro Center Station interface. Construction would be facilitated by utilizing two excavation shafts along Flower Street to remove excavated soil and construct temporary and permanent structures for all the cut-and-cover section.

The alignment allows for construction of a track crossover, protection in place of utilities, and does not preclude the construction of a future station at 5th and Flower Streets, and allows for simple extraction of existing building tiebacks.

Figure 6-1: Baseline Summary Schedule

Flower Street Baseline/LPA Schedule

Task Name	Start	Finish
Baseline	**Wed 9/3/14**	**Thu 10/1/20**
EPBM tunneling WB (76+45 - 19+00)	Mon 6/22/15	Thu 1/21/16
Demob/remob TBM	Fri 1/22/16	Thu 4/14/16
EPBM Tunneling R Tunnel 4563' at 34' per day	Fri 4/15/16	Wed 11/16/16
Demob TBM	Thu 11/17/16	Wed 11/30/16
EPBM Sections Finishes	Tue 12/13/16	Thu 9/6/18
Cross Passages	Fri 10/21/16	Tue 3/28/17
Sequential Mining & Crossover Cavern [STA 53+76 to STA 57+30]	Wed 11/30/16	Wed 7/26/17
Flower St. Cut & Cover Sta Structure 4+20 to 19+00	**Wed 9/3/14**	**Tue 9/26/17**
Soldeir Pile Installation	Wed 9/3/14	Thu 11/6/14
Deck installation and Support of Existing Utlities	Thu 11/6/14	Fri 5/1/15
Excavate & Shotcrete, lagging	Tue 4/7/15	Tue 9/15/15
Structure contstruction below deck	Thu 9/3/15	Fri 8/11/17
Remove Flower St. Raised Deck	Fri 11/4/16	Mon 3/13/17
Flower Street Improvement	Mon 3/13/17	Tue 9/26/17
Systems Installation and testing	Tue 12/13/16	Thu 10/1/20
START REVENUE OPERATION - CONSTRUCTION END	Thu 10/1/20	Thu 10/1/20



6.4 EPBM/Open Face Shield/SEM LPA Profile Schedule (Alternative A)

This alternative minimizes the amount of cut-and-cover construction on Flower Street by utilizing open-face shield for excavation of a portion of the guideway and SEM excavation for other portion of the underground guideway on Flower Street. It is based on the Final Preliminary Engineering horizontal alignment, with horizontal and vertical adjustments. See Figure 6-2 for the construction schedule.

With this alternative, EPBM bored tunnels are excavated on the LPA alignment to a 4th street shaft similar to the Baseline. Open face shields are used to excavate tunnels from the 4th Street shaft to 5th Street abandoning the shields underground and constructing the balance of the tunnels by SEM tunneling methods to the 7th/Metro Station. This method requires muck removal through the westbound track (westbound for operations, designated the L track in design) tunnel to the Mangrove portal and thereby delays the construction of station facilities which are dependent on the completion of all tunneling operations. Jet grouting is required to improve the ground conditions above the open-face shield and SEM tunnels. See Section 4.5.

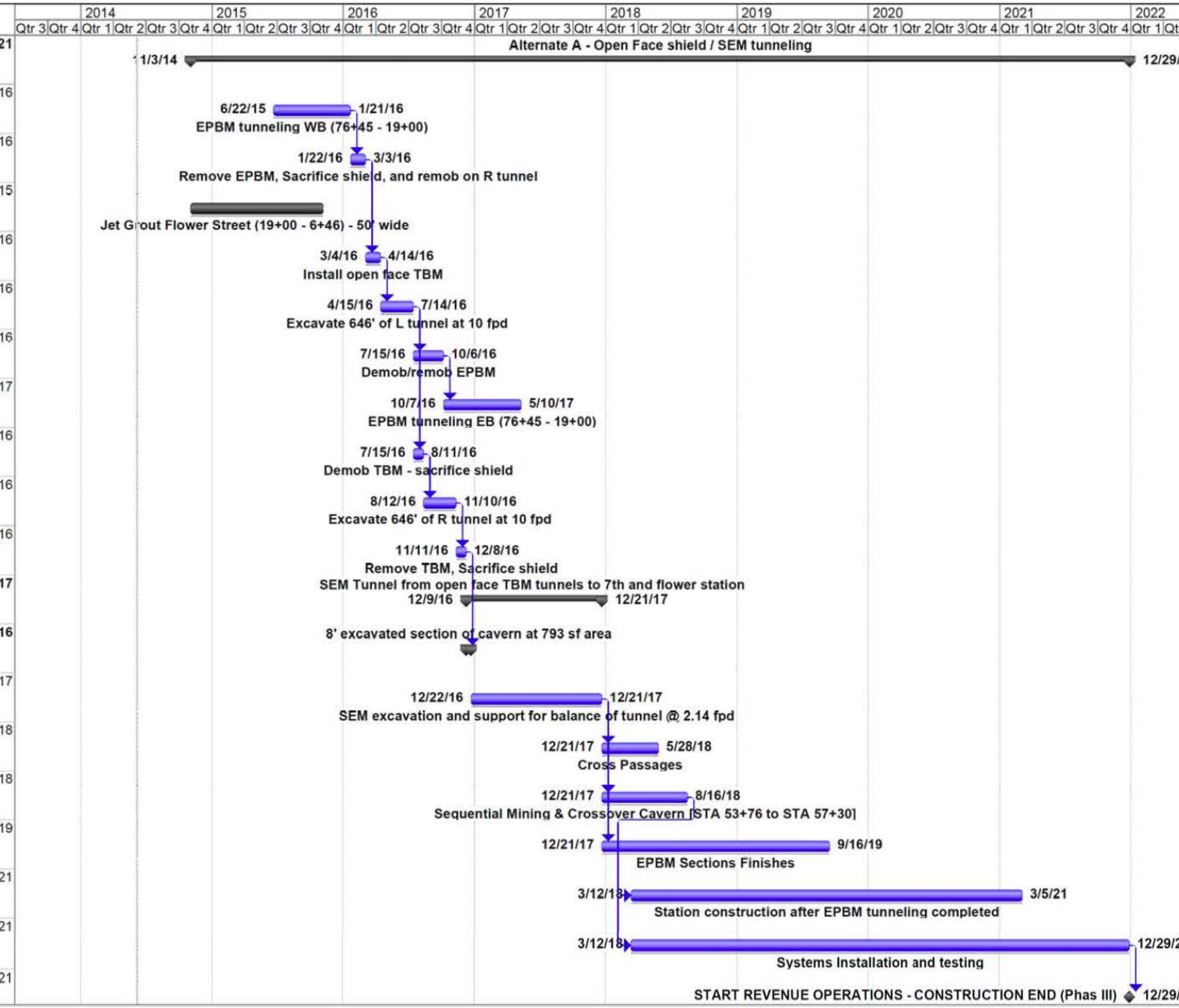
The length of the bored tunnels with EPBM is the same as in the Baseline alignment. Approximately 646 ft of twin tunnels are constructed using open-face shield and approximately 507 ft are constructed using sequential excavation method (SEM) techniques using the westbound tunnel and the Mangrove portal for tunnel excavation mucking and support. The alignment allows for the construction of a track crossover, and would not preclude the construction of a future station at 5th and Flower Streets. See comment on constructing a future station in Section 5.2.

The Open-face shield and SEM approach requires extensive jet grouting to improve the ground conditions for tunneling between 4th Street and the 7th/Metro Station. The jet grouting can be performed concurrently with the EPBM tunneling and will have duration of approximately 12 to 24 months. Due to the requirement to remove spoils through the Mangrove portal, the westbound tunneling operation will continue until the SEM excavation work is complete thereby holding the start of station construction work until after tunneling is complete and holding the start of the 2nd/Broadway SEM cavern and cross passages. This will result in a total additional construction duration compared to the Baseline of approximately 15 months.

Figure 6-2: EPBM/Open Face Shield SEM LPA Profile Alternative Summary Schedule (Alternative A)

Alternate A analysis

ID	Task Name	Duration	Start	Finish
1	**Alternate A - Open Face shield / SEM tunneling**	**1867.22 days**	**Mon 11/3/14**	**Wed 12/29/21**
2	EPBM tunneling WB (76+45 - 19+00)	154 days	Mon 6/22/15	Thu 1/21/16
3	Remove EPBM, Sacrifice shield, and remob on R tunnel	30 days	Fri 1/22/16	Thu 3/3/16
4	Jet Grout Flower Street (19+00 - 6+46) - 50' wide	265 days	Mon 11/3/14	Fri 11/6/15
5	Install open face TBM	30 days	Fri 3/4/16	Thu 4/14/16
6	Excavate 646' of L tunnel at 10 fpd	65 days	Fri 4/15/16	Thu 7/14/16
7	Demob/remob EPBM	60 days	Fri 7/15/16	Thu 10/6/16
8	EPBM tunneling EB (76+45 - 19+00)	154 days	Fri 10/7/16	Wed 5/10/17
9	Demob TBM - sacrifice shield	20 days	Fri 7/15/16	Thu 8/11/16
10	Excavate 646' of R tunnel at 10 fpd	65 days	Fri 8/12/16	Thu 11/10/16
11	Remove TBM, Sacrifice shield	20 days	Fri 11/11/16	Thu 12/8/16
12	**SEM Tunnel from open face TBM tunnels to 7th and flower station**	**269.35 days**	**Fri 12/9/16**	**Thu 12/21/17**
13	**8' excavated section of cavern at 793 sf area**	**9.35 days**	**Fri 12/9/16**	**Thu 12/22/16**
22	SEM excavation and support for balance of tunnel @ 2.14 fpd	260 days	Thu 12/22/16	Thu 12/21/17
23	Cross Passages	112 days	Thu 12/21/17	Mon 5/28/18
24	Sequential Mining & Crossover Cavern [STA 53+76 to STA 57+30]	170.25 days	Thu 12/21/17	Thu 8/16/18
25	EPBM Sections Finishes	451.75 days	Thu 12/21/17	Mon 9/16/19
26	Station construction after EPBM tunneling completed	779 days	Mon 3/12/18	Fri 3/5/21
27	Systems Installation and testing	991.63 days	Mon 3/12/18	Wed 12/29/21
28	START REVENUE OPERATIONS - CONSTRUCTION END (Phas III)	0 days	Wed 12/29/21	Wed 12/29/21



6.5 EPBM/SEM Low Alignment Schedule (Alternative B)

The EPBM and SEM excavation approach proposes a deep alignment profile of the EPBM bored tunnels on the LPA horizontal alignment to a location south of 5th Street from which an SEM cavern will be constructed for the balance of the guideway to the 7th/Metro station. This approach minimizes cut-and-cover work on Flower Street but requires jet grouting operations to modify the ground for the SEM tunneling between 5th Street and the 7th/Metro station. See Figure 6-3 for the construction schedule.

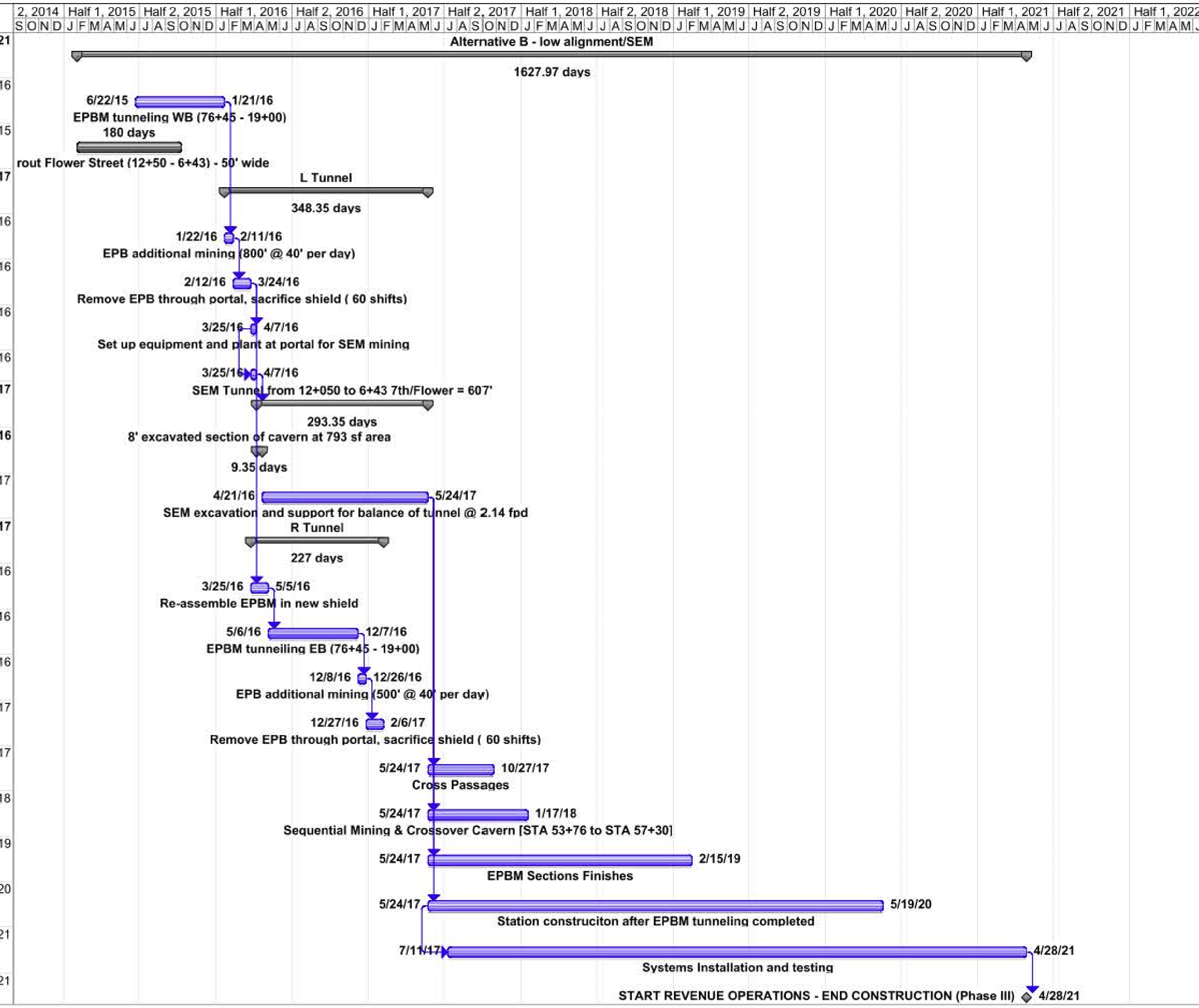
This approach extends the EPBM bored tunnels along Flower Street from 1,035 to 1,647 ft and constructs approximately 597 ft of SEM cavern from the end of the EPBM bored tunnels. The method requires removing the EPBM through the portal at Mangrove abandoning the shields in place. When the westbound EPBM tunnel is completed and the EPBM removed, the westbound tunnel will be used to support the excavation and support of the SEM cavern from south of 5th Street to the 7th/Metro station. The alignment allows for the construction of a track crossover, and would not preclude the construction of a future station at 5th and Flower Streets. See comment on constructing a future station in Section 5.3.

The SEM tunnel section requires extensive jet grouting to improve the ground conditions for tunneling between 5th Street and the 7th/Metro Station. The jet grouting can be performed concurrently with the EPBM tunneling and will have duration of approximately 8 to 16 months. Due to the requirement to remove spoils through the Mangrove portal, the tunneling operation will continue until the SEM excavation work is complete thereby holding the start of station construction work and holding the start of the 2nd/Broadway SEM cavern and all cross passages after tunneling is completed. This will require additional construction duration of approximately 7 months.

Figure 6-3: EPBM/SEM Low Alignment Summary Schedule (Alternative B)

Alternate B analysis

ID	Task Name	Duration	Start	Finish
1	**Alternative B - low alignment/SEM**	**1627.97 days**	**Mon 2/2/15**	**Wed 4/28/21**
2	EPBM tunneling WB (76+45 - 19+00)	154 days	Mon 6/22/15	Thu 1/21/16
3	Jet Grout Flower Street (12+50 - 6+43) - 50' wide	180 days	Mon 2/2/15	Fri 10/9/15
4	**L Tunnel**	**348.35 days**	**Fri 1/22/16**	**Wed 5/24/17**
5	EPB additional mining (800' @ 40' per day)	15 days	Fri 1/22/16	Thu 2/11/16
6	Remove EPB through portal, sacrifice shield (60 shifts)	30 days	Fri 2/12/16	Thu 3/24/16
7	Set up equipment and plant at portal for SEM mining	10 days	Fri 3/25/16	Thu 4/7/16
8	Reinstal removed utilities in tunnel	10 days	Fri 3/25/16	Thu 4/7/16
9	**SEM Tunnel from 12+050 to 6+43 7th/Flower = 607'**	**293.35 days**	**Fri 4/8/16**	**Wed 5/24/17**
10	**8' excavated section of cavern at 793 sf area**	**9.35 days**	**Fri 4/8/16**	**Thu 4/21/16**
19	SEM excavation and support for balance of tunnel @ 2.14 fpd	284 days	Thu 4/21/16	Wed 5/24/17
20	**R Tunnel**	**227 days**	**Fri 3/25/16**	**Mon 2/6/17**
21	Re-assemble EPBM in new shield	30 days	Fri 3/25/16	Thu 5/5/16
22	EPBM tunneiling EB (76+45 - 19+00)	154 days	Fri 5/6/16	Wed 12/7/16
23	EPB additional mining (500' @ 40' per day)	13 days	Thu 12/8/16	Mon 12/26/16
24	Remove EPB through portal, sacrifice shield (60 shifts)	30 days	Tue 12/27/16	Mon 2/6/17
25	Cross Passages	112 days	Wed 5/24/17	Fri 10/27/17
26	Sequential Mining & Crossover Cavern [STA 53+76 to STA 57+30]	170.25 days	Wed 5/24/17	Wed 1/17/18
27	EPBM Sections Finishes	451.75 days	Wed 5/24/17	Fri 2/15/19
28	Station construciton after EPBM tunneling completed	779 days	Wed 5/24/17	Tue 5/19/20
29	Systems Installation and testing	991.63 days	Tue 7/11/17	Wed 4/28/21
30	START REVENUE OPERATIONS - END CONSTRUCTION (Phase III)	0 days	Wed 4/28/21	Wed 4/28/21



6.6 Summary of Schedule Impacts

The delay in start of revenue operations including the delay necessary for SEIS/SEIR is summarized in Table 6-1.

Table 6-1 Summary of Construction Duration and Schedule Delay

	Duration of Construction (Months)	Extended Construction (Months)	SEIS Delay (Months)	Total Project Delay (Months)
Baseline	78	-	-	-
Alternative A	93	15	29	44
Alternative B	85	7	29	35

Both alternatives take longer to construct, 15 months for Alternative A, and 7 months for Alternative B. Both alternatives have the same 29 month delay for a change resulting from the SEIS/SEIR, design updates, and re-procurement. In round numbers the combined, total delay is 3 or more years until the public would have the benefit of the project.

7.0 COST ESTIMATE

Cost estimates for alternatives were prepared on the basis of conceptual designs. The cost estimates utilized values and comparable unit prices from the detailed engineer's cost estimate prepared for the Baseline design in August 2013. See Table 7-1 below. This table summarizes the base cost estimates for the Flower Street section only. The estimated costs are based on design and construction of each alternative starting in 2014 and allow for costs of additional construction duration, where applicable, but do not include additional costs to construct the project in later years if the schedule is delayed due to a supplemental environmental process.

Table 7-1: Base Cost Estimate for Flower Street Baseline and Alternatives Including Contingency ($M)

	Baseline	Alternative A	Alternative B
Base Year Dollars	$152	$250	$206
Year-Of-Expenditure (YOE) Dollars	$171	$294	$238

8.0 RISK IDENTIFICATION AND ASSESSMENT

8.1 Preface

This section describes the process used for identification and quantification of specific risks for the Flower Street tunneling alternatives. The objective is for the risk process to assist LACMTA in making an informed evaluation of the potential cost of each alternative.

In addition the intention is to provide the Board and the FTA with the confidence that LACMTA have made a significant effort in determining the potential cost for each alternative.

The structured process by which this study has been undertaken, with the involvement, consideration, and agreement, in the analysis and results of this study, by the study participants, provides the best current assessment of risk exposure for each alignment.

The risk assessment records and models the views of LACMTA and their consultant team during the study. The risk assessment addresses, at the point in time, issues that could arise on the alternatives given the experiences of LACMTA and their consultant team associated with the study.

The study is based on credible ranges of costs and possible schedule deviation.

8.2 Risk Assessment Methodology

At a Risk Assessment Workshop, held on June 19, 2012, a number of alternatives were analyzed for potential risks and a summary level risk register was developed which contained 13 specific risks to each alternative. Subsequent to this risk assessment, Alternatives A and B have been added to the study of Flower Street construction alternatives.

Similar to the risk analysis conducted in June 2012, Alternatives A and B were analyzed for potential risks and the risk register was further expanded to include a total of 17 risks pertaining to these alignment alternatives.

The identified specific risks for each alignment alternative, shown in Table 8-1 are itemized and include a description of the risk along with a discussion of the identified risks.

Table 8-1: Allocation of Risks per Alternative

ID	Description	Comments	Baseline	Alt A	Alt B
1	Additional CEQA challenges from stakeholders	The construction staging and TBM recovery pit will change from base configurations within the FEIS/FEIR and could lead to CEQA challenges from stakeholders		X	X
2	The FEIS/FEIR may have to be re-opened.	Additional spoils to Little Tokyo and environmental justice issues would also be a basis for re-opening the environmental document. (Alternatives A and B)		X	X
3	Tiebacks could be encountered during tunnel construction of Alternative B.	The tunnel depth in Alternative B from 4th street to 5th street is designed to avoid potential tiebacks in this section. However there is still a possibility that tiebacks could be encountered thus delaying tunnel work.			X
4	Increased number of tiebacks to be removed	Both Baseline and Alternative A have risk of encountering more tiebacks than anticipated. Alternative A tunnels through tiebacks., while Baseline is open excavation. Both situations could lead to construction delays.	X	X	
5	4th Street Bridge Settlement analysis still to be approved by City of Los Angeles. Additional requirements may be required.	The base alternative anticipates that the construction will only induce a 3/8" settlement to 4th Street Bridge piers which is within acceptable tolerance. The analysis is still to be approved and agreed with City of Los Angeles	X	X	X
6	4th Street Bridge retrofit requirement not fully understood	Baseline and all Alternatives anticipate that some retrofit to the 4th Street Bridge will be required and allowances are carried in each estimate. However exact requirement is unknown and allowances could increase with final designs.	X	X	X
7	Late approval of 4th Street Bridge retrofit designs by City of Los Angeles. Approval from City of LA for bridge retrofit designs	4th Street Bridge retrofit designs will require City of Los Angeles approval which could delay construction start date.	X	X	X

ID	Description	Comments	Baseline	Alt A	Alt B
8	Limited worksite and laydown area. Further analysis required to assess construction impacts	Both Alternatives A and B requires shaft constructions at Blue Line connection and the emergency exit shaft at 5th Street. This will increase construction interface with public and traffic.		X	X
9	Increased depth of 2nd and Hope Station.	Alternatives B will increase the overall depth of 2nd and Hope Station by 32 ft. The estimate has been increased to allow for the deeper excavation. And a soldier pile and timber lagging excavation support system is anticipated.			X
10	Depth of emergency exit shaft excavation increases overall construction risk	There is risk in support of excavation especially in deep sections.			X
11	Ground improvement (jet grouting)	Messy operation, utility impacts. Application from inside tunnel often difficult and time consuming.		X	X
12	SEM Construction on Flower Street	Gas, settlement, and tunnel instability leading to collapse		X	X
13	Using Open Face Shield	Gas, settlement, and tunnel face instability leading to collapse		X	
14	TBM goes through existing Pacific Electric (PE) tunnel, Alternative A.	The PE is an obstruction, which may have disturbed ground outside of the lining. The PE is also a void, through which the TBM has to pass through. There is a risk of excessive surface settlement associated with tunneling in this complicated situation.		X	
15	Operational requirements	Increase operational time, vehicle maintenance (need larger queuing area), fire life safety (emergency exits from station)		X	X
16	Impact to revenue service date	Longer construction duration.		X	X
17	Unacceptable excessive settlement possibly leading to collapse	Uncertain ground conditions with respect to alluvium-Fernando interface.		X	X

8.3 Cost Risk Analysis

In order to determine the potential cost range of each Flower Street alternative, a cost risk model was developed by the LACMTA Risk Manager.

8.3.1 Calculation of Capital Cost Estimate Allocated and Unallocated Contingency Ranges

For each alignment alternative, the cost model applies variance against a minimum and maximum percentage value, of the allocated contingency, for the Flower Street segment of the alternative only.

8.3.2 Delay/Consequential Cost Analysis

For each alignment alternative it is anticipated that the project would be required to execute a further SEIS process with subsequent re-design and procurement activities which could delay a construction contract NTP by 29 months, which was carried in this analysis as an approximate 3-year delay, for Alternatives A and B. The delay will result in an additional cost for environmental, engineering and agency support activities. This cost has been added as an additional cost within the model.

A delay of 3 years for construction NTP will incur an additional cost escalation factor as project construction will be moved out by an additional 3 years. For each alignment alternative the 3 years of additional escalation has been calculated into the cost risk model at a compounding factor of 3.5% per annum.

Per Section 6, Alternatives A and B would take longer than the current estimated duration of the Flower Street section with subsequent delay to the overall project completion. This anticipated additional duration has been factored into the base cost estimate for each alternative.

8.3.3 Comparison of Total Project Estimate for Each Alternative

Table 8-2 summarizes the results of the cost adjustments and risk analysis for the Flower Street tunneling alternatives, as set out above.

Table 8-2: Summary Risk Analysis Results ($M)

	Base Cost YOE Estimate with Contingency	Min Expected Cost	Max Expected Cost
Alternative A	$294	$509	$575
Alternative B	$238	$447	$503

APPENDIX B

REGULATORY FRAMEWORK

1.1 Transportation Regulatory Framework

The "Regulatory Framework" in the 2010 Regional Connector Final EIS/EIR has remained unchanged and is hereby incorporated by reference. The 2010 Final EIS/EIR addressed the federal, state, regional, and local regulations, laws, policies, ordinances, and guidelines listed below.

Federal and State

- National Environmental Protection Agency (NEPA)
- California Environmental Quality Act (CEQA)

Regional and Local

- Los Angeles County Department of Transportation (LADOT)
- City of Los Angeles General Plan Circulation Element

The determination of whether a project may have a significant effect on the environment calls for careful judgement on the part of the public agency involved, based to the extent possible on scientific and factual data. There are few quantitative standards of significance related to transportation effects. The measurement and prediction of level of service (LOS) at potentially affected intersections is a standard that is used to evaluate the significance of potential traffic impacts. Predicted changes in level of service provide indications of how well road-based movements may function under the different alternatives, which may have implications for vehicular traffic, and certain types of transit and non-motorized transportation.

To represent the affected environment from a traffic operations perspective, only locations affected by the changes to the project description (extension of tunneling activities further south on Flower Street and the increase of muck truck activity to the Little Tokyo area) were analyzed. Updated 2014 traffic counts at key locations on Flower Street and within Little Tokyo were obtained from the LADOT. Additional count data was referenced from nearby projects and applicable growth rates were utilized where necessary.

1.1.1 Transit

Existing transit services within the project area that parallel the Regional Connector alignment were identified and tabulated to show destinations, existing headways, service characteristics, and operating time periods. No NEPA, or local thresholds are available for determining the significance of impacts to transit service. Changes to the transit network are described for each alternative in Section 3.3. This section analyzes transit impacts and benefits for each project refinement alternative by examining changes in transit performance. Transit performance includes travel speeds and times, transit service reliability, transit ridership, and passenger comfort and convenience. Evaluation criteria included:

- Transit travel times,
- Speed and reliability,
- Transit ridership, and
- Passenger comfort and convenience.

1.1.2 Traffic Circulation

Significant impacts generated by the project refinement alternatives were identified by comparing the LOS results to the Project. The reason for this is to determine the potential increase or decrease in significant impacts of the proposed alternatives compared to those already identified as part of the Project.

For purposes of this analysis, a focused study area was defined to be the locations where the changes to the project description could potentially affect LOS. Per the LADOT *Traffic Study Policies and Procedures* (June 2013), volume-to-capacity (v/c ratios) are used to analyze traffic operation conditions at study roadway segments.

Updated count data (counts taken in 2013 and 2014) for roadway segments within the Flower Street and Little Tokyo study areas were provided by LADOT in the form of daily traffic volumes (no intersection turning movements were provided). The roadway segment analysis was performed using these counts compared to the roadway capacity derived from the City's General Plan designations. Due to the nature of construction the proposed project (reduced lane capacity on Flower Street and increased truck traffic in Little Tokyo), only roadway segment impacts were considered. In the event that roadway segment impacts are identified, the intersections along the impacted segments would also be considered impacted.

Traffic circulation impacts at study roadway segments were evaluated based on the project-related increase in v/c ratio beyond the Project. Table 1-1 presents the applicable thresholds for this evaluation. For example, an alternative would have a significant impact at a roadway segment with existing LOS C if it increases the v/c ratio by 0.020. If a roadway segment continues to operate at LOS A or B during construction or after implementation of an alternative, the alternative is considered to have no substantial adverse impact on that facility.

More information regarding the methodology used for traffic circulation impact evaluation is available in Appendix L, Transportation Technical Memorandum of the Final EIS/EIR.

Table 1-1: Roadway Significance Thresholds

Final LOS with Project	Roadway Thresholds Change in v/c from LPA	Intersection Thresholds Change in Delay (in seconds) from LPA
LOS A	-----	-----
LOS B	-----	-----
LOS C	equal to or greater than 0.040	6.0
LOS D	equal to or greater than 0.020	4.0
LOS E	equal to or greater than 0.010	2.5

LOS F	equal to or greater than 0.010	2.5

Source: Los Angeles Department of Transportation, June 2013

1.1.3 Parking

An on-street parking evaluation was conducted to assess the number of spaces that may be removed due to each of the project refinement alternatives, compared to the Project. The analysis included a field inventory of the number of available on-street parking and loading spaces and identification of peak period parking restrictions, if applicable. No NEPA or local thresholds are available to guide the determination of the significance of impacts to parking. Reductions in parking are described for each alternative in Section 3.3. Evaluation of potential parking impacts included consideration of:

- The availability of parking within one-half mile walking distance; and
- The availability of loading zones in relation to the location of commercial enterprises.

Refer to Section 4.2, Displacement and Relocation in the Final EIS/EIR, for analysis of off-street parking impacts.

1.1.4 Other Modes

Bicycle and pedestrian circulation was evaluated as part of this transportation analysis. No NEPA or local thresholds are available to guide the determination of significance of impacts to bicycle and pedestrian circulations. Changes to the bicycle and pedestrian network are described for each alternative in Section 3.3. Evaluation of potential impacts to bicycle and pedestrian circulation included consideration of:

- Detours that might lengthen bicycle commutes or pedestrian routes (which would increase travel time); and
- Safety of alternate routes.

1.2 Visual Quality Regulatory Framework

Guidance for assessing potential visual impacts of the tunneling alternatives is identified in the National Historic Preservation Act (NHPA), and was used to evaluate potential visual and aesthetic effects under NEPA and findings for the Project are from the Final EIS/EIR. Multiple federal agencies have developed analytical frameworks for visual resource management, including:

- United States Department of Agriculture (USDA), Forest Service (USFS 1974, 1995)
- United States Department of Interior (USDOI), Bureau of Land Management (BLM 1978)
- United States Department of Transportation (USDOT), Federal Highway Administration (FHWA 1981)

The methodology and assumptions used to assess visual and aesthetic impacts of these alternatives build on the guidance developed by these federal agencies, as described in the Final EIS/EIR.

Analyzing potential visual impacts includes evaluating the following effects of implementing an infrastructure project:

- Conflicts with or compliments the existing visual character
- Changes in visual quality
- Intrudes on or blocks sensitive views (emphasizes views protected by local jurisdictions)
- Creation of shadows
- Creation of new light or glare sources

1.2.1 Thresholds of Significance

This analysis examines whether the alternatives under evaluation have the potential to cause significant visual impacts. Though NEPA offers no definition for "significance," the CEQA Guidelines define a significant impact as "... a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project, including ... objects of ... aesthetic significance." The methodology applied to this assessment expands upon the CEQA definition and draws from methodology recommendations included in the Los Angeles CEQA Thresholds Guide, as followed in the Final EIS/EIR.

As outlined in Appendix G of the CEQA Guidelines, determination of a significant impact to visual and aesthetic resources is based on the following thresholds:

- Would the project have a substantial, adverse effect on a scenic vista?
- Would the project substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within [view from] a state scenic highway?
- Would the project substantially degrade the existing visual character or quality of a site and its surroundings?
- Would the project create a new source of substantial light or glare that would adversely affect day or nighttime views in the area?

The City of Los Angeles CEQA Thresholds Guide includes the following criteria for identifying and evaluating potentially significant visual resources impacts from proposed actions occurring within the City:

- Would project-related structures result in the shading of shadow-sensitive uses for more than three hours between the hours of 9:00 a.m. and 3:00 p.m. Pacific Standard Time (between late October and early April), or for more than four hours between the hours of 9:00 a.m. and 5:00 p.m. Pacific Standard Time (between early April and late October)?

Additional background information regarding visual resource evaluation methodology is available in Visual and Aesthetic Impacts Technical Memorandum (Appendix P) of the Final EIS/EIR.

1.3 Air Quality Regulatory Framework

The Regulatory Framework in the 2010 Regional Connector Final EIS/EIR has remained unchanged and is hereby incorporated by reference. The Final EIS/EIR addressed the federal and state regulations listed below:

- Clean Air Act
  - Clean Air Act 40 CFR 93, Subpart A Transportation Conformity Regulations
- California Clean Air Act

The Final EIS/EIR addressed the local plans and regulations listed below:

- Southern California Association of Governments (SCAG) Regional Transportation Plan;
- SCAG Regional Transportation Improvement Program; and
- South Coast Air Quality Management District (SCAQMD) Air Quality Management Plans

1.3.1. Standards of Significance

National ambient air quality standards (NAAQS) are used to determine air quality impacts under NEPA. The most recent CEQA thresholds of significance published by the SCAQMD were released in 2011. These thresholds supersede the City of Los Angeles thresholds; therefore, this analysis uses the most recent significance thresholds from the SCAQMD to determine construction air quality impacts under CEQA. CEQA thresholds of significance are also used to analyze NEPA compliance because NEPA does not contain thresholds specific to construction. Since CEQA has stricter requirements than NEPA, this is a conservative assumption. The SCAQMD construction significance thresholds include daily emission thresholds for regional air quality impacts, as listed in Table 1.3-1. These thresholds apply to total daily emissions from both on-site sources, such as construction equipment exhaust, and off-site sources, such as haul truck and worker commuting vehicle exhaust.

Table 1.3-1: SCAQMD CEQA Construction Daily Emission Thresholds

Pollutant	Daily Emission Threshold (pounds/day)
VOC	75
NOx	100
CO	550
SO2	150
PM10	150
PM2.5	55

The SCAQMD has also developed significance thresholds for local air quality impacts. Localized significance thresholds (LSTs) are applicable to the following criteria pollutants: NOx, CO, PM10 and PM2.5. LSTs are analogous to NAAQS and CAAQS (pollutant levels below LSTs necessarily do not violate NAAQS and CAAQs). The SCAQMD has used dispersion modeling to develop LST emission look-up tables. The emission values in the tables depend on the size of the construction or operation area, the distance to the nearest receptor and the geographic source-receptor area. If the maximum daily on-site emissions are less than the emissions in the look-up tables, the emissions would not cause the LST to be exceeded.

1.4 Climate Change Regulatory Framework

The Regulatory Framework in the Final EIS/EIR hereby incorporated by reference. The 2010 Final EIS/EIR addressed the federal, state, and local regulations and policies listed below:

- Massachusetts et al. v. Environmental Protection Agency et al.
- Mandatory GHG Reporting Rule (U.S. Environmental Protection Agency (USEPA))
- Endangerment Finding (USEPA)
- American Clean Energy and Security Act of 2009
- Clean Energy Jobs and American Power Act
- California Assembly Bill 1493
- California Executive Order S-3-05
- Global Warming Solutions Act of 2006 (Assembly Bill 32)
- Senate Bill 97
- California Air Resources Board (CARB) Interim Significance Thresholds
- Senate Bill 375
- SCAQMD Guidelines and Regulations

Additional local plans related to climate change and GHG emission reductions recently adopted are described below:

- Los Angeles County Metropolitan Transportation Authority's Climate Action and Adaptation Plan, finalized in June 2012, identifies the regional GHG emissions inventory along with goals for future GHG emission reductions due to operation of Metro facilities.
- Los Angeles County Metropolitan Transportation Authority's Countywide Sustainability Planning Policy and Implementation Plan, adopted in December 2012, establishes goals for sustainable transportation solutions including provisions for clean-fueled, efficient, long-term transportation systems while minimizing material and resource use through conservation, re-use, recycling and re-purposing.

Metro Polices/City of LA Policies

The Council on Environmental Quality (CEQ) dictates requirements for reporting environmental consequences under the National Environmental Policy Act (NEPA). While there are no specific NEPA criteria for analyzing climate change impacts, the CEQ developed draft guidance that directs environmental impact statements (EISs) to consider "the GHG emissions effects of a proposed action and alternative actions" and "the relationship of climate change effects to a proposed action or alternative, including the relationship to proposal design, environmental impacts, mitigation and adaptation measures." In addition, the South Coast Air Quality Management District (SCAQMD) developed *Interim GHG Significance Threshold Staff Proposal* (SCAQMD 2008) which states that an evaluation of project-level GHG emissions should be conducted and include direct, indirect, and, if possible, life-cycle emissions during construction and operation. The SCAQMD's recommendations regarding the quantification of emissions were followed for this project; however, the SCAQMD interim thresholds are largely geared towards industrial, residential, and commercial projects, and do not specifically address transportation projects. Therefore, to establish additional context for considering the magnitude of a project alternative's construction-related GHG emissions, this analysis considers the following guidelines for identifying the levels of GHG emissions that would constitute a cumulatively considerable incremental contribution to the impact on climate change:

- Any residential, commercial, or industrial project that would generate more than 900 MT CO_2e per year would make a cumulatively considerable incremental contribution to climate change.
- Facilities (i.e., stationary, continuous sources of GHG emissions) that generate more than 25,000 MT CO_2e per year must report their GHG emissions to ARB, pursuant to AB 32.

The following additional significance criteria are based on Appendix G of the state CEQA Guidelines. The proposed project alternatives would result in a significant climate change and GHG emissions impact if they would:

- Result in an increase or reduce GHG emissions as compared to the existing environmental setting;
- Result in project emissions in excess of a threshold of significance that the lead agency determines applies to the project; or
- Result in non-conformance with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of GHG emissions. Such requirements must be adopted by the relevant public agency through a public review process and must reduce or mitigate the project's incremental contribution of GHG emissions. If there is substantial evidence that the possible effects of a particular project are still cumulatively considerable notwithstanding compliance with the adopted regulations or requirements, an EIR must be prepared for the project.

In order to evaluate the affected environment from a climate change perspective, GHG emissions from construction activities associated with the changes to the project description (extension of tunneling activities further south on Flower Street and the increase of muck truck activity to the Little Tokyo area) were analyzed.

1.5 Noise and Vibration Regulatory Framework

The Federal Noise Control Act of 1972 (Public Law 92-574) requires that all federal agencies administer their programs in a manner that promotes an environment free from noises that could jeopardize public health or welfare. The operational impacts were evaluated using the guidelines set forth by the FTA's guidance manual on *Transit Noise and Vibration Assessment* (May 2006).

1.5.1 Construction Noise and Vibration Criteria

FTA guidelines address the potential for noise and vibration impacts during construction. In the absence of local criteria, construction noise may be evaluated using the FTA criteria summarized in Table 1.5-1. Similarly, the FTA guidelines also address the potential for construction-activity-induced vibration to damage buildings. The potential for ground-borne vibration to cause damage to a building varies by the type of materials and structural techniques used to construct each building. FTA vibration damage criteria for various structural categories are shown in Table 1.5-2. The same criteria shown in Table 1.5-2 are also used to assess human annoyance and interference.

Table 1.5-1: FTA Construction Airborne-Noise Criteria

	General Assessment		Detailed Assessment		
	1-hour Leq (dBA)		8-hour Leq (dBA)		Ldn (dBA)
Land Use	Day	Night	Day	Night	30-day Avg.
Residential	90	80	80	70	75[a]
Commercial	100	100	85	85	80[b]
Industrial	100	100	90	90	85[b]

a - In urban areas with very high ambient noise levels (Ldn > 65 dB), Ldn from construction operations should not exceed existing ambient + 10 dB.
b - Twenty-four-hour Leq, not Ldn.

Table 1.5-2: FTA Construction Vibration Damage Criteria

Building Category	PPV (in/sec)	RMS (in VdB)[1]
I. Reinforced-concrete, steel or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

1 RMS velocity in decibels (VdB) re 1 micro-inch/second

1.6 Geotechnical Regulatory Framework

Currently there are no federal regulations regarding geology, soils and seismicity issues. The International Building Code is modified by the State of California and incorporated into the California Building Code, which by state law must be used as minimum level of effort for designing structures in California. The design standards of these codes are also incorporated into Metro's design guidelines and safety standards. There are several hazardous materials regulatory agencies and policies in place that would apply to the monitoring and compliance of the Project and refinement alternatives including:

- United States Environmental Protection Agency (USEPA)
- Resources Conservation and Recovery Act (RCRA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERLA)
- Superfund Amendments and Reauthorization Act (SARA)
- Toxic Substances Control Act (TSCA)
- Federal Occupational Safety and Health Act (OSHA)

Detailed information on each can be found in Section 3.1.1 in the Final EIS/EIR. There have been no new regulatory updates from publication of the Final EIS/EIR to the evaluation of the two tunneling method alternatives that would apply.

The National Environmental Policy Act (NEPA) does not have specific requirements related to geologic hazards or soils. NEPA requires an evaluation of potential impacts related to hazardous materials, which may be categorized in two different ways. First, there is potential for hazardous materials associated with previous land use to pose an impact for the proposed project. Second, there is potential for the proposed project to generate hazardous material impacts to the surrounding human and natural environments. Impacts associated with hazardous materials may occur during construction or operation of the project.

1.6.1 Evaluation Methodology

In general, impacts related to hazardous materials associated with current or previous land use are most relevant to the project alternatives that entail property acquisition and/or construction and thus have the potential to encounter hazardous materials, including contaminated soil and/or groundwater that may exist in the area of potential impact. Generally, conditions along the Flower Street portion of the two tunneling method alternatives, compared to the Project, have remained unchanged. A reconnaissance of the regulatory database, field observations, historical information, and supplemental materials described in the Final EIS/EIR was completed. In addition, the Hazardous Materials Investigation and Analysis report (CDM 2009) identified sites along Flower Street and surrounding properties and provided a determination regarding level of concern associated with environmental contaminants and/or naturally occurring hazardous substances. The Hazardous Materials Investigation and Analysis report, and the Tunnel Feasibility Report form the basis of the evaluation of the two tunneling method alternatives and the potential for new impacts associated with any of these alternatives.

1.7 Energy Resources Regulatory Framework

The Regulatory Framework in the Final EIS/EIR has remained unchanged and is hereby incorporated by reference (Final EIS/EIR, pages 4-223 to 4-224). The 2010 Final EIS/FEIR addressed the federal, state, and local regulations and policies listed below:

- The Energy Policy and Conservation Act of 1975
- The Alternative Fuels Act of 1988
- Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)
- Senate Bill 1389
- Executive Order S-3-05
- Metro's Energy and Sustainability Policy

The Council on Environmental Quality (CEQ) dictates requirements for reporting environmental consequences under the National Environmental Policy Act (NEPA). While there are no specific NEPA criteria for analyzing impacts to energy resources, 40 CFR § 1502.16(e) directs that environmental impact statements (EISs) include a discussion of the "energy requirements and conservation potential of various alternatives," "natural or depletable resource requirements and conservation potential of various alternatives," and potential mitigation measures. In addition, the following significance criteria are based on Appendix G of the state CEQA Guidelines and the Los Angeles CEQA Thresholds Guide (2006). The tunneling alternatives would result in a significant impact to energy resources if they would:

- Require new (off-site) energy supply facilities and distribution infrastructure or capacity enhancing alterations to existing facilities
- Conflict with adopted energy conservation plans
- Use nonrenewable resources in a wasteful and inefficient manner
- Result in a need for new systems or substantial alterations to power or natural gas

In order to evaluate the affected environment from an energy resource perspective, energy usage from construction activities associated with the changes to the project description (extension of tunneling activities further south on Flower Street and the increase of muck truck activity to the Little Tokyo area) were analyzed.

1.8 Historic Resources Regulatory Framework

This SEIS specifically addresses requirements for environmental review under NEPA and NHPA. NEPA guidelines include compliance with related federal laws that require identification of historic properties and consideration of project-related effects on those properties. Section 106 of NHPA and NEPA procedures, particularly through involvement of Native American and other public constituents in the identification, evaluation, and mitigation processes, might address impact resolution required under other federal laws.

For historic resources, including built environment and archaeological resources, the most relevant laws, regulations, and standards include:

- National Environmental Policy Act of 1969 (NEPA)
- National Historic Preservation Act of 1966 (NHPA)
- FTA Transit Vibration and Noise Standards

1.8.1 NEPA and NHPA

Federal agencies must consider the effects of proposed projects on historic properties. Lead agencies evaluate potential impacts under NEPA and potential effects under NHPA to "historic properties" that are defined as resources that are listed in or eligible for listing in the National Register of Historic Places (NRHP) in an effort to avoid potential significant impacts and adverse effects. Resources that may be eligible for listing in the NRHP include districts, sites, buildings, structures, and objects that are at least 50 years old and are significant in American history, prehistory, architecture, archaeology, engineering, and culture. To be eligible for listing, the resource must meet one of the NRHP Criteria for Evaluation (36 CFR 60.4):

- Criterion A: A property is associated with events that have made a significant contribution to the broad patterns of our history; or
- Criterion B: A property is associated with the lives of a person or persons significant in our past; or
- Criterion C: A property embodies the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possesses high artistic values, or that represents a significant and distinguishable entity whose components may lack individual distinction; or
- Criterion D: A property has yielded, or may be likely to yield, information important in prehistory or history.

In addition, resources must possess integrity of location, design, setting, material, workmanship, feeling and association. Resources less than 50 years old may be eligible if they have exceptional importance and meet Criteria Consideration G, as described in the NPS's Bulletin No. 22, "How to Evaluate and Nominate Potential National Register Properties That Have Achieved Significance Within the Last 50 Years." Other types of resources that are typically not eligible for the NRHP, including religious properties, moved properties, birthplaces or graves, cemeteries, reconstructed properties, and commemorative properties may be eligible under other specific NRHP criteria considerations.

NEPA requires that environmental impacts to historic properties be evaluated and addressed during the EIS process, in coordination with procedures established by Section 106 of NHPA to address effects on historic properties. A significant impact and/or an adverse effect would occur if the project would directly or indirectly diminish any of the characteristics that qualify a historic property for NRHP eligibility or listing. Under NEPA, a significant impact may be resolved with mitigation measures to avoid the impact or to reduce the impact to a level of less-than-adverse. Under Section 106 of NHPA, adverse effects must be resolved through a consultation process between the federal lead agency, SHPO, interested parties, and the Advisory Council on Historic Preservation (ACHP). If an adverse effect cannot be avoided, mitigation may be agreed upon and documented in a signed MOA to resolve the adverse effect. If mitigation is not agreed upon through the Section 106 process, consultation is terminated and the ACHP may make comments on the procedure.

As part of the original EIS/EIR study for the Project and the tunneling method alternatives, historic properties located in the APE were identified, evaluated for NRHP eligibility, and assessed for effects under Section 106 of NHPA and the Criteria of Adverse Effects as contained in 36 CFR Part 800.5 (a)(1). On June 1, 2010, SHPO concurred with the determinations of eligibility and finding of effects by the FTA. An MOA was prepared and signed in September 2011 to address adverse effects. Section 106 consultation is an on-going process, and project changes may require further consultation and potential amendments to the existing signed MOA.

1.8.2 FTA Transit Noise and Vibration Impact Assessment

FTA's *Transit Noise and Vibration Impact Assessment Manual* (FTA-VA-90-1003-06) (Hanson 2006) provides standards by which it can be determined whether noise and ground-borne vibration (GBV) will cause damage to adjacent buildings and structures. Noise generated by construction equipment can cause adverse effects to historic properties and significant impacts to historical resources when exposure exceeds the "severe level" as established by FTA (Hanson 2006). Noise that reaches a severe level that cannot be reduced through mitigation or other measures may cause a reduction in use or access to historic properties or historical resources, and thus cause an adverse effect to historic properties or a significant impact to historical resources. For properties or resources where the sense of quiet represents a characteristic of its historical significance, increases in noise may also cause adverse effects and/or significant impacts. GBV generated by construction equipment can also cause adverse effects to historic properties and significant impacts to historical resources that are close to construction activities. Construction-related vibration can cause damage ranging from minor cosmetic damage to interior plaster or woodwork damage to major structural damage. Thus, GBV can harm the characteristics that make historic properties eligible for the NRHP and historical resources eligible for the CRHR.

GBV is established by measuring the vibratory potential of construction equipment, the distance between the equipment and a sensitive receptor (i.e., historical resource or historic property), and the structural category of the historic property and/or historical resource. When assessing the potential for building damage, GBV is usually expressed in terms of the peak particle velocity (PPV) in units of inches per second. FTA vibration damage criteria for various structural categories are listed in Table 1.8-1. The FTA threshold for Category IV buildings (i.e., buildings that are extremely susceptible to vibration damage) of 0.12 inches per second PPV.

Table 1.8-1: FTA Construction Vibration Damage Criteria

Building Category and Description	PPV (in/sec)
I. Reinforced-concrete, steel, or timber (no plaster)	0.5
II. Engineered concrete and masonry (no plaster)	0.3
III. Non-engineered timber and masonry buildings	0.2
IV. Buildings extremely susceptible to vibration damage	0.12

Source: U.S. Federal Transit Administration's Transit Noise and Vibration Impact Assessment Manual, May 2006. FTA-VA-90-1003-06. Table 12-3.

FTA guidelines address the potential for construction-activity-induced vibration to damage buildings. Project construction activities that have the potential for construction-related noise and vibration impacts include cut-and-cover construction, SEM construction, and TBM tunneling. Equipment, such as large bulldozers and drill rigs, would be the main source of construction vibration that could have the potential to cause vibration damage. Based on the FTA's minimum safe distances identified for Category IV buildings of 0.12 inches per second PPV, the minimum safe distance between construction activities (involving large bulldozers and drill rigs) and buildings would be 21 feet. As a result, historic buildings within 21 feet of construction may be susceptible to vibration damage, and were identified in the MOA and MMRP.

1.9 Environmental Justice Regulatory Framework and Methodology

Executive Order (EO) 12898, **Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,** signed by President Clinton on April 11, 1994 directs federal agencies to take appropriate and necessary steps to identify and address disproportionately high and adverse environmental effects of federal agency actions (including transportation projects) on minority and low-income populations. Following is a summary of other guidance and procedures that are used in the environmental justice analysis:

- **Environmental Justice Guidance under the National Environmental Policy Act (CEQ 1997):** Established guidance to assist federal agencies in effectively integrating the issue of environmental justice into their project development procedures.
- **United States Department of Transportation (USDOT) Updated Final Order on Environmental Justice, 5610.2(a) (USDOT 2012):** Provides detailed procedures for identifying environmental justice populations and for determining disproportionately high and adverse effects to the targeted populations.
- **FTA Circular 4703.1 Environmental Justice Policy Guidance for Federal Transit Administration Recipients (FTA 2012):** Provides guidance for incorporating environmental justice principles into plans, projects, and activities receiving funding from FTA.

The strategies developed under **FTA Circular 4703.1** are intended to ensure that communities are offered the opportunity to provide input on the planning and design of a federal action, as well as effects and mitigation measures, and disproportionately high and adverse effects on minority or low-income populations are appropriately addressed. The general methodology for addressing EO 12898 involves identifying the environmental justice populations within the study area and assessing whether the Project would result in disproportionately high and adverse effects on environmental justice populations, taking into consideration mitigation and enhancement measures and Project benefits, as appropriate. As part of the project, future public outreach efforts could include involvement of environmental justice groups when the outreach efforts are initiated given potential impacts to the Little Tokyo area.

The study area for the environmental justice analysis includes the Census block groups that fall within 1/4-mile of a proposed alignment. The assessment of the potential for disproportionate high and adverse effects is based upon the environmental impact information developed for the overall Project. Using the results of the technical studies conducted for the Project, the physical locations of adverse impacts were identified, and a map analysis was conducted to determine whether patterns or concentrations of adverse effects occurred in areas with environmental justice populations.
The data sources used in this SEIS analysis for the identification of minority, low-income, and LEP populations was the American Community Survey (ACS) 5-year average data for 2008-2012.

1.9.1 Identifying Low-Income and Minority Populations

The USDOT Order on Environmental Justice (5610.2a) and FTA Circular 4703.1 provide definitions of minority and low-income populations. These populations are as follows:

- **Minority Populations:** Any readily identifiable groups of minority persons who live in geographic proximity, and if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who would be similarly affected by a proposed FTA program, policy, or activity. Minority includes persons who are American Indian or Alaskan Native, Asian American, Native Hawaiian or Other Pacific Islander, Black (not of Hispanic Origin), and Hispanic or Latino.
- **Low-Income Population:** Any readily identifiable group of low-income persons whose household income is at or below the US Department of Health and Human Services (DHHS) poverty guidelines, and if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who would be similarly affected by a proposed USDOT program, policy, or activity. As established by the DHHS, the poverty guidelines in 2012 are shown in Table 1.9-1 (Health and Human Services Poverty Guidelines, 2012).

Table 1.9-1: Health and Human Services Poverty Guidelines, 2012

Persons in Family	Annual Median Household Income Poverty Levels in 48 Contiguous States and Washington, D.C.
1	$11,170
2	$15,130
3	$19,090
4	$23,050
5	$27,010
6	$30,970
7	$34,930
8	$38,890
For each additional person, add	$3,960

SOURCE: *Federal Register*, Vol. 77, No. 17, January 26, 2012, pp. 4034-4035.

When identifying environmental justice communities of concern, FTA calls for the analyses to include "reasonable efforts to identify the presence of distinct minority and/or low-income communities residing both within, and in close proximity to, the proposed project, or activity." The first step in the process relied on the use of thresholds based on CEQ guidance provided in *Environmental Justice Guidance under NEPA* (CEQ 1997). An environmental justice community was defined to include any Census block group in which the minority or low-income population meets either of the following thresholds:

a) Minority population or low-income households in the Census block group exceeds 50 percent;

b) Percentage of a minority population in the affected area is meaningfully greater than the lowest percentage in either the county or study area; and

c) Percentage of low-income households in the affected area is meaningfully greater than the lowest percentage in either the county or the study area. For low-income populations, FTA encourages the use of a locally developed threshold, such as that used for FTA's grant program (Public Law 112-141), or a percentage of median income for the area, provided that the threshold is at least as inclusive as the DHHS poverty guidelines.

The CEQ guidance does not define the specific percentage that should be used for determining if the minority or low-income household is "meaningfully greater" than the average in the surrounding jurisdiction. However, it is consistent with the CEQ guidance to set a threshold that is higher than (not the same as) the average of the low-income or minority population in the surrounding jurisdictions. For this Project, it was determined that the minority or low-income population is "meaningfully greater" than the average in the surrounding jurisdictions if it is higher than the average for the Los Angeles County.

Minority population and low-income household data from the U.S. Census Bureau were compiled at the state, county, and study area levels to provide a basis for identifying areas with high levels of environmental justice populations. Geographic Information System (GIS) maps were developed to illustrate the minority and income characteristics of the population in the study area.

Evaluating Potential Effects on Minority and Low-Income Populations

Disproportionately High and Adverse Effect on Minority and Low-income Populations means an adverse effect that:

- Is predominantly borne by a minority population and/or a low-income population; or
- Will be suffered by the minority population and/or low-income population and is appreciably more severe or greater in magnitude than the adverse effect that will be suffered by the non-minority population and/or non-low-income population.

Determinations of whether a project would have disproportionately high and adverse effects must take into consideration "mitigation and enhancements measures that will be taken and all offsetting benefits to the affected minority and low-income populations..." (USDOT Order, Section 8.b). The FTA Circular explains how benefits are considered in making this determination:

> *"...your analysis also should include consideration of offsetting benefits to the affected minority and low-income populations. This is particularly important for public transit projects because they often involve both adverse effects (such as short-term construction impacts, increases in bus traffic, etc.) and positive benefits (such as increased transportation options, improved connectivity, or overall improvement in air quality). The NEPA environmental justice analysis will include a review of the totality of the circumstances before determining whether there will be disproportionately high and adverse effects on environmental justice populations."* (See FTA Circular 4703.1, p. 46.)

The potential environmental impacts related to operations would remain the same as was determined in the Final EIS/EIR for the Project. As such, analysis of potential environmental justice-related impacts focused on the potential construction impacts of each alternative. Section 2 describes the alternatives that are evaluated in this document.

1.10 NEPA Guidance

An analysis of cumulative impacts is required by NEPA, as defined in 40 CFR 1508.7. The NEPA analysis of cumulative impacts follows the guidance of the Council on Environmental Quality (CEQ) 1997 document, Considering Cumulative Effects under the National Environmental Policy Act. In accordance with this guidance, the significance of impacts is evaluated based on context and intensity. Considerations of context and intensity also include a discussion of the severity of the impacts and the likelihood of their occurrence. The standards of significance for cumulative impacts depend on “the type of resource being analyzed, the condition of the resource, and the importance of the resource as an issue (as identified through scoping)” (CEQ 1997, p.45). Therefore, the standards of significance used for cumulative impacts are discipline-specific and may follow the same standards of significance established for the direct and indirect impacts of the project on each resource area. For some resources, limited details about other projects may prevent analysis from reaching the level of precision implied in the standards of significance for the direct and indirect impacts.

APPENDIX C

AIR QUALITY

Metro's Regional Connector Transit Corridor Supplemental Environmental Impact Study - Air Quality Appendix

Prepared June 2014

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Table 1-1: Summary of Maximum Daily Emissions

Alternative	Daily Emissions (lbs/day)					
	VOC	NOx	CO	SO2	PM10	PM2.5
Locally Preferred Alternative	32	124	257	1	6	3
Alternative 1	32	124	257	1	6	2
Alternative 2	26	123	248	1	6	2
Alternative 3	47	316	375	2	11	1
Alternative 4	38	195	266	1	7	5
Threshold of Significance	75	100	550	150	150	55

Note:
If threshold exceeded, then cell highlighted red.

Table 1-2: Summary of Annual Construction Emissions - Locally Preferred Alternative

Locally Preferred Alternative/Baseline

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	ROG Emissions (lbs/day)												ROG Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.54	9.54	9.54	9.54	12.77	12.77	12.77	12.77	24.91	24.91	24.91	24.91	24.91	24.91	24.91	24.91
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*9.54*	*9.54*	*9.54*	*9.54*	*12.77*	*12.77*	*12.77*	*12.77*	*24.91*	*24.91*	*24.91*	*24.91*	*24.91*	*24.91*	*24.91*	*24.91*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.12	0.12	0.12	0.10	0.10	0.10	0.10	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.71	0.71	0.71	0.63	0.63	0.63	0.63	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.83*	*0.83*	*0.83*	*0.83*	*0.73*	*0.73*	*0.73*	*0.73*	*1.43*	*1.43*	*1.43*	*1.43*	*1.43*	*1.43*	*1.43*	*1.43*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**10.36**	**10.36**	**10.36**	**10.36**	**13.51**	**13.51**	**13.51**	**13.51**	**26.35**	**26.35**	**26.35**	**26.35**	**26.35**	**26.35**	**26.35**	**26.35**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	NOx Emissions (lbs/day)												NOx Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.46	53.46	53.46	53.46	54.90	54.90	54.90	54.90	108.11	108.11	108.11	108.11	108.11	108.11	108.11	108.11
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*53.46*	*53.46*	*53.46*	*53.46*	*54.90*	*54.90*	*54.90*	*54.90*	*108.11*	*108.11*	*108.11*	*108.11*	*108.11*	*108.11*	*108.11*	*108.11*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.34	0.34	0.34	0.30	0.30	0.30	0.30	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.46	8.46	8.46	8.46	7.39	7.39	7.39	7.39	14.77	14.77	14.77	14.77	14.77	14.77	14.77	14.77
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*8.79*	*8.79*	*8.79*	*8.79*	*7.69*	*7.69*	*7.69*	*7.69*	*15.28*	*15.28*	*15.28*	*15.28*	*15.28*	*15.28*	*15.28*	*15.28*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**62.26**	**62.26**	**62.26**	**62.26**	**62.59**	**62.59**	**62.59**	**62.59**	**123.39**	**123.39**	**123.39**	**123.39**	**123.39**	**123.39**	**123.39**	**123.39**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	CO Emissions (lbs/day)												CO Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	116.01	116.01	116.01	116.01	121.32	121.32	121.32	121.32	236.47	236.47	236.47	236.47	236.47	236.47	236.47	236.47
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*116.01*	*116.01*	*116.01*	*116.01*	*121.32*	*121.32*	*121.32*	*121.32*	*236.47*	*236.47*	*236.47*	*236.47*	*236.47*	*236.47*	*236.47*	*236.47*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.17	4.17	4.17	4.17	3.80	3.80	3.80	3.80	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.24	3.24	3.24	3.24	2.84	2.84	2.84	2.84	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*7.41*	*7.41*	*7.41*	*7.41*	*6.64*	*6.64*	*6.64*	*6.64*	*12.01*	*12.01*	*12.01*	*12.01*	*12.01*	*12.01*	*12.01*	*12.01*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**123.42**	**123.42**	**123.42**	**123.42**	**127.96**	**127.96**	**127.96**	**127.96**	**248.49**	**248.49**	**248.49**	**248.49**	**248.49**	**248.49**	**248.49**	**248.49**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	SO2 Emissions (lbs/day)												SO2 Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM10 Emissions (lbs/day)												PM10 Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.84	0.84	0.84	0.91	0.91	0.91	0.91	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.96*	*0.96*	*0.96*	*0.96*	*1.03*	*1.03*	*1.03*	*1.03*	*1.94*	*1.94*	*1.94*	*1.94*	*1.94*	*1.94*	*1.94*	*1.94*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.69	0.69	0.69	0.65	0.65	0.65	0.65	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*2.37*	*2.37*	*2.37*	*2.37*	*2.32*	*2.32*	*2.32*	*2.32*	*4.08*	*4.08*	*4.08*	*4.08*	*4.08*	*4.08*	*4.08*	*4.08*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3.33**	**3.33**	**3.33**	**3.33**	**3.35**	**3.35**	**3.35**	**3.35**	**6.02**	**6.02**	**6.02**	**6.02**	**6.02**	**6.02**	**6.02**	**6.02**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM2.5 Emissions (lbs/day)												PM2.5 Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.78	0.78	0.78	0.84	0.84	0.84	0.84	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.79*	*0.79*	*0.79*	*0.79*	*0.86*	*0.86*	*0.86*	*0.86*	*1.65*	*1.65*	*1.65*	*1.65*	*1.65*	*1.65*	*1.65*	*1.65*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.35	0.35	0.35	0.31	0.31	0.31	0.31	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.63*	*0.63*	*0.63*	*0.63*	*0.59*	*0.59*	*0.59*	*0.59*	*1.09*	*1.09*	*1.09*	*1.09*	*1.09*	*1.09*	*1.09*	*1.09*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.43**	**1.43**	**1.43**	**1.43**	**1.45**	**1.45**	**1.45**	**1.45**	**2.74**	**2.74**	**2.74**	**2.74**	**2.74**	**2.74**	**2.74**	**2.74**

Table 1-2: Summary of Annual Construction Emissions - Locally Preferred Alternative

Locally Preferred Alternative/Baseline

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	ROG Emissions (lbs/day)												ROG Emissions (lbs/day)											
Construction Equipment Emissions	31.05	31.05	31.05	31.05	31.05	31.05	31.05	31.05	31.05	31.05	31.05	15.89	18.90	18.90	18.90	18.90	18.90	18.90	18.90	18.90	18.90	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*31.05*	*31.05*	*31.05*	*31.05*	*31.05*	*31.05*	*31.05*	*31.05*	*31.05*	*31.05*	*31.05*	*15.89*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.09	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00
Haul Truck Emissions	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	0.57	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.00	0.00	0.00
Offsite Subtotal	*1.29*	*1.29*	*1.29*	*1.29*	*1.29*	*1.29*	*1.29*	*1.29*	*1.29*	*1.29*	*1.29*	*0.66*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.00*	*0.00*	*0.00*
Total	**32.34**	**32.34**	**32.34**	**32.34**	**32.34**	**32.34**	**32.34**	**32.34**	**32.34**	**32.34**	**32.34**	**16.55**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	NOx Emissions (lbs/day)												NOx Emissions (lbs/day)											
Construction Equipment Emissions	110.86	110.86	110.86	110.86	110.86	110.86	110.86	110.86	110.86	110.86	110.86	56.29	57.62	57.62	57.62	57.62	57.62	57.62	57.62	57.62	57.62	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*110.86*	*110.86*	*110.86*	*110.86*	*110.86*	*110.86*	*110.86*	*110.86*	*110.86*	*110.86*	*110.86*	*56.29*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.27	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.00	0.00	0.00
Haul Truck Emissions	13.08	13.08	13.08	13.08	13.08	13.08	13.08	13.08	13.08	13.08	13.08	6.54	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	0.00	0.00	0.00
Offsite Subtotal	*13.54*	*13.54*	*13.54*	*13.54*	*13.54*	*13.54*	*13.54*	*13.54*	*13.54*	*13.54*	*13.54*	*6.81*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*0.00*	*0.00*	*0.00*
Total	**124.39**	**124.39**	**124.39**	**124.39**	**124.39**	**124.39**	**124.39**	**124.39**	**124.39**	**124.39**	**124.39**	**63.10**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	CO Emissions (lbs/day)												CO Emissions (lbs/day)											
Construction Equipment Emissions	246.58	246.58	246.58	246.58	246.58	246.58	246.58	246.58	246.58	246.58	246.58	126.45	131.38	131.38	131.38	131.38	131.38	131.38	131.38	131.38	131.38	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*246.58*	*246.58*	*246.58*	*246.58*	*246.58*	*246.58*	*246.58*	*246.58*	*246.58*	*246.58*	*246.58*	*126.45*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	5.82	5.82	5.82	5.82	5.82	5.82	5.82	5.82	5.82	5.82	5.82	3.49	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	0.00	0.00	0.00
Haul Truck Emissions	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	2.52	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	0.00	0.00	0.00
Offsite Subtotal	*10.87*	*10.87*	*10.87*	*10.87*	*10.87*	*10.87*	*10.87*	*10.87*	*10.87*	*10.87*	*10.87*	*6.01*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*0.00*	*0.00*	*0.00*
Total	**257.45**	**257.45**	**257.45**	**257.45**	**257.45**	**257.45**	**257.45**	**257.45**	**257.45**	**257.45**	**257.45**	**132.46**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	SO2 Emissions (lbs/day)												SO2 Emissions (lbs/day)											
Construction Equipment Emissions	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
Haul Truck Emissions	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00
Offsite Subtotal	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.00*	*0.00*	*0.00*
Total	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM10 Emissions (lbs/day)												PM10 Emissions (lbs/day)											
Construction Equipment Emissions	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	0.98	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	0.00	0.00	0.00
Fugitive Dust Emissions	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	--	--	--
Onsite Subtotal	*2.07*	*2.07*	*2.07*	*2.07*	*2.07*	*2.07*	*2.07*	*2.07*	*2.07*	*2.07*	*2.07*	*1.10*	*1.16*	*1.16*	*1.16*	*1.16*	*1.16*	*1.16*	*1.16*	*1.16*	*1.16*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	0.00	0.00	0.00
Haul Truck Emissions	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	0.61	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.00	0.00	0.00
Offsite Subtotal	*4.02*	*4.02*	*4.02*	*4.02*	*4.02*	*4.02*	*4.02*	*4.02*	*4.02*	*4.02*	*4.02*	*2.29*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*0.00*	*0.00*	*0.00*
Total	**6.08**	**6.08**	**6.08**	**6.08**	**6.08**	**6.08**	**6.08**	**6.08**	**6.08**	**6.08**	**6.08**	**3.38**	**3.42**	**3.42**	**3.42**	**3.42**	**3.42**	**3.42**	**3.42**	**3.42**	**3.42**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM2.5 Emissions (lbs/day)												PM2.5 Emissions (lbs/day)											
Construction Equipment Emissions	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	0.90	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.00	0.00	0.00
Fugitive Dust Emissions	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	--	--	--
Onsite Subtotal	*1.77*	*1.77*	*1.77*	*1.77*	*1.77*	*1.77*	*1.77*	*1.77*	*1.77*	*1.77*	*1.77*	*0.92*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.00	0.00	0.00
Haul Truck Emissions	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.28	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.00	0.00	0.00
Offsite Subtotal	*1.02*	*1.02*	*1.02*	*1.02*	*1.02*	*1.02*	*1.02*	*1.02*	*1.02*	*1.02*	*1.02*	*0.56*	*0.53*	*0.53*	*0.53*	*0.53*	*0.53*	*0.53*	*0.53*	*0.53*	*0.53*	*0.00*	*0.00*	*0.00*
Total	**2.79**	**2.79**	**2.79**	**2.79**	**2.79**	**2.79**	**2.79**	**2.79**	**2.79**	**2.79**	**2.79**	**1.48**	**1.51**	**1.51**	**1.51**	**1.51**	**1.51**	**1.51**	**1.51**	**1.51**	**1.51**	**0.00**	**0.00**	**0.00**

Table 1-3: Summary of Annual Construction Emissions - Alternative 1

Alternative 1

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	ROG Emissions (lbs/day)												ROG Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.54	9.54	9.54	9.54	12.77	12.77	12.77	12.77	24.91	24.91	24.91	24.91	24.91	24.91	24.91	24.91
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*9.54*	*9.54*	*9.54*	*9.54*	*12.77*	*12.77*	*12.77*	*12.77*	*24.91*	*24.91*	*24.91*	*24.91*	*24.91*	*24.91*	*24.91*	*24.91*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.12	0.12	0.12	0.10	0.10	0.10	0.10	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.71	0.71	0.71	0.63	0.63	0.63	0.63	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.83*	*0.83*	*0.83*	*0.83*	*0.73*	*0.73*	*0.73*	*0.73*	*1.43*	*1.43*	*1.43*	*1.43*	*1.43*	*1.43*	*1.43*	*1.43*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**10.36**	**10.36**	**10.36**	**10.36**	**13.51**	**13.51**	**13.51**	**13.51**	**26.35**	**26.35**	**26.35**	**26.35**	**26.35**	**26.35**	**26.35**	**26.35**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	NOx Emissions (lbs/day)												NOx Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.46	53.46	53.46	53.46	54.90	54.90	54.90	54.90	108.11	108.11	108.11	108.11	108.11	108.11	108.11	108.11
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*53.46*	*53.46*	*53.46*	*53.46*	*54.90*	*54.90*	*54.90*	*54.90*	*108.11*	*108.11*	*108.11*	*108.11*	*108.11*	*108.11*	*108.11*	*108.11*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.34	0.34	0.34	0.30	0.30	0.30	0.30	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.46	8.46	8.46	8.46	7.39	7.39	7.39	7.39	14.77	14.77	14.77	14.77	14.77	14.77	14.77	14.77
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*8.79*	*8.79*	*8.79*	*8.79*	*7.69*	*7.69*	*7.69*	*7.69*	*15.28*	*15.28*	*15.28*	*15.28*	*15.28*	*15.28*	*15.28*	*15.28*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**62.26**	**62.26**	**62.26**	**62.26**	**62.59**	**62.59**	**62.59**	**62.59**	**123.39**	**123.39**	**123.39**	**123.39**	**123.39**	**123.39**	**123.39**	**123.39**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	CO Emissions (lbs/day)												CO Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	116.01	116.01	116.01	116.01	121.32	121.32	121.32	121.32	236.47	236.47	236.47	236.47	236.47	236.47	236.47	236.47
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*116.01*	*116.01*	*116.01*	*116.01*	*121.32*	*121.32*	*121.32*	*121.32*	*236.47*	*236.47*	*236.47*	*236.47*	*236.47*	*236.47*	*236.47*	*236.47*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.17	4.17	4.17	4.17	3.80	3.80	3.80	3.80	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.24	3.24	3.24	3.24	2.84	2.84	2.84	2.84	5.68	5.68	5.68	5.68	5.68	5.68	5.68	5.68
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*7.41*	*7.41*	*7.41*	*7.41*	*6.64*	*6.64*	*6.64*	*6.64*	*12.01*	*12.01*	*12.01*	*12.01*	*12.01*	*12.01*	*12.01*	*12.01*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**123.42**	**123.42**	**123.42**	**123.42**	**127.96**	**127.96**	**127.96**	**127.96**	**248.49**	**248.49**	**248.49**	**248.49**	**248.49**	**248.49**	**248.49**	**248.49**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	SO2 Emissions (lbs/day)												SO2 Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM10 Emissions (lbs/day)												PM10 Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.84	0.84	0.84	0.91	0.91	0.91	0.91	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.95*	*0.95*	*0.95*	*0.95*	*1.02*	*1.02*	*1.02*	*1.02*	*1.95*	*1.95*	*1.95*	*1.95*	*1.95*	*1.95*	*1.95*	*1.95*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.69	0.69	0.69	0.65	0.65	0.65	0.65	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*2.37*	*2.37*	*2.37*	*2.37*	*2.32*	*2.32*	*2.32*	*2.32*	*4.08*	*4.08*	*4.08*	*4.08*	*4.08*	*4.08*	*4.08*	*4.08*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3.32**	**3.32**	**3.32**	**3.32**	**3.34**	**3.34**	**3.34**	**3.34**	**6.04**	**6.04**	**6.04**	**6.04**	**6.04**	**6.04**	**6.04**	**6.04**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM2.5 Emissions (lbs/day)												PM2.5 Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.78	0.78	0.78	0.84	0.84	0.84	0.84	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.79*	*0.79*	*0.79*	*0.79*	*0.86*	*0.86*	*0.86*	*0.86*	*1.65*	*1.65*	*1.65*	*1.65*	*1.65*	*1.65*	*1.65*	*1.65*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.31	0.31	0.31	0.27	0.27	0.27	0.27	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.33*	*0.33*	*0.33*	*0.33*	*0.29*	*0.29*	*0.29*	*0.29*	*0.57*	*0.57*	*0.57*	*0.57*	*0.57*	*0.57*	*0.57*	*0.57*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.13**	**1.13**	**1.13**	**1.13**	**1.15**	**1.15**	**1.15**	**1.15**	**2.22**	**2.22**	**2.22**	**2.22**	**2.22**	**2.22**	**2.22**	**2.22**

Alternative 1

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	ROG Emissions (lbs/day)												ROG Emissions (lbs/day)											
Construction Equipment Emissions	31.05	31.05	31.05	31.05	31.05	15.16	15.16	15.16	15.16	15.16	15.16	15.16	18.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*31.05*	*31.05*	*31.05*	*31.05*	*31.05*	*15.16*	*15.16*	*15.16*	*15.16*	*15.16*	*15.16*	*15.16*	*18.07*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.14	0.14	0.14	0.14	0.14	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	1.15	1.15	1.15	1.15	1.15	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*1.29*	*1.29*	*1.29*	*1.29*	*1.29*	*0.63*	*0.63*	*0.63*	*0.63*	*0.63*	*0.63*	*0.63*	*0.57*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**32.34**	**32.34**	**32.34**	**32.34**	**32.34**	**15.79**	**15.79**	**15.79**	**15.79**	**15.79**	**15.79**	**15.79**	**18.65**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	NOx Emissions (lbs/day)												NOx Emissions (lbs/day)											
Construction Equipment Emissions	110.86	110.86	110.86	110.86	110.86	54.57	54.57	54.57	54.57	54.57	54.57	54.57	53.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*110.86*	*110.86*	*110.86*	*110.86*	*110.86*	*54.57*	*54.57*	*54.57*	*54.57*	*54.57*	*54.57*	*54.57*	*53.46*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.46	0.46	0.46	0.46	0.46	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	13.08	13.08	13.08	13.08	13.08	6.54	6.54	6.54	6.54	6.54	6.54	6.54	5.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*13.54*	*13.54*	*13.54*	*13.54*	*13.54*	*6.72*	*6.72*	*6.72*	*6.72*	*6.72*	*6.72*	*6.72*	*6.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**124.39**	**124.39**	**124.39**	**124.39**	**124.39**	**61.29**	**61.29**	**61.29**	**61.29**	**61.29**	**61.29**	**61.29**	**59.47**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	CO Emissions (lbs/day)												CO Emissions (lbs/day)											
Construction Equipment Emissions	246.58	246.58	246.58	246.58	246.58	120.13	120.13	120.13	120.13	120.13	120.13	120.13	116.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*246.58*	*246.58*	*246.58*	*246.58*	*246.58*	*120.13*	*120.13*	*120.13*	*120.13*	*120.13*	*120.13*	*120.13*	*116.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	5.82	5.82	5.82	5.82	5.82	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	5.05	5.05	5.05	5.05	5.05	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*10.87*	*10.87*	*10.87*	*10.87*	*10.87*	*4.85*	*4.85*	*4.85*	*4.85*	*4.85*	*4.85*	*4.85*	*4.39*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**257.45**	**257.45**	**257.45**	**257.45**	**257.45**	**124.99**	**124.99**	**124.99**	**124.99**	**124.99**	**124.99**	**124.99**	**120.40**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	SO2 Emissions (lbs/day)												SO2 Emissions (lbs/day)											
Construction Equipment Emissions	1.00	1.00	1.00	1.00	1.00	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*0.48*	*0.48*	*0.48*	*0.48*	*0.48*	*0.48*	*0.48*	*0.52*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.54**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM10 Emissions (lbs/day)												PM10 Emissions (lbs/day)											
Construction Equipment Emissions	1.90	1.90	1.90	1.90	1.90	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	0.19	0.19	0.19	0.19	0.19	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*2.08*	*2.08*	*2.08*	*2.08*	*2.08*	*0.99*	*0.99*	*0.99*	*0.99*	*0.99*	*0.99*	*0.99*	*0.92*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	2.79	2.79	2.79	2.79	2.79	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	1.23	1.23	1.23	1.23	1.23	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*4.02*	*4.02*	*4.02*	*4.02*	*4.02*	*1.73*	*1.73*	*1.73*	*1.73*	*1.73*	*1.73*	*1.73*	*1.70*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**6.10**	**6.10**	**6.10**	**6.10**	**6.10**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**	**2.72**	**2.62**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM2.5 Emissions (lbs/day)												PM2.5 Emissions (lbs/day)											
Construction Equipment Emissions	1.74	1.74	1.74	1.74	1.74	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	0.03	0.03	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*1.77*	*1.77*	*1.77*	*1.77*	*1.77*	*0.86*	*0.86*	*0.86*	*0.86*	*0.86*	*0.86*	*0.86*	*0.79*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.04	0.04	0.04	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	0.46	0.46	0.46	0.46	0.46	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.22*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**2.27**	**2.27**	**2.27**	**2.27**	**2.27**	**1.10**	**1.10**	**1.10**	**1.10**	**1.10**	**1.10**	**1.10**	**1.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Alternative 2

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	ROG Emissions (lbs/day)												ROG Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.54	9.54	9.54	9.54	12.77	12.77	12.77	12.77	24.91	24.91	24.91	24.91	24.91	24.91	12.77	12.77
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*9.54*	*9.54*	*9.54*	*9.54*	*12.77*	*12.77*	*12.77*	*12.77*	*24.91*	*24.91*	*24.91*	*24.91*	*24.91*	*24.91*	*12.77*	*12.77*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.12	0.12	0.12	0.10	0.10	0.10	0.10	0.17	0.17	0.17	0.17	0.17	0.17	0.10	0.10
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.71	0.71	0.71	0.63	0.63	0.63	0.63	1.27	1.27	1.27	1.27	1.27	1.27	0.63	0.63
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.83*	*0.83*	*0.83*	*0.83*	*0.73*	*0.73*	*0.73*	*0.73*	*1.43*	*1.43*	*1.43*	*1.43*	*1.43*	*1.43*	*0.73*	*0.73*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**10.36**	**10.36**	**10.36**	**10.36**	**13.51**	**13.51**	**13.51**	**13.51**	**26.35**	**26.35**	**26.35**	**26.35**	**26.35**	**26.35**	**13.51**	**13.51**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	NOx Emissions (lbs/day)												NOx Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.46	53.46	53.46	53.46	54.90	54.90	54.90	54.90	108.11	108.11	108.11	108.11	108.11	108.11	54.90	54.90
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*53.46*	*53.46*	*53.46*	*53.46*	*54.90*	*54.90*	*54.90*	*54.90*	*108.11*	*108.11*	*108.11*	*108.11*	*108.11*	*108.11*	*54.90*	*54.90*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.34	0.34	0.34	0.30	0.30	0.30	0.30	0.50	0.50	0.50	0.50	0.50	0.50	0.30	0.30
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.46	8.46	8.46	8.46	7.39	7.39	7.39	7.39	14.77	14.77	14.77	14.77	14.77	14.77	7.39	7.39
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*8.79*	*8.79*	*8.79*	*8.79*	*7.69*	*7.69*	*7.69*	*7.69*	*15.28*	*15.28*	*15.28*	*15.28*	*15.28*	*15.28*	*7.69*	*7.69*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**62.26**	**62.26**	**62.26**	**62.26**	**62.59**	**62.59**	**62.59**	**62.59**	**123.39**	**123.39**	**123.39**	**123.39**	**123.39**	**123.39**	**62.59**	**62.59**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	CO Emissions (lbs/day)												CO Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	116.01	116.01	116.01	116.01	121.32	121.32	121.32	121.32	236.47	236.47	236.47	236.47	236.47	236.47	121.32	121.32
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*116.01*	*116.01*	*116.01*	*116.01*	*121.32*	*121.32*	*121.32*	*121.32*	*236.47*	*236.47*	*236.47*	*236.47*	*236.47*	*236.47*	*121.32*	*121.32*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.17	4.17	4.17	4.17	3.80	3.80	3.80	3.80	6.33	6.33	6.33	6.33	6.33	6.33	3.80	3.80
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.24	3.24	3.24	3.24	2.84	2.84	2.84	2.84	5.68	5.68	5.68	5.68	5.68	5.68	2.84	2.84
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*7.41*	*7.41*	*7.41*	*7.41*	*6.64*	*6.64*	*6.64*	*6.64*	*12.01*	*12.01*	*12.01*	*12.01*	*12.01*	*12.01*	*6.64*	*6.64*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**123.42**	**123.42**	**123.42**	**123.42**	**127.96**	**127.96**	**127.96**	**127.96**	**248.49**	**248.49**	**248.49**	**248.49**	**248.49**	**248.49**	**127.96**	**127.96**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	SO2 Emissions (lbs/day)												SO2 Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	1.00	1.00	1.00	1.00	1.00	1.00	0.52	0.52
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*0.52*	*0.52*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.02*	*0.02*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**1.05**	**0.54**	**0.54**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM10 Emissions (lbs/day)												PM10 Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.84	0.84	0.84	0.91	0.91	0.91	0.91	1.77	1.77	1.77	1.77	1.77	1.77	0.91	0.91
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.24	0.24	0.24	0.24	0.24	0.24	0.14	0.14
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.99*	*0.99*	*0.99*	*0.99*	*1.06*	*1.06*	*1.06*	*1.06*	*2.01*	*2.01*	*2.01*	*2.01*	*2.01*	*2.01*	*1.06*	*1.06*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	2.79	2.79	2.79	2.79	2.79	2.79	1.67	1.67
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.69	0.69	0.69	0.65	0.65	0.65	0.65	1.30	1.30	1.30	1.30	1.30	1.30	0.65	0.65
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*2.37*	*2.37*	*2.37*	*2.37*	*2.32*	*2.32*	*2.32*	*2.32*	*4.08*	*4.08*	*4.08*	*4.08*	*4.08*	*4.08*	*2.32*	*2.32*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3.35**	**3.35**	**3.35**	**3.35**	**3.38**	**3.38**	**3.38**	**3.38**	**6.09**	**6.09**	**6.09**	**6.09**	**6.09**	**6.09**	**3.38**	**3.38**

Table 1-4: Summary of Annual Construction Emissions - Alternative 2

YEAR	2014												2015											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	**PM2.5 Emissions (lbs/day)**												**PM2.5 Emissions (lbs/day)**											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.78	0.78	0.78	0.84	0.84	0.84	0.84	1.62	1.62	1.62	1.62	1.62	1.62	0.84	0.84
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.02	0.02
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.80*	*0.80*	*0.80*	*0.80*	*0.86*	*0.86*	*0.86*	*0.86*	*1.66*	*1.66*	*1.66*	*1.66*	*1.66*	*1.66*	*0.86*	*0.86*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.02	0.02
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.31	0.31	0.31	0.27	0.27	0.27	0.27	0.53	0.53	0.53	0.53	0.53	0.53	0.27	0.27
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.33*	*0.33*	*0.33*	*0.33*	*0.29*	*0.29*	*0.29*	*0.29*	*0.57*	*0.57*	*0.57*	*0.57*	*0.57*	*0.57*	*0.29*	*0.29*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.13**	**1.13**	**1.13**	**1.13**	**1.15**	**1.15**	**1.15**	**1.15**	**2.23**	**2.23**	**2.23**	**2.23**	**2.23**	**2.23**	**1.15**	**1.15**

Table 1-4: Summary of Annual Construction Emissions - Alternative 2

Alternative 2

YEAR	2016												2017											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	ROG Emissions (lbs/day)												ROG Emissions (lbs/day)											
Construction Equipment Emissions	15.89	15.89	15.89	15.89	15.89	15.89	15.89	15.89	15.89	15.89	15.89	15.89	18.90	18.90	18.90	18.90	18.90	18.90	18.90	18.90	18.90	18.90	18.90	18.90
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*15.89*	*15.89*	*15.89*	*15.89*	*15.89*	*15.89*	*15.89*	*15.89*	*15.89*	*15.89*	*15.89*	*15.89*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*	*18.90*
Construction Worker Commuting	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Haul Truck Emissions	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Offsite Subtotal	*0.66*	*0.66*	*0.66*	*0.66*	*0.66*	*0.66*	*0.66*	*0.66*	*0.66*	*0.66*	*0.66*	*0.66*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*	*0.60*
Total	**16.55**	**16.55**	**16.55**	**16.55**	**16.55**	**16.55**	**16.55**	**16.55**	**16.55**	**16.55**	**16.55**	**16.55**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**	**19.50**

YEAR	2016												2017											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	NOx Emissions (lbs/day)												NOx Emissions (lbs/day)											
Construction Equipment Emissions	56.29	56.29	56.29	56.29	56.29	56.29	56.29	56.29	56.29	56.29	56.29	56.29	57.62	57.62	57.62	57.62	57.62	57.62	57.62	57.62	57.62	57.62	57.62	57.62
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*56.29*	*56.29*	*56.29*	*56.29*	*56.29*	*56.29*	*56.29*	*56.29*	*56.29*	*56.29*	*56.29*	*56.29*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*	*57.62*
Construction Worker Commuting	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Haul Truck Emissions	6.54	6.54	6.54	6.54	6.54	6.54	6.54	6.54	6.54	6.54	6.54	6.54	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84
Offsite Subtotal	*6.81*	*6.81*	*6.81*	*6.81*	*6.81*	*6.81*	*6.81*	*6.81*	*6.81*	*6.81*	*6.81*	*6.81*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*	*6.09*
Total	**63.10**	**63.10**	**63.10**	**63.10**	**63.10**	**63.10**	**63.10**	**63.10**	**63.10**	**63.10**	**63.10**	**63.10**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**	**63.71**

YEAR	2016												2017											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	CO Emissions (lbs/day)												CO Emissions (lbs/day)											
Construction Equipment Emissions	126.45	126.45	126.45	126.45	126.45	126.45	126.45	126.45	126.45	126.45	126.45	126.45	131.38	131.38	131.38	131.38	131.38	131.38	131.38	131.38	131.38	131.38	131.38	131.38
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*126.45*	*126.45*	*126.45*	*126.45*	*126.45*	*126.45*	*126.45*	*126.45*	*126.45*	*126.45*	*126.45*	*126.45*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*	*131.38*
Construction Worker Commuting	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19
Haul Truck Emissions	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26
Offsite Subtotal	*6.01*	*6.01*	*6.01*	*6.01*	*6.01*	*6.01*	*6.01*	*6.01*	*6.01*	*6.01*	*6.01*	*6.01*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*	*5.46*
Total	**132.46**	**132.46**	**132.46**	**132.46**	**132.46**	**132.46**	**132.46**	**132.46**	**132.46**	**132.46**	**132.46**	**132.46**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**	**136.84**

YEAR	2016												2017											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	SO2 Emissions (lbs/day)												SO2 Emissions (lbs/day)											
Construction Equipment Emissions	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*	*0.52*
Construction Worker Commuting	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Haul Truck Emissions	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Offsite Subtotal	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*
Total	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**	**0.54**

YEAR	2016												2017											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	PM10 Emissions (lbs/day)												PM10 Emissions (lbs/day)											
Construction Equipment Emissions	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
Fugitive Dust Emissions	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Onsite Subtotal	*1.12*	*1.12*	*1.12*	*1.12*	*1.12*	*1.12*	*1.12*	*1.12*	*1.12*	*1.12*	*1.12*	*1.12*	*1.19*	*1.19*	*1.19*	*1.19*	*1.19*	*1.19*	*1.19*	*1.19*	*1.19*	*1.19*	*1.19*	*1.19*
Construction Worker Commuting	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
Haul Truck Emissions	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Offsite Subtotal	*2.29*	*2.29*	*2.29*	*2.29*	*2.29*	*2.29*	*2.29*	*2.29*	*2.29*	*2.29*	*2.29*	*2.29*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*	*2.26*
Total	**3.41**	**3.41**	**3.41**	**3.41**	**3.41**	**3.41**	**3.41**	**3.41**	**3.41**	**3.41**	**3.41**	**3.41**	**3.44**	**3.44**	**3.44**	**3.44**	**3.44**	**3.44**	**3.44**	**3.44**	**3.44**	**3.44**	**3.44**	**3.44**

Table 1-4: Summary of Annual Construction Emissions - Alternative 2

YEAR	2016												2017											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	**PM2.5 Emissions (lbs/day)**												**PM2.5 Emissions (lbs/day)**											
Construction Equipment Emissions	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Fugitive Dust Emissions	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Onsite Subtotal	*0.92*	*0.92*	*0.92*	*0.92*	*0.92*	*0.92*	*0.92*	*0.92*	*0.92*	*0.92*	*0.92*	*0.92*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*
Construction Worker Commuting	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Haul Truck Emissions	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Offsite Subtotal	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.22*	*0.22*	*0.22*	*0.22*	*0.22*	*0.22*	*0.22*	*0.22*	*0.22*	*0.22*	*0.22*	*0.22*
Total	**1.18**	**1.18**	**1.18**	**1.18**	**1.18**	**1.18**	**1.18**	**1.18**	**1.18**	**1.18**	**1.18**	**1.18**	**1.21**	**1.21**	**1.21**	**1.21**	**1.21**	**1.21**	**1.21**	**1.21**	**1.21**	**1.21**	**1.21**	**1.21**

Table 1-5: Summary of Annual Construction Emissions - Alternative 3

Alternative 3

YEAR	2014												2015											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	**ROG Emissions (lbs/day)**												**ROG Emissions (lbs/day)**											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.74	20.74	25.84	25.84	25.84	25.84	25.84	37.99	37.99	37.99	37.99	37.99	37.99	12.14
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*20.74*	*20.74*	*25.84*	*25.84*	*25.84*	*25.84*	*25.84*	*37.99*	*37.99*	*37.99*	*37.99*	*37.99*	*37.99*	*12.14*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.16	0.13	0.13	0.13	0.13	0.13	0.20	0.20	0.20	0.20	0.20	0.20	0.07
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.16*	*0.16*	*0.13*	*0.13*	*0.13*	*0.13*	*0.13*	*0.84*	*0.84*	*0.84*	*0.84*	*0.84*	*0.84*	*0.70*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**20.90**	**20.90**	**25.98**	**25.98**	**25.98**	**25.98**	**25.98**	**38.82**	**38.82**	**38.82**	**38.82**	**38.82**	**38.82**	**12.84**

YEAR	2014												2015											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	**NOx Emissions (lbs/day)**												**NOx Emissions (lbs/day)**											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	254.93	254.93	254.47	254.47	254.47	254.47	254.47	307.68	307.68	307.68	307.68	307.68	307.68	53.21
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*254.93*	*254.93*	*254.47*	*254.47*	*254.47*	*254.47*	*254.47*	*307.68*	*307.68*	*307.68*	*307.68*	*307.68*	*307.68*	*53.21*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.45	0.40	0.40	0.40	0.40	0.40	0.61	0.61	0.61	0.61	0.61	0.61	0.20
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.39	7.39	7.39	7.39	7.39	7.39	7.39
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.45*	*0.45*	*0.40*	*0.40*	*0.40*	*0.40*	*0.40*	*7.99*	*7.99*	*7.99*	*7.99*	*7.99*	*7.99*	*7.59*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**255.37**	**255.37**	**254.87**	**254.87**	**254.87**	**254.87**	**254.87**	**315.67**	**315.67**	**315.67**	**315.67**	**315.67**	**315.67**	**60.80**

YEAR	2014												2015											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	**CO Emissions (lbs/day)**												**CO Emissions (lbs/day)**											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	198.48	198.48	202.14	202.14	202.14	202.14	202.14	317.29	317.29	317.29	317.29	317.29	317.29	115.15
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*198.48*	*198.48*	*202.14*	*202.14*	*202.14*	*202.14*	*202.14*	*317.29*	*317.29*	*317.29*	*317.29*	*317.29*	*317.29*	*115.15*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.56	5.56	5.07	5.07	5.07	5.07	5.07	7.60	7.60	7.60	7.60	7.60	7.60	2.53
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	2.84	2.84	2.84	2.84	2.84	2.84
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*5.56*	*5.56*	*5.07*	*5.07*	*5.07*	*5.07*	*5.07*	*10.44*	*10.44*	*10.44*	*10.44*	*10.44*	*10.44*	*5.37*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**204.03**	**204.03**	**207.20**	**207.20**	**207.20**	**207.20**	**207.20**	**327.73**	**327.73**	**327.73**	**327.73**	**327.73**	**327.73**	**120.52**

YEAR	2014												2015											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	**SO2 Emissions (lbs/day)**												**SO2 Emissions (lbs/day)**											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.18	1.18	1.17	1.17	1.17	1.17	1.17	1.65	1.65	1.65	1.65	1.65	1.65	0.48
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*1.18*	*1.18*	*1.17*	*1.17*	*1.17*	*1.17*	*1.17*	*1.65*	*1.65*	*1.65*	*1.65*	*1.65*	*1.65*	*0.48*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.02*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.19**	**1.19**	**1.18**	**1.18**	**1.18**	**1.18**	**1.18**	**1.68**	**1.68**	**1.68**	**1.68**	**1.68**	**1.68**	**0.50**

YEAR	2014												2015											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	**PM10 Emissions (lbs/day)**												**PM10 Emissions (lbs/day)**											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.37	6.37	6.59	6.59	6.59	6.59	6.59	7.44	7.44	7.44	7.44	7.44	7.44	0.85
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*6.37*	*6.37*	*6.59*	*6.59*	*6.59*	*6.59*	*6.59*	*7.49*	*7.49*	*7.49*	*7.49*	*7.49*	*7.49*	*0.90*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.23	2.23	2.23	2.23	2.23	2.23	2.23	3.34	3.34	3.34	3.34	3.34	3.34	1.11
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*2.23*	*2.23*	*2.23*	*2.23*	*2.23*	*2.23*	*2.23*	*3.99*	*3.99*	*3.99*	*3.99*	*3.99*	*3.99*	*1.76*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**8.60**	**8.60**	**8.82**	**8.82**	**8.82**	**8.82**	**8.82**	**11.49**	**11.49**	**11.49**	**11.49**	**11.49**	**11.49**	**2.67**

YEAR	2014												2015											
MONTH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Phase	**PM2.5 Emissions (lbs/day)**												**PM2.5 Emissions (lbs/day)**											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.05	0.05	0.02
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.02*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.05	0.05	0.02
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.31*	*0.31*	*0.31*	*0.31*	*0.31*	*0.31*	*0.28*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.06**	**0.06**	**0.06**	**0.06**	**0.06**	**0.06**	**0.06**	**0.37**	**0.37**	**0.37**	**0.37**	**0.37**	**0.37**	**0.30**

Alternative 3

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	ROG Emissions (lbs/day)												ROG Emissions (lbs/day)											
Construction Equipment Emissions	15.16	15.16	30.32	15.16	15.16	15.16	15.16	15.16	15.16	30.32	30.32	45.48	36.15	36.15	36.15	36.15	36.15	18.07	18.07	18.07	18.07	18.07	18.07	36.97
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*15.16*	*15.16*	*30.32*	*15.16*	*15.16*	*15.16*	*15.16*	*15.16*	*15.16*	*30.32*	*30.32*	*45.48*	*36.15*	*36.15*	*36.15*	*36.15*	*36.15*	*18.07*	*18.07*	*18.07*	*18.07*	*18.07*	*18.07*	*36.97*
Construction Worker Commuting	0.06	0.06	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.12	0.12	0.17	0.10	0.10	0.10	0.10	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.12
Haul Truck Emissions	0.57	0.57	1.15	0.57	0.57	0.57	0.57	0.57	0.57	1.15	1.15	1.72	1.05	1.05	1.05	1.05	1.05	0.53	0.53	0.53	0.53	0.53	0.53	1.05
Offsite Subtotal	*0.63*	*0.63*	*1.26*	*0.63*	*0.63*	*0.63*	*0.63*	*0.63*	*0.63*	*1.26*	*1.26*	*1.89*	*1.15*	*1.15*	*1.15*	*1.15*	*1.15*	*0.57*	*0.57*	*0.57*	*0.57*	*0.57*	*0.57*	*1.17*
Total	**15.79**	**15.79**	**31.58**	**15.79**	**15.79**	**15.79**	**15.79**	**15.79**	**15.79**	**31.58**	**31.58**	**47.37**	**37.29**	**37.29**	**37.29**	**37.29**	**37.29**	**18.65**	**18.65**	**18.65**	**18.65**	**18.65**	**18.65**	**38.14**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	NOx Emissions (lbs/day)												NOx Emissions (lbs/day)											
Construction Equipment Emissions	54.57	54.57	109.14	54.57	54.57	54.57	54.57	54.57	54.57	109.14	109.14	163.71	111.76	111.76	111.76	111.76	111.76	55.88	55.88	55.88	55.88	55.88	55.88	113.50
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*54.57*	*54.57*	*109.14*	*54.57*	*54.57*	*54.57*	*54.57*	*54.57*	*54.57*	*109.14*	*109.14*	*163.71*	*111.76*	*111.76*	*111.76*	*111.76*	*111.76*	*55.88*	*55.88*	*55.88*	*55.88*	*55.88*	*55.88*	*113.50*
Construction Worker Commuting	0.18	0.18	0.37	0.18	0.18	0.18	0.18	0.18	0.18	0.37	0.37	0.55	0.33	0.33	0.33	0.33	0.33	0.17	0.17	0.17	0.17	0.17	0.17	0.42
Haul Truck Emissions	6.54	6.54	13.08	6.54	6.54	6.54	6.54	6.54	6.54	13.08	13.08	19.62	11.68	11.68	11.68	11.68	11.68	5.84	5.84	5.84	5.84	5.84	5.84	11.68
Offsite Subtotal	*6.72*	*6.72*	*13.44*	*6.72*	*6.72*	*6.72*	*6.72*	*6.72*	*6.72*	*13.44*	*13.44*	*20.17*	*12.01*	*12.01*	*12.01*	*12.01*	*12.01*	*6.01*	*6.01*	*6.01*	*6.01*	*6.01*	*6.01*	*12.09*
Total	**61.29**	**61.29**	**122.58**	**61.29**	**61.29**	**61.29**	**61.29**	**61.29**	**61.29**	**122.58**	**122.58**	**183.88**	**123.77**	**123.77**	**123.77**	**123.77**	**123.77**	**61.89**	**61.89**	**61.89**	**61.89**	**61.89**	**61.89**	**125.60**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	CO Emissions (lbs/day)												CO Emissions (lbs/day)											
Construction Equipment Emissions	120.13	120.13	240.27	120.13	120.13	120.13	120.13	120.13	120.13	240.27	240.27	360.40	249.89	249.89	249.89	249.89	249.89	124.95	124.95	124.95	124.95	124.95	124.95	256.33
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*120.13*	*120.13*	*240.27*	*120.13*	*120.13*	*120.13*	*120.13*	*120.13*	*120.13*	*240.27*	*240.27*	*360.40*	*249.89*	*249.89*	*249.89*	*249.89*	*249.89*	*124.95*	*124.95*	*124.95*	*124.95*	*124.95*	*124.95*	*256.33*
Construction Worker Commuting	2.33	2.33	4.65	2.33	2.33	2.33	2.33	2.33	2.33	4.65	4.65	6.98	4.26	4.26	4.26	4.26	4.26	2.13	2.13	2.13	2.13	2.13	2.13	5.32
Haul Truck Emissions	2.52	2.52	5.05	2.52	2.52	2.52	2.52	2.52	2.52	5.05	5.05	7.57	4.53	4.53	4.53	4.53	4.53	2.26	2.26	2.26	2.26	2.26	2.26	4.53
Offsite Subtotal	*4.85*	*4.85*	*9.70*	*4.85*	*4.85*	*4.85*	*4.85*	*4.85*	*4.85*	*9.70*	*9.70*	*14.55*	*8.78*	*8.78*	*8.78*	*8.78*	*8.78*	*4.39*	*4.39*	*4.39*	*4.39*	*4.39*	*4.39*	*9.85*
Total	**124.99**	**124.99**	**249.97**	**124.99**	**124.99**	**124.99**	**124.99**	**124.99**	**124.99**	**249.97**	**249.97**	**374.96**	**258.68**	**258.68**	**258.68**	**258.68**	**258.68**	**129.34**	**129.34**	**129.34**	**129.34**	**129.34**	**129.34**	**266.18**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	SO2 Emissions (lbs/day)												SO2 Emissions (lbs/day)											
Construction Equipment Emissions	0.48	0.48	0.97	0.48	0.48	0.48	0.48	0.48	0.48	0.97	0.97	1.45	0.97	0.97	0.97	0.97	0.97	0.48	0.48	0.48	0.48	0.48	0.48	1.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.48*	*0.48*	*0.97*	*0.48*	*0.48*	*0.48*	*0.48*	*0.48*	*0.48*	*0.97*	*0.97*	*1.45*	*0.97*	*0.97*	*0.97*	*0.97*	*0.97*	*0.48*	*0.48*	*0.48*	*0.48*	*0.48*	*0.48*	*1.00*
Construction Worker Commuting	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Haul Truck Emissions	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03
Offsite Subtotal	*0.02*	*0.02*	*0.04*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.04*	*0.04*	*0.06*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.04*
Total	**0.50**	**0.50**	**1.01**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**1.01**	**1.01**	**1.51**	**1.01**	**1.01**	**1.01**	**1.01**	**1.01**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**1.05**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM10 Emissions (lbs/day)												PM10 Emissions (lbs/day)											
Construction Equipment Emissions	0.92	0.92	1.83	0.92	0.92	0.92	0.92	0.92	0.92	1.83	1.83	2.75	1.96	1.96	1.96	1.96	1.96	0.98	0.98	0.98	0.98	0.98	0.98	2.02
Fugitive Dust Emissions	0.05	0.05	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.13	0.13	0.18	0.12	0.12	0.12	0.12	0.12	0.05	0.05	0.05	0.05	0.05	0.05	0.31
Onsite Subtotal	*0.97*	*0.97*	*1.95*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*	*1.96*	*1.96*	*2.93*	*2.08*	*2.08*	*2.08*	*2.08*	*2.08*	*1.03*	*1.03*	*1.03*	*1.03*	*1.03*	*1.03*	*2.33*
Construction Worker Commuting	1.12	1.12	2.23	1.12	1.12	1.12	1.12	1.12	1.12	2.23	2.23	3.35	2.23	2.23	2.23	2.23	2.23	1.12	1.12	1.12	1.12	1.12	1.12	2.79
Haul Truck Emissions	0.61	0.61	1.23	0.61	0.61	0.61	0.61	0.61	0.61	1.23	1.23	1.84	1.17	1.17	1.17	1.17	1.17	0.58	0.58	0.58	0.58	0.58	0.58	1.17
Offsite Subtotal	*1.73*	*1.73*	*3.46*	*1.73*	*1.73*	*1.73*	*1.73*	*1.73*	*1.73*	*3.46*	*3.46*	*5.19*	*3.40*	*3.40*	*3.40*	*3.40*	*3.40*	*1.70*	*1.70*	*1.70*	*1.70*	*1.70*	*1.70*	*3.96*
Total	**2.70**	**2.70**	**5.41**	**2.71**	**2.71**	**2.71**	**2.71**	**2.71**	**2.71**	**5.42**	**5.42**	**8.12**	**5.47**	**5.47**	**5.47**	**5.47**	**5.47**	**2.73**	**2.73**	**2.73**	**2.73**	**2.73**	**2.73**	**6.29**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM2.5 Emissions (lbs/day)												PM2.5 Emissions (lbs/day)											
Construction Equipment Emissions	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.04
Fugitive Dust Emissions	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.05
Onsite Subtotal	*0.02*	*0.02*	*0.05*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.05*	*0.05*	*0.08*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.09*
Construction Worker Commuting	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.04
Haul Truck Emissions	0.23	0.23	0.46	0.23	0.23	0.23	0.23	0.23	0.23	0.46	0.46	0.69	0.40	0.40	0.40	0.40	0.40	0.20	0.20	0.20	0.20	0.20	0.20	0.40
Offsite Subtotal	*0.25*	*0.25*	*0.49*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.49*	*0.49*	*0.74*	*0.43*	*0.43*	*0.43*	*0.43*	*0.43*	*0.22*	*0.22*	*0.22*	*0.22*	*0.22*	*0.22*	*0.44*
Total	**0.27**	**0.27**	**0.54**	**0.27**	**0.27**	**0.27**	**0.27**	**0.27**	**0.27**	**0.55**	**0.55**	**0.82**	**0.48**	**0.48**	**0.48**	**0.48**	**0.48**	**0.24**	**0.24**	**0.24**	**0.24**	**0.24**	**0.24**	**0.53**

Alternative 4

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	ROG Emissions (lbs/day)												ROG Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.04	16.04	16.04	16.04	16.04	28.19	28.19	28.19	28.19	12.14	12.14
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*16.04*	*16.04*	*16.04*	*16.04*	*16.04*	*28.19*	*28.19*	*28.19*	*28.19*	*12.14*	*12.14*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.07	0.07	0.13	0.13	0.13	0.13	0.13	0.07	0.07
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.07*	*0.07*	*0.07*	*0.07*	*0.77*	*0.77*	*0.77*	*0.77*	*0.77*	*0.70*	*0.70*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**16.11**	**16.11**	**16.11**	**16.11**	**16.81**	**28.95**	**28.95**	**28.95**	**28.95**	**12.84**	**12.84**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	NOx Emissions (lbs/day)												NOx Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	133.54	133.54	133.54	133.54	133.54	186.75	186.75	186.75	186.75	53.21	53.21
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*133.54*	*133.54*	*133.54*	*133.54*	*133.54*	*186.75*	*186.75*	*186.75*	*186.75*	*53.21*	*53.21*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.20	0.40	0.40	0.40	0.40	0.40	0.20	0.20
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.39	7.39	7.39	7.39	7.39	7.39	7.39
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.20*	*0.20*	*0.20*	*0.20*	*7.79*	*7.79*	*7.79*	*7.79*	*7.79*	*7.59*	*7.59*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**133.75**	**133.75**	**133.75**	**133.75**	**141.33**	**194.54**	**194.54**	**194.54**	**194.54**	**60.80**	**60.80**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	CO Emissions (lbs/day)												CO Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	124.42	124.42	124.42	124.42	124.42	239.57	239.57	239.57	239.57	115.15	115.15
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*124.42*	*124.42*	*124.42*	*124.42*	*124.42*	*239.57*	*239.57*	*239.57*	*239.57*	*115.15*	*115.15*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.53	2.53	2.53	2.53	5.07	5.07	5.07	5.07	5.07	2.53	2.53
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	2.84	2.84	2.84	2.84	2.84	2.84
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*2.53*	*2.53*	*2.53*	*2.53*	*7.91*	*7.91*	*7.91*	*7.91*	*7.91*	*5.37*	*5.37*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**126.95**	**126.95**	**126.95**	**126.95**	**132.33**	**247.48**	**247.48**	**247.48**	**247.48**	**120.52**	**120.52**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	SO2 Emissions (lbs/day)												SO2 Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.71	0.71	0.71	0.71	1.20	1.20	1.20	1.20	0.48	0.48
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.71*	*0.71*	*0.71*	*0.71*	*0.71*	*1.20*	*1.20*	*1.20*	*1.20*	*0.48*	*0.48*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.02*	*0.02*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.72**	**0.72**	**0.72**	**0.72**	**0.74**	**1.22**	**1.22**	**1.22**	**1.22**	**0.50**	**0.50**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM10 Emissions (lbs/day)												PM10 Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.53	3.53	3.53	3.53	3.53	4.38	4.38	4.38	4.38	0.85	0.85
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*3.53*	*3.53*	*3.53*	*3.53*	*3.61*	*4.46*	*4.46*	*4.46*	*4.46*	*0.93*	*0.93*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	1.11	1.11	1.11	2.23	2.23	2.23	2.23	2.23	1.11	1.11
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*1.11*	*1.11*	*1.11*	*1.11*	*2.88*	*2.88*	*2.88*	*2.88*	*2.88*	*1.76*	*1.76*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**4.64**	**4.64**	**4.64**	**4.64**	**6.49**	**7.34**	**7.34**	**7.34**	**7.34**	**2.69**	**2.69**

YEAR	2014												2015											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM2.5 Emissions (lbs/day)												PM2.5 Emissions (lbs/day)											
Construction Equipment Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.25	3.25	3.25	3.25	3.25	4.03	4.03	4.03	4.03	0.78	0.78
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Onsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*3.25*	*3.25*	*3.25*	*3.25*	*3.51*	*4.30*	*4.30*	*4.30*	*4.30*	*1.05*	*1.05*
Construction Worker Commuting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.02
Haul Truck Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Offsite Subtotal	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.02*	*0.02*	*0.02*	*0.02*	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*	*0.28*	*0.28*
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3.26**	**3.26**	**3.26**	**3.26**	**3.81**	**4.59**	**4.59**	**4.59**	**4.59**	**1.33**	**1.33**

Alternative 4

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	ROG Emissions (lbs/day)												ROG Emissions (lbs/day)											
Construction Equipment Emissions	15.16	15.16	15.16	30.32	30.32	30.32	30.32	30.32	30.32	30.32	30.32	30.32	36.15	36.15	18.07	18.07	36.97	18.90	18.90	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*15.16*	*15.16*	*15.16*	*30.32*	*30.32*	*30.32*	*30.32*	*30.32*	*30.32*	*30.32*	*30.32*	*30.32*	*36.15*	*36.15*	*18.07*	*18.07*	*36.97*	*18.90*	*18.90*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.06	0.06	0.06	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.10	0.10	0.05	0.05	0.12	0.07	0.07	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	0.57	0.57	0.57	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.05	1.05	0.53	0.53	1.05	0.53	0.53	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*0.63*	*0.63*	*0.63*	*1.26*	*1.26*	*1.26*	*1.26*	*1.26*	*1.26*	*1.26*	*1.26*	*1.26*	*1.15*	*1.15*	*0.57*	*0.57*	*1.17*	*0.60*	*0.60*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**15.79**	**15.79**	**15.79**	**31.58**	**31.58**	**31.58**	**31.58**	**31.58**	**31.58**	**31.58**	**31.58**	**31.58**	**37.29**	**37.29**	**18.65**	**18.65**	**38.14**	**19.50**	**19.50**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	NOx Emissions (lbs/day)												NOx Emissions (lbs/day)											
Construction Equipment Emissions	54.57	54.57	54.57	109.14	109.14	109.14	109.14	109.14	109.14	109.14	109.14	109.14	111.76	111.76	55.88	55.88	113.50	57.62	57.62	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*54.57*	*54.57*	*54.57*	*109.14*	*109.14*	*109.14*	*109.14*	*109.14*	*109.14*	*109.14*	*109.14*	*109.14*	*111.76*	*111.76*	*55.88*	*55.88*	*113.50*	*57.62*	*57.62*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.18	0.18	0.18	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.33	0.33	0.17	0.17	0.42	0.25	0.25	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	6.54	6.54	6.54	13.08	13.08	13.08	13.08	13.08	13.08	13.08	13.08	13.08	11.68	11.68	5.84	5.84	11.68	5.84	5.84	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*6.72*	*6.72*	*6.72*	*13.44*	*13.44*	*13.44*	*13.44*	*13.44*	*13.44*	*13.44*	*13.44*	*13.44*	*12.01*	*12.01*	*6.01*	*6.01*	*12.09*	*6.09*	*6.09*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**61.29**	**61.29**	**61.29**	**122.58**	**122.58**	**122.58**	**122.58**	**122.58**	**122.58**	**122.58**	**122.58**	**122.58**	**123.77**	**123.77**	**61.89**	**61.89**	**125.60**	**63.71**	**63.71**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	CO Emissions (lbs/day)												CO Emissions (lbs/day)											
Construction Equipment Emissions	120.13	120.13	120.13	240.27	240.27	240.27	240.27	240.27	240.27	240.27	240.27	240.27	249.89	249.89	124.95	124.95	256.33	131.38	131.38	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*120.13*	*120.13*	*120.13*	*240.27*	*240.27*	*240.27*	*240.27*	*240.27*	*240.27*	*240.27*	*240.27*	*240.27*	*249.89*	*249.89*	*124.95*	*124.95*	*256.33*	*131.38*	*131.38*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	2.33	2.33	2.33	4.65	4.65	4.65	4.65	4.65	4.65	4.65	4.65	4.65	4.26	4.26	2.13	2.13	5.32	3.19	3.19	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	2.52	2.52	2.52	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	4.53	4.53	2.26	2.26	4.53	2.26	2.26	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*4.85*	*4.85*	*4.85*	*9.70*	*9.70*	*9.70*	*9.70*	*9.70*	*9.70*	*9.70*	*9.70*	*9.70*	*8.78*	*8.78*	*4.39*	*4.39*	*9.85*	*5.46*	*5.46*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**124.99**	**124.99**	**124.99**	**249.97**	**249.97**	**249.97**	**249.97**	**249.97**	**249.97**	**249.97**	**249.97**	**249.97**	**258.68**	**258.68**	**129.34**	**129.34**	**266.18**	**136.84**	**136.84**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	SO2 Emissions (lbs/day)												SO2 Emissions (lbs/day)											
Construction Equipment Emissions	0.48	0.48	0.48	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.48	0.48	1.00	0.52	0.52	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Subtotal	*0.48*	*0.48*	*0.48*	*0.97*	*0.97*	*0.97*	*0.97*	*0.97*	*0.97*	*0.97*	*0.97*	*0.97*	*0.97*	*0.97*	*0.48*	*0.48*	*1.00*	*0.52*	*0.52*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.02	0.02	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*0.02*	*0.02*	*0.02*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*	*0.02*	*0.02*	*0.04*	*0.02*	*0.02*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**0.50**	**0.50**	**0.50**	**1.01**	**1.01**	**1.01**	**1.01**	**1.01**	**1.01**	**1.01**	**1.01**	**1.01**	**1.01**	**1.01**	**0.50**	**0.50**	**1.05**	**0.54**	**0.54**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM10 Emissions (lbs/day)												PM10 Emissions (lbs/day)											
Construction Equipment Emissions	0.92	0.92	0.92	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.96	1.96	0.98	0.98	2.02	1.04	1.04	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	0.08	0.08	0.08	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.06	0.06	0.26	0.20	0.20	--	--	--	--	--
Onsite Subtotal	*0.99*	*0.99*	*0.99*	*1.97*	*1.97*	*1.97*	*1.97*	*1.97*	*1.97*	*1.97*	*1.97*	*1.97*	*2.09*	*2.09*	*1.04*	*1.04*	*2.28*	*1.24*	*1.24*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	1.12	1.12	1.12	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	1.12	1.12	2.79	1.67	1.67	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	0.61	0.61	0.61	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.17	1.17	0.58	0.58	1.17	0.58	0.58	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*1.73*	*1.73*	*1.73*	*3.46*	*3.46*	*3.46*	*3.46*	*3.46*	*3.46*	*3.46*	*3.46*	*3.46*	*3.40*	*3.40*	*1.70*	*1.70*	*3.96*	*2.26*	*2.26*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**2.72**	**2.72**	**2.72**	**5.43**	**5.43**	**5.43**	**5.43**	**5.43**	**5.43**	**5.43**	**5.43**	**5.43**	**5.49**	**5.49**	**2.74**	**2.74**	**6.24**	**3.50**	**3.50**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

YEAR	2016												2017											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase	PM2.5 Emissions (lbs/day)												PM2.5 Emissions (lbs/day)											
Construction Equipment Emissions	0.84	0.84	0.84	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.80	1.80	0.90	0.90	1.86	0.96	0.96	0.00	0.00	0.00	0.00	0.00
Fugitive Dust Emissions	0.23	0.23	0.23	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.40	0.40	0.20	0.20	0.40	0.20	0.20	--	--	--	--	--
Onsite Subtotal	*1.07*	*1.07*	*1.07*	*2.15*	*2.15*	*2.15*	*2.15*	*2.15*	*2.15*	*2.15*	*2.15*	*2.15*	*2.20*	*2.20*	*1.10*	*1.10*	*2.26*	*1.16*	*1.16*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Construction Worker Commuting	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.04	0.02	0.02	0.00	0.00	0.00	0.00	0.00
Haul Truck Emissions	0.23	0.23	0.23	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.40	0.40	0.20	0.20	0.40	0.20	0.20	0.00	0.00	0.00	0.00	0.00
Offsite Subtotal	*0.25*	*0.25*	*0.25*	*0.49*	*0.49*	*0.49*	*0.49*	*0.49*	*0.49*	*0.49*	*0.49*	*0.49*	*0.43*	*0.43*	*0.22*	*0.22*	*0.44*	*0.22*	*0.22*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Total	**1.32**	**1.32**	**1.32**	**2.64**	**2.64**	**2.64**	**2.64**	**2.64**	**2.64**	**2.64**	**2.64**	**2.64**	**2.64**	**2.64**	**1.32**	**1.32**	**2.70**	**1.39**	**1.39**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Table 2-1: Hourly, Daily and Annual Emissions Summary (Construction Equipment) - Locally Preferred Alternative

Inputs: Locally Preferred Alternative/Baseline

		Hours per	Start	End	Duration (months)				Number of Equipment							
Phase	Description	Day	Month	Month	2014	2015	2016	2017	Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	20	May-15	Nov-16	--	7	11	--	2	4	2	0	0	0	0	5
2	Cut & Cover Along Flower Street	20	Sep-14	Sep-17	4	12	12	9	2	4	2	1	0	0	0	5

Table 2-1: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Locally Preferred Alternative

Hourly Emissions by Equipment

Phase	Description	Year	ROG Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.082	0.162	0.051	0.000	0.000	0.000	0.000	0.312
1	EPBM Flower	2016	0.102	0.200	0.061	0.000	0.000	0.000	0.000	0.395
2	Cut & Cover Along Flower Street	2014	0.061	0.123	0.041	0.026	0.000	0.000	0.000	0.226
2	Cut & Cover Along Flower Street	2015	0.082	0.162	0.051	0.031	0.000	0.000	0.000	0.312
2	Cut & Cover Along Flower Street	2016	0.102	0.200	0.061	0.037	0.000	0.000	0.000	0.395
2	Cut & Cover Along Flower Street	2017	0.122	0.236	0.071	0.041	0.000	0.000	0.000	0.474

Table 2-1: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Locally Preferred Alternative

Hourly Emissions by Equipment

			CO Emissions (pounds per hour)							
Phase	Description	Year	Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.666	2.265	0.492	0.000	0.000	0.000	0.000	2.335
1	EPBM Flower	2016	0.692	2.368	0.505	0.000	0.000	0.000	0.000	2.442
2	Cut & Cover Along Flower Street	2014	0.639	2.157	0.479	0.301	0.000	0.000	0.000	2.224
2	Cut & Cover Along Flower Street	2015	0.666	2.265	0.492	0.309	0.000	0.000	0.000	2.335
2	Cut & Cover Along Flower Street	2016	0.692	2.368	0.505	0.316	0.000	0.000	0.000	2.442
2	Cut & Cover Along Flower Street	2017	0.718	2.467	0.518	0.322	0.000	0.000	0.000	2.545

Table 2-1: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Locally Preferred Alternative

Hourly Emissions by Equipment

Phase	Description	Year	NOx Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.181	1.714	0.135	0.000	0.000	0.000	0.000	0.631
1	EPBM Flower	2016	0.186	1.754	0.137	0.000	0.000	0.000	0.000	0.652
2	Cut & Cover Along Flower Street	2014	0.176	1.673	0.132	0.083	0.000	0.000	0.000	0.609
2	Cut & Cover Along Flower Street	2015	0.181	1.714	0.135	0.085	0.000	0.000	0.000	0.631
2	Cut & Cover Along Flower Street	2016	0.186	1.754	0.137	0.086	0.000	0.000	0.000	0.652
2	Cut & Cover Along Flower Street	2017	0.191	1.791	0.140	0.087	0.000	0.000	0.000	0.672

Table 2-1: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Locally Preferred Alternative

Hourly Emissions by Equipment

Phase	Description	Year	SO2 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
1	EPBM Flower	2016	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2014	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2015	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2016	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2017	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013

Table 2-1: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Locally Preferred Alternative

Hourly Emissions by Equipment

Phase	Description	Year	PM10 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
1	EPBM Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
2	Cut & Cover Along Flower Street	2014	0.006	0.007	0.005	0.003	0.000	0.000	0.000	0.022
2	Cut & Cover Along Flower Street	2015	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.023
2	Cut & Cover Along Flower Street	2016	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.025
2	Cut & Cover Along Flower Street	2017	0.008	0.009	0.005	0.003	0.000	0.000	0.000	0.027

Table 2-1: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Locally Preferred Alternative

Hourly Emissions by Equipment

Phase	Description	Year	PM2.5 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.006	0.007	0.004	0.000	0.000	0.000	0.000	0.022
1	EPBM Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
2	Cut & Cover Along Flower Street	2014	0.006	0.007	0.004	0.003	0.000	0.000	0.000	0.020
2	Cut & Cover Along Flower Street	2015	0.006	0.007	0.004	0.003	0.000	0.000	0.000	0.022
2	Cut & Cover Along Flower Street	2016	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.023
2	Cut & Cover Along Flower Street	2017	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.025

Table 2-1: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Locally Preferred Alternative

Hourly Emissions by Equipment

Daily Emissions

Phase	Description	Year	Emissions (pounds per day)					
			ROG	CO	NOx	SO2	PM10	PM2.5
1	EPBM Flower	2015	12.14	115.15	53.21	0.48	0.85	0.78
1	EPBM Flower	2016	15.16	120.13	54.57	0.48	0.92	0.84
2	Cut & Cover Along Flower Street	2014	9.54	116.01	53.46	0.52	0.84	0.78
2	Cut & Cover Along Flower Street	2015	12.77	121.32	54.90	0.52	0.91	0.84
2	Cut & Cover Along Flower Street	2016	15.89	126.45	56.29	0.52	0.98	0.90
2	Cut & Cover Along Flower Street	2017	18.90	131.38	57.62	0.52	1.04	0.96

Annual Emissions

Phase	Description	Year	Emissions (tons per year)					
			ROG	CO	NOx	SO2	PM10	PM2.5
1	EPBM Flower	2015	0.94	8.87	4.10	0.04	0.07	0.06
1	EPBM Flower	2016	1.83	14.54	6.60	0.06	0.11	0.10
2	Cut & Cover Along Flower Street	2014	0.42	5.10	2.35	0.02	0.04	0.03
2	Cut & Cover Along Flower Street	2015	1.69	16.01	7.25	0.07	0.12	0.11
2	Cut & Cover Along Flower Street	2016	2.10	16.69	7.43	0.07	0.13	0.12
2	Cut & Cover Along Flower Street	2017	1.87	13.01	5.70	0.05	0.10	0.09

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:
Construction equipment emission factors from OFFROAD2007
PM10 Size Fraction: CARB Speciation Profiles http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-2: Hourly, Daily and Annual Emissions Summary (Construction Equipment) - Alternative 1

Inputs: Alternative 1

Phase	Description	Hours per Day	Start Month	End Month	Duration (months) 2014	2015	2016	2017	Number of Equipment Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	20	May-15	Jan-17	--	8	12	1	2	4	2	0	0	0	0	5
2	Cut & Cover Along Flower Street	20	Sep-14	May-16	4	12	5	--	2	4	2	1	0	0	0	5

Table 2-2: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Alternative 1
Hourly Emissions by Equipment

Phase	Description	Year	ROG Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.082	0.162	0.051	0.000	0.000	0.000	0.000	0.312
1	EPBM Flower	2016	0.102	0.200	0.061	0.000	0.000	0.000	0.000	0.395
1	EPBM Flower	2017	0.122	0.236	0.071	0.000	0.000	0.000	0.000	0.474
2	Cut & Cover Along Flower Street	2014	0.061	0.123	0.041	0.026	0.000	0.000	0.000	0.226
2	Cut & Cover Along Flower Street	2015	0.082	0.162	0.051	0.031	0.000	0.000	0.000	0.312
2	Cut & Cover Along Flower Street	2016	0.102	0.200	0.061	0.037	0.000	0.000	0.000	0.395

Table 2-2: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Alternative 1
Hourly Emissions by Equipment

Phase	Description	Year	CO Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.666	2.265	0.492	0.000	0.000	0.000	0.000	2.335
1	EPBM Flower	2016	0.692	2.368	0.505	0.000	0.000	0.000	0.000	2.442
1	EPBM Flower	2017	0.718	2.467	0.518	0.000	0.000	0.000	0.000	2.545
2	Cut & Cover Along Flower Street	2014	0.639	2.157	0.479	0.301	0.000	0.000	0.000	2.224
2	Cut & Cover Along Flower Street	2015	0.666	2.265	0.492	0.309	0.000	0.000	0.000	2.335
2	Cut & Cover Along Flower Street	2016	0.692	2.368	0.505	0.316	0.000	0.000	0.000	2.442

Table 2-2: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Alternative 1
Hourly Emissions by Equipment

Phase	Description	Year	NOx Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.181	1.714	0.135	0.000	0.000	0.000	0.000	0.631
1	EPBM Flower	2016	0.186	1.754	0.137	0.000	0.000	0.000	0.000	0.652
1	EPBM Flower	2017	0.191	1.791	0.140	0.000	0.000	0.000	0.000	0.672
2	Cut & Cover Along Flower Street	2014	0.176	1.673	0.132	0.083	0.000	0.000	0.000	0.609
2	Cut & Cover Along Flower Street	2015	0.181	1.714	0.135	0.085	0.000	0.000	0.000	0.631
2	Cut & Cover Along Flower Street	2016	0.186	1.754	0.137	0.086	0.000	0.000	0.000	0.652

Table 2-2: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Alternative 1
Hourly Emissions by Equipment

Phase	Description	Year	SO2 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
1	EPBM Flower	2016	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
1	EPBM Flower	2017	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2014	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2015	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2016	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013

Table 2-2: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Alternative 1
Hourly Emissions by Equipment

Phase	Description	Year	PM10 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
1	EPBM Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
1	EPBM Flower	2017	0.008	0.009	0.005	0.000	0.000	0.000	0.000	0.027
2	Cut & Cover Along Flower Street	2014	0.006	0.007	0.005	0.003	0.000	0.000	0.000	0.022
2	Cut & Cover Along Flower Street	2015	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.023
2	Cut & Cover Along Flower Street	2016	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.025

Table 2-2: Hourly, Daily and Annual Emissions Summary
(Construction Equipment) - Alternative 1
Hourly Emissions by Equipment

Phase	Description	Year	PM2.5 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.006	0.007	0.004	0.000	0.000	0.000	0.000	0.022
1	EPBM Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
1	EPBM Flower	2017	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
2	Cut & Cover Along Flower Street	2014	0.006	0.007	0.004	0.003	0.000	0.000	0.000	0.020
2	Cut & Cover Along Flower Street	2015	0.006	0.007	0.004	0.003	0.000	0.000	0.000	0.022
2	Cut & Cover Along Flower Street	2016	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.023

Table 2-2: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 1

Daily Emissions

Phase	Description	Year	Emissions (pounds per day)					
			ROG	CO	NOx	SO2	PM10	PM2.5
1	EPBM Flower	2015	12.14	115.15	53.21	0.48	0.85	0.78
1	EPBM Flower	2016	15.16	120.13	54.57	0.48	0.92	0.84
1	EPBM Flower	2017	18.07	124.95	55.88	0.48	0.98	0.90
2	Cut & Cover Along Flower Street	2014	9.54	116.01	53.46	0.52	0.84	0.78
2	Cut & Cover Along Flower Street	2015	12.77	121.32	54.90	0.52	0.91	0.84
2	Cut & Cover Along Flower Street	2016	15.89	126.45	56.29	0.52	0.98	0.90

Annual Emissions

Phase	Description	Year	Emissions (tons per year)					
			ROG	CO	NOx	SO2	PM10	PM2.5
1	EPBM Flower	2015	1.07	10.13	4.68	0.04	0.08	0.07
1	EPBM Flower	2016	2.00	15.86	7.20	0.06	0.12	0.11
1	EPBM Flower	2017	0.20	1.37	0.61	0.01	0.01	0.01
2	Cut & Cover Along Flower Street	2014	0.42	5.10	2.35	0.02	0.04	0.03
2	Cut & Cover Along Flower Street	2015	1.69	16.01	7.25	0.07	0.12	0.11
2	Cut & Cover Along Flower Street	2016	0.87	6.95	3.10	0.03	0.05	0.05

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:
Construction equipment emission factors from OFFROAD2007
PM10 Size Fraction: CARB Speciation Profiles http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-3: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 2

Alternative 2

		Hours per	Start	End	Duration (months)				Number of Equipment							
Phase	Description	Day	Month	Month	2014	2015	2016	2017	Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	20	May-15	Oct-15	--	6	--	--	2	4	2	0	0	0	0	5
2	Cut & Cover Along Flower Street	20	Sep-14	Dec-17	4	12	12	12	2	4	2	1	0	0	0	5

Work days per month	22

Table 2-3: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 2

Hourly Emissions by Equipment

			ROG Emissions (pounds per hour)							
Phase	Description	Year	Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.082	0.162	0.051	0.000	0.000	0.000	0.000	0.312
2	Cut & Cover Along Flower Street	2014	0.061	0.123	0.041	0.026	0.000	0.000	0.000	0.226
2	Cut & Cover Along Flower Street	2015	0.082	0.162	0.051	0.031	0.000	0.000	0.000	0.312
2	Cut & Cover Along Flower Street	2016	0.102	0.200	0.061	0.037	0.000	0.000	0.000	0.395
2	Cut & Cover Along Flower Street	2017	0.122	0.236	0.071	0.041	0.000	0.000	0.000	0.474

Table 2-3: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 2

Hourly Emissions by Equipment

Phase	Description	Year	CO Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.666	2.265	0.492	0.000	0.000	0.000	0.000	2.335
2	Cut & Cover Along Flower Street	2014	0.639	2.157	0.479	0.301	0.000	0.000	0.000	2.224
2	Cut & Cover Along Flower Street	2015	0.666	2.265	0.492	0.309	0.000	0.000	0.000	2.335
2	Cut & Cover Along Flower Street	2016	0.692	2.368	0.505	0.316	0.000	0.000	0.000	2.442
2	Cut & Cover Along Flower Street	2017	0.718	2.467	0.518	0.322	0.000	0.000	0.000	2.545

Table 2-3: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 2

Hourly Emissions by Equipment

Phase	Description	Year	NOx Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.181	1.714	0.135	0.000	0.000	0.000	0.000	0.631
2	Cut & Cover Along Flower Street	2014	0.176	1.673	0.132	0.083	0.000	0.000	0.000	0.609
2	Cut & Cover Along Flower Street	2015	0.181	1.714	0.135	0.085	0.000	0.000	0.000	0.631
2	Cut & Cover Along Flower Street	2016	0.186	1.754	0.137	0.086	0.000	0.000	0.000	0.652
2	Cut & Cover Along Flower Street	2017	0.191	1.791	0.140	0.087	0.000	0.000	0.000	0.672

Table 2-3: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 2

Hourly Emissions by Equipment

Phase	Description	Year	SO2 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2014	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2015	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2016	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2017	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013

Table 2-3: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 2

Hourly Emissions by Equipment

Phase	Description	Year	PM10 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
2	Cut & Cover Along Flower Street	2014	0.006	0.007	0.005	0.003	0.000	0.000	0.000	0.022
2	Cut & Cover Along Flower Street	2015	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.023
2	Cut & Cover Along Flower Street	2016	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.025
2	Cut & Cover Along Flower Street	2017	0.008	0.009	0.005	0.003	0.000	0.000	0.000	0.027

Table 2-3: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 2

Hourly Emissions by Equipment

Phase	Description	Year	PM2.5 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.006	0.007	0.004	0.000	0.000	0.000	0.000	0.022
2	Cut & Cover Along Flower Street	2014	0.006	0.007	0.004	0.003	0.000	0.000	0.000	0.020
2	Cut & Cover Along Flower Street	2015	0.006	0.007	0.004	0.003	0.000	0.000	0.000	0.022
2	Cut & Cover Along Flower Street	2016	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.023
2	Cut & Cover Along Flower Street	2017	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.025

Table 2-3: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 2

Daily Emissions

Phase	Description	Year	Emissions (pounds per day)					
			ROG	CO	NOx	SO2	PM10	PM2.5
1	EPBM Flower	2015	12.14	115.15	53.21	0.48	0.85	0.78
2	Cut & Cover Along Flower Street	2014	9.54	116.01	53.46	0.52	0.84	0.78
2	Cut & Cover Along Flower Street	2015	12.77	121.32	54.90	0.52	0.91	0.84
2	Cut & Cover Along Flower Street	2016	15.89	126.45	56.29	0.52	0.98	0.90
2	Cut & Cover Along Flower Street	2017	18.90	131.38	57.62	0.52	1.04	0.96

Annual Emissions

Phase	Description	Year	Emissions (tons per year)					
			ROG	CO	NOx	SO2	PM10	PM2.5
1	EPBM Flower	2015	0.80	7.60	3.51	0.03	0.06	0.05
2	Cut & Cover Along Flower Street	2014	0.42	5.10	2.35	0.02	0.04	0.03
2	Cut & Cover Along Flower Street	2015	1.69	16.01	7.25	0.07	0.12	0.11
2	Cut & Cover Along Flower Street	2016	2.10	16.69	7.43	0.07	0.13	0.12
2	Cut & Cover Along Flower Street	2017	2.49	17.34	7.61	0.07	0.14	0.13

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:
Construction equipment emission factors from OFFROAD2007
PM10 Size Fraction: CARB Speciation Profiles http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-4: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 3

Inputs: Alternative 3

Phase	Description	Hours per Day	Start Month	End Month	Duration (months) 2014	2015	2016	2017	Number of Equipment Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower WB	20	Jun-15	Mar-16	--	7	3	--	2	4	2	0	0	0	0	5
2	EPBM Flower EB	20	Oct-16	May-17	--	--	3	5	2	4	2	0	0	0	0	5
3	Grouting on Flower	20	Nov-14	Nov-15	2	11	--	--	0	0	0	0	4	4	4	5
4	Open Face/Shield on Flower	20	Mar-16	Dec-16	--	--	9	--	2	4	2	0	0	0	0	5
5	SEM on Flower	20	Dec-16	Dec-17	--	--	1	12	2	4	2	0	0	0	0	5
6	Cut & Cover Along Flower Street	20	Dec-17	Feb-18	--	--	--	1	2	4	2	1	0	0	0	5

Work days per month 22

Table 2-4: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 3
Hourly Emissions by Equipment

Phase	Description	Year	ROG Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower WB	2015	0.082	0.162	0.051	0.000	0.000	0.000	0.000	0.312
1	EPBM Flower WB	2016	0.102	0.200	0.061	0.000	0.000	0.000	0.000	0.395
2	EPBM Flower EB	2016	0.102	0.200	0.061	0.000	0.000	0.000	0.000	0.395
2	EPBM Flower EB	2017	0.122	0.236	0.071	0.000	0.000	0.000	0.000	0.474
3	Grouting on Flower	2014	0.000	0.000	0.000	0.000	0.573	0.055	0.182	0.226
3	Grouting on Flower	2015	0.000	0.000	0.000	0.000	0.701	0.065	0.215	0.312
4	Open Face/Shield on Flower	2016	0.102	0.200	0.061	0.000	0.000	0.000	0.000	0.395
5	SEM on Flower	2016	0.102	0.200	0.061	0.000	0.000	0.000	0.000	0.395
5	SEM on Flower	2017	0.122	0.236	0.071	0.000	0.000	0.000	0.000	0.474
6	Cut & Cover Along Flower Street	2017	0.122	0.236	0.071	0.041	0.000	0.000	0.000	0.474
2	Cut & Cover Along Flower Street	2015	0.082	0.162	0.051	0.000	0.000	0.000	0.000	0.312
2	Cut & Cover Along Flower Street	2016	0.102	0.200	0.061	0.000	0.000	0.000	0.000	0.395
2	Cut & Cover Along Flower Street	2017	0.122	0.236	0.071	0.000	0.000	0.000	0.000	0.474

Table 2-4: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 3
Hourly Emissions by Equipment

Phase	Description	Year	CO Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower WB	2015	0.666	2.265	0.492	0.000	0.000	0.000	0.000	2.335
1	EPBM Flower WB	2016	0.692	2.368	0.505	0.000	0.000	0.000	0.000	2.442
2	EPBM Flower EB	2016	0.692	2.368	0.505	0.000	0.000	0.000	0.000	2.442
2	EPBM Flower EB	2017	0.718	2.467	0.518	0.000	0.000	0.000	0.000	2.545
3	Grouting on Flower	2014	0.000	0.000	0.000	0.000	4.695	0.694	2.310	2.224
3	Grouting on Flower	2015	0.000	0.000	0.000	0.000	4.713	0.707	2.352	2.335
4	Open Face/Shield on Flower	2016	0.692	2.368	0.505	0.000	0.000	0.000	0.000	2.442
5	SEM on Flower	2016	0.692	2.368	0.505	0.000	0.000	0.000	0.000	2.442
5	SEM on Flower	2017	0.718	2.467	0.518	0.000	0.000	0.000	0.000	2.545
6	Cut & Cover Along Flower Street	2017	0.718	2.467	0.518	0.322	0.000	0.000	0.000	2.545
2	Cut & Cover Along Flower Street	2015	0.666	2.265	0.492	0.000	0.000	0.000	0.000	2.335
2	Cut & Cover Along Flower Street	2016	0.692	2.368	0.505	0.000	0.000	0.000	0.000	2.442
2	Cut & Cover Along Flower Street	2017	0.718	2.467	0.518	0.000	0.000	0.000	0.000	2.545

Table 2-4: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 3
Hourly Emissions by Equipment

Phase	Description	Year	NOx Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower WB	2015	0.181	1.714	0.135	0.000	0.000	0.000	0.000	0.631
1	EPBM Flower WB	2016	0.186	1.754	0.137	0.000	0.000	0.000	0.000	0.652
2	EPBM Flower EB	2016	0.186	1.754	0.137	0.000	0.000	0.000	0.000	0.652
2	EPBM Flower EB	2017	0.191	1.791	0.140	0.000	0.000	0.000	0.000	0.672
3	Grouting on Flower	2014	0.000	0.000	0.000	0.000	11.306	0.192	0.639	0.609
3	Grouting on Flower	2015	0.000	0.000	0.000	0.000	11.251	0.194	0.647	0.631
4	Open Face/Shield on Flower	2016	0.186	1.754	0.137	0.000	0.000	0.000	0.000	0.652
5	SEM on Flower	2016	0.186	1.754	0.137	0.000	0.000	0.000	0.000	0.652
5	SEM on Flower	2017	0.191	1.791	0.140	0.000	0.000	0.000	0.000	0.672
6	Cut & Cover Along Flower Street	2017	0.191	1.791	0.140	0.087	0.000	0.000	0.000	0.672
2	Cut & Cover Along Flower Street	2015	0.181	1.714	0.135	0.000	0.000	0.000	0.000	0.631
2	Cut & Cover Along Flower Street	2016	0.186	1.754	0.137	0.000	0.000	0.000	0.000	0.652
2	Cut & Cover Along Flower Street	2017	0.191	1.791	0.140	0.000	0.000	0.000	0.000	0.672

Table 2-4: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 3
Hourly Emissions by Equipment

Phase	Description	Year	SO2 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower WB	2015	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
1	EPBM Flower WB	2016	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
2	EPBM Flower EB	2016	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
2	EPBM Flower EB	2017	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
3	Grouting on Flower	2014	0.000	0.000	0.000	0.000	0.028	0.004	0.014	0.013
3	Grouting on Flower	2015	0.000	0.000	0.000	0.000	0.028	0.004	0.014	0.013
4	Open Face/Shield on Flower	2016	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
5	SEM on Flower	2016	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
5	SEM on Flower	2017	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
6	Cut & Cover Along Flower Street	2017	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2015	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2016	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
2	Cut & Cover Along Flower Street	2017	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013

Table 2-4: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 3
Hourly Emissions by Equipment

Phase	Description	Year	PM10 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower WB	2015	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
1	EPBM Flower WB	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
2	EPBM Flower EB	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
2	EPBM Flower EB	2017	0.008	0.009	0.005	0.000	0.000	0.000	0.000	0.027
3	Grouting on Flower	2014	0.000	0.000	0.000	0.000	0.269	0.007	0.022	0.022
3	Grouting on Flower	2015	0.000	0.000	0.000	0.000	0.277	0.007	0.022	0.023
4	Open Face/Shield on Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
5	SEM on Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
5	SEM on Flower	2017	0.008	0.009	0.005	0.000	0.000	0.000	0.000	0.027
6	Cut & Cover Along Flower Street	2017	0.008	0.009	0.005	0.003	0.000	0.000	0.000	0.027
2	Cut & Cover Along Flower Street	2015	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
2	Cut & Cover Along Flower Street	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
2	Cut & Cover Along Flower Street	2017	0.008	0.009	0.005	0.000	0.000	0.000	0.000	0.027

Table 2-4: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 3
Hourly Emissions by Equipment

Phase	Description	Year	PM2.5 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower WB	2015	0.006	0.007	0.004	0.000	0.000	0.000	0.000	0.022
1	EPBM Flower WB	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
2	EPBM Flower EB	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
2	EPBM Flower EB	2017	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
3	Grouting on Flower	2014	0.000	0.000	0.000	0.000	0.247	0.006	0.020	0.020
3	Grouting on Flower	2015	0.000	0.000	0.000	0.000	0.255	0.006	0.021	0.022
4	Open Face/Shield on Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
5	SEM on Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
5	SEM on Flower	2017	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
6	Cut & Cover Along Flower Street	2017	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.025
2	Cut & Cover Along Flower Street	2015	0.006	0.007	0.004	0.000	0.000	0.000	0.000	0.022
2	Cut & Cover Along Flower Street	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
2	Cut & Cover Along Flower Street	2017	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025

Table 2-4: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 3
Daily Emissions

Phase	Description	Year	Emissions (pounds per day)					
			ROG	CO	NOx	SO2	PM10	PM2.5
1	EPBM Flower WB	2015	12.14	115.15	53.21	0.48	0.85	0.78
1	EPBM Flower WB	2016	15.16	120.13	54.57	0.48	0.92	0.84
2	EPBM Flower EB	2016	15.16	120.13	54.57	0.48	0.92	0.84
2	EPBM Flower EB	2017	18.07	124.95	55.88	0.48	0.98	0.90
3	Grouting on Flower	2014	20.74	198.48	254.93	1.18	6.37	5.86
3	Grouting on Flower	2015	25.84	202.14	254.47	1.17	6.59	6.06
4	Open Face/Shield on Flower	2016	15.16	120.13	54.57	0.48	0.92	0.84
5	SEM on Flower	2016	15.16	120.13	54.57	0.48	0.92	0.84
5	SEM on Flower	2017	18.07	124.95	55.88	0.48	0.98	0.90
6	Cut & Cover Along Flower Street	2017	18.90	131.38	57.62	0.52	1.04	0.96

Annual Emissions - Alternative 3a (2nd/Hope Station (SEM))

Phase	Description	Year	Emissions (tons per year)					
			ROG	CO	NOx	SO2	PM10	PM2.5
1	EPBM Flower WB	2015	0.94	8.87	4.10	0.04	0.07	0.06
1	EPBM Flower WB	2016	0.50	3.96	1.80	0.02	0.03	0.03
2	EPBM Flower EB	2016	0.50	3.96	1.80	0.02	0.03	0.03
2	EPBM Flower EB	2017	0.99	6.87	3.07	0.03	0.05	0.05
3	Grouting on Flower	2014	0.46	4.37	5.61	0.03	0.14	0.13
3	Grouting on Flower	2015	3.13	24.46	30.79	0.14	0.80	0.73
4	Open Face/Shield on Flower	2016	1.50	11.89	5.40	0.05	0.09	0.08
5	SEM on Flower	2016	0.17	1.32	0.60	0.01	0.01	0.01
5	SEM on Flower	2017	2.39	16.49	7.38	0.06	0.13	0.12
6	Cut & Cover Along Flower Street	2017	0.21	1.45	0.63	0.01	0.01	0.01

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:
Construction equipment emission factors from OFFROAD2007
PM10 Size Fraction: CARB Speciation Profiles http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-5: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 4

Inputs: Alternative 4

Phase	Description	Hours per Day	Start Month	End Month	Duration (months) 2014	2015	2016	2017	Number of Equipment Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	20	Jun-15	Feb-17	--	7	12	2	2	4	2	0	0	0	0	5
2	Grouting on Flower	20	Feb-15	Oct-15	--	8	--	--	0	0	0	0	2	2	2	5
3	SEM on Flower	20	Apr-16	May-17	--	--	9	5	2	4	2	0	0	0	0	5
4	Cut & Cover Along Flower Street	20	May-17	Jul-17	--	--	--	2	2	4	2	1	0	0	0	5

Work days per month 22

Table 2-5: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 4

Hourly Emissions by Equipment

Phase	Description	Year	ROG Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.082	0.162	0.051	0.000	0.000	0.000	0.000	0.312
1	EPBM Flower	2016	0.102	0.200	0.061	0.000	0.000	0.000	0.000	0.395
1	EPBM Flower	2017	0.122	0.236	0.071	0.000	0.000	0.000	0.000	0.474
2	Grouting on Flower	2015	0.000	0.000	0.000	0.000	0.350	0.032	0.107	0.312
3	SEM on Flower	2016	0.102	0.200	0.061	0.000	0.000	0.000	0.000	0.395
3	SEM on Flower	2017	0.122	0.236	0.071	0.000	0.000	0.000	0.000	0.474
4	Cut & Cover Along Flower Street	2017	0.122	0.236	0.071	0.041	0.000	0.000	0.000	0.474

Table 2-5: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 4

Hourly Emissions by Equipment

Phase	Description	Year	CO Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.666	2.265	0.492	0.000	0.000	0.000	0.000	2.335
1	EPBM Flower	2016	0.692	2.368	0.505	0.000	0.000	0.000	0.000	2.442
1	EPBM Flower	2017	0.718	2.467	0.518	0.000	0.000	0.000	0.000	2.545
2	Grouting on Flower	2015	0.000	0.000	0.000	0.000	2.356	0.353	1.176	2.335
3	SEM on Flower	2016	0.692	2.368	0.505	0.000	0.000	0.000	0.000	2.442
3	SEM on Flower	2017	0.718	2.467	0.518	0.000	0.000	0.000	0.000	2.545
4	Cut & Cover Along Flower Street	2017	0.718	2.467	0.518	0.322	0.000	0.000	0.000	2.545

Table 2-5: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 4

Hourly Emissions by Equipment

Phase	Description	Year	NOx Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.181	1.714	0.135	0.000	0.000	0.000	0.000	0.631
1	EPBM Flower	2016	0.186	1.754	0.137	0.000	0.000	0.000	0.000	0.652
1	EPBM Flower	2017	0.191	1.791	0.140	0.000	0.000	0.000	0.000	0.672
2	Grouting on Flower	2015	0.000	0.000	0.000	0.000	5.625	0.097	0.324	0.631
3	SEM on Flower	2016	0.186	1.754	0.137	0.000	0.000	0.000	0.000	0.652
3	SEM on Flower	2017	0.191	1.791	0.140	0.000	0.000	0.000	0.000	0.672
4	Cut & Cover Along Flower Street	2017	0.191	1.791	0.140	0.087	0.000	0.000	0.000	0.672

Table 2-5: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 4

Hourly Emissions by Equipment

Phase	Description	Year	SO2 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
1	EPBM Flower	2016	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
1	EPBM Flower	2017	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
2	Grouting on Flower	2015	0.000	0.000	0.000	0.000	0.014	0.002	0.007	0.013
3	SEM on Flower	2016	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
3	SEM on Flower	2017	0.004	0.005	0.003	0.000	0.000	0.000	0.000	0.013
4	Cut & Cover Along Flower Street	2017	0.004	0.005	0.003	0.002	0.000	0.000	0.000	0.013

Table 2-5: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 4

Hourly Emissions by Equipment

Phase	Description	Year	PM10 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
1	EPBM Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
1	EPBM Flower	2017	0.008	0.009	0.005	0.000	0.000	0.000	0.000	0.027
2	Grouting on Flower	2015	0.000	0.000	0.000	0.000	0.138	0.003	0.011	0.023
3	SEM on Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
3	SEM on Flower	2017	0.008	0.009	0.005	0.000	0.000	0.000	0.000	0.027
4	Cut & Cover Along Flower Street	2017	0.008	0.009	0.005	0.003	0.000	0.000	0.000	0.027

Table 2-5: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 4

Hourly Emissions by Equipment

Phase	Description	Year	PM2.5 Emissions (pounds per hour)							
			Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	0.006	0.007	0.004	0.000	0.000	0.000	0.000	0.022
1	EPBM Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
1	EPBM Flower	2017	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
2	Grouting on Flower	2015	0.000	0.000	0.000	0.000	0.127	0.003	0.010	0.022
3	SEM on Flower	2016	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.023
3	SEM on Flower	2017	0.007	0.008	0.005	0.000	0.000	0.000	0.000	0.025
4	Cut & Cover Along Flower Street	2017	0.007	0.008	0.005	0.003	0.000	0.000	0.000	0.025

Table 2-5: Hourly, Daily and Annual Emissions
Summary (Construction Equipment) - Alternative 4

Daily Emissions

Phase	Description	Year	Emissions (pounds per day)					
			ROG	CO	NOx	SO2	PM10	PM2.5
1	EPBM Flower	2015	12.14	115.15	53.21	0.48	0.85	0.78
1	EPBM Flower	2016	15.16	120.13	54.57	0.48	0.92	0.84
1	EPBM Flower	2017	18.07	124.95	55.88	0.48	0.98	0.90
2	Grouting on Flower	2015	16.04	124.42	133.54	0.71	3.53	3.25
3	SEM on Flower	2016	15.16	120.13	54.57	0.48	0.92	0.84
3	SEM on Flower	2017	18.07	124.95	55.88	0.48	0.98	0.90
4	Cut & Cover Along Flower Street	2017	18.90	131.38	57.62	0.52	1.04	0.96

Annual Emissions - Alternative 4

Phase	Description	Year	Emissions (tons per year)					
			ROG	CO	NOx	SO2	PM10	PM2.5
1	EPBM Flower	2015	0.94	8.87	4.10	0.04	0.07	0.06
1	EPBM Flower	2016	2.00	15.86	7.20	0.06	0.12	0.11
1	EPBM Flower	2017	0.40	2.75	1.23	0.01	0.02	0.02
2	Grouting on Flower	2015	1.41	10.95	11.75	0.06	0.31	0.29
3	SEM on Flower	2016	1.50	11.89	5.40	0.05	0.09	0.08
3	SEM on Flower	2017	0.99	6.87	3.07	0.03	0.05	0.05
4	Cut & Cover Along Flower Street	2017	0.42	2.89	1.27	0.01	0.02	0.02

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:

Construction equipment emission factors from OFFROAD2007

PM10 Size Fraction: CARB Speciation Profiles http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-6: Daily and Annual Emissions Summary (Haul Trucks) - Locally Preferred Alternative

Inputs: Locally Preferred Alternative/Baseline

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Duration (months) Total	2014	2015	2016	2017
1	EPBM Flower	20	400	May-15	Nov-16	19	--	8	11	--
2	Cut & Cover Along Flower Street	20	400	Sep-14	Sep-17	37	4	12	12	9

Daily vehicle miles traveled (round-trip) 20 *(estimated value)* Default value from URBEMIS

Daily Emissions

Phase	Description	Year	Emissions (lb/day) ROG	CO	NOx	SO2	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust
1	EPBM Flower	2015	0.63	2.84	7.39	0.02	0.65	0.27	0.03	0.02	0.33	0.31	0.25	0.01	0.01	0.05
1	EPBM Flower	2016	0.57	2.52	6.54	0.02	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05
2	Cut & Cover Along Flower Street	2014	0.71	3.24	8.46	0.02	0.69	0.31	0.03	0.02	0.33	0.35	0.29	0.01	0.01	0.05
2	Cut & Cover Along Flower Street	2015	0.63	2.84	7.39	0.02	0.65	0.27	0.03	0.02	0.33	0.31	0.25	0.01	0.01	0.05
2	Cut & Cover Along Flower Street	2016	0.57	2.52	6.54	0.02	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05
2	Cut & Cover Along Flower Street	2017	0.53	2.26	5.84	0.02	0.58	0.20	0.03	0.02	0.33	0.25	0.19	0.01	0.01	0.05

Annual Emissions

Phase	Description	Year	Emissions (tons per year) ROG	CO	NOx	SO2	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust
1	EPBM Flower	2015	5.57E-02	2.50E-01	6.50E-01	1.40E-03	5.71E-02	2.34E-02	2.79E-03	2.17E-03	2.87E-02	2.75E-02	2.16E-02	6.98E-04	9.31E-04	4.31E-03
1	EPBM Flower	2016	6.95E-02	3.05E-01	7.91E-01	1.92E-03	7.43E-02	2.80E-02	3.84E-03	2.99E-03	3.95E-02	3.39E-02	2.57E-02	9.60E-04	1.28E-03	5.92E-03
2	Cut & Cover Along Flower Street	2014	3.11E-02	1.43E-01	3.72E-01	6.98E-04	3.06E-02	1.37E-02	1.40E-03	1.09E-03	1.44E-02	1.56E-02	1.26E-02	3.49E-04	4.66E-04	2.15E-03
2	Cut & Cover Along Flower Street	2015	8.36E-02	3.75E-01	9.75E-01	2.10E-03	8.57E-02	3.52E-02	4.19E-03	3.26E-03	4.31E-02	4.13E-02	3.24E-02	1.05E-03	1.40E-03	6.46E-03
2	Cut & Cover Along Flower Street	2016	7.58E-02	3.33E-01	8.63E-01	2.10E-03	8.10E-02	3.05E-02	4.19E-03	3.26E-03	4.31E-02	3.70E-02	2.81E-02	1.05E-03	1.40E-03	6.46E-03
2	Cut & Cover Along Flower Street	2017	5.20E-02	2.24E-01	5.78E-01	1.57E-03	5.78E-02	1.99E-02	3.14E-03	2.44E-03	3.23E-02	2.50E-02	1.83E-02	7.86E-04	1.05E-03	4.85E-03

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

Paved Road PM10 Emission Factors

Condition	Emission Factor (g/VMT) High-ADT	Low-ADT	Average
Average	0.37	1.3	0.81
Worst-Case	0.64	3.9	2.1

PM Size Fractions

PM10	0.4572
PM2.5	0.0686
PM2.5 EF	0.06

Source:

Midwest Research Institute (MRI). 1996. *Improvement of Specific Emission Factors (BADM Project No. 1)*. Final Report. March 29. Table ES-3.

PM10 and PM 2.5 Size Fractions: CARB Speciation Profiles. Profile Number 471 (PAVED ROAD DUST, 97 N AFTER)

http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-7: Daily and Annual Emissions Summary (Haul Trucks) - Alternative 1

Inputs: Alternative 1

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower	20	400	May-15	Jan-17	21	--	8	12	1
2	Cut & Cover Along Flower Street	20	400	Sep-14	May-16	21	4	12	5	--

Daily vehicle miles traveled (round-trip) 20 *(estimated value)* Default value from URBEMIS

Daily Emissions

			Emissions (lb/day)						PM10					PM2.5				
Phase	Description	Year	ROG	CO	NOx	SO2	CO2	CH4	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust
1	EPBM Flower	2015	0.63	2.84	7.39	0.02	1696.86	0.03	0.65	0.27	0.03	0.02	0.33	0.31	0.25	0.01	0.01	0.05
1	EPBM Flower	2016	0.57	2.52	6.54	0.02	1696.86	0.03	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05
1	EPBM Flower	2017	0.53	2.26	5.84	0.02	1696.86	0.02	0.58	0.20	0.03	0.02	0.33	0.25	0.19	0.01	0.01	0.05
2	Cut & Cover Along Flower Street	2014	0.71	3.24	8.46	0.02	1696.86	0.03	0.69	0.31	0.03	0.02	0.33	0.35	0.29	0.01	0.01	0.05
2	Cut & Cover Along Flower Street	2015	0.63	2.84	7.39	0.02	1696.86	0.03	0.65	0.27	0.03	0.02	0.33	0.31	0.25	0.01	0.01	0.05
2	Cut & Cover Along Flower Street	2016	0.57	2.52	6.54	0.02	1696.86	0.03	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05

Annual Emissions

			Emissions (tons per year)						PM10					PM2.5				
Phase	Description	Year	ROG	CO	NOx	SO2	CO2	CH4	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust
1	EPBM Flower	2015	5.57E-02	2.50E-01	6.50E-01	1.40E-03	149.32	2.56E-03	5.71E-02	2.34E-02	2.79E-03	2.17E-03	2.87E-02	2.75E-02	2.16E-02	6.98E-04	9.31E-04	4.31E-03
1	EPBM Flower	2016	7.58E-02	3.33E-01	8.63E-01	2.10E-03	223.98	3.49E-03	8.10E-02	3.05E-02	4.19E-03	3.26E-03	4.31E-02	3.70E-02	2.81E-02	1.05E-03	1.40E-03	6.46E-03
1	EPBM Flower	2017	5.78E-03	2.49E-02	6.42E-02	1.75E-04	18.67	2.72E-04	6.42E-03	2.21E-03	3.49E-04	2.72E-04	3.59E-03	2.78E-03	2.04E-03	8.73E-05	1.16E-04	5.39E-04
2	Cut & Cover Along Flower Street	2014	3.11E-02	1.43E-01	3.72E-01	6.98E-04	74.66	1.44E-03	3.06E-02	1.37E-02	1.40E-03	1.09E-03	1.44E-02	1.56E-02	1.26E-02	3.49E-04	4.66E-04	2.15E-03
2	Cut & Cover Along Flower Street	2015	8.36E-02	3.75E-01	9.75E-01	2.10E-03	223.98	3.84E-03	8.57E-02	3.52E-02	4.19E-03	3.26E-03	4.31E-02	4.13E-02	3.24E-02	1.05E-03	1.40E-03	6.46E-03
2	Cut & Cover Along Flower Street	2016	3.16E-02	1.39E-01	3.60E-01	8.73E-04	93.33	1.46E-03	3.38E-02	1.27E-02	1.75E-03	1.36E-03	1.79E-02	1.54E-02	1.17E-02	4.37E-04	5.82E-04	2.69E-03

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:
INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.
MATCH formula used to identify row number and column number for each year-pollutant combination.

Paved Road PM10 Emission Factors

Condition	Emission Factor (g/VMT) High-ADT	Low-ADT	Average
Average	0.37	1.3	0.81
Worst-Case	0.64	3.9	2.1

PM Size Fractions

PM10	0.4572
PM2.5	0.0686
PM2.5 EF	0.06

Source:
Midwest Research Institute (MRI). 1996. *Improvement of Specific Emission Factors (BADM Project No. 1)* . Final Report. March 29. Table ES-3.

PM10 and PM 2.5 Size Fractions: CARB Speciation Profiles. Profile Number 471 (PAVED ROAD DUST, 97 N AFTER)
http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-8: Daily and Annual Emissions Summary (Haul Trucks) - Alternative 2

Inputs: Alternative 2

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower	20	400	May-15	Oct-15	6	--	6	--	--
2	Cut & Cover Along Flower Street	20	400	Sep-14	Dec-17	40	4	12	12	12

Daily vehicle miles traveled (round-trip) 20 *(estimated value)* Default value from URBEMIS

Daily Emissions

Phase	Description	Year	Emissions (lb/day) ROG	CO	NOx	SO2	CO2	CH4	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust
1	EPBM Flower	2015	0.63	2.84	7.39	0.02	1696.86	0.03	0.65	0.27	0.03	0.02	0.33	0.31	0.25	0.01	0.01	0.05
2	Cut & Cover Along Flower Street	2014	0.71	3.24	8.46	0.02	1696.86	0.03	0.69	0.31	0.03	0.02	0.33	0.35	0.29	0.01	0.01	0.05
2	Cut & Cover Along Flower Street	2015	0.63	2.84	7.39	0.02	1696.86	0.03	0.65	0.27	0.03	0.02	0.33	0.31	0.25	0.01	0.01	0.05
2	Cut & Cover Along Flower Street	2016	0.57	2.52	6.54	0.02	1696.86	0.03	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05
2	Cut & Cover Along Flower Street	2017	0.53	2.26	5.84	0.02	1696.86	0.02	0.58	0.20	0.03	0.02	0.33	0.25	0.19	0.01	0.01	0.05

Annual Emissions

Phase	Description	Year	Emissions (tons per year) ROG	CO	NOx	SO2	CO2	CH4	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust
1	EPBM Flower	2015	4.18E-02	1.87E-01	4.87E-01	1.05E-03	1.12E+02	1.92E-03	4.28E-02	1.76E-02	2.10E-03	1.63E-03	2.15E-02	2.06E-02	1.62E-02	5.24E-04	6.98E-04	3.23E-03
2	Cut & Cover Along Flower Street	2014	3.11E-02	1.43E-01	3.72E-01	6.98E-04	7.47E+01	1.44E-03	3.06E-02	1.37E-02	1.40E-03	1.09E-03	1.44E-02	1.56E-02	1.26E-02	3.49E-04	4.66E-04	2.15E-03
2	Cut & Cover Along Flower Street	2015	8.36E-02	3.75E-01	9.75E-01	2.10E-03	2.24E+02	3.84E-03	8.57E-02	3.52E-02	4.19E-03	3.26E-03	4.31E-02	4.13E-02	3.24E-02	1.05E-03	1.40E-03	6.46E-03
2	Cut & Cover Along Flower Street	2016	7.58E-02	3.33E-01	8.63E-01	2.10E-03	2.24E+02	3.49E-03	8.10E-02	3.05E-02	4.19E-03	3.26E-03	4.31E-02	3.70E-02	2.81E-02	1.05E-03	1.40E-03	6.46E-03
2	Cut & Cover Along Flower Street	2017	6.94E-02	2.99E-01	7.71E-01	2.10E-03	2.24E+02	3.26E-03	7.71E-02	2.65E-02	4.19E-03	3.26E-03	4.31E-02	3.34E-02	2.44E-02	1.05E-03	1.40E-03	6.46E-03

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:
INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.
MATCH formula used to identify row number and column number for each year-pollutant combination.

Paved Road PM10 Emission Factors

Condition	Emission Factor (g/VMT) High-ADT	Low-ADT	Average
Average	0.37	1.3	0.81
Worst-Case	0.64	3.9	2.1

PM Size Fractions

PM10	0.4572
PM2.5	0.0686
PM2.5 EF	0.06

Source:
Midwest Research Institute (MRI). 1996. *Improvement of Specific Emission Factors (BADM Project No. 1)* . Final Report. March 29. Table ES-3.

PM10 and PM 2.5 Size Fractions: CARB Speciation Profiles. Profile Number 471 (PAVED ROAD DUST, 97 N AFTER)
http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-9: Daily and Annual Emissions Summary (Haul Trucks) - Alternative 3

Inputs: Alternative 3

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower WB	20	400	Jun-15	Mar-16	10	--	7	3	--
2	EPBM Flower EB	20	400	Oct-16	May-17	8	--	--	3	5
3	Grouting on Flower	0	0	Nov-14	Nov-15	13	2	11	--	--
4	Open Face/Shield on Flower	20	400	Mar-16	Dec-16	10	--	--	10	--
5	SEM on Flower	20	400	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	20	400	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 20 *(estimated value)* Default value from URBEMIS

Daily Emissions

Phase	Description	Year	Emissions (lb/day) ROG	CO	NOx	SO2	CO2	CH4	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust
1	EPBM Flower WB	2015	0.63	2.84	7.39	0.02	1696.86	0.03	0.65	0.27	0.03	0.02	0.33	0.31	0.25	0.01	0.01	0.05
1	EPBM Flower WB	2016	0.57	2.52	6.54	0.02	1696.86	0.03	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05
2	EPBM Flower EB	2016	0.57	2.52	6.54	0.02	1696.86	0.03	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05
2	EPBM Flower EB	2017	0.53	2.26	5.84	0.02	1696.86	0.02	0.58	0.20	0.03	0.02	0.33	0.25	0.19	0.01	0.01	0.05
3	Grouting on Flower	2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Grouting on Flower	2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Open Face/Shield on Flower	2016	0.57	2.52	6.54	0.02	1696.86	0.03	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05
5	SEM on Flower	2016	0.57	2.52	6.54	0.02	1696.86	0.03	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05
5	SEM on Flower	2017	0.53	2.26	5.84	0.02	1696.86	0.02	0.58	0.20	0.03	0.02	0.33	0.25	0.19	0.01	0.01	0.05
6	Cut & Cover Along Flower Street	2017	0.53	2.26	5.84	0.02	1696.86	0.02	0.58	0.20	0.03	0.02	0.33	0.25	0.19	0.01	0.01	0.05

Annual Emissions

Phase	Description	Year	Emissions (tons per year) ROG	CO	NOx	SO2	CO2	CH4	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust
1	EPBM Flower WB	2015	4.88E-02	2.19E-01	5.69E-01	1.22E-03	130.66	2.24E-03	5.00E-02	2.05E-02	2.44E-03	1.90E-03	2.51E-02	2.41E-02	1.89E-02	6.11E-04	8.15E-04	3.77E-03
1	EPBM Flower WB	2016	1.89E-02	8.33E-02	2.16E-01	5.24E-04	56.00	8.73E-04	2.03E-02	7.62E-03	1.05E-03	8.15E-04	1.08E-02	9.24E-03	7.01E-03	2.62E-04	3.49E-04	1.62E-03
2	EPBM Flower EB	2016	1.89E-02	8.33E-02	2.16E-01	5.24E-04	56.00	8.73E-04	2.03E-02	7.62E-03	1.05E-03	8.15E-04	1.08E-02	9.24E-03	7.01E-03	2.62E-04	3.49E-04	1.62E-03
2	EPBM Flower EB	2017	2.89E-02	1.25E-01	3.21E-01	8.73E-04	93.33	1.36E-03	3.21E-02	1.11E-02	1.75E-03	1.36E-03	1.79E-02	1.39E-02	1.02E-02	4.37E-04	5.82E-04	2.69E-03
3	Grouting on Flower	2014	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	Grouting on Flower	2015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4	Open Face/Shield on Flower	2016	6.31E-02	2.78E-01	7.19E-01	1.75E-03	186.65	2.91E-03	6.75E-02	2.54E-02	3.49E-03	2.72E-03	3.59E-02	3.08E-02	2.34E-02	8.73E-04	1.16E-03	5.39E-03
5	SEM on Flower	2016	6.31E-03	2.78E-02	7.19E-02	1.75E-04	18.67	2.91E-04	6.75E-03	2.54E-03	3.49E-04	2.72E-04	3.59E-03	3.08E-03	2.34E-03	8.73E-05	1.16E-04	5.39E-04
5	SEM on Flower	2017	6.94E-02	2.99E-01	7.71E-01	2.10E-03	223.98	3.26E-03	7.71E-02	2.65E-02	4.19E-03	3.26E-03	4.31E-02	3.34E-02	2.44E-02	1.05E-03	1.40E-03	6.46E-03
6	Cut & Cover Along Flower Street	2017	5.78E-03	2.49E-02	6.42E-02	1.75E-04	18.67	2.72E-04	6.42E-03	2.21E-03	3.49E-04	2.72E-04	3.59E-03	2.78E-03	2.04E-03	8.73E-05	1.16E-04	5.39E-04

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

Paved Road PM10 Emission Factors

Condition	Emission Factor (g/VMT) High-ADT	Low-ADT	Average
Average	0.37	1.3	0.81
Worst-Case	0.64	3.9	2.1

PM Size Fractions

PM10	0.4572
PM2.5	0.0686
PM2.5 EF	0.06

Source:

Midwest Research Institute (MRI). 1996. *Improvement of Specific Emission Factors (BADM Project No. 1)* . Final Report. March 29. Table ES-3.

PM10 and PM 2.5 Size Fractions: CARB Speciation Profiles. Profile Number 471 (PAVED ROAD DUST, 97 N AFTER)

http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-10: Daily and Annual Emissions Summary (Haul Trucks) - Alternative 4

Inputs: Alternative 4

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower	20	400	Jun-15	Feb-17	21	--	7	12	2
2	Grouting on Flower	0	0	Feb-15	Oct-15	9	--	9	--	--
3	SEM on Flower	20	400	Apr-16	May-17	14	--	--	9	5
4	Cut & Cover Along Flower Street	20	400	May-17	Jul-17	3	--	--	--	3
5	SEM on Flower	20	400	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	20	400	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 20 *(estimated value)* Default value from URBEMIS

Daily Emissions

Phase	Description	Year	Emissions (lb/day) ROG	CO	NOx	SO2	CO2	CH4	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust
1	EPBM Flower	2015	0.63	2.84	7.39	0.02	1696.86	0.03	0.65	0.27	0.03	0.02	0.33	0.31	0.25	0.01	0.01	0.05
1	EPBM Flower	2016	0.57	2.52	6.54	0.02	1696.86	0.03	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05
1	EPBM Flower	2017	0.53	2.26	5.84	0.02	1696.86	0.02	0.58	0.20	0.03	0.02	0.33	0.25	0.19	0.01	0.01	0.05
2	Grouting on Flower	2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	SEM on Flower	2016	0.57	2.52	6.54	0.02	1696.86	0.03	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05
3	SEM on Flower	2017	0.53	2.26	5.84	0.02	1696.86	0.02	0.58	0.20	0.03	0.02	0.33	0.25	0.19	0.01	0.01	0.05
4	Cut & Cover Along Flower Street	2017	0.53	2.26	5.84	0.02	1696.86	0.02	0.58	0.20	0.03	0.02	0.33	0.25	0.19	0.01	0.01	0.05
5	SEM on Flower	2016	0.57	2.52	6.54	0.02	1696.86	0.03	0.61	0.23	0.03	0.02	0.33	0.28	0.21	0.01	0.01	0.05
5	SEM on Flower	2017	0.53	2.26	5.84	0.02	1696.86	0.02	0.58	0.20	0.03	0.02	0.33	0.25	0.19	0.01	0.01	0.05
6	Cut & Cover Along Flower Street	2017	0.53	2.26	5.84	0.02	1696.86	0.02	0.58	0.20	0.03	0.02	0.33	0.25	0.19	0.01	0.01	0.05

Annual Emissions

Phase	Description	Year	Emissions (tons per year) ROG	CO	NOx	SO2	CO2	CH4	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust
1	EPBM Flower	2015	4.88E-02	2.19E-01	5.69E-01	1.22E-03	130.66	2.24E-03	5.00E-02	2.05E-02	2.44E-03	1.90E-03	2.51E-02	2.41E-02	1.89E-02	6.11E-04	8.15E-04	3.77E-03
1	EPBM Flower	2016	7.58E-02	3.33E-01	8.63E-01	2.10E-03	223.98	3.49E-03	8.10E-02	3.05E-02	4.19E-03	3.26E-03	4.31E-02	3.70E-02	2.81E-02	1.05E-03	1.40E-03	6.46E-03
1	EPBM Flower	2017	1.16E-02	4.98E-02	1.28E-01	3.49E-04	37.33	5.43E-04	1.28E-02	4.42E-03	6.98E-04	5.43E-04	7.18E-03	5.56E-03	4.07E-03	1.75E-04	2.33E-04	1.08E-03
2	Grouting on Flower	2015	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	SEM on Flower	2016	5.68E-02	2.50E-01	6.47E-01	1.57E-03	167.99	2.62E-03	6.08E-02	2.29E-02	3.14E-03	2.44E-03	3.23E-02	2.77E-02	2.10E-02	7.86E-04	1.05E-03	4.85E-03
3	SEM on Flower	2017	2.89E-02	1.25E-01	3.21E-01	8.73E-04	93.33	1.36E-03	3.21E-02	1.11E-02	1.75E-03	1.36E-03	1.79E-02	1.39E-02	1.02E-02	4.37E-04	5.82E-04	2.69E-03
4	Cut & Cover Along Flower Street	2017	1.73E-02	7.47E-02	1.93E-01	5.24E-04	56.00	8.15E-04	1.93E-02	6.63E-03	1.05E-03	8.15E-04	1.08E-02	8.34E-03	6.11E-03	2.62E-04	3.49E-04	1.62E-03
5	SEM on Flower	2016	5.68E-02	2.50E-01	6.47E-01	1.57E-03	167.99	2.62E-03	6.08E-02	2.29E-02	3.14E-03	2.44E-03	3.23E-02	2.77E-02	2.10E-02	7.86E-04	1.05E-03	4.85E-03
5	SEM on Flower	2017	2.89E-02	1.25E-01	3.21E-01	8.73E-04	93.33	1.36E-03	3.21E-02	1.11E-02	1.75E-03	1.36E-03	1.79E-02	1.39E-02	1.02E-02	4.37E-04	5.82E-04	2.69E-03
6	Cut & Cover Along Flower Street	2017	1.73E-02	7.47E-02	1.93E-01	5.24E-04	56.00	8.15E-04	1.93E-02	6.63E-03	1.05E-03	8.15E-04	1.08E-02	8.34E-03	6.11E-03	2.62E-04	3.49E-04	1.62E-03

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

Paved Road PM10 Emission Factors

Condition	Emission Factor (g/VMT) High-ADT	Low-ADT	Average
Average	0.37	1.3	0.81
Worst-Case	0.64	3.9	2.1

PM Size Fractions

PM10	0.4572
PM2.5	0.0686
PM2.5 EF	0.06

Source:

Midwest Research Institute (MRI). 1996. *Improvement of Specific Emission Factors (BADM Project No. 1)* . Final Report. March 29. Table ES-3.

PM10 and PM 2.5 Size Fractions: CARB Speciation Profiles. Profile Number 471 (PAVED ROAD DUST, 97 N AFTER)

http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-11: Daily and Annual Emissions Summary (Worker Commute) - Locally Preferred Alternative

Inputs: Locally Preferred Alternative/Baseline

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Duration (months) Total	2014	2015	2016	2017
1	EPBM Flower	20	600	May-15	Nov-16	19	--	8	11	--
2	Cut & Cover Along Flower Street	30	900	Sep-14	Sep-17	37	4	12	12	9

Daily vehicle miles traveled (round-trip) 30 *(estimated value)*

Daily Emissions

			Emissions (lb/day)													
							PM10					PM2.5				
Phase	Description	Year	ROG	CO	NOx	SO2	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust
1	EPBM Flower	2015	0.07	2.53	0.20	0.00	1.11	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
1	EPBM Flower	2016	0.06	2.33	0.18	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
2	Cut & Cover Along Flower Street	2014	0.12	4.17	0.34	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24
2	Cut & Cover Along Flower Street	2015	0.10	3.80	0.30	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24
2	Cut & Cover Along Flower Street	2016	0.09	3.49	0.27	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24
2	Cut & Cover Along Flower Street	2017	0.07	3.19	0.25	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24

Annual Emissions

			Emissions (tons per year)													
							PM10					PM2.5				
Phase	Description	Year	ROG	CO	NOx	SO2	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust
1	EPBM Flower	2015	5.94E-03	2.23E-01	1.78E-02	4.07E-04	9.81E-02	1.34E-03	9.31E-04	1.51E-03	9.43E-02	1.62E-02	1.28E-03	2.33E-04	5.82E-04	1.41E-02
1	EPBM Flower	2016	6.96E-03	2.82E-01	2.22E-02	5.60E-04	1.35E-01	1.92E-03	1.28E-03	2.08E-03	1.30E-01	2.23E-02	1.76E-03	3.20E-04	8.00E-04	1.95E-02
2	Cut & Cover Along Flower Street	2014	5.28E-03	1.83E-01	1.48E-02	3.06E-04	7.36E-02	1.00E-03	6.98E-04	1.13E-03	7.07E-02	1.22E-02	9.60E-04	1.75E-04	4.37E-04	1.06E-02
2	Cut & Cover Along Flower Street	2015	1.34E-02	5.02E-01	3.99E-02	9.17E-04	2.21E-01	3.01E-03	2.10E-03	3.40E-03	2.12E-01	3.65E-02	2.88E-03	5.24E-04	1.31E-03	3.18E-02
2	Cut & Cover Along Flower Street	2016	1.14E-02	4.61E-01	3.63E-02	9.17E-04	2.21E-01	3.14E-03	2.10E-03	3.40E-03	2.12E-01	3.65E-02	2.88E-03	5.24E-04	1.31E-03	3.18E-02
2	Cut & Cover Along Flower Street	2017	7.07E-03	3.16E-01	2.47E-02	6.88E-04	1.66E-01	2.36E-03	1.57E-03	2.55E-03	1.59E-01	2.74E-02	2.16E-03	3.93E-04	9.82E-04	2.39E-02

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:
INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.
MATCH formula used to identify row number and column number for each year-pollutant combination.

Paved Road PM10 Emission Factors

Condition	Emission Factor (g/VMT) High-ADT	Low-ADT	Average
Average	0.37	1.3	0.81
Worst-Case	0.64	3.9	2.1

PM Size Fractions

PM10	0.4572
PM2.5	0.0686
PM2.5 EF	0.12

Source:
Midwest Research Institute (MRI). 1996. *Improvement of Specific Emission Factors (BADM Project No. 1)* . Final Report. March 29. Table ES-3.

PM10 and PM 2.5 Size Fractions: CARB Speciation Profiles. Profile Number 471 (PAVED ROAD DUST, 97 N AFTER)
http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-12: Daily and Annual Emissions Summary (Worker Commute) - Alternative 1

Inputs: Alternative 1

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower	20	600	May-15	Jan-17	21	--	8	12	1
2	Cut & Cover Along Flower Street	30	900	Sep-14	May-16	21	4	12	5	--

Daily vehicle miles traveled (round-trip) 30 *(estimated value)*

Daily Emissions

Phase	Description	Year	Emissions (lb/day) ROG	CO	NOx	SO2	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust
1	EPBM Flower	2015	0.07	2.53	0.20	0.00	1.11	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
1	EPBM Flower	2016	0.06	2.33	0.18	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
1	EPBM Flower	2017	0.05	2.13	0.17	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
2	Cut & Cover Along Flower Street	2014	0.12	4.17	0.34	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24
2	Cut & Cover Along Flower Street	2015	0.10	3.80	0.30	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24
2	Cut & Cover Along Flower Street	2016	0.09	3.49	0.27	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24

Annual Emissions

Phase	Description	Year	Emissions (tons per year) ROG	CO	NOx	SO2	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM10 Paved Road Dust	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	PM2.5 Paved Road Dust
1	EPBM Flower	2015	5.94E-03	2.23E-01	1.78E-02	4.07E-04	9.81E-02	1.34E-03	9.31E-04	1.51E-03	9.43E-02	1.62E-02	1.28E-03	2.33E-04	5.82E-04	1.41E-02
1	EPBM Flower	2016	7.60E-03	3.07E-01	2.42E-02	6.11E-04	1.47E-01	2.10E-03	1.40E-03	2.27E-03	1.41E-01	2.44E-02	1.92E-03	3.49E-04	8.73E-04	2.12E-02
1	EPBM Flower	2017	5.24E-04	2.34E-02	1.83E-03	5.09E-05	1.23E-02	1.75E-04	1.16E-04	1.89E-04	1.18E-02	2.03E-03	1.60E-04	2.91E-05	7.28E-05	1.77E-03
2	Cut & Cover Along Flower Street	2014	5.28E-03	1.83E-01	1.48E-02	3.06E-04	7.36E-02	1.00E-03	6.98E-04	1.13E-03	7.07E-02	1.22E-02	9.60E-04	1.75E-04	4.37E-04	1.06E-02
2	Cut & Cover Along Flower Street	2015	1.34E-02	5.02E-01	3.99E-02	9.17E-04	2.21E-01	3.01E-03	2.10E-03	3.40E-03	2.12E-01	3.65E-02	2.88E-03	5.24E-04	1.31E-03	3.18E-02
2	Cut & Cover Along Flower Street	2016	4.75E-03	1.92E-01	1.51E-02	3.82E-04	9.20E-02	1.31E-03	8.73E-04	1.42E-03	8.84E-02	1.52E-02	1.20E-03	2.18E-04	5.46E-04	1.33E-02

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:
INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.
MATCH formula used to identify row number and column number for each year-pollutant combination.

Paved Road PM10 Emission Factors

Condition	Emission Factor (g/VMT) High-ADT	Low-ADT	Average
Average	0.37	1.3	0.81
Worst-Case	0.64	3.9	2.1

PM Size Fractions

PM10	0.4572
PM2.5	0.0686
PM2.5 EF	0.12

Source:
Midwest Research Institute (MRI). 1996. *Improvement of Specific Emission Factors (BADM Project No. 1)* . Final Report. March 29. Table ES-3.

PM10 and PM 2.5 Size Fractions: CARB Speciation Profiles. Profile Number 471 (PAVED ROAD DUST, 97 N AFTER)
http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-13: Daily and Annual Emissions Summary (Worker Commute) - Alternative 2

Inputs: Alternative 2

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Duration (months) Total	2014	2015	2016	2017
1	EPBM Flower	20	600	May-15	Oct-15	6	--	6	--	--
2	Cut & Cover Along Flower Street	30	900	Sep-14	Dec-17	40	4	12	12	12

Daily vehicle miles traveled (round-trip) 30 *(estimated value)*

Daily Emissions

			Emissions (lb/day)													
							PM10					PM2.5				
Phase	Description	Year	ROG	CO	NOx	SO2	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust
1	EPBM Flower	2015	0.07	2.53	0.20	0.00	1.11	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
2	Cut & Cover Along Flower Street	2014	0.12	4.17	0.34	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24
2	Cut & Cover Along Flower Street	2015	0.10	3.80	0.30	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24
2	Cut & Cover Along Flower Street	2016	0.09	3.49	0.27	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24
2	Cut & Cover Along Flower Street	2017	0.07	3.19	0.25	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24

Annual Emissions

			Emissions (tons per year)													
							PM10					PM2.5				
Phase	Description	Year	ROG	CO	NOx	SO2	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust
1	EPBM Flower	2015	4.45E-03	1.67E-01	1.33E-02	3.06E-04	7.36E-02	1.00E-03	6.98E-04	1.13E-03	7.07E-02	1.22E-02	9.60E-04	1.75E-04	4.37E-04	1.06E-02
2	Cut & Cover Along Flower Street	2014	5.28E-03	1.83E-01	1.48E-02	3.06E-04	7.36E-02	1.00E-03	6.98E-04	1.13E-03	7.07E-02	1.22E-02	9.60E-04	1.75E-04	4.37E-04	1.06E-02
2	Cut & Cover Along Flower Street	2015	1.34E-02	5.02E-01	3.99E-02	9.17E-04	2.21E-01	3.01E-03	2.10E-03	3.40E-03	2.12E-01	3.65E-02	2.88E-03	5.24E-04	1.31E-03	3.18E-02
2	Cut & Cover Along Flower Street	2016	1.14E-02	4.61E-01	3.63E-02	9.17E-04	2.21E-01	3.14E-03	2.10E-03	3.40E-03	2.12E-01	3.65E-02	2.88E-03	5.24E-04	1.31E-03	3.18E-02
2	Cut & Cover Along Flower Street	2017	9.43E-03	4.21E-01	3.29E-02	9.17E-04	2.21E-01	3.14E-03	2.10E-03	3.40E-03	2.12E-01	3.65E-02	2.88E-03	5.24E-04	1.31E-03	3.18E-02

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

Paved Road PM10 Emission Factors

Condition	Emission Factor (g/VMT) High-ADT	Low-ADT	Average
Average	0.37	1.3	0.81
Worst-Case	0.64	3.9	2.1

PM Size Fractions

PM10	0.4572
PM2.5	0.0686
PM2.5 EF	0.12

Source:

Midwest Research Institute (MRI). 1996. *Improvement of Specific Emission Factors (BADM Project No. 1)* . Final Report. March 29. Table ES-3.

PM10 and PM 2.5 Size Fractions: CARB Speciation Profiles. Profile Number 471 (PAVED ROAD DUST, 97 N AFTER)

http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-14: Daily and Annual Emissions Summary (Worker Commute) - Alternative 3

Inputs: Alternative 3

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower WB	20	600	Jun-15	Mar-16	10	--	7	3	--
2	EPBM Flower EB	20	600	Oct-16	May-17	8	--	--	3	5
3	Grouting on Flower	40	1,200	Nov-14	Nov-15	13	2	11	--	--
4	Open Face/Shield on Flower	20	600	Mar-16	Dec-16	10	--	--	10	--
5	SEM on Flower	20	600	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	30	900	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 30 *(estimated value)*

Daily Emissions

			Emissions (lb/day)													
							PM10					PM2.5				
Phase	Description	Year	ROG	CO	NOx	SO2	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust
1	EPBM Flower WB	2015	0.07	2.53	0.20	0.00	1.11	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
1	EPBM Flower WB	2016	0.06	2.33	0.18	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
2	EPBM Flower EB	2016	0.06	2.33	0.18	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
2	EPBM Flower EB	2017	0.05	2.13	0.17	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
3	Grouting on Flower	2014	0.16	5.56	0.45	0.01	2.23	0.03	0.02	0.03	2.14	0.37	0.03	0.01	0.01	0.32
3	Grouting on Flower	2015	0.13	5.07	0.40	0.01	2.23	0.03	0.02	0.03	2.14	0.37	0.03	0.01	0.01	0.32
4	Open Face/Shield on Flower	2016	0.06	2.33	0.18	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
5	SEM on Flower	2016	0.06	2.33	0.18	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
5	SEM on Flower	2017	0.05	2.13	0.17	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
6	Cut & Cover Along Flower Street	2017	0.07	3.19	0.25	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24

Table 2-14: Daily and Annual Emissions Summary (Worker Commute) - Alternative 3

Annual Emissions

Phase	Description	Year	Emissions (tons per year)													
							PM10					PM2.5				
			ROG	CO	NOx	SO2	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust
1	EPBM Flower WB	2015	5.19E-03	1.95E-01	1.55E-02	3.56E-04	8.58E-02	1.17E-03	8.15E-04	1.32E-03	8.25E-02	1.42E-02	1.12E-03	2.04E-04	5.09E-04	1.24E-02
1	EPBM Flower WB	2016	1.90E-03	7.68E-02	6.05E-03	1.53E-04	3.68E-02	5.24E-04	3.49E-04	5.67E-04	3.54E-02	6.09E-03	4.80E-04	8.73E-05	2.18E-04	5.31E-03
2	EPBM Flower EB	2016	1.90E-03	7.68E-02	6.05E-03	1.53E-04	3.68E-02	5.24E-04	3.49E-04	5.67E-04	3.54E-02	6.09E-03	4.80E-04	8.73E-05	2.18E-04	5.31E-03
2	EPBM Flower EB	2017	2.62E-03	1.17E-01	9.13E-03	2.55E-04	6.13E-02	8.73E-04	5.82E-04	9.46E-04	5.89E-02	1.02E-02	8.00E-04	1.46E-04	3.64E-04	8.84E-03
3	Grouting on Flower	2014	3.52E-03	1.22E-01	9.84E-03	2.04E-04	4.90E-02	6.69E-04	4.66E-04	7.57E-04	4.71E-02	8.12E-03	6.40E-04	1.16E-04	2.91E-04	7.07E-03
3	Grouting on Flower	2015	1.63E-02	6.13E-01	4.88E-02	1.12E-03	2.70E-01	3.68E-03	2.56E-03	4.16E-03	2.59E-01	4.47E-02	3.52E-03	6.40E-04	1.60E-03	3.89E-02
4	Open Face/Shield on Flower	2016	6.33E-03	2.56E-01	2.02E-02	5.09E-04	1.23E-01	1.75E-03	1.16E-03	1.89E-03	1.18E-01	2.03E-02	1.60E-03	2.91E-04	7.28E-04	1.77E-02
5	SEM on Flower	2016	6.33E-04	2.56E-02	2.02E-03	5.09E-05	1.23E-02	1.75E-04	1.16E-04	1.89E-04	1.18E-02	2.03E-03	1.60E-04	2.91E-05	7.28E-05	1.77E-03
5	SEM on Flower	2017	6.29E-03	2.81E-01	2.19E-02	6.11E-04	1.47E-01	2.10E-03	1.40E-03	2.27E-03	1.41E-01	2.44E-02	1.92E-03	3.49E-04	8.73E-04	2.12E-02
6	Cut & Cover Along Flower Street	2017	7.86E-04	3.51E-02	2.74E-03	7.64E-05	1.84E-02	2.62E-04	1.75E-04	2.84E-04	1.77E-02	3.05E-03	2.40E-04	4.37E-05	1.09E-04	2.65E-03

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

Paved Road PM10 Emission Factors

Condition	Emission Factor (g/VMT)		
	High-ADT	Low-ADT	Average
Average	0.37	1.3	0.81
Worst-Case	0.64	3.9	2.1

PM Size Fractions

PM10	0.4572
PM2.5	0.0686
PM2.5 EF	0.12

Source:

Midwest Research Institute (MRI). 1996. *Improvement of Specific Emission Factors (BADM Project No. 1)* . Final Report. March 29. Table ES-3.

PM10 and PM 2.5 Size Fractions: CARB Speciation Profiles. Profile Number 471 (PAVED ROAD DUST, 97 N AFTER)

http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-15: Daily and Annual Emissions Summary (Worker Commute) - Alternative 4

Inputs: Alternative 4

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Total	2014	2015	2016	2017
						Duration (months)				
1	EPBM Flower	20	600	Jun-15	Feb-17	21	--	7	12	2
2	Grouting on Flower	20	600	Feb-15	Oct-15	9	--	9	--	--
3	SEM on Flower	20	600	Apr-16	May-17	14	--	--	9	5
4	Cut & Cover Along Flower Street	30	900	May-17	Jul-17	3	--	--	--	3
5	SEM on Flower	20	600	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	20	600	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 30 *(estimated value)*

Daily Emissions

			Emissions (lb/day)													
							PM10					PM2.5				
Phase	Description	Year	ROG	CO	NOx	SO2	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust
1	EPBM Flower	2015	0.07	2.53	0.20	0.00	1.11	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
1	EPBM Flower	2016	0.06	2.33	0.18	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
1	EPBM Flower	2017	0.05	2.13	0.17	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
2	Grouting on Flower	2015	0.07	2.53	0.20	0.00	1.11	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
3	SEM on Flower	2016	0.06	2.33	0.18	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
3	SEM on Flower	2017	0.05	2.13	0.17	0.00	1.12	0.02	0.01	0.02	1.07	0.18	0.01	0.00	0.01	0.16
4	Cut & Cover Along Flower Street	2017	0.07	3.19	0.25	0.01	1.67	0.02	0.02	0.03	1.61	0.28	0.02	0.00	0.01	0.24
5	SEM on Flower	2016	0.86	3.79	9.81	0.02	0.92	0.35	0.05	0.04	0.49	0.51	0.32	0.01	0.02	0.16
5	SEM on Flower	2017	0.79	3.40	8.76	0.02	0.88	0.30	0.05	0.04	0.49	0.47	0.28	0.01	0.02	0.16
6	Cut & Cover Along Flower Street	2017	0.79	3.40	8.76	0.02	0.88	0.30	0.05	0.04	0.49	0.47	0.28	0.01	0.02	0.16

Table 2-15: Daily and Annual Emissions Summary (Worker Commute) - Alternative 4

Annual Emissions

Phase	Description	Year	Emissions (tons per year)													
							PM10					PM2.5				
			ROG	CO	NOx	SO2	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust	Total	Exhaust	Tire Wear	Brake Wear	Paved Road Dust
1	EPBM Flower	2015	5.19E-03	1.95E-01	1.55E-02	3.56E-04	8.58E-02	1.17E-03	8.15E-04	1.32E-03	8.25E-02	1.42E-02	1.12E-03	2.04E-04	5.09E-04	1.24E-02
1	EPBM Flower	2016	7.60E-03	3.07E-01	2.42E-02	6.11E-04	1.47E-01	2.10E-03	1.40E-03	2.27E-03	1.41E-01	2.44E-02	1.92E-03	3.49E-04	8.73E-04	2.12E-02
1	EPBM Flower	2017	1.05E-03	4.68E-02	3.65E-03	1.02E-04	2.45E-02	3.49E-04	2.33E-04	3.78E-04	2.36E-02	4.06E-03	3.20E-04	5.82E-05	1.46E-04	3.54E-03
2	Grouting on Flower	2015	6.68E-03	2.51E-01	2.00E-02	4.58E-04	1.10E-01	1.51E-03	1.05E-03	1.70E-03	1.06E-01	1.83E-02	1.44E-03	2.62E-04	6.55E-04	1.59E-02
3	SEM on Flower	2016	5.70E-03	2.30E-01	1.81E-02	4.58E-04	1.10E-01	1.57E-03	1.05E-03	1.70E-03	1.06E-01	1.83E-02	1.44E-03	2.62E-04	6.55E-04	1.59E-02
3	SEM on Flower	2017	2.62E-03	1.17E-01	9.13E-03	2.55E-04	6.13E-02	8.73E-04	5.82E-04	9.46E-04	5.89E-02	1.02E-02	8.00E-04	1.46E-04	3.64E-04	8.84E-03
4	Cut & Cover Along Flower Street	2017	2.36E-03	1.05E-01	8.22E-03	2.29E-04	5.52E-02	7.86E-04	5.24E-04	8.51E-04	5.30E-02	9.14E-03	7.20E-04	1.31E-04	3.27E-04	7.96E-03
5	SEM on Flower	2016	8.53E-02	3.75E-01	9.71E-01	2.36E-03	9.11E-02	3.43E-02	4.71E-03	3.67E-03	4.85E-02	5.02E-02	3.16E-02	1.18E-03	1.57E-03	1.59E-02
5	SEM on Flower	2017	4.34E-02	1.87E-01	4.82E-01	1.31E-03	4.82E-02	1.66E-02	2.62E-03	2.04E-03	2.69E-02	2.56E-02	1.53E-02	6.55E-04	8.73E-04	8.84E-03
6	Cut & Cover Along Flower Street	2017	2.60E-02	1.12E-01	2.89E-01	7.86E-04	2.89E-02	9.95E-03	1.57E-03	1.22E-03	1.62E-02	1.54E-02	9.17E-03	3.93E-04	5.24E-04	5.31E-03

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:
INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.
MATCH formula used to identify row number and column number for each year-pollutant combination.

Paved Road PM10 Emission Factors

Condition	Emission Factor (g/VMT)		
	High-ADT	Low-ADT	Average
Average	0.37	1.3	0.81
Worst-Case	0.64	3.9	2.1

PM Size Fractions

PM10	0.4572
PM2.5	0.0686
PM2.5 EF	0.12

Source:
Midwest Research Institute (MRI). 1996. *Improvement of Specific Emission Factors (BADM Project No. 1)* . Final Report. March 29. Table ES-3.

PM10 and PM 2.5 Size Fractions: CARB Speciation Profiles. Profile Number 471 (PAVED ROAD DUST, 97 N AFTER)
http://www.arb.ca.gov/ei/speciate/dnldopt.htm

Table 2-16: Daily and Annual Fugitive Dust Emissions Summary - Locally Preferred Alternative

Locally Preferred Alternative

Description	Soil (cy)	Start Month	End Month	Duration (months) Total	2014	2015	2016	2017	Duration (days) Total	2014	2015	2016	2017
EPBM Flower	27,834	May-15	Nov-16	19	--	8	11	--	418	n/a	176	242	n/a
Cut & Cover Along Flower Street	118,231	Sep-14	Sep-17	37	4	9	--	--	814	88	198	n/a	n/a

Note:
Construction Schedule: 22 days/month
(assumes 5 days per week)

Material Hauling Emissions

Description		PM10 Annual Emissions (tons per year) Total	2014	2015	2016	2017	PM2.5 Annual Emissions (tons per year) Total	2014	2015	2016	2017	Daily Emissions (lbs/day) PM10	PM2.5
EPBM Flower		1.13E-02	n/a	4.78E-03	6.57E-03	n/a	1.72E-03	n/a	7.23E-04	9.94E-04	n/a	5.43E-02	8.22E-03
Cut & Cover Along Flower Street		4.82E-02	5.21E-03	1.17E-02	n/a	n/a	7.30E-03	7.89E-04	1.77E-03	n/a	n/a	1.18E-01	1.79E-02
	Total	5.95E-02	5.21E-03	1.65E-02	6.57E-03	0.00E+00	9.01E-03	7.89E-04	2.50E-03	9.94E-04	0.00E+00	1.73E-01	2.61E-02

Number of drops: 3
Note:
Yellow text - assumed value.
Daily emission calculations assume that emissions are spread evenly throughout construction period.

Table 2-17: Daily and Annual Fugitive Dust Emissions Summary - Alternative 1

Alternative 1

Description	Soil (cy)	Start Month	End Month	Duration (months) Total	2014	2015	2016	2017	Duration (days) Total	2014	2015	2016	2017
EPBM Flower	44,292	May-15	Jan-17	21	--	8	12	1	462	n/a	176	264	22
Cut & Cover Along Flower Street	61,824	Sep-14	May-16	21	4	12	5	--	462	88	264	110	n/a

Note:
Construction Schedule: 22 days/month
(assumes 5 days per week)

Material Hauling Emissions

Description	PM10 Annual Emissions (tons per year) Total	2014	2015	2016	2017	PM2.5 Annual Emissions (tons per year) Total	2014	2015	2016	2017	Daily Emissions (lbs/day) PM10	PM2.5
EPBM Flower	1.81E-02	n/a	6.88E-03	1.03E-02	8.60E-04	2.73E-03	n/a	1.04E-03	1.56E-03	1.30E-04	7.81E-02	1.18E-02
Cut & Cover Along Flower Street	2.52E-02	4.80E-03	1.44E-02	6.00E-03	n/a	3.82E-03	7.27E-04	2.18E-03	9.08E-04	n/a	1.09E-01	1.65E-02
Total	4.32E-02	4.80E-03	2.13E-02	1.63E-02	8.60E-04	6.55E-03	7.27E-04	3.22E-03	2.47E-03	1.30E-04	1.87E-01	2.84E-02

Number of drops: 3

Note:
Yellow text - assumed value.
Daily emission calculations assume that emissions are spread evenly throughout construction period.

Table 2-18: Daily and Annual Fugitive Dust Emissions Summary - Alternative 2

Alternative 2

Description	Soil (cy)	Start Month	End Month	Duration (months) Total	2014	2015	2016	2017	Duration (days) Total	2014	2015	2016	2017
EPBM Flower	15,974	May-15	Oct-15	6	--	6	--	--	132	n/a	132	n/a	n/a
Cut & Cover Along Flower Street	154,526	Sep-14	Dec-17	40	4	12	12	12	880	88	264	264	264

Note:
Construction Schedule: 22 days/month
(assumes 5 days per week)

Material Hauling Emissions

Description	PM10 Annual Emissions (tons per year) Total	2014	2015	2016	2017	PM2.5 Annual Emissions (tons per year) Total	2014	2015	2016	2017	Daily Emissions (lbs/day) PM10	PM2.5
EPBM Flower	6.51E-03	n/a	6.51E-03	n/a	n/a	9.86E-04	n/a	9.86E-04	n/a	n/a	9.86E-02	1.49E-02
Cut & Cover Along Flower Street	6.30E-02	6.30E-03	1.89E-02	1.89E-02	1.89E-02	9.54E-03	9.54E-04	2.86E-03	2.86E-03	2.86E-03	1.43E-01	2.17E-02
Total	6.95E-02	6.30E-03	2.54E-02	1.89E-02	1.89E-02	1.05E-02	9.54E-04	3.85E-03	2.86E-03	2.86E-03	2.42E-01	3.66E-02

Number of drops: 3

Note:
Yellow text - assumed value.
Daily emission calculations assume that emissions are spread evenly throughout construction period.

Table 2-19: Daily and Annual Fugitive Dust Emissions Summary - Alternative 3

Alternative 3

Description	Soil (cy)	Start Month	End Month	Duration (months) Total	2014	2015	2016	2017	Duration (days) Total	2014	2015	2016	2017
EPBM Flower WB	13,917	Jun-15	Mar-16	10	--	7	3	--	220	n/a	154	66	n/a
EPBM Flower EB	13,917	Oct-16	May-17	8	--	--	3	5	176	n/a	n/a	66	110
Grouting on Flower	0	Nov-14	Nov-15	13	2	11	--	--	286	44	242	n/a	n/a
Open Face/Shield on Flower	17,373	Mar-16	Dec-16	10	--	--	10	--	220	n/a	n/a	220	n/a
SEM on Flower	19,097	Dec-16	Dec-17	13	--	--	1	12	286	n/a	n/a	22	264
Cut & Cover Along Flower Street	20,925	Dec-17	Feb-18	3	--	--	--	1	66	n/a	n/a	n/a	22

Note:
Construction Schedule: 22 days/month
(assumes 5 days per week)

Material Hauling Emissions

Description	PM10 Annual Emissions (tons per year) Total	2014	2015	2016	2017	PM2.5 Annual Emissions (tons per year) Total	2014	2015	2016	2017	Daily Emissions (lbs/day) PM10	PM2.5
EPBM Flower WB	5.67E-03	n/a	3.97E-03	1.70E-03	n/a	8.59E-04	n/a	6.01E-04	2.58E-04	n/a	5.16E-02	7.81E-03
EPBM Flower EB	5.67E-03	n/a	n/a	2.13E-03	3.54E-03	8.59E-04	n/a	n/a	3.22E-04	5.37E-04	6.45E-02	9.76E-03
Grouting on Flower	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	0.00E+00	0.00E+00
Open Face/Shield on Flower	7.08E-03	n/a	n/a	7.08E-03	n/a	1.07E-03	n/a	n/a	1.07E-03	n/a	6.44E-02	9.75E-03
SEM on Flower	7.78E-03	n/a	n/a	5.99E-04	7.18E-03	1.18E-03	n/a	n/a	9.07E-05	1.09E-03	5.44E-02	8.24E-03
Cut & Cover Along Flower Street	8.53E-03	n/a	n/a	n/a	2.84E-03	1.29E-03	n/a	n/a	n/a	4.30E-04	2.58E-01	3.91E-02
Total	3.47E-02	0.00E+00	3.97E-03	1.15E-02	1.36E-02	5.26E-03	0.00E+00	6.01E-04	1.74E-03	2.06E-03	4.93E-01	7.47E-02

Number of drops: 3
Note:
Yellow text - assumed value.
Daily emission calculations assume that emissions are spread evenly throughout construction period.

Table 2-20: Daily and Annual Fugitive Dust Emissions Summary - Alternative 4

Alternative 4

Description	Soil (cy)	Start Month	End Month	Duration (months) Total	2014	2015	2016	2017	Duration (days) Total	2014	2015	2016	2017
EPBM Flower	44,292	Jun-15	Feb-17	21	--	7	12	2	462	n/a	154	264	44
Grouting on Flower	0	Feb-15	Oct-15	9	--	9	--	--	198	n/a	198	n/a	n/a
SEM on Flower	22,487	Apr-16	May-17	14	--	--	9	5	308	n/a	n/a	198	110
Cut & Cover Along Flower Street	16,231	May-17	Jul-17	3	--	--	--	3	66	n/a	n/a	n/a	66
SEM on Flower	19,097	Dec-16	Dec-17	13	--	--	1	12	286	n/a	n/a	22	264
Cut & Cover Along Flower Street	20,925	Dec-17	Feb-18	3	--	--	--	1	66	n/a	n/a	n/a	22

Note:
Construction Schedule: 22 days/month
(assumes 5 days per week)

Material Hauling Emissions

Description	PM10 Annual Emissions (tons per year) Total	2014	2015	2016	2017	PM2.5 Annual Emissions (tons per year) Total	2014	2015	2016	2017	Daily Emissions (lbs/day) PM10	PM2.5
EPBM Flower	1.81E-02	n/a	6.02E-03	1.03E-02	1.72E-03	2.73E-03	n/a	9.11E-04	1.56E-03	2.60E-04	7.81E-02	1.18E-02
Grouting on Flower	0.00E+00	n/a	0.00E+00	n/a	n/a	0.00E+00	n/a	0.00E+00	n/a	n/a	0.00E+00	0.00E+00
SEM on Flower	9.16E-03	n/a	n/a	5.89E-03	3.27E-03	1.39E-03	n/a	n/a	8.92E-04	4.96E-04	5.95E-02	9.01E-03
Cut & Cover Along Flower Street	6.61E-03	n/a	n/a	n/a	6.61E-03	1.00E-03	n/a	n/a	n/a	1.00E-03	2.00E-01	3.04E-02
SEM on Flower	7.78E-03	n/a	n/a	5.99E-04	7.18E-03	1.18E-03	n/a	n/a	9.07E-05	1.09E-03	5.44E-02	8.24E-03
Cut & Cover Along Flower Street	8.53E-03	n/a	n/a	n/a	2.84E-03	1.29E-03	n/a	n/a	n/a	4.30E-04	2.58E-01	3.91E-02
Total	5.01E-02	0.00E+00	6.02E-03	1.68E-02	2.16E-02	7.59E-03	0.00E+00	9.11E-04	2.54E-03	3.28E-03	6.51E-01	9.86E-02

Number of drops: 3
Note:
Yellow text - assumed value.
Daily emission calculations assume that emissions are spread evenly throughout construction period.

Localized Air Quality Impact Assessment - Localized Significance Thresholds (LST)

Table 3-1: LST Analysis - Locally Preferred Alternative/Baseline

ID	Phase	Mitigated			
		Maximum Daily Onsite Emissions (lbs/day)			
		NOx	CO	PM10	PM2.5
1	EPBM Flower	55	120	1	1
2	Cut & Cover Along Flower Street	58	131	1	1
	Allowable Emissions	161	1,861	16	8

Table 3-2: LST Analysis - Alternative 1

ID	Phase	Mitigated			
		Maximum Daily Onsite Emissions (lbs/day)			
		NOx	CO	PM10	PM2.5
1	EPBM Flower	55	120	1	1
2	Cut & Cover Along Flower Street	56	126	1	1
	Allowable Emissions	161	1,861	16	8

Table 3-3: LST Analysis - Alternative 2

ID	Phase	Mitigated			
		Maximum Daily Onsite Emissions (lbs/day)			
		NOx	CO	PM10	PM2.5
1	EPBM Flower	53	115	1	1
2	Cut & Cover Along Flower Street	58	131	1	1
	Allowable Emissions	161	1,861	16	8

Table 3-4: LST Analysis - Alternative 3

ID	Phase	Mitigated			
		Maximum Daily Onsite Emissions (lbs/day)			
		NOx	CO	PM10	PM2.5
1	EPBM Flower WB	55	120	1	1
2	EPBM Flower EB	56	125	1	1
3	Grouting on Flower	64	51	2	2
4	Open Face/Shield on Flower	55	120	1	1
5	SEM on Flower	56	125	1	1
6	Cut & Cover Along Flower Street	58	131	1	1
	Allowable Emissions	161	1,861	16	8

Table 3-5: LST Analysis - Alternative 4

ID	Phase	Mitigated			
		Maximum Daily Onsite Emissions (lbs/day)			
		NOx	CO	PM10	PM2.5
1	EPBM Flower	56	125	1	1
2	Grouting on Flower	67	62	2	2
3	SEM on Flower	56	125	1	1
4	Cut & Cover Along Flower Street	58	131	1	1
	Allowable Emissions	161	1,861	16	8

APPENDIX D

GREEN HOUSE GASES

Metro's Regional Connector Transit Corridor Supplemental Environmental Impact Study - Greenhouse Gas Emission Calculations Appendix

Prepared June 2014

Greenhouse Gas Emission Calculations - Appendix Index	
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Table 1-1: GHG Emissions Summary - Locally Preferred Alternative						
GHG Emission Source	Annual GHG Emissions (MTCO2e/yr)				Total Project	Amortized Emissions
	2014	2015	2016	2017		
Construction Equipment	2,060	9,533	11,449	4,636	27,679	923
Construction Worker Commuting	31	132	147	69	379	13
Haul Trucks	68	339	390	152	948	32
Total =	2,159	10,004	11,986	4,857	29,006	967
Acronyms: MTCO2e = metric tons of carbon dioxide equivalent; MTCO2e/yr = metric tons of carbon dioxide equivalent per year						

Table 1-2: GHG Emissions Summary - Alternative 1						
GHG Emission Source	Annual GHG Emissions (MTCO2e/yr)				Total Project	Amortized Emissions
	2014	2015	2016	2017		
Construction Equipment	2,060	10,012	8,323	479	20,874	696
Construction Worker Commuting	31	132	99	5	267	9
Haul Trucks	68	339	288	17	712	24
Total =	2,158	10,483	8,710	501	21,853	728
Acronyms: MTCO2e = metric tons of carbon dioxide equivalent; MTCO2e/yr = metric tons						

Table 1-3: GHG Emissions Summary - Alternative 2						
GHG Emission Source	Annual GHG Emissions (MTCO2e/yr)				Total Project	Amortized Emissions
	2014	2015	2016	2017		
Construction Equipment	2,060	9,054	6,181	6,182	23,477	783
Construction Worker Commuting	31	122	92	91	336	11
Haul Trucks	68	305	203	203	779	26
Total =	2,158	9,481	6,476	6,476	24,591	820
Acronyms: MTCO2e = metric tons of carbon dioxide equivalent; MTCO2e/yr = metric tons						

Table 1-4: GHG Emissions Summary - Alternative 3						
GHG Emission Source	Annual GHG Emissions (MTCO2e/yr)				Total Project	Amortized Emissions
	2014	2015	2016	2017		
Construction Equipment	2,373	16,277	7,663	8,658	34,972	1,166
Construction Worker Commuting	20	148	86	94	348	12
Haul Trucks	0	119	288	305	712	24
Total =	2,394	16,543	8,038	9,057	36,032	1,201
Acronyms: MTCO2e = metric tons of carbon dioxide equivalent; MTCO2e/yr = metric tons						

Table 1-5: GHG Emissions Summary - Alternative 4						
GHG Emission Source	Annual GHG Emissions (MTCO2e/yr)				Total Project	Amortized Emissions
	2014	2015	2016	2017		
Construction Equipment	0	9,093	10,058	4,383	23,534	784
Construction Worker Commuting	0	81	335	262	678	23
Haul Trucks	0	119	508	305	931	31
Total =	0	9,293	10,901	4,950	25,144	838
Acronyms: MTCO2e = metric tons of carbon dioxide equivalent; MTCO2e/yr = metric tons						

Table 2-1: Hourly, Daily, Annual GHG Emissions Summary - Locally Preferred Alternative

Locally Preferred Alternative/Baseline

Phase	Description	Hours per Day	Start Month	End Month	Duration (months) 2014	2015	2016	2017	Number of Equipment Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	20	May-15	Nov-16	--	7	11	--	2	4	2	0	0	0	0	5
2	Cut & Cover Along Flower Street	20	Sep-14	Sep-17	4	12	12	9	2	4	2	1	0	0	0	5

Work days per month 22

Hourly Emissions by Equipment

Phase	Description	Year	CO2 Emissions (pounds per hour) Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed	CH4 Emissions (pounds per hour) Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	377.84	430.55	287.24	0.00	0.00	0.00	0.00	1303.32	0.007	0.015	0.005	0.000	0.000	0.000	0.000	0.028
1	EPBM Flower	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.009	0.018	0.006	0.000	0.000	0.000	0.000	0.036
2	Cut & Cover Along Flower Street	2014	377.92	430.55	287.22	181.02	0.00	0.00	0.00	1303.29	0.006	0.011	0.004	0.002	0.000	0.000	0.000	0.020
2	Cut & Cover Along Flower Street	2015	377.84	430.55	287.24	180.98	0.00	0.00	0.00	1303.32	0.007	0.015	0.005	0.003	0.000	0.000	0.000	0.028
2	Cut & Cover Along Flower Street	2016	377.83	430.54	287.18	180.99	0.00	0.00	0.00	1303.29	0.009	0.018	0.006	0.003	0.000	0.000	0.000	0.036
2	Cut & Cover Along Flower Street	2017	377.93	430.54	287.14	181.03	0.00	0.00	0.00	1303.26	0.011	0.021	0.006	0.004	0.000	0.000	0.000	0.043

Daily Emissions

Phase	Description	Year	Emissions (pounds per day) CO2	CH4
1	EPBM Flower	2015	47978.74	1.10
1	EPBM Flower	2016	47977.00	1.37
2	Cut & Cover Along Flower Street	2014	51599.76	0.86
2	Cut & Cover Along Flower Street	2015	51598.31	1.15
2	Cut & Cover Along Flower Street	2016	51596.84	1.43
2	Cut & Cover Along Flower Street	2017	51598.13	1.71

Annual Emissions by Phase

Phase	Description	Year	Emissions (tons per year) CO2	CH4	CO2e Emissions (tons per year) CO2	CH4:CO2	CO2e	MTCO2e/Yr
1	EPBM Flower	2015	3694.36	0.08	3694.36	1.77	3696.13	3352.39
1	EPBM Flower	2016	5805.22	0.17	5805.22	3.48	5808.69	5268.48
2	Cut & Cover Along Flower Street	2014	2270.39	0.04	2270.39	0.80	2271.18	2059.96
2	Cut & Cover Along Flower Street	2015	6810.98	0.15	6810.98	3.19	6814.17	6180.45
2	Cut & Cover Along Flower Street	2016	6810.78	0.19	6810.78	3.97	6814.76	6180.99
2	Cut & Cover Along Flower Street	2017	5108.22	0.17	5108.22	3.55	5111.76	4636.37

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:

Construction equipment emission factors from OFFROAD2007

21 GWP of CH4:CO2

0.907 tons/MT

Table 2-1: Hourly, Daily, Annual GHG Emissions Summary - Locally Preferred Alternative

Annual GHG Emissions Summary

Year	Description	MTCO2e
2014	Cut & Cover Along Flower Street	2059.96
	2014 Total, MTCO2e/Yr =	2059.96
2015	EPBM Flower	3352.39
	Cut & Cover Along Flower Street	6180.45
	2015 Total, MTCO2e/Yr =	9532.85
2016	EPBM Flower	5268.48
	Cut & Cover Along Flower Street	6180.99
	2016 Total, MTCO2e/Yr =	11449.47
2017	Cut & Cover Along Flower Street	4636.37
	2017 Total, MTCO2e/Yr =	4636.37

Table 2-2: Hourly, Daily, Annual GHG Emissions Summary - Alternative 1

Alternative 1

Phase	Description	Hours per Day	Start Month	End Month	Duration (months) 2014	2015	2016	2017	Number of Equipment Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	20	May-15	Jan-17	--	8	12	1	2	4	2	0	0	0	0	5
2	Cut & Cover Along Flower Street	20	Sep-14	May-16	4	12	5	--	2	4	2	1	0	0	0	5

Work days per month 22

Hourly Emissions by Equipment

Phase	Description	Year	CO2 Emissions (pounds per hour) Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed	CH4 Emissions (pounds per hour) Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	377.84	430.55	287.24	0.00	0.00	0.00	0.00	1303.32	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03
1	EPBM Flower	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
1	EPBM Flower	2017	377.93	430.54	287.14	0.00	0.00	0.00	0.00	1303.26	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
2	Cut & Cover Along Flower Street	2014	377.92	430.55	287.22	181.02	0.00	0.00	0.00	1303.29	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.02
2	Cut & Cover Along Flower Street	2015	377.84	430.55	287.24	180.98	0.00	0.00	0.00	1303.32	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03
2	Cut & Cover Along Flower Street	2016	377.83	430.54	287.18	180.99	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04

Daily Emissions

Phase	Description	Year	Emissions (pounds per day) CO2	CH4
1	EPBM Flower	2015	47,978.74	1.10
1	EPBM Flower	2016	47,977.00	1.37
1	EPBM Flower	2017	47,977.47	1.63
2	Cut & Cover Along Flower Street	2014	51,599.76	0.86
2	Cut & Cover Along Flower Street	2015	51,598.31	1.15
2	Cut & Cover Along Flower Street	2016	51,596.84	1.43

Annual Emissions by Phase

Phase	Description	Year	Emissions (tons per year) CO2	CH4	CO2e Emissions (tons per year) CO2	CH4:CO2	CO2e	MTCO2e/Yr
1	EPBM Flower	2015	4,222.13	0.10	4,222.13	2.02	4,224.15	3,831.31
1	EPBM Flower	2016	6,332.96	0.18	6,332.96	3.79	6,336.76	5,747.44
1	EPBM Flower	2017	527.75	0.02	527.75	0.38	528.13	479.01
2	Cut & Cover Along Flower Street	2014	2,270.39	0.04	2,270.39	0.80	2,271.18	2,059.96
2	Cut & Cover Along Flower Street	2015	6,810.98	0.15	6,810.98	3.19	6,814.17	6,180.45
2	Cut & Cover Along Flower Street	2016	2,837.83	0.08	2,837.83	1.66	2,839.48	2,575.41

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:

Construction equipment emission factors from OFFROAD2007

21 GWP of CH4:CO2

0.907 tons/MT

Table 2-2: Hourly, Daily, Annual GHG Emissions Summary - Alternative 1

Annual GHG Emissions Summary

Year	Description	MTCO2e
2014	Cut & Cover Along Flower Street	2,059.96
	2014 Total, MTCO2e/Yr =	2,059.96
2015	EPBM Flower	3,831.31
	Cut & Cover Along Flower Street	6,180.45
	2015 Total, MTCO2e/Yr =	10,011.76
2016	EPBM Flower	5,747.44
	Cut & Cover Along Flower Street	2,575.41
	2016 Total, MTCO2e/Yr =	8,322.85
2017	EPBM Flower	479.01
	2017 Total, MTCO2e/Yr =	479.01

Table 2-3: Hourly, Daily, Annual GHG Emissions Summary - Alternative 2

Alternative 2

Phase	Description	Hours per Day	Start Month	End Month	Duration (months) 2014	2015	2016	2017	Number of Equipment Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	20	May-15	Oct-15	--	6	--	--	2	4	2	0	0	0	0	5
2	Cut & Cover Along Flower Street	20	Sep-14	Dec-17	4	12	12	12	2	4	2	1	0	0	0	5

Work days per month 22

Hourly Emissions by Equipment

Phase	Description	Year	CO2 Emissions (pounds per hour) Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed	CH4 Emissions (pounds per hour) Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	377.84	430.55	287.24	0.00	0.00	0.00	0.00	1,303.32	0.007	0.015	0.005	0.000	0.000	0.000	0.000	0.028
2	Cut & Cover Along Flower Street	2014	377.92	430.55	287.22	181.02	0.00	0.00	0.00	1,303.29	0.006	0.011	0.004	0.002	0.000	0.000	0.000	0.020
2	Cut & Cover Along Flower Street	2015	377.84	430.55	287.24	180.98	0.00	0.00	0.00	1,303.32	0.007	0.015	0.005	0.003	0.000	0.000	0.000	0.028
2	Cut & Cover Along Flower Street	2016	377.83	430.54	287.18	180.99	0.00	0.00	0.00	1,303.29	0.009	0.018	0.006	0.003	0.000	0.000	0.000	0.036
2	Cut & Cover Along Flower Street	2017	377.93	430.54	287.14	181.03	0.00	0.00	0.00	1,303.26	0.011	0.021	0.006	0.004	0.000	0.000	0.000	0.043

Daily Emissions

Phase	Description	Year	Emissions (pounds per day) CO2	CH4
1	EPBM Flower	2015	47,978.74	1.10
2	Cut & Cover Along Flower Street	2014	51,599.76	0.86
2	Cut & Cover Along Flower Street	2015	51,598.31	1.15
2	Cut & Cover Along Flower Street	2016	51,596.84	1.43
2	Cut & Cover Along Flower Street	2017	51,598.13	1.71

Annual Emissions by Phase

Phase	Description	Year	Emissions (tons per year) CO2	CH4	CO2e Emissions (tons per year) CO2	CH4:CO2	CO2e	MTCO2e/Yr
1	EPBM Flower	2015	3166.60	0.07	3166.60	1.52	3168.12	2873.48
2	Cut & Cover Along Flower Street	2014	2270.39	0.04	2270.39	0.80	2271.18	2059.96
2	Cut & Cover Along Flower Street	2015	6810.98	0.15	6810.98	3.19	6814.17	6180.45
2	Cut & Cover Along Flower Street	2016	6810.78	0.19	6810.78	3.97	6814.76	6180.99
2	Cut & Cover Along Flower Street	2017	6810.95	0.23	6810.95	4.73	6815.68	6181.82

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:

Construction equipment emission factors from OFFROAD2007

21 GWP of CH4:CO2

0.907 tons/MT

Table 2-3: Hourly, Daily, Annual GHG Emissions Summary - Alternative 2

Annual GHG Emissions Summary

Year	Description	MTCO2e
2014	Cut & Cover Along Flower Street	2,059.96
	2014 Total, MTCO2e/Yr =	2,059.96
2015	EPBM Flower	2,873.48
	Cut & Cover Along Flower Street	6,180.45
	2015 Total, MTCO2e/Yr =	9,053.93
2016	Cut & Cover Along Flower Street	6,180.99
	2016 Total, MTCO2e/Yr =	6,180.99
2017	Cut & Cover Along Flower Street	6,181.82
	2017 Total, MTCO2e/Yr =	6,181.82

Table 2-4: Hourly, Daily, Annual GHG Emissions Summary - Alternative 3

Alternative 3

Phase	Description	Hours per Day	Start Month	End Month	Duration (months) 2014	2015	2016	2017	Number of Equipment Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower WB	20	Jun-15	Mar-16	--	7	3	--	2	4	2	0	0	0	0	5
2	EPBM Flower EB	20	Oct-16	May-17	--	--	3	5	2	4	2	0	0	0	0	5
3	Grouting on Flower	20	Nov-14	Nov-15	2	11	--	--	0	0	0	0	4	4	4	5
4	Open Face/Shield on Flower	20	Mar-16	Dec-16	--	--	9	--	2	4	2	0	0	0	0	5
5	SEM on Flower	20	Dec-16	Dec-17	--	--	1	12	2	4	2	0	0	0	0	5
6	Cut & Cover Along Flower Street	20	Dec-17	Feb-18	--	--	--	1	2	4	2	1	0	0	0	5

Work days per month 22

Hourly Emissions by Equipment

Phase	Description	Year	CO2 Emissions (pounds per hour) Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed	CH4 Emissions (pounds per hour) Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower WB	2015	377.84	430.55	287.24	0.00	0.00	0.00	0.00	1303.32	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03
1	EPBM Flower WB	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
2	EPBM Flower EB	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
2	EPBM Flower EB	2017	377.93	430.54	287.14	0.00	0.00	0.00	0.00	1303.26	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
3	Grouting on Flower	2014	0.00	0.00	0.00	0.00	2820.76	420.62	1400.03	1303.29	0.00	0.00	0.00	0.00	0.05	0.00	0.02	0.02
3	Grouting on Flower	2015	0.00	0.00	0.00	0.00	2762.11	420.57	1399.88	1303.32	0.00	0.00	0.00	0.00	0.06	0.01	0.02	0.03
4	Open Face/Shield on Flower	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
5	SEM on Flower	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
5	SEM on Flower	2017	377.93	430.54	287.14	0.00	0.00	0.00	0.00	1303.26	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
6	Cut & Cover Along Flower Street	2017	377.93	430.54	287.14	181.03	0.00	0.00	0.00	1303.26	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
2	Cut & Cover Along Flower Street	2015	377.84	430.55	287.24	0.00	0.00	0.00	0.00	1303.32	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03
2	Cut & Cover Along Flower Street	2016	377.83	430.54	287.18	0.00	0.00	0.00	0.00	1303.29	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04
2	Cut & Cover Along Flower Street	2017	377.93	430.54	287.14	0.00	0.00	0.00	0.00	1303.26	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.04

Daily Emissions

Phase	Description	Year	Emissions (pounds per day) CO2	CH4
1	EPBM Flower WB	2015	47,978.74	1.10
1	EPBM Flower WB	2016	47,977.00	1.37
2	EPBM Flower EB	2016	47,977.00	1.37
2	EPBM Flower EB	2017	47,977.47	1.63
3	Grouting on Flower	2014	118,893.76	1.87
3	Grouting on Flower	2015	117,717.56	2.33
4	Open Face/Shield on Flower	2016	47,977.00	1.37
5	SEM on Flower	2016	47,977.00	1.37
5	SEM on Flower	2017	47,977.47	1.63
6	Cut & Cover Along Flower Street	2017	51,598.13	1.71

Table 2-4: Hourly, Daily, Annual GHG Emissions Summary - Alternative 3

Annual Emissions by Phase - Alternative 3a (2nd/Hope Station (SEM))

Phase	Description	Year	Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/Yr
			CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower WB	2015	3,694.36	0.08	3,694.36	1.77	3,696.13	3,352.39
1	EPBM Flower WB	2016	1,583.24	0.05	1,583.24	0.95	1,584.19	1,436.86
2	EPBM Flower EB	2016	1,583.24	0.05	1,583.24	0.95	1,584.19	1,436.86
2	EPBM Flower EB	2017	2,638.76	0.09	2,638.76	1.88	2,640.64	2,395.06
3	Grouting on Flower	2014	2,615.66	0.04	2,615.66	0.86	2,616.53	2,373.19
3	Grouting on Flower	2015	14,243.82	0.28	14,243.82	5.93	14,249.75	12,924.52
4	Open Face/Shield on Flower	2016	4,749.72	0.14	4,749.72	2.84	4,752.57	4,310.58
5	SEM on Flower	2016	527.75	0.02	527.75	0.32	528.06	478.95
5	SEM on Flower	2017	6,333.03	0.22	6,333.03	4.52	6,337.55	5,748.15
6	Cut & Cover Along Flower Street	2017	567.58	0.02	567.58	0.39	567.97	515.15

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:

Construction equipment emission factors from OFFROAD2007

21 GWP of CH4:CO2

0.907 tons/MT

Annual GHG Emissions Summary

Year	Description	MTCO2e
2014	Grouting on Flower	2,373.19
	2014 Total, MTCO2e/Yr =	2,373.19
2015	EPBM Flower WB	3,352.39
	Grouting on Flower	12,924.52
	2015 Total, MTCO2e/Yr =	16,276.92
2016	EPBM Flower WB	1,436.86
	EPBM Flower EB	1,436.86
	Open Face/Shield on Flower	4,310.58
	SEM on Flower	478.95
	2016 Total, MTCO2e/Yr =	7,663.25
2017	EPBM Flower EB	2,395.06
	SEM on Flower	5,748.15
	Cut & Cover Along Flower Street	515.15
	2017 Total, MTCO2e/Yr =	8,658.37

Table 2-5: Hourly, Daily, Annual GHG Emissions Summary - Alternative 4

Alternative 4

Phase	Description	Hours per Day	Start Month	End Month	Duration (months) 2014	2015	2016	2017	Number of Equipment Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	20	Jun-15	Feb-17	--	7	12	2	2	4	2	0	0	0	0	5
2	Grouting on Flower	20	Feb-15	Oct-15	--	8	--	--	0	0	0	0	2	2	2	5
3	SEM on Flower	20	Apr-16	May-17	--	--	9	5	2	4	2	0	0	0	0	5
4	Cut & Cover Along Flower Street	20	May-17	Jul-17	--	--	--	2	2	4	2	1	0	0	0	5

Work days per month 22

Hourly Emissions by Equipment

Phase	Description	Year	CO2 Emissions (pounds per hour) Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed	CH4 Emissions (pounds per hour) Dozer	Excavator	Crane	Drill	Grout Drill	Grout Comp	Grout Gen	Flatbed
1	EPBM Flower	2015	377.837	430.546	287.238	0.000	0.000	0.000	0.000	1303.316	0.007	0.015	0.005	0.000	0.000	0.000	0.000	0.028
1	EPBM Flower	2016	377.834	430.544	287.184	0.000	0.000	0.000	0.000	1303.288	0.009	0.018	0.006	0.000	0.000	0.000	0.000	0.036
1	EPBM Flower	2017	377.933	430.544	287.140	0.000	0.000	0.000	0.000	1303.256	0.011	0.021	0.006	0.000	0.000	0.000	0.000	0.043
2	Grouting on Flower	2015	0.000	0.000	0.000	0.000	1381.056	210.286	699.939	1303.316	0.000	0.000	0.000	0.000	0.032	0.003	0.010	0.028
3	SEM on Flower	2016	377.834	430.544	287.184	0.000	0.000	0.000	0.000	1303.288	0.009	0.018	0.006	0.000	0.000	0.000	0.000	0.036
3	SEM on Flower	2017	377.933	430.544	287.140	0.000	0.000	0.000	0.000	1303.256	0.011	0.021	0.006	0.000	0.000	0.000	0.000	0.043
4	Cut & Cover Along Flower Street	2017	377.933	430.544	287.140	181.033	0.000	0.000	0.000	1303.256	0.011	0.021	0.006	0.004	0.000	0.000	0.000	0.043

Daily Emissions

Phase	Description	Year	Emissions (pounds per day) CO2	CH4
1	EPBM Flower	2015	47978.74	1.10
1	EPBM Flower	2016	47977.00	1.37
1	EPBM Flower	2017	47977.47	1.63
2	Grouting on Flower	2015	71891.94	1.45
3	SEM on Flower	2016	47977.00	1.37
3	SEM on Flower	2017	47977.47	1.63
4	Cut & Cover Along Flower Street	2017	51598.13	1.71

Annual Emissions - Alternative 4

Phase	Description	Year	Emissions (tons per year) CO2	CH4	CO2e Emissions (tons per year) CO2	CH4:CO2	CO2e	MTCO2e/Yr
1	EPBM Flower	2015	3694.36	0.08	3694.36	1.77	3696.13	3352.39
1	EPBM Flower	2016	6332.96	0.18	6332.96	3.79	6336.76	5747.44
1	EPBM Flower	2017	1055.50	0.04	1055.50	0.75	1056.26	958.03
2	Grouting on Flower	2015	6326.49	0.13	6326.49	2.67	6329.17	5740.55
3	SEM on Flower	2016	4749.72	0.14	4749.72	2.84	4752.57	4310.58
3	SEM on Flower	2017	2638.76	0.09	2638.76	1.88	2640.64	2395.06
4	Cut & Cover Along Flower Street	2017	1135.16	0.04	1135.16	0.79	1135.95	1030.30

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Source:

Construction equipment emission factors from OFFROAD2007

21 GWP of CH4:CO2

0.907 tons/MT

Table 2-5: Hourly, Daily, Annual GHG Emissions Summary - Alternative 4

Annual GHG Emissions Summary

Year	Description	MTCO2e
2014	No Activity	0.00
	2014 Total, MTCO2e/Yr =	0.00
2015	EPBM Flower	3,352.39
	Grouting on Flower	5,740.55
	2015 Total, MTCO2e/Yr =	9,092.95
2016	EPBM Flower	5,747.44
	SEM on Flower	4,310.58
	2016 Total, MTCO2e/Yr =	10,058.02
2017	EPBM Flower	958.03
	SEM on Flower	2,395.06
	Cut & Cover Along Flower Street	1,030.30
	2017 Total, MTCO2e/Yr =	4,383.39

Table 2-6: Daily and Annual GHG Emissions (Haul Trucks) - Locally Preferred Alternative

Locally Preferred Alternative/Baseline

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower	20	400	May-15	Nov-16	19	--	8	11	--
2	Cut & Cover Along Flower Street	20	400	Sep-14	Sep-17	37	4	12	12	9

Daily vehicle miles traveled (round-trip) 20 *(estimated value)* Default value from URBEMIS

Daily Emissions

Phase	Description	Year	Emissions (lb/day) CO2	CH4
1	EPBM Flower	2015	1,696.86	0.03
1	EPBM Flower	2016	1,696.86	0.03
2	Cut & Cover Along Flower Street	2014	1,696.86	0.03
2	Cut & Cover Along Flower Street	2015	1,696.86	0.03
2	Cut & Cover Along Flower Street	2016	1,696.86	0.03
2	Cut & Cover Along Flower Street	2017	1,696.86	0.02

Annual Emissions by Phase - Haul Trucks

Phase	Description	Year	Emissions (tons per year) CO2	CH4	CO2e Emissions (tons per year) CO2	CH4:CO2	CO2e	MTCO2e/Yr
1	EPBM Flower	2015	149.32	2.56E-03	149.32	0.05	149.38	135.48
1	EPBM Flower	2016	205.32	3.20E-03	205.32	0.07	205.39	186.29
2	Cut & Cover Along Flower Street	2014	74.66	1.44E-03	74.66	0.03	74.69	67.75
2	Cut & Cover Along Flower Street	2015	223.98	3.84E-03	223.98	0.08	224.07	203.23
2	Cut & Cover Along Flower Street	2016	223.98	3.49E-03	223.98	0.07	224.06	203.22
2	Cut & Cover Along Flower Street	2017	167.99	2.44E-03	167.99	0.05	168.04	152.41

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2

0.907 tons/MT

Annual GHG Emissions Summary - Haul Trucks

Year	Description	MTCO2e
2014	Cut & Cover Along Flower Street	67.75
	2014 Total, MTCO2e/Yr =	67.75
2015	EPBM Flower	135.48
	Cut & Cover Along Flower Street	203.23
	2015 Total, MTCO2e/Yr =	338.71
2016	EPBM Flower	186.29
	Cut & Cover Along Flower Street	203.22
	2016 Total, MTCO2e/Yr =	389.51
2017	Cut & Cover Along Flower Street	152.41
	2017 Total, MTCO2e/Yr =	152.41

Table 2-7: Daily and Annual GHG Emissions (Haul Trucks) - Alternative 1

Alternative 1

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower	20	400	May-15	Jan-17	21	--	8	12	1
2	Cut & Cover Along Flower Street	20	400	Sep-14	May-16	21	4	12	5	--

Daily vehicle miles traveled (round-trip) 20 *(estimated value)* Default value from URBEMIS

Daily Emissions

Phase	Description	Year	Emissions (lb/day) CO2	CH4
1	EPBM Flower	2015	1,696.86	0.03
1	EPBM Flower	2016	1,696.86	0.03
1	EPBM Flower	2017	1,696.86	0.02
2	Cut & Cover Along Flower Street	2014	1,696.86	0.03
2	Cut & Cover Along Flower Street	2015	1,696.86	0.03
2	Cut & Cover Along Flower Street	2016	1,696.86	0.03

Annual Emissions

			Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/Yr
Phase	Description	Year	CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower	2015	149.32	2.56E-03	149.32	0.05	149.38	135.48
1	EPBM Flower	2016	223.98	3.49E-03	223.98	0.07	224.06	203.22
1	EPBM Flower	2017	18.67	2.72E-04	18.67	0.01	18.67	16.93
2	Cut & Cover Along Flower Street	2014	74.66	1.44E-03	74.66	0.03	74.69	67.75
2	Cut & Cover Along Flower Street	2015	223.98	3.84E-03	223.98	0.08	224.07	203.23
2	Cut & Cover Along Flower Street	2016	93.33	1.46E-03	93.33	0.03	93.36	84.68

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2

0.907 tons/MT

Annual GHG Emissions Summary - Haul Trucks

Year	Description	MTCO2e
2014	Cut & Cover Along Flower Street	67.75
	2014 Total, MTCO2e/Yr =	67.75
2015	EPBM Flower	135.48
	Cut & Cover Along Flower Street	203.23
	2015 Total, MTCO2e/Yr =	338.71
2016	EPBM Flower	203.22
	Cut & Cover Along Flower Street	84.68
	2016 Total, MTCO2e/Yr =	287.90
2017	EPBM Flower	16.93
	2017 Total, MTCO2e/Yr =	16.93

Table 2-8: Daily and Annual GHG Emissions (Haul Trucks) - Alternative 2

Alternative 2

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower	20	400	May-15	Oct-15	6	--	6	--	--
2	Cut & Cover Along Flower Street	20	400	Sep-14	Dec-17	40	4	12	12	12

Daily vehicle miles traveled (round-trip) 20 *(estimated value)* Default value from URBEMIS

Daily Emissions

Phase	Description	Year	Emissions (lb/day) CO2	CH4
1	EPBM Flower	2015	1,696.86	0.03
2	Cut & Cover Along Flower Street	2014	1,696.86	0.03
2	Cut & Cover Along Flower Street	2015	1,696.86	0.03
2	Cut & Cover Along Flower Street	2016	1,696.86	0.03
2	Cut & Cover Along Flower Street	2017	1,696.86	0.02

Annual Emissions

Phase	Description	Year	Emissions (tons per year) CO2	CH4	CO2e Emissions (tons per year) CO2	CH4:CO2	CO2e	MTCO2e/Yr
1	EPBM Flower	2015	1.12E+02	1.92E-03	111.99	0.04	112.03	101.61
2	Cut & Cover Along Flower Street	2014	7.47E+01	1.44E-03	74.66	0.03	74.69	67.75
2	Cut & Cover Along Flower Street	2015	2.24E+02	3.84E-03	223.98	0.08	224.07	203.23
2	Cut & Cover Along Flower Street	2016	2.24E+02	3.49E-03	223.98	0.07	224.06	203.22
2	Cut & Cover Along Flower Street	2017	2.24E+02	3.26E-03	223.98	0.07	224.05	203.22

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2

0.907 tons/MT

Annual GHG Emissions Summary - Haul Trucks

Year	Description	MTCO2e
2014	Cut & Cover Along Flower Street	67.75
	2014 Total, MTCO2e/Yr =	67.75
2015	EPBM Flower	101.61
	Cut & Cover Along Flower Street	203.23
	2015 Total, MTCO2e/Yr =	304.84
2016	Cut & Cover Along Flower Street	203.22
	2016 Total, MTCO2e/Yr =	203.22
2017	Cut & Cover Along Flower Street	203.22
	2017 Total, MTCO2e/Yr =	203.22

Table 2-9: Daily and Annual GHG Emissions (Haul Trucks) - Alternative 3

Alternative 3

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower WB	20	400	Jun-15	Mar-16	10	--	7	3	--
2	EPBM Flower EB	20	400	Oct-16	May-17	8	--	--	3	5
3	Grouting on Flower	0	0	Nov-14	Nov-15	13	2	11	--	--
4	Open Face/Shield on Flower	20	400	Mar-16	Dec-16	10	--	--	10	--
5	SEM on Flower	20	400	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	20	400	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 20 *(estimated value)* Default value from URBEMIS

Daily Emissions

Phase	Description	Year	Emissions (lb/day) CO2	CH4
1	EPBM Flower WB	2015	1696.86	0.03
1	EPBM Flower WB	2016	1696.86	0.03
2	EPBM Flower EB	2016	1696.86	0.03
2	EPBM Flower EB	2017	1696.86	0.02
3	Grouting on Flower	2014	0.00	0.00
3	Grouting on Flower	2015	0.00	0.00
4	Open Face/Shield on Flower	2016	1696.86	0.03
5	SEM on Flower	2016	1696.86	0.03
5	SEM on Flower	2017	1696.86	0.02
6	Cut & Cover Along Flower Street	2017	1696.86	0.02

Annual Emissions

Phase	Description	Year	Emissions (tons per year) CO2	CH4	CO2e Emissions (tons per year) CO2	CH4:CO2	CO2e	MTCO2e/Yr
1	EPBM Flower WB	2015	130.66	2.24E-03	130.66	0.05	130.70	118.55
1	EPBM Flower WB	2016	56.00	8.73E-04	56.00	0.02	56.01	50.81
2	EPBM Flower EB	2016	56.00	8.73E-04	56.00	0.02	56.01	50.81
2	EPBM Flower EB	2017	93.33	1.36E-03	93.33	0.03	93.36	84.67
3	Grouting on Flower	2014	0.00	0.00E+00	0.00	0.00	0.00	0.00
3	Grouting on Flower	2015	0.00	0.00E+00	0.00	0.00	0.00	0.00
4	Open Face/Shield on Flower	2016	186.65	2.91E-03	186.65	0.06	186.72	169.35
5	SEM on Flower	2016	18.67	2.91E-04	18.67	0.01	18.67	16.94
5	SEM on Flower	2017	223.98	3.26E-03	223.98	0.07	224.05	203.22
6	Cut & Cover Along Flower Street	2017	18.67	2.72E-04	18.67	0.01	18.67	16.93

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2

0.907 tons/MT

Annual GHG Emissions Summary - Haul Trucks

Year	Description	MTCO2e
2014	Grouting on Flower	0.00
	2014 Total, MTCO2e/Yr =	0.00
2015	EPBM Flower WB	118.55
	Grouting on Flower	0.00
	2015 Total, MTCO2e/Yr =	118.55
2016	EPBM Flower WB	50.81
	EPBM Flower EB	50.81
	Open Face/Shield on Flower	169.35
	SEM on Flower	16.94
	2016 Total, MTCO2e/Yr =	287.90
2017	EPBM Flower EB	84.67
	SEM on Flower	203.22
	Cut & Cover Along Flower Street	16.93
	2017 Total, MTCO2e/Yr =	304.82

Table 2-10: Daily and Annual GHG Emissions (Haul Trucks) - Alternative 4

Alternative 4

Phase	Description	Truck Trips	Daily VMT	Start Month	End Month	Duration (months) Total	2014	2015	2016	2017
1	EPBM Flower	20	400	Jun-15	Feb-17	21	--	7	12	2
2	Grouting on Flower	0	0	Feb-15	Oct-15	9	--	9	--	--
3	SEM on Flower	20	400	Apr-16	May-17	14	--	--	9	5
4	Cut & Cover Along Flower Street	20	400	May-17	Jul-17	3	--	--	--	3
5	SEM on Flower	20	400	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	20	400	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 20 *(estimated value)* Default value from URBEMIS

Daily Emissions

Phase	Description	Year	Emissions (lb/day) CO2	CH4
1	EPBM Flower	2015	1696.86	0.03
1	EPBM Flower	2016	1696.86	0.03
1	EPBM Flower	2017	1696.86	0.02
2	Grouting on Flower	2015	0.00	0.00
3	SEM on Flower	2016	1696.86	0.03
3	SEM on Flower	2017	1696.86	0.02
4	Cut & Cover Along Flower Street	2017	1696.86	0.02
5	SEM on Flower	2016	1696.86	0.03
5	SEM on Flower	2017	1696.86	0.02
6	Cut & Cover Along Flower Street	2017	1696.86	0.02

Annual Emissions

Phase	Description	Year	Emissions (tons per year) CO2	CH4	CO2e Emissions (tons per year) CO2	CH4:CO2	CO2e	MTCO2e/Yr
1	EPBM Flower	2015	130.66	2.24E-03	130.66	0.05	130.70	118.55
1	EPBM Flower	2016	223.98	3.49E-03	223.98	0.07	224.06	203.22
1	EPBM Flower	2017	37.33	5.43E-04	37.33	0.01	37.34	33.87
2	Grouting on Flower	2015	0.00	0.00E+00	0.00	0.00	0.00	0.00
3	SEM on Flower	2016	167.99	2.62E-03	167.99	0.06	168.04	152.42
3	SEM on Flower	2017	93.33	1.36E-03	93.33	0.03	93.36	84.67
4	Cut & Cover Along Flower Street	2017	56.00	8.15E-04	56.00	0.02	56.01	50.80
5	SEM on Flower	2016	167.99	2.62E-03	167.99	0.06	168.04	152.42
5	SEM on Flower	2017	93.33	1.36E-03	93.33	0.03	93.36	84.67
6	Cut & Cover Along Flower Street	2017	56.00	8.15E-04	56.00	0.02	56.01	50.80

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2

0.907 tons/MT

Annual GHG Emissions Summary - Haul Trucks

Year	Description	MTCO2e
2014	No Activity	0.00
	2014 Total, MTCO2e/Yr =	0.00
2015	EPBM Flower	118.55
	Grouting on Flower	0.00
	2015 Total, MTCO2e/Yr =	118.55
2016	EPBM Flower	203.22
	SEM on Flower	152.42
	SEM on Flower	152.42
	2016 Total, MTCO2e/Yr =	508.05
2017	EPBM Flower	33.87
	SEM on Flower	84.67
	Cut & Cover Along Flower Street	50.80
	SEM on Flower	84.67
	Cut & Cover Along Flower Street	50.80
	2017 Total, MTCO2e/Yr	304.82

Table 2-11: Daily and Annual GHG Emissions Summary (Worker Commute) - Locally Preferred Alternative

Locally Preferred Alternative/Baseline

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower	20	600	May-15	Nov-16	19	--	8	11	--
2	Cut & Cover Along Flower Street	30	900	Sep-14	Sep-17	37	4	12	12	9

Daily vehicle miles traveled (round-trip) 30 *(estimated value)*

Daily Emissions

Phase	Description	Year	Emissions (lb/day) CO2	CH4
1	EPBM Flower	2015	509.81	0.02
1	EPBM Flower	2016	509.18	0.02
2	Cut & Cover Along Flower Street	2014	765.81	0.04
2	Cut & Cover Along Flower Street	2015	764.71	0.04
2	Cut & Cover Along Flower Street	2016	763.77	0.03
2	Cut & Cover Along Flower Street	2017	762.89	0.03

Annual Emissions

Phase	Description	Year	Emissions (tons per year) CO2	CH4	CO2e Emissions (tons per year) CO2	CH4:CO2	CO2e	MTCO2e/Yr
1	EPBM Flower	2015	4.49E+01	2.10E-03	44.86	0.04	44.91	40.73
1	EPBM Flower	2016	6.16E+01	2.64E-03	61.61	0.06	61.67	55.93
2	Cut & Cover Along Flower Street	2014	3.37E+01	1.75E-03	33.70	0.04	33.73	30.60
2	Cut & Cover Along Flower Street	2015	1.01E+02	4.71E-03	100.94	0.10	101.04	91.64
2	Cut & Cover Along Flower Street	2016	1.01E+02	4.32E-03	100.82	0.09	100.91	91.52
2	Cut & Cover Along Flower Street	2017	7.55E+01	3.04E-03	75.53	0.06	75.59	68.56

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2

0.907 tons/MT

Annual GHG Emissions Summary - Worker Commute

Year	Description	MTCO2e
2014	Cut & Cover Along Flower Street	30.60
	2014 Total, MTCO2e/Yr =	30.60
2015	EPBM Flower	40.73
	Cut & Cover Along Flower Street	91.64
	2015 Total, MTCO2e/Yr =	132.37
2016	EPBM Flower	55.93
	Cut & Cover Along Flower Street	91.52
	2016 Total, MTCO2e/Yr =	147.46
2017	Cut & Cover Along Flower Street	68.56
	2017 Total, MTCO2e/Yr =	68.56

Table 2-12: Daily and Annual GHG Emissions Summary (Worker Commute) - Alternative 1

Alternative 1

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower	20	600	May-15	Jan-17	21	--	8	12	1
2	Cut & Cover Along Flower Street	30	900	Sep-14	May-16	21	4	12	5	--

Daily vehicle miles traveled (round-trip) 30 *(estimated value)*

Daily Emissions

Phase	Description	Year	Emissions (lb/day) CO2	CH4
1	EPBM Flower	2015	509.81	0.02
1	EPBM Flower	2016	509.18	0.02
1	EPBM Flower	2017	508.59	0.02
2	Cut & Cover Along Flower Street	2014	765.81	0.04
2	Cut & Cover Along Flower Street	2015	764.71	0.04
2	Cut & Cover Along Flower Street	2016	763.77	0.03

Annual Emissions

Phase	Description	Year	Emissions (tons per year) CO2	CH4	CO2e Emissions (tons per year) CO2	CH4:CO2	CO2e	MTCO2e/Yr
1	EPBM Flower	2015	44.86	0.00	44.86	0.04	44.91	40.73
1	EPBM Flower	2016	67.21	0.00	67.21	0.06	67.27	61.02
1	EPBM Flower	2017	5.59	0.00	5.59	0.00	5.60	5.08
2	Cut & Cover Along Flower Street	2014	33.70	0.00	33.70	0.04	33.73	30.60
2	Cut & Cover Along Flower Street	2015	100.94	0.00	100.94	0.10	101.04	91.64
2	Cut & Cover Along Flower Street	2016	42.01	0.00	42.01	0.04	42.05	38.14

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2

0.907 tons/MT

Annual GHG Emissions Summary - Worker Commute

Year	Description	MTCO2e
2014	Cut & Cover Along Flower Street	30.60
	2014 Total, MTCO2e/Yr =	30.60
2015	EPBM Flower	40.73
	Cut & Cover Along Flower Street	91.64
	2015 Total, MTCO2e/Yr =	132.37
2016	EPBM Flower	61.02
	Cut & Cover Along Flower Street	38.14
	2016 Total, MTCO2e/Yr =	99.15
2017	EPBM Flower	5.08
	2017 Total, MTCO2e/Yr =	5.08

Table 2-13: Daily and Annual GHG Emissions Summary (Worker Commute) - Alternative 2

Alternative 2

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower	20	600	May-15	Oct-15	6	--	6	--	--
2	Cut & Cover Along Flower Street	30	900	Sep-14	Dec-17	40	4	12	12	12

Daily vehicle miles traveled (round-trip) 30 *(estimated value)*

Daily Emissions

Phase	Description	Year	Emissions (lb/day) CO2	CH4
1	EPBM Flower	2015	509.81	0.02
2	Cut & Cover Along Flower Street	2014	765.81	0.04
2	Cut & Cover Along Flower Street	2015	764.71	0.04
2	Cut & Cover Along Flower Street	2016	763.77	0.03
2	Cut & Cover Along Flower Street	2017	762.89	0.03

Annual Emissions

			Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/ Yr
Phase	Description	Year	CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower	2015	33.65	0.00	33.65	0.03	33.68	30.55
2	Cut & Cover Along Flower Street	2014	33.70	0.00	33.70	0.04	33.73	30.60
2	Cut & Cover Along Flower Street	2015	100.94	0.00	100.94	0.10	101.04	91.64
2	Cut & Cover Along Flower Street	2016	100.82	0.00	100.82	0.09	100.91	91.52
2	Cut & Cover Along Flower Street	2017	100.70	0.00	100.70	0.09	100.79	91.41

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2

0.907 tons/MT

Annual GHG Emissions Summary - Worker Commute

Year	Description	MTCO2e
2014	Cut & Cover Along Flower Street	30.60
	2014 Total, MTCO2e/Yr =	30.60
2015	EPBM Flower	30.55
	Cut & Cover Along Flower Street	91.64
	2015 Total, MTCO2e/Yr =	122.19
2016	Cut & Cover Along Flower Street	91.52
	2016 Total, MTCO2e/Yr =	91.52
2017	Cut & Cover Along Flower Street	91.41
	2017 Total, MTCO2e/Yr =	91.41

Table 2-14: Daily and Annual GHG Emissions Summary (Worker Commute) - Alternative 3

Alternative 3

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Total	Duration (months) 2014	2015	2016	2017
1	EPBM Flower WB	20	600	Jun-15	Mar-16	10	--	7	3	--
2	EPBM Flower EB	20	600	Oct-16	May-17	8	--	--	3	5
3	Grouting on Flower	40	1,200	Nov-14	Nov-15	13	2	11	--	--
4	Open Face/Shield on Flower	20	600	Mar-16	Dec-16	10	--	--	10	--
5	SEM on Flower	20	600	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	30	900	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 30 *(estimated value)*

Daily Emissions

Phase	Description	Year	Emissions (lb/day) CO2	CH4
1	EPBM Flower WB	2015	509.81	0.02
1	EPBM Flower WB	2016	509.18	0.02
2	EPBM Flower EB	2016	509.18	0.02
2	EPBM Flower EB	2017	508.59	0.02
3	Grouting on Flower	2014	1021.08	0.05
3	Grouting on Flower	2015	1019.61	0.05
4	Open Face/Shield on Flower	2016	509.18	0.02
5	SEM on Flower	2016	509.18	0.02
5	SEM on Flower	2017	508.59	0.02
6	Cut & Cover Along Flower Street	2017	762.89	0.03

Annual Emissions

Phase	Description	Year	Emissions (tons per year) CO2	CH4	CO2e Emissions (tons per year) CO2	CH4:CO2	CO2e	MTCO2e/Yr
1	EPBM Flower WB	2015	3.93E+01	1.83E-03	3.93E+01	3.85E-02	3.93E+01	3.56E+01
1	EPBM Flower WB	2016	1.68E+01	7.20E-04	1.68E+01	1.51E-02	1.68E+01	1.53E+01
2	EPBM Flower EB	2016	1.68E+01	7.20E-04	1.68E+01	1.51E-02	1.68E+01	1.53E+01
2	EPBM Flower EB	2017	2.80E+01	1.13E-03	2.80E+01	2.37E-02	2.80E+01	2.54E+01
3	Grouting on Flower	2014	2.25E+01	1.16E-03	2.25E+01	2.44E-02	2.25E+01	2.04E+01
3	Grouting on Flower	2015	1.23E+02	5.76E-03	1.23E+02	1.21E-01	1.23E+02	1.12E+02
4	Open Face/Shield on Flower	2016	5.60E+01	2.40E-03	5.60E+01	5.04E-02	5.61E+01	5.08E+01
5	SEM on Flower	2016	5.60E+00	2.40E-04	5.60E+00	5.04E-03	5.61E+00	5.08E+00
5	SEM on Flower	2017	6.71E+01	2.71E-03	6.71E+01	5.68E-02	6.72E+01	6.09E+01
6	Cut & Cover Along Flower Street	2017	8.39E+00	3.38E-04	8.39E+00	7.10E-03	8.40E+00	7.62E+00

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2

0.907 tons/MT

Annual GHG Emissions Summary - Worker Commute

Year	Description	MTCO2e
2014	Grouting on Flower	20.40
	2014 Total, MTCO2e/Yr =	20.40
2015	EPBM Flower WB	35.64
	Grouting on Flower	112.01
	2015 Total, MTCO2e/Yr =	147.65
2016	EPBM Flower WB	15.25
	EPBM Flower EB	15.25
	Open Face/Shield on Flower	50.85
	SEM on Flower	5.08
	2016 Total, MTCO2e/Yr =	86.44
2017	EPBM Flower EB	25.39
	SEM on Flower	60.94
	Cut & Cover Along Flower Street	7.62
	2017 Total, MTCO2e/Yr =	93.95

Table 2-15: Daily and Annual GHG Emissions Summary (Worker Commute) - Alternative 4

Alternative 4

Phase	Description	No. of Crew	Daily VMT	Start Month	End Month	Duration (months) Total	2014	2015	2016	2017
1	EPBM Flower	20	600	Jun-15	Feb-17	21	--	7	12	2
2	Grouting on Flower	20	600	Feb-15	Oct-15	9	--	9	--	--
3	SEM on Flower	20	600	Apr-16	May-17	14	--	--	9	5
4	Cut & Cover Along Flower Street	30	900	May-17	Jul-17	3	--	--	--	3
5	SEM on Flower	20	600	Dec-16	Dec-17	13	--	--	1	12
6	Cut & Cover Along Flower Street	20	600	Dec-17	Feb-18	3	--	--	--	1

Daily vehicle miles traveled (round-trip) 30 *(estimated value)*

Daily Emissions

Phase	Description	Year	Emissions (lb/day) CO2	CH4
1	EPBM Flower	2015	509.81	0.02
1	EPBM Flower	2016	509.18	0.02
1	EPBM Flower	2017	508.59	0.02
2	Grouting on Flower	2015	509.81	0.02
3	SEM on Flower	2016	509.18	0.02
3	SEM on Flower	2017	508.59	0.02
4	Cut & Cover Along Flower Street	2017	762.89	0.03
5	SEM on Flower	2016	2545.28	0.04
5	SEM on Flower	2017	2545.28	0.04
6	Cut & Cover Along Flower Street	2017	2545.28	0.04

Annual Emissions

Phase	Description	Year	Emissions (tons per year)		CO2e Emissions (tons per year)			MTCO2e/ Yr
			CO2	CH4	CO2	CH4:CO2	CO2e	
1	EPBM Flower	2015	39.26	0.00	39.26	0.04	39.29	35.64
1	EPBM Flower	2016	67.21	0.00	67.21	0.06	67.27	61.02
1	EPBM Flower	2017	11.19	0.00	11.19	0.01	11.20	10.16
2	Grouting on Flower	2015	50.47	0.00	50.47	0.05	50.52	45.82
3	SEM on Flower	2016	50.41	0.00	50.41	0.05	50.45	45.76
3	SEM on Flower	2017	27.97	0.00	27.97	0.02	28.00	25.39
4	Cut & Cover Along Flower Street	2017	25.18	0.00	25.18	0.02	25.20	22.85
5	SEM on Flower	2016	251.98	0.00	251.98	0.08	252.07	228.62
5	SEM on Flower	2017	139.99	0.00	139.99	0.04	140.03	127.01
6	Cut & Cover Along Flower Street	2017	83.99	0.00	83.99	0.03	84.02	76.21

Note: Construction assumed to occur 22 days per month (i.e., 5 days per week).

Comments:

INDEX formula used to look-up emission factor from "EMFAC_Construction.xlsx" spreadsheet.

MATCH formula used to identify row number and column number for each year-pollutant combination.

21 GWP of CH4:CO2

0.907 tons/MT

Annual GHG Emissions Summary - Worker Commute

Year	Description	MTCO2e
2014	No Activity	0.00
	2014 Total, MTCO2e/Yr =	0.00
2015	EPBM Flower	35.64
	Grouting on Flower	45.82
	2015 Total, MTCO2e/Yr =	81.46
2016	EPBM Flower	61.02
	SEM on Flower	45.76
	SEM on Flower	228.62
	2016 Total, MTCO2e/Yr =	335.40
2017	EPBM Flower	10.16
	SEM on Flower	25.39
	Cut & Cover Along Flower Street	22.85
	SEM on Flower	127.01
	Cut & Cover Along Flower Street	76.21
	2017 Total, MTCO2e/Yr =	261.62

APPENDIX E

ENERGY RESOURCES

Regional Connector - Supplemental Environmental Impact Study (SEIS)

Supporting Energy Calculations

Prepared May 2014

Regional Connector SEIS - Construction Energy Impacts (Indirect)									
Construction Description	Construction Cost, Engineer's Estimate (2013$)			Conversion Factors		Construction Energy Factor	Construction Energy Consumption		
	Construction Cost Summary ($)[1] (thousands)			Dollar-to-Energy Factor[2]	2013 Price Escalation[3]		Units		
	Direct	Indirect*	Total	(Btu/1973$)	1973$/2013$	Btu/2013$	Btu	MMBtu	Billion Btu
Baseline/LPA									
Earth Pressure Balance Tunnel Boring Machine (EPBM) Bored Tunnels, Cut-and-Cover	$63,162	$21,475	$84,637	24,600	0.204	5,017	316,869,876	316,870	317
Alternative 1									
EPBM Bored Tunnels on Low Alignment, Cut-and-Cover	$45,798	$15,571	$61,369	24,600	0.204	5,017	229,758,802	229,759	230
Alternative 2									
EPBM bored tunnels on LPA alignment; Cut-and-Cover	$65,657	$22,324	$87,981	24,600	0.204	5,017	329,389,588	329,390	329
Alternative 3									
EPBM Bored Tunnels on LPA Alignment; Open Face Shield Tunnel Excavation; Sequential Excavation Method (SEM) Tunnel Construction; and Mucking	$64,359	$50,502	$114,861	24,600	0.204	5,017	322,875,529	322,876	323
Alternative 4									
EPBM Bored Tunnels on Deep Alignment; Remove EPBMs through Tunnel Portal, SEM Tunnel Construction; and Mucking	$58,726	$39,047	$97,773	24,600	0.204	5,017	294,618,122	294,618	295

Notes

* = Indirect costs include contractor mark-up fees and project schedule delay costs and are not included in the energy consumption analysis.

Methodology:

Construction Energy Consumption

Input/Output Approach for Urban Conventional Highway Construction (CalTrans' Energy and Transportation Systems, July 1983)

Construction Energy Formula

E = C x EF x DC

E = Energy consumed (Btu)

C = Cost of a particular construction activity (2007$)

DEF = Dollar-to-Energy Factor for Urban Freeway Widen (Btu/1973$)

DC = Dollar Conversion (1973$/2013$)

Conversation Factors

2013 Price Escalation

1973$/2013$ = 19.8/97.09 = 0.203934494

References and Source:

[1] Construction Cost Estimate obtained from Metro, dated 4/12/13

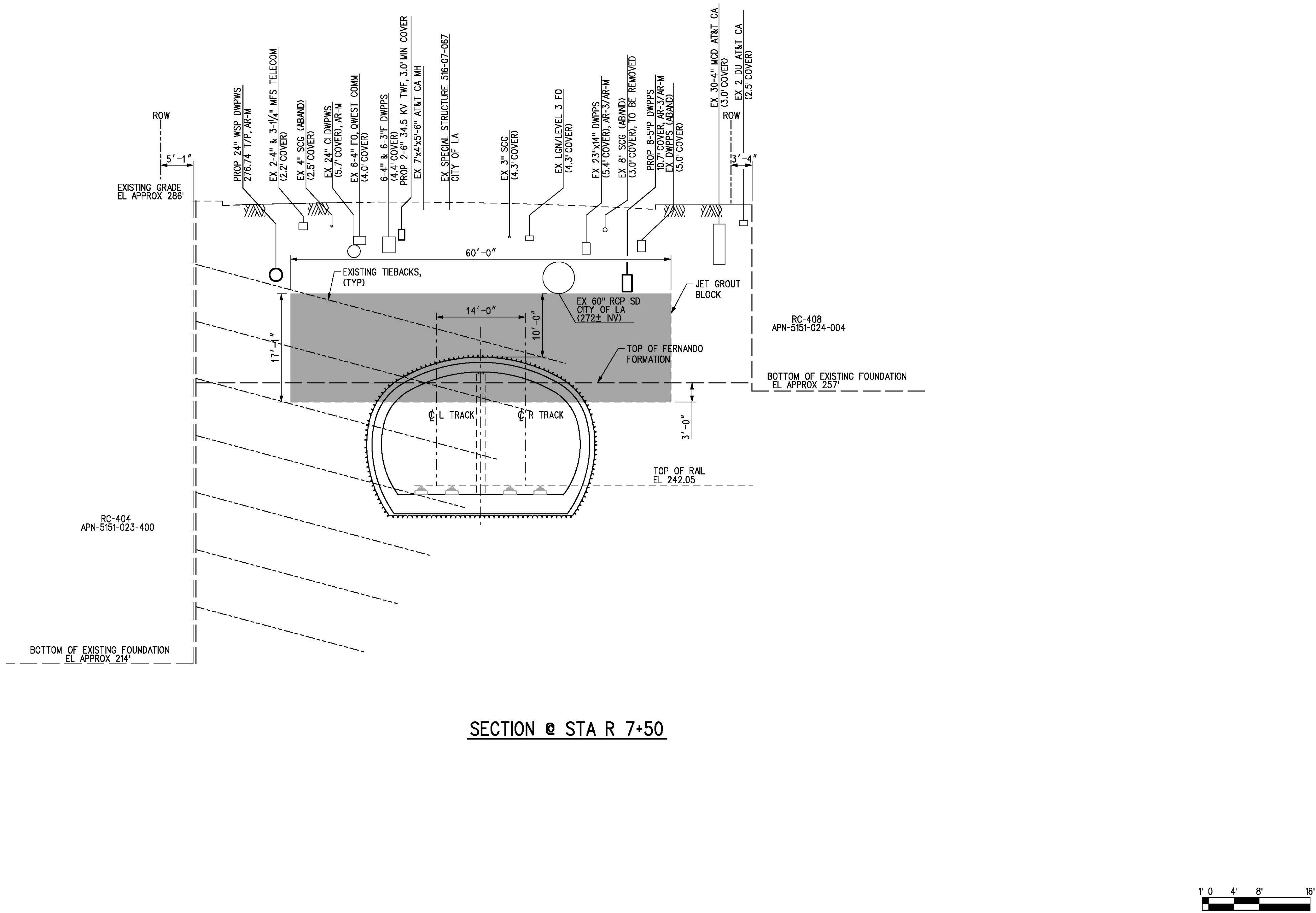
[2] Caltrans Construction Activity, Energy and Transportation Systems, 1983, State of California Department of Transportation

[3] Price Index for Selected Construction Items, Caltrans. Obtained from http://www.dot.ca.gov/hq/esc/oe/cost_index/historical_reports/CCI_4QTR_2013.pdf. Accessed May 23, 2014.

APPENDIX F

ENGINEERING DRAWINGS

Alternative A



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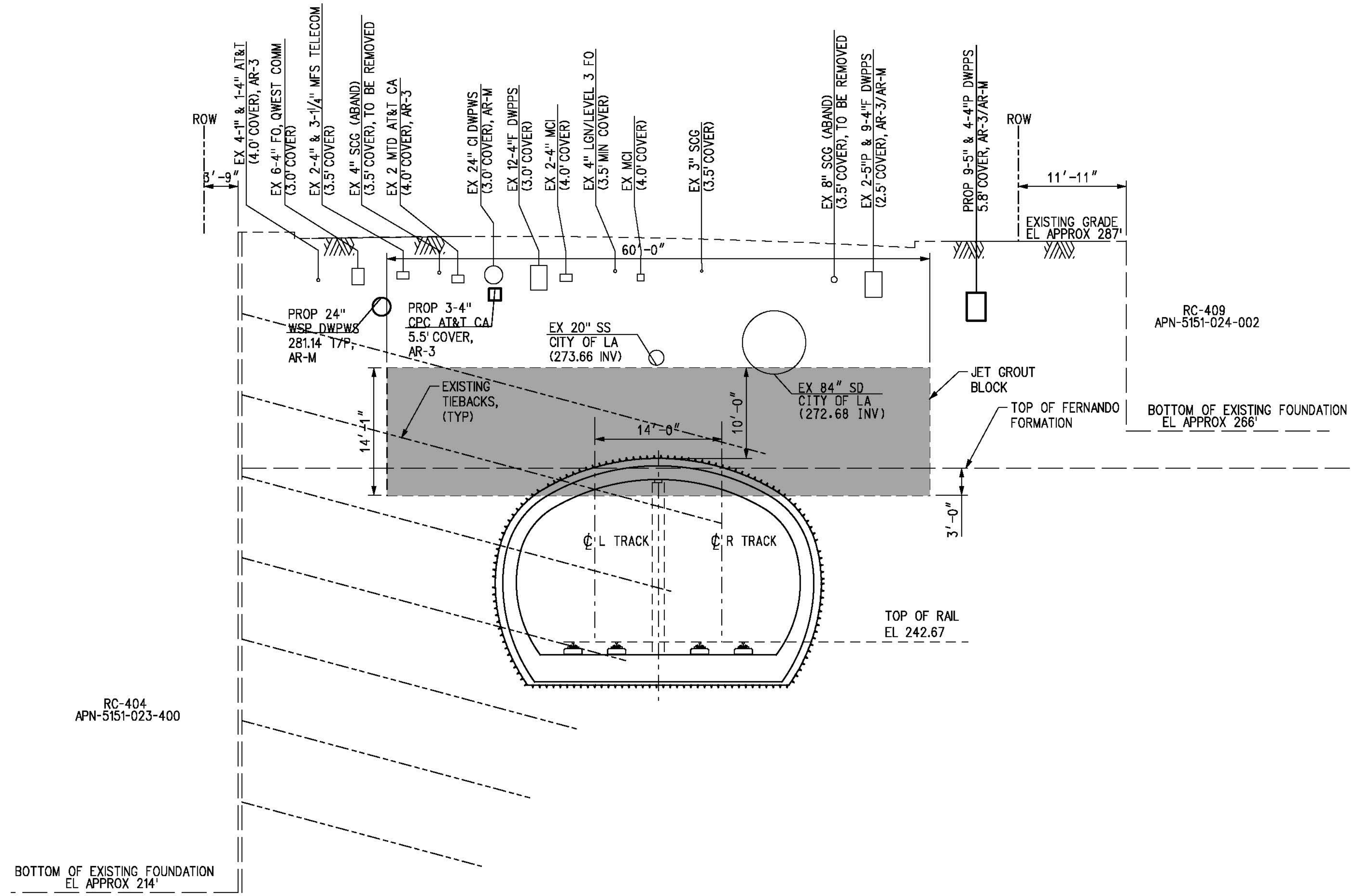

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SECTION AT STATION 9+05

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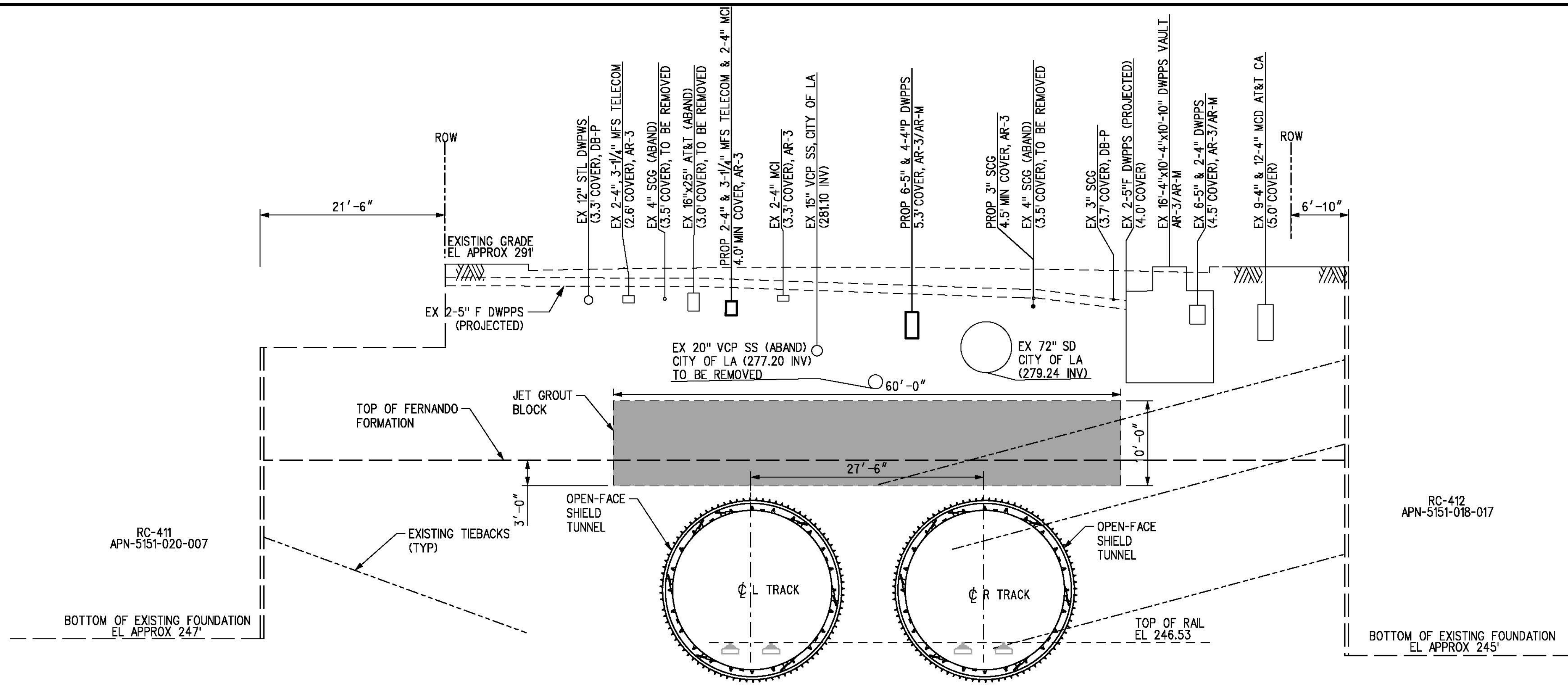

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RE EVALUATION
OPTION 4
SECTION AT STATION 14+96

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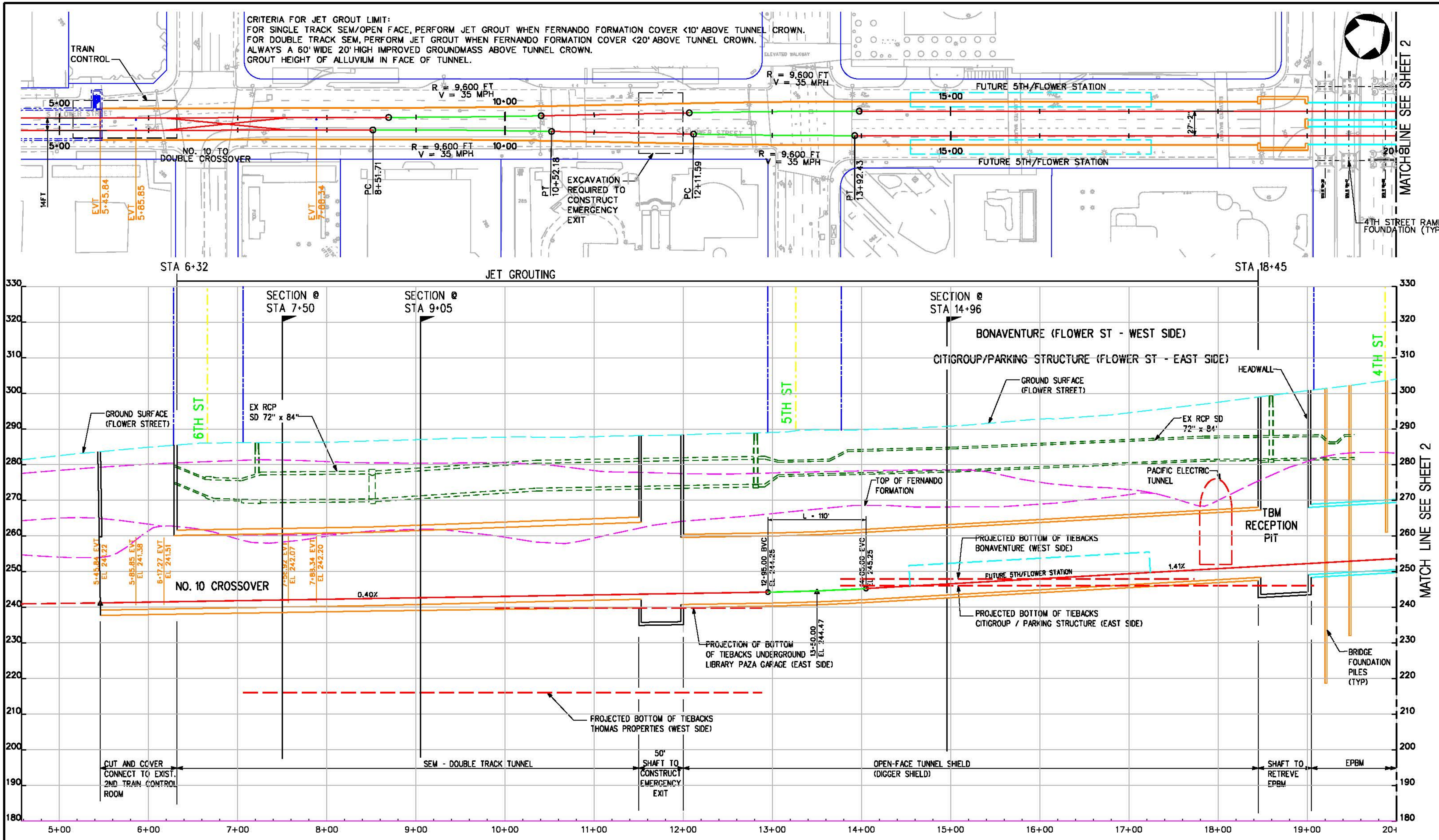

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

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REGIONAL CONNECTOR TRANSIT CORRIDOR
FLOWER STREET RE EVALUATION OPTION 4 OPEN FACE TBM/SEM ALTERNATIVE

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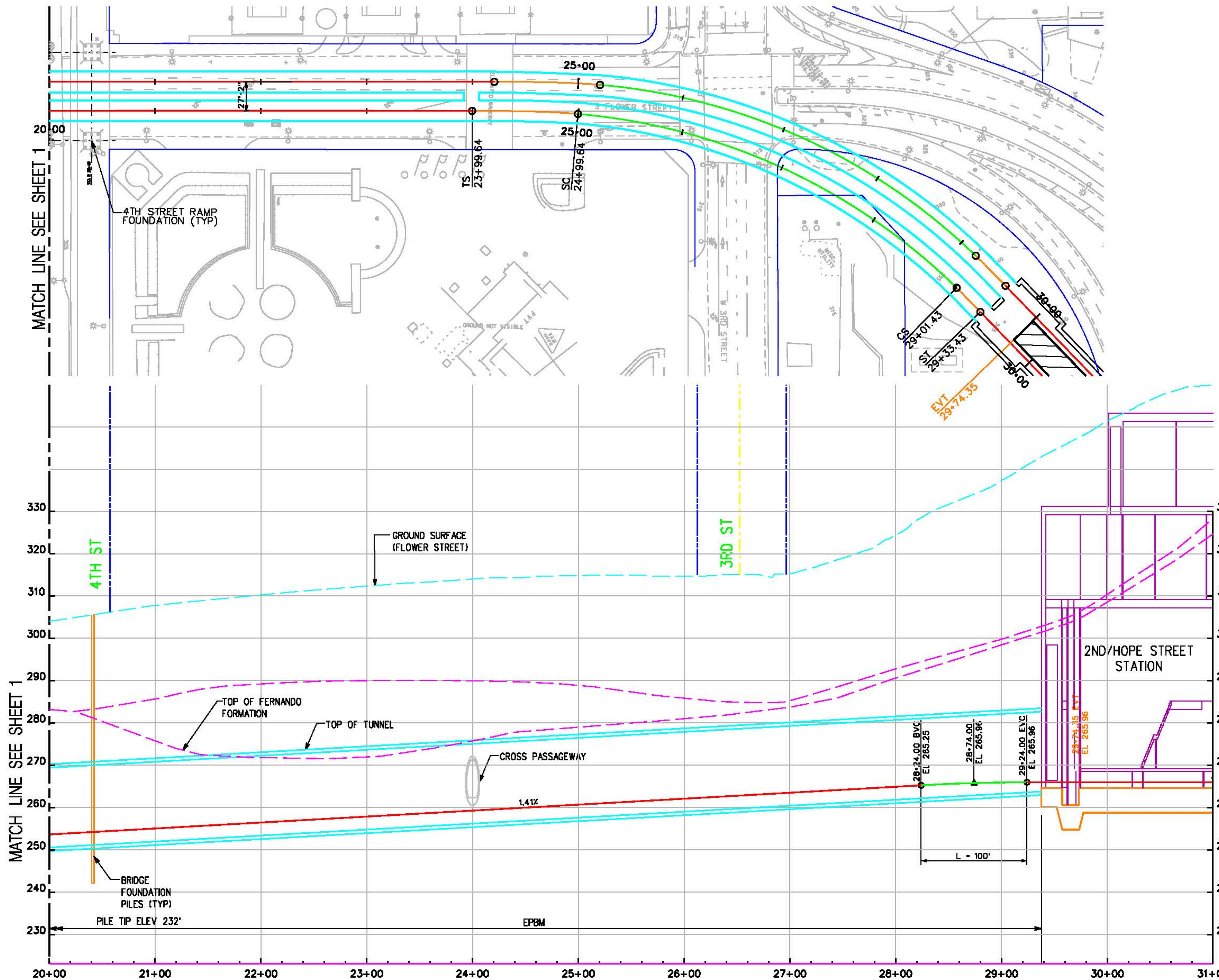

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REGIONAL CONNECTOR TRANSIT CORRIDOR
FLOWER STREET
RE EVALUATION
OPTION 4
OPEN FACE TBM/SEM ALTERNATIVE

CONTRACT NO
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REV
SCALE
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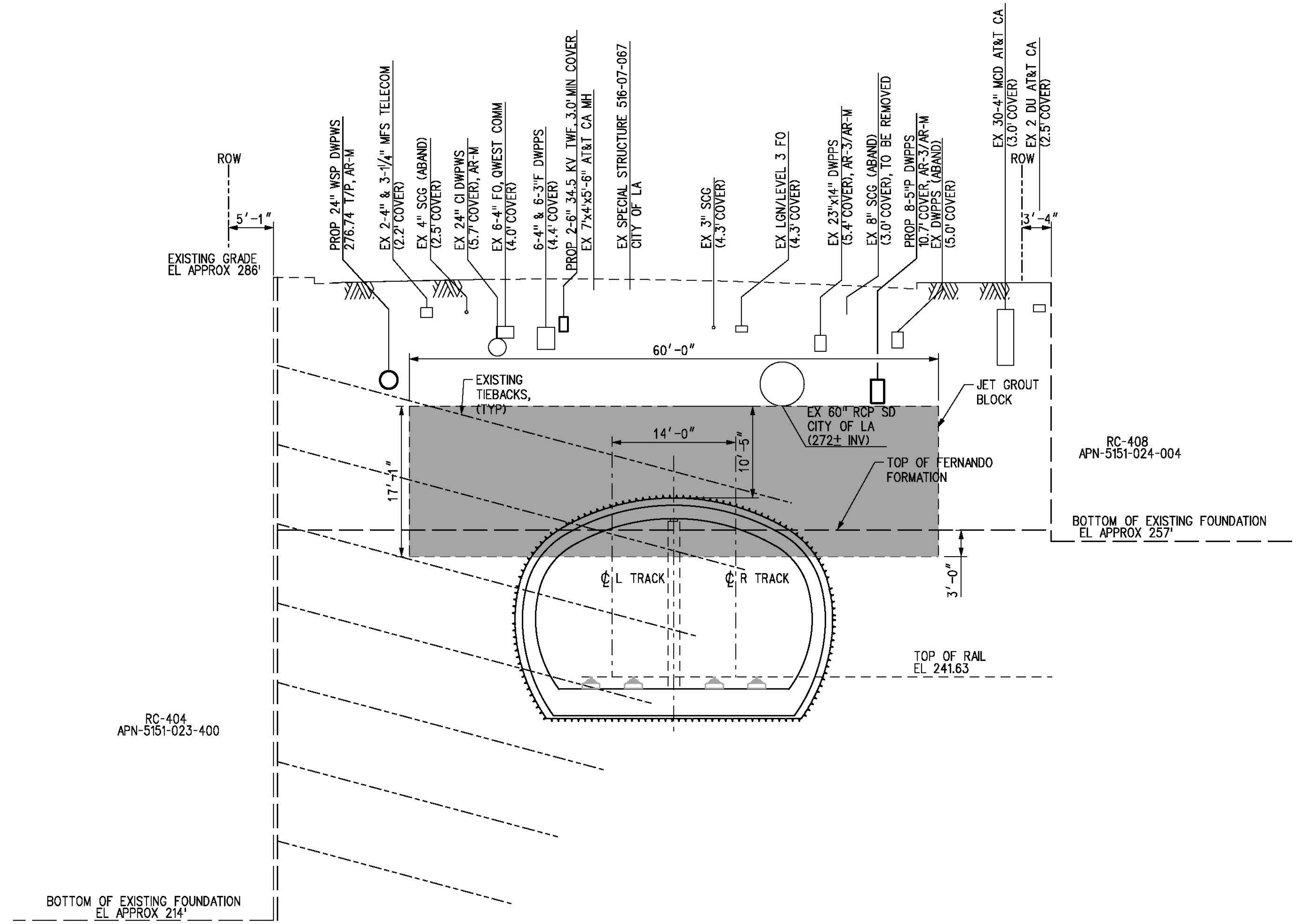

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FLOWER STREET
RE EVALUATION
OPTION 5
SECTION AT STATION 7+50

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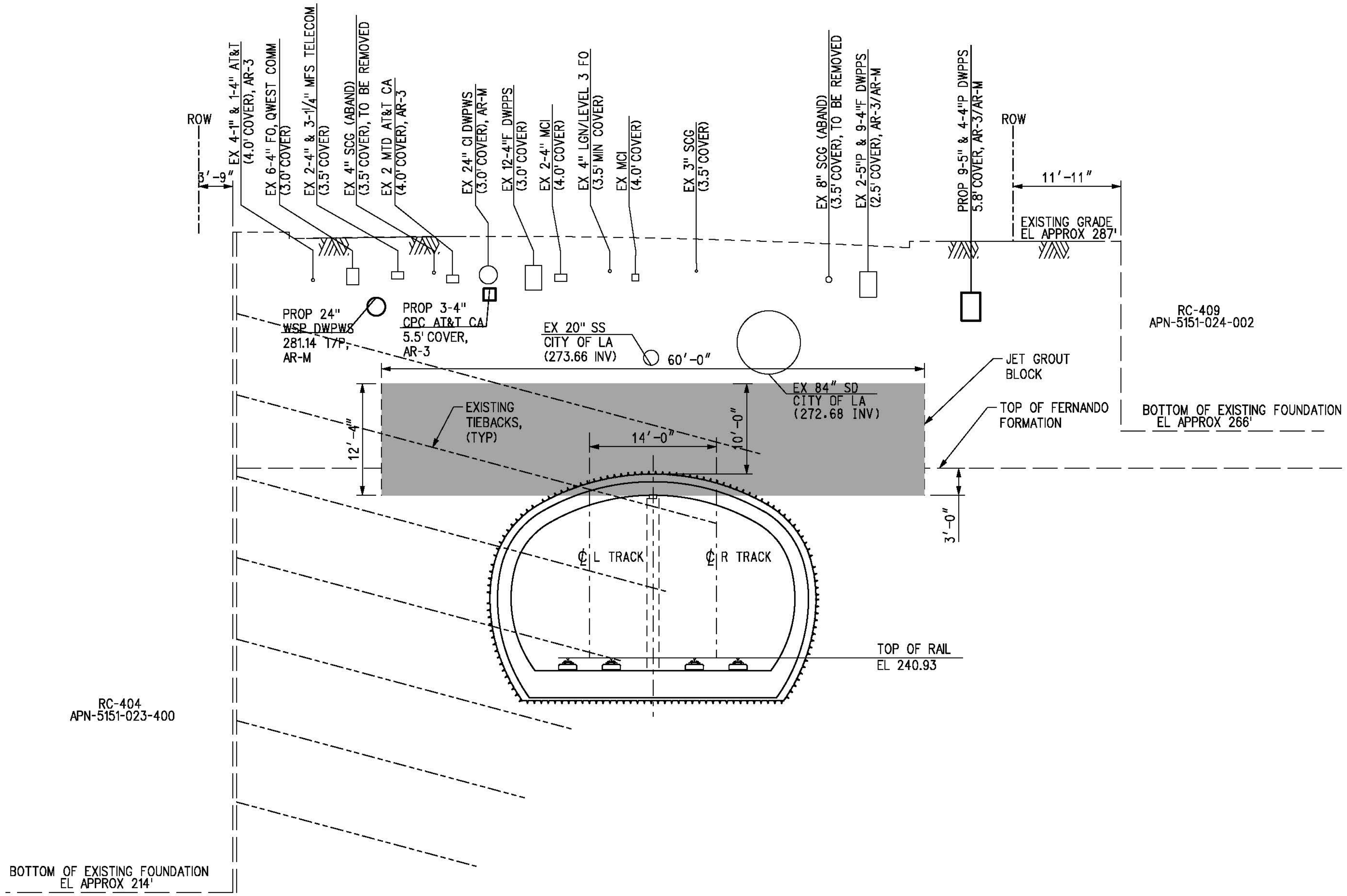

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FLOWER STREET
RE EVALUATION
OPTION 5
SECTION AT STATION 9+05

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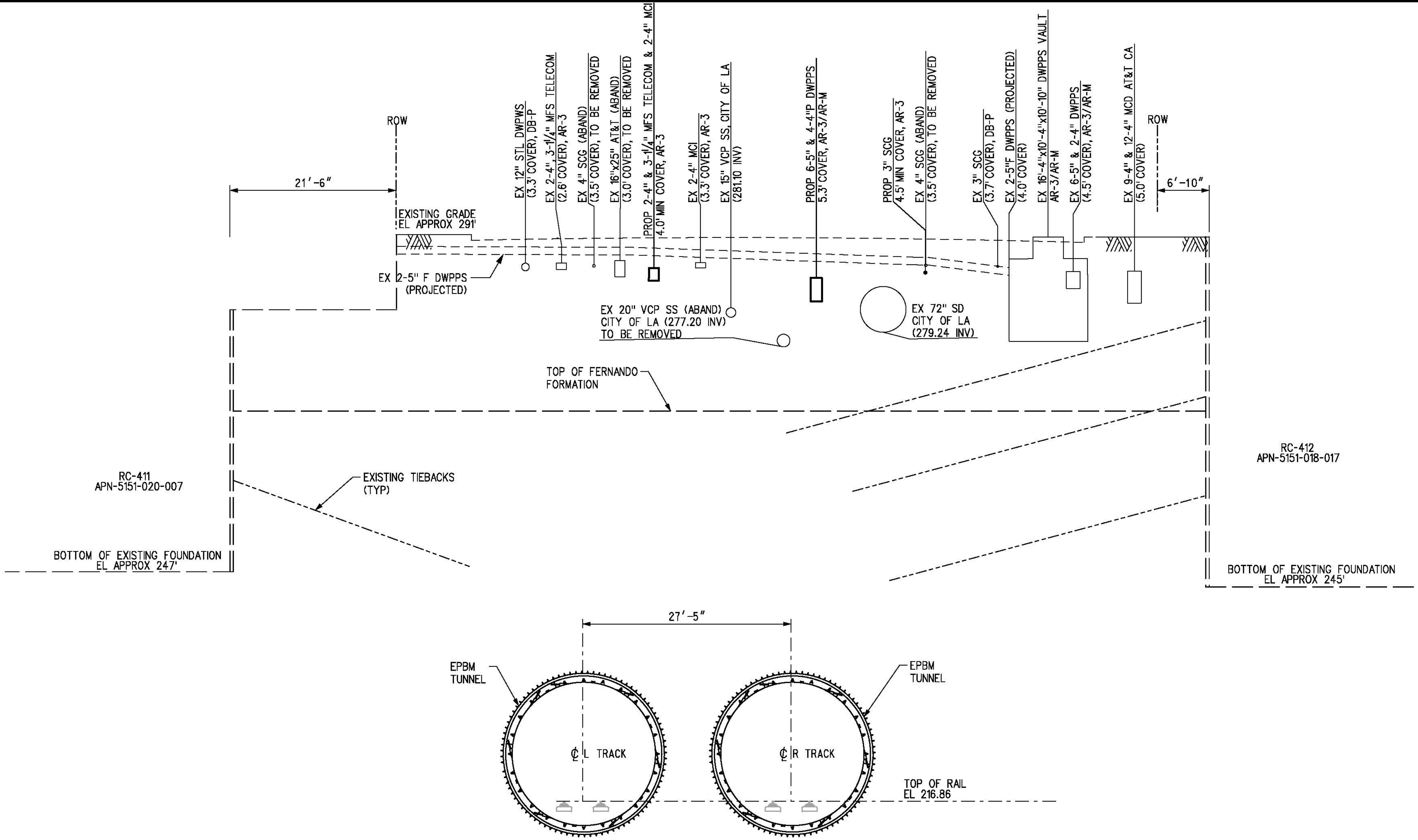

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FLOWER STREET
RE EVALUATION
OPTION 5
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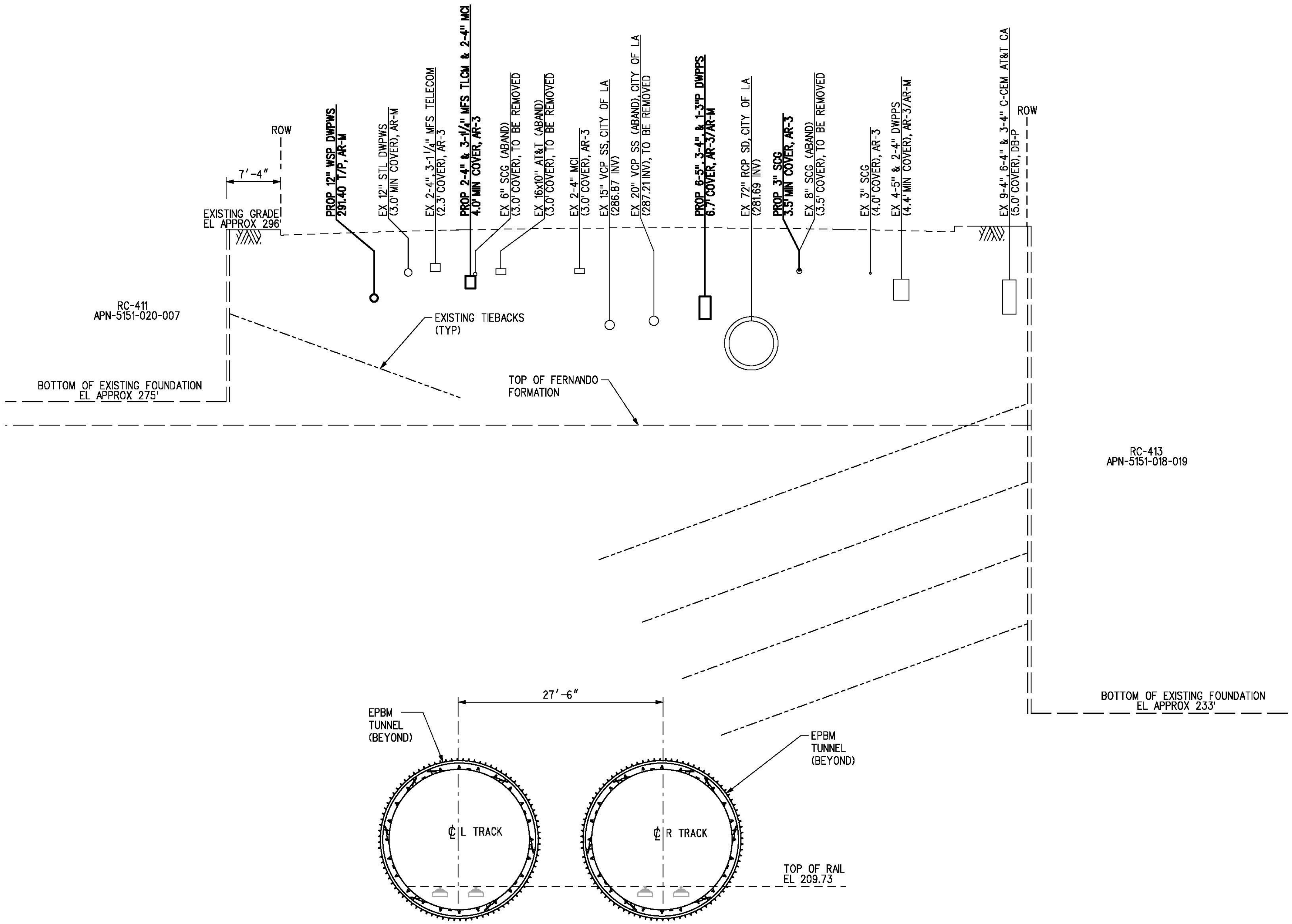

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REGIONAL CONNECTOR TRANSIT CORRIDOR
FLOWER STREET
RE EVALUATION
OPTION 5
SECTION AT STA 17+00

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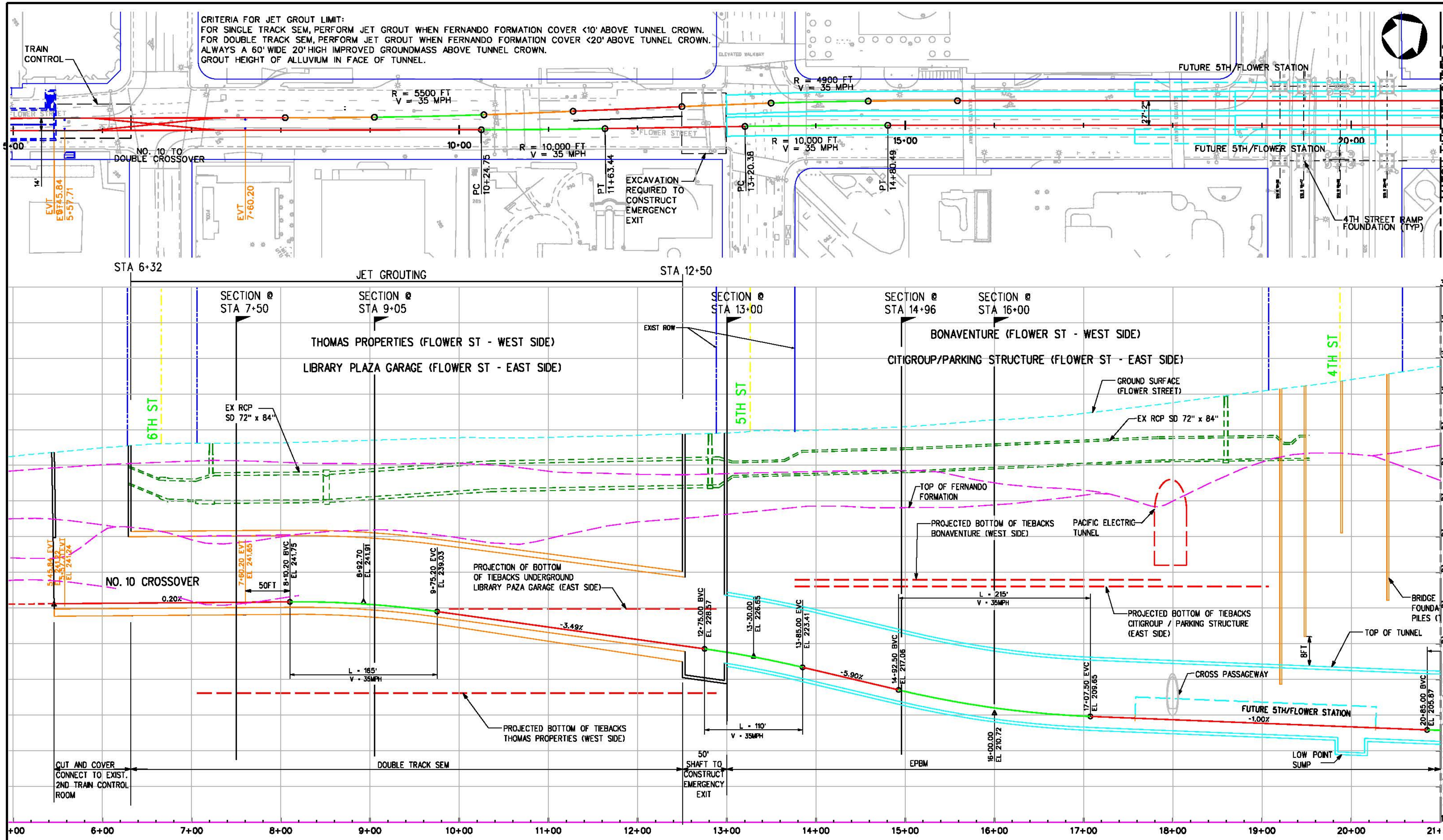

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REGIONAL CONNECTOR TRANSIT CORRIDOR
FLOWER STREET
RE EVALUATION
OPTION 5
SEM LOW ALIGNMENT ALTERNATIVE

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DRAWING NO
REV
SCALE
SHEET NO 1 OF 2

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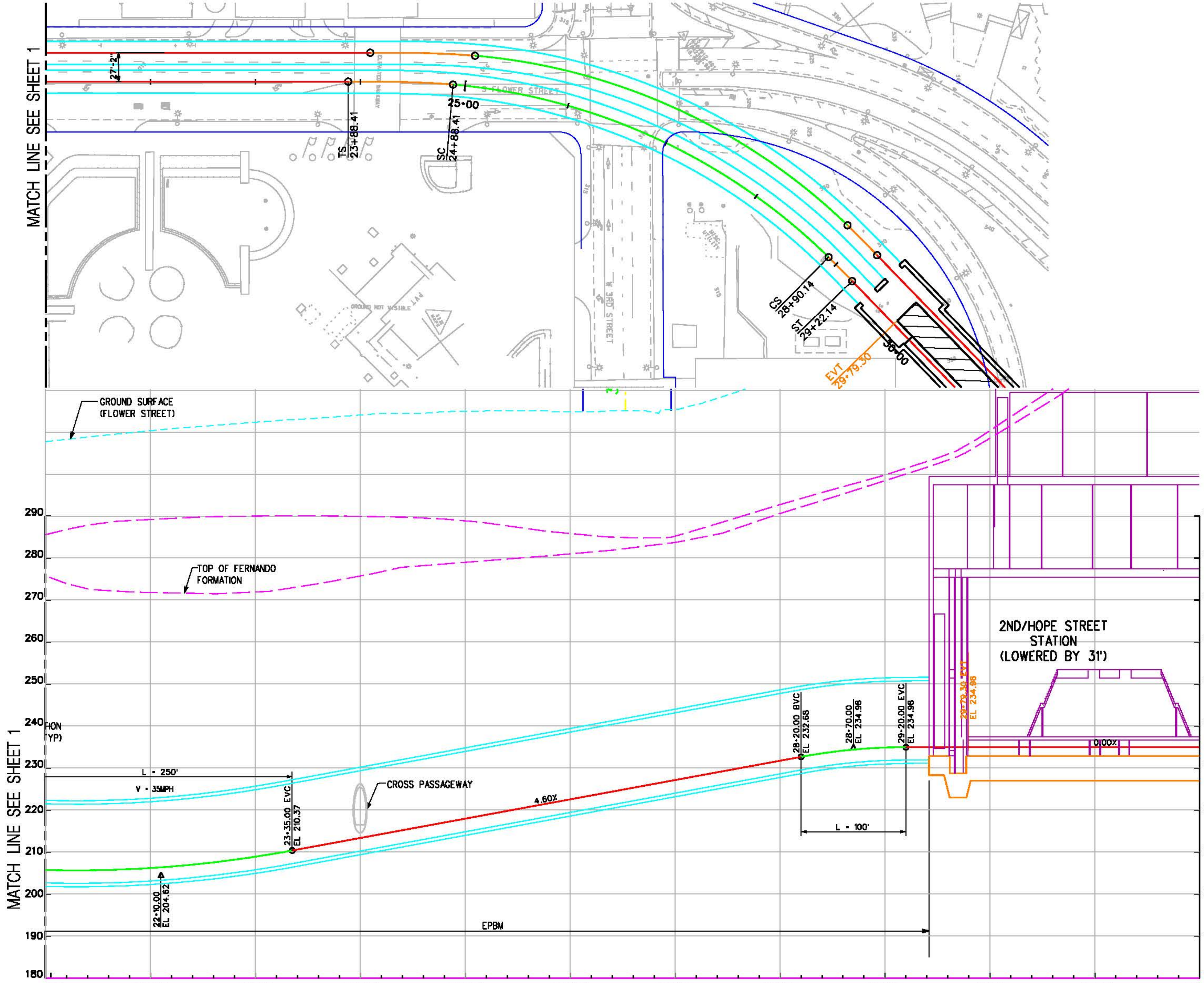

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F 213-312-3114

REGIONAL CONNECTOR TRANSIT CORRIDOR
FLOWER STREET
RE EVALUATION
OPTION 5
SEM LOW ALIGNMENT ALTERNATIVE

CONTRACT NO

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REV

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APPENDIX G

MITIGATION MEASURES

MITIGATION MONITORING AND REPORTING PROGRAM FOR THE LOCALLY PREFERRED ALTERNATIVE

REGIONAL CONNECTOR TRANSIT CORRIDOR PROJECT

All mitigation measure herein shall be implemented and monitored by Metro. A mitigation measure field report (see attached form) for each mitigation measure shall be filed at least twice annually as needed. A summary of mitigation monitoring activities shall be provided to the Metro Board of Directors twice annually. Issues identified during monitoring shall be discussed with the Regional Connector Community Leadership Council (RCCLC) monthly.

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Transportation Impacts						
Traffic circulation disruption would occur during construction.	TR-1: Prior to the initiation of localized construction activities, a traffic management and construction mitigation plan shall be devised. The closure schedules in the construction traffic plan shall be coordinated to minimize impacts to residences, businesses, special events, and traffic flow. During these times, traffic shall be re-routed to adjacent streets via clearly marked detours. The traffic management and construction mitigation plan shall identify, for instance, proposed closure schedules and detour routes; construction traffic routes, including haul truck route, and hours so as to avoid peak hours where feasible. It shall also account for the provisions below. Traffic flow shall be maintained, particularly during peak hours, to the degree feasible. Access to adjacent businesses shall be maintained via existing or temporary driveways at all times during business hours, and residences at all times. Metro shall provide signage to indicate new ways to access businesses and community facilities affected by construction. Metro shall post advance notice signs prior to construction in areas where business access could be affected. Metro shall also notify Los Angeles Department of Transportation (LADOT) in advance of street closures, detours, or temporary lane reductions. Metro shall also inform advisory committees of known road closures during regularly scheduled meetings. If, for whatever reason, Metro is unable to maintain access to the Japanese Village Parking garage from the existing entry and exit points on Central Avenue at all times, Metro shall provide valet parking from vehicle pickup/drop-off points immediately adjacent to Japanese Village Plaza.	Check design contract documents for compliance	Metro	Final Design	Traffic Control Plans	LADOT/Metro
		Monitor construction activities for compliance.	Metro	Construction	Traffic Control Plans	LADOT/Metro
	See also CN-1 through CN-3 and CN-5.					
Construction haul routes along project area streets would be needed.	TR-2: Haul routes for trucks shall be confirmed during the final design phase of the project. The routes shall be located to minimize noise, vibration, and other possible impacts to adjacent businesses and neighborhoods. Truck trips shall be primarily scheduled at times when they would be least disruptive to the community. Lighted or reflective signage shall direct truck drivers to the haul routes. If physical damage to the haul route roads occurs due to project-related traffic, the roads shall be restored to their pre-construction condition as quickly as is practicable. Haul routes shall be discussed with and approved by the City of Los Angeles through the Transportation Construction Traffic Management Committee (TCTMC).	Verify that community input into hauling schedule has occurred	Metro	Final Design	Haul Routes	LADOT/Metro
		Verify that TCTMC input into haul routes has occurred.	Metro, City of Los Angeles TCTMC	Final Design	Haul Routes	LADOT/Metro
		Check design contract documents for compliance.	Metro	Final Design	Haul Routes	LADOT/Metro
		Monitor construction activities for compliance.	Metro	Construction	Haul Routes	LADOT/Metro
		Verify whether roadway deterioration due to project traffic has occurred, and ensure that it is repaired.	Metro	Construction		Metro
Street parking would need to be temporarily removed during construction.	TR-3: To avoid impacts to neighborhood parking supplies, Metro shall require the contractor to designate areas for construction/contractor employee parking and shall not allow employees to park in other lots or unauthorized areas. Metro shall identify and implement measures to reduce the need for parking by construction workers, including carpool incentives, transit passes, or designated on-site or off-site parking. Metro shall direct construction workers not to park on the street.	Check design contract documents for compliance.	Metro	Final Design	Parking Plans	Metro
		Monitor construction activities for compliance.	Metro	Construction		Contractor/Metro
	See also DR-4 and DR-5.					
Re-routing of pedestrian and bicycle traffic would be needed during construction.	TR-4: Safe pedestrian detours with handrails, fences, k-rail, canopies, and walkways shall be provided as needed. When a crosswalk is closed due to construction activities, pedestrians shall be directed to nearby alternate crosswalks. Access shall be Americans with Disabilities Act (ADA) accessible at all times per existing Metro policy.	Check design contract documents for compliance.	Metro	Final Design	Pedestrian Access Plan	Contractor/Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	TR-5: Bicyclists shall be encouraged through signage to ride carefully in streets near construction activities, ride carefully on sidewalks (as City of Los Angeles municipal code permits), or choose nearby alternate routes around construction sites. Detours shall be provided as needed. Metro shall provide signage showing the alternate bicycle routes. Pedestrian and bicycle circulation, and travel lanes temporarily impacted during construction shall be restored to their permanent configurations at the conclusion of the construction period and prior to operations.	Check design contract documents for compliance.	Metro	Final Design	Bicycle Plans	LADOT/Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Permanent reductions in intersection performance on Flower Street from 4th to 6th Streets would occur.	TR-6: At the intersection of 4th and Flower Streets, Metro, in coordination with LADOT, shall permanently restripe the southbound Flower Street approach to provide one shared left-turn/through lane and two through lanes. Metro, in coordination with LADOT, shall also optimize the signal splits.	Verify that LADOT coordination has occurred.	Metro	Final Design	Design Drawings	LADOT/Metro
		Check design contract documents for compliance.	Metro	Final Design	Design Documents	LADOT/Metro
		Verify that the restriping has occurred after the street has been restored from cut and cover activities.	Metro	Construction		Metro
	TR-7: At the intersection of 5th and Flower Streets, Metro, in coordination with LADOT, shall permanently restripe the southbound Flower Street approach to provide three through lanes and one exclusive right-turn lane. Metro, in coordination with LADOT, shall also optimize the signal splits.	Verify that LADOT coordination has occurred.	Metro	Final Design	Design Drawings	LADOT/Metro
		Check design contract documents for compliance.	Metro	Final Design	Design Drawings	Metro
		Verify that restriping has occurred after the street has been restored from cut and cover activities.	Metro	Construction		Metro
	TR-8: At the intersection of 6th and Flower Streets, Metro, in coordination with LADOT, shall permanently restripe the eastbound 6th Street approach to provide three through lanes and two exclusive right-turn lanes. Metro, in coordination with LADOT, shall also optimize the signal splits.	Verify that LADOT coordination has occurred.	Metro	Final Design	Design Drawings	LADOT/Metro
		Check design contract documents for compliance.	Metro	Final Design	Design Drawings	Metro
		Verify that the restriping has occurred after the street has been restored from cut and cover activities.	Metro	Construction		Metro
Shuttle bus drop-off areas for City National Plaza could be affected by construction activities.	TR-9: Metro shall ensure that shuttle bus drop-off areas at City National Plaza are provided throughout construction.	Check design contract documents for compliance.	Metro	Final Design	Design Drawings	Metro
		Verify that the restriping has occurred after the street has been restored from cut and cover activities.	Metro	Construction		Metro
Connectivity with other transit lines and pedestrian systems would be needed.	TR-10: Metro shall design and implement linkages with the proposed streetcar project and Bringing Back Broadway project at the 2nd/Broadway station. The project shall also provide a knockout panel to the west side of Flower Street at 3rd Street to connect to the pedestrian system previously designed by the City of Los Angeles.	Check design contract documents for compliance.	Metro	Final Design	Design Drawings	Metro
	TR-11: Metro shall construct an enhanced pedestrian walkway along the east side of Flower Street between 4th and 7th Streets to better connect the Financial District to the improved transit services available at the existing 7th Street/Metro Center Station.	Check design contract documents for compliance.	Metro	Final Design	Design Drawings	Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Access to some bus stops would be restricted during construction.	TR-12: Metro shall maintain access to bus stops and provide adequate signage to guide bus users to accessible stops. Metro shall minimize temporary closures or relocations of bus stops and layover zones. Metro shall provide notices of closures and relocations on its website, smart phone apps, and other modes typically used to communicate service announcements. When closures of other bus operators' stops are needed, Metro shall work closely with the affected operators to provide notices.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Construction Notices	Metro
		Monitor construction activities and bus stop operation for compliance.	Metro	Construction		Metro
Some bus stops would need to be temporarily relocated due to street closures during construction, and buses may need to be re-routed around construction areas.	TR-13: As needed, Metro shall temporarily relocate bus stops to nearby alternative locations based on the re-routing of bus service, and provide adequate signage and notices at strategic locations indicating the relocated bus stops. Metro shall provide notices of relocations on its website, smart phone apps, and other modes typically used to communicate service announcements. Metro shall coordinate with municipal transit providers to temporarily relocate non-Metro bus stops. When bus re-routing is necessary, buses shall be re-routed to adjacent streets in a manner that minimizes inconvenience to bus passengers and to affected neighborhoods.	Check design contract documents for compliance.	Metro	Final Design	Construction Notices	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Displacement and Relocation Impacts						
Partial taking of parking and primary access to the Central Plant (APN 5151-014-032, 703 W. 3rd Street).	DR-1: For parcels in which parking is displaced by the project, Metro shall provide replacement parking elsewhere on the parcel or on a nearby parcel during construction.	Check design contract documents for compliance.	Metro	Final Design	Design Drawings	Metro
		Monitor construction activities and parking lot use to ensure that replacement parking is maintained.	Metro	Construction		Metro
	DR-2: In using parcel APN 5151014032 for construction staging, Metro shall maintain access to the Central Plant located on that parcel at all times during construction.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Drawings	LADOT/Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Some privately-owned parcels needed for construction staging currently contain buildings, but would be owned by Metro and may be vacant after construction.	DR-3: Upon completion of construction, property needed for construction but not required to maintain the physical infrastructure or necessary for access shall be included in the Metro Joint Development Program for possible development. Any development shall be environmentally and separately cleared from this project and shall undergo its own community input process. Until a development is approved, the remaining underutilized property may be used for public parking spaces or at the very least shall be graded and fenced to a higher standard that reflects the community's identity and character more than typical gravel and chain link. Per Metro's Joint Development Policy, the community shall be included in the development process.	Oversee Metro Joint Development Program and ensure compliance.	Metro	Post-Construction	Joint Development Documents	Metro
Public parking spaces would be lost in Little Tokyo during construction.	DR-4: Metro shall work with the City to develop a parking mitigation program to mitigate the loss of public parking spaces during construction. This would include, but is not limited to, restriping the existing street to allow for diagonal parking, reducing the number of restricted parking areas, phasing construction activities in a way that minimizes parking disruption, and increasing the time limits for on-street parking. Restriping would occur on portions of Temple Street, Alameda Street, 1st Street, 2nd Street, Central Avenue, San Pedro Street, Judge John Aiso Street, 3rd Street, and Traction Avenue. Such parking mitigation shall be implemented on a temporary, tiered basis pending findings of the annual parking analysis described in EJ-11.	Check design contract documents for compliance.	Metro, LADOT	Final Design	Parking Plans	LADOT/Metro
		Monitor construction activities for compliance.	Metro, LADOT	Construction		LADOT/Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	DR-5: Metro shall not hinder access to other public parking lots during construction.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		
	See also EJ-2 through EJ-9, EJ-11, and EF-1.					
Access to the Little Tokyo Library and other community destinations could be affected by construction.	DR-6: Metro shall maintain access to the Little Tokyo Library and other community facilities at all times during construction.	Check design contract documents for compliance.	Metro	Final Design	Construction Plans	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	DR-7: Metro shall develop a Construction Mitigation Program that includes protocol for community notification of construction activities, including traffic control measures, schedule of activities, and duration of operations, with written communications to the community translated into appropriate languages.	Ensure that an adequate Construction Mitigation Program has been developed.	Metro	Final Design	Community Outreach Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Displacement and relocation of businesses would be necessary.	DR-8: Metro shall provide relocation assistance and compensation as required by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.	Verify qualifications of property appraiser.	Metro	Pre-Construction	Reacquisition Plans	Metro
		Ensure provision of relocation assistance and payment of affected owners just compensation not less than the appraised market value for their property.	Metro	Pre-Construction		Metro
A portion of the LADWP site on parcels 5173-007-901 and 5173-006-900 would need to be permanently acquired for right-of-way.	DR-9: Metro shall consult Los Angeles Department of Water and Power (LADWP) during the design phase to accommodate its operational needs during construction and operation of the project.	Check design contract documents for compliance and documentation of consultation with LADWP.	Metro, LADWP	Final Design		DWP/Metro
		Monitor construction activities for compliance.	Metro, LADWP	Construction		
Community and Neighborhood Impacts						
Disruption of traffic patterns during construction would affect access to residences and businesses, which could affect the economic vitality of some businesses.	CN-1: Accessible detours shall be provided whenever possible. Detours shall be compliant with the ADA. Signage shall be provided in those languages most commonly spoken in the immediate community. Signs shall mark detours in accordance with the Manual on Uniform Traffic Control Devices, and other applicable local and state requirements. Detours shall be designed to minimize cut-through traffic in adjacent residential areas.	Check design contract documents for compliance.	Metro	Final Design	Traffic Control Plans	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	CN-2: Early notification of traffic disruption shall be given to emergency service providers. Work plans and traffic control measures shall be coordinated with emergency responders to prevent impacts to emergency response times.	Verify that plans were developed in conjunction with emergency responders.	Metro, emergency service providers	Final Design	Traffic Control Plans	Metro
		Monitor construction activities for compliance.	Metro, emergency service providers	Construction		

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	CN-3: Traffic management and construction mitigation plans shall be developed in coordination with the community to minimize disruption and limit construction activities during special events. Worksite Traffic Control Plans shall be developed in conjunction with LADOT and surrounding communities to minimize impacts to traffic, businesses, residents, and other stakeholders. Crossing guards and other temporary traffic controls shall be provided in the vicinity of construction sites, haul routes, and other relevant sites as proposed in California DOT Traffic Manual, Section 10-07.3, Warrants for Adult Crossing Guards, and as appropriate to maintain traffic flow during construction.	Monitor Final Design process and check documents for compliance.	Metro, LADOT	Final Design	Traffic Control Plans	LADOT/Metro
		Monitor construction activities for compliance.	Metro, LADOT	Construction		LADOT/Metro
	CN-4: A 24-hour live hotline for community concerns regarding construction shall be provided, as well as a project office within the Little Tokyo community. Residents and businesses shall also be provided with comment/complaint forms during construction. A construction office shall also be placed within the community to provide in-person assistance and services. Metro shall negotiate with the Japanese American National Museum (JANM) to locate the office within the museum's historic building on 1st Street. The hotline and office shall enable Metro to maintain day-to-day contact with the community during construction and provide community members with all project details that may be relevant to the public.	Verify continuous operation of hotline and construction office.	Metro	Construction	Community Outreach Plan	Metro
	CN-5: A community outreach plan shall be developed and implemented to notify local communities and the general public of construction schedules and road and sidewalk detours. Metro shall coordinate with local communities during preparation of the traffic management plans to minimize potential construction impacts to community resources and special events. Construction activities shall be coordinated with special events.	Verify preparation of community outreach plan.	Metro	Final Design	Community Outreach Plan	Metro
		Verify preparation of traffic management plans in conjunction with community stakeholders.	Metro	Final Design	Traffic Management Plans	LADOT/Metro
		Check design contract documents for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	CN-6: Metro shall develop a construction mitigation plan with community input to directly address specific construction impacts in the project area. Metro shall establish and receive input from the RCCLC in developing the construction mitigation plan. The RCCLC shall consist of representatives from all parts of the alignment area. Metro shall work with the RCCLC in developing the outreach plan.	Establish RCCLC.	Metro, Community stakeholders	Preliminary Engineering	Community Outreach Plan	Metro
		Verify preparation of construction mitigation plan and outreach plan in conjunction with community stakeholders.	Metro	Final Design	Community Outreach Plan	Metro
		Check design contract documents for compliance.	Metro	Final Design	Design Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	See also DR-4 and DR-5.					
Construction sites could have a negative impact on the community if left unsecured.	CN-7: Barriers shall be erected and security personnel provided during construction to minimize trespassing and vandalism. Barriers shall be enhanced with culturally-relevant artwork, attractive design features, and advertisements for parking locations and businesses. Signage shall also identify that businesses are open during construction. Community input shall be sought in determining artwork and design features.	Verify incorporation of community input into artwork and design feature plans.	Metro	Final Design	Traffic Control Plans	Metro
		Check design contract documents for compliance.	Metro	Final Design	Design Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
The 1st/Central Avenue station should incorporate the Arts District's identity, in addition to Little Tokyo.	CN-8: Metro shall implement urban design improvements in the form of an "Arts District Path" linking the Arts District to the 1st/Central Avenue station. Metro shall invite Southern California Institute of Architecture and other local students to participate in the path's design. The path shall include sidewalk enhancements, design elements, way finding signage, and crosswalk improvements. The design of the station shall enhance pedestrian circulation.	Verify incorporation of Arts District input into art path design.	Metro	Preliminary Engineering, Final Design	Design Documents	Metro
	CN-9: Design of the 1st/Central Avenue station shall encourage connections and pedestrian travel to the Japanese Village Plaza (JVP), Los Angeles Hompa Hongwanji Temple, the JANM, and businesses south of 2nd Street.	Check design contract documents for compliance.	Metro	Final Design	Design Documents	Metro
Temporary intermittent utility disruption could occur as part of construction.	CN-10: Metro shall field verify (by potholing or other methods) the exact locations and depths of underground utilities and conduct condition checks prior to utility relocation.	Check design contract documents for compliance.	Metro	Final Design	Utility Plans	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	CN-11: Metro shall coordinate closely with utility providers to develop a service plan as needed to address planned and unplanned utility service interruptions. Should an unplanned outage occur as a result of construction activities, Metro shall contact the appropriate utility provider immediately to restore service. Metro shall also maintain access to utilities for providers' technicians. Metro shall provide protective measures such as pipe and conduit support systems, vibration and settlement monitoring, trench sheeting, and shoring during construction to avoid potential damage to utilities.	Verify that utility provider coordination has occurred.	Metro	Final Design	Utility Plans	Metro
		Check design contract documents for compliance.	Metro	Final Design	Design Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Visual and Aesthetic Impacts						
Prominent street-level features would be installed, including station entrances and tunnel portals. Visual character of the corridor could change slightly.	VA-1: Metro shall coordinate with the station area communities to obtain input on the urban design of the project within the community.	Verify that community input has been incorporated into urban design.	Metro	Preliminary Engineering	Design Documents	Metro
		Check preliminary engineering and design contract documents for compliance.	Metro	Preliminary Engineering and Final Design		Metro
	VA-2: Urban design measures shall be developed to integrate the light rail transit (LRT) facilities (stations, portals, entrances, etc.) into each community as appropriate. Designs might address elements such as materials and colors. This process has already begun with community urban design workshops, and Metro shall continue to involve communities in this process. Metro shall coordinate with the City of Los Angeles Department of Planning staff during the design process and regarding urban design elements.	Check preliminary engineering and Final Design drawings for compliance.	Metro	Preliminary Engineering and Final Design	Design Documents	Metro Community Outreach
Temporary visual impacts could occur during construction, but would be less than significant.	VA-3: Metro shall shield temporary lighting during construction to reduce spillover lighting.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Construction Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	VA-4: Metro shall locate stockpile areas (storage areas for construction equipment, supplies, and excavated soil) primarily in less visually sensitive locations, where they are not visible from the road or to businesses or residents.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	VA-5: Temporary construction sheds and barricades shall be located so as to avoid obscuring significant views of historic properties.	Compare design contract documents and construction specifications to Final EIS/EIR to determine compliance.	Metro	Final Design	Design Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Air Quality						
Construction emissions of VOC, NOX, CO, PM2.5, and dust would occur.	AQ-1: Contractors shall be required to adhere to South Coast Air Quality Management District (SCAQMD) standards for off-road engine emissions (refer to Section 4.5.1.1). Examples of how the contractors could ensure adherence include retrofitting off-road engines with add-on control devices such as catalytic oxidizers and diesel particulate filters where feasible.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	AQMD Regulations	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	AQ-2: Metro shall require contractors to use equipment that meets up-to-date specifications (equivalent to models manufactured from 2013 to 2017) for pollutant emissions during project construction.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	BMPs	AQMD/Metro
		Monitor construction activities for compliance.	Metro	Construction		AQMD/Metro
	AQ-3: Contractors shall be required to adhere to SCAQMD standards for dust emissions such as SCAQMD Rule 403. Examples of how the contractors could ensure adherence include applying water or a stabilizing agent to exposed surfaces in sufficient quantity to prevent generation of dust plumes.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	BMPs	AQMD/Metro
		Monitor construction activities for compliance.	Metro	Construction		AQMD/Metro
	AQ-4: Dirt from construction equipment shall not extend 25 feet or more from an active operation, and shall be removed at the conclusion of each workday (refer to Section 4.5.3.3). Street sweeping services shall be coordinated with construction activity to minimize impacts to surrounding businesses and residences.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	BMPs	AQMD/Metro
		Monitor construction activities for compliance.	Metro	Construction		AQMD/Metro
	AQ-5: Contractors shall be required to utilize at least one of the measures set forth in SCAQMD Rule 403 Section (d)(5) to remove bulk material from tires and vehicle undercarriages before vehicles exit the project site.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	BMPs	AQMD/Metro
		Monitor construction activities for compliance.	Metro	Construction		AQMD/Metro
	AQ-6: All haul trucks hauling soil, sand, and other loose materials shall maintain at least six inches of freeboard (not filling trucks all the way to the top) in accordance with California Vehicle Code 23114.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	BMPs	AQMD/Metro
		Monitor construction activities for compliance.	Metro	Construction		AQMD/Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	AQ-7: All haul trucks hauling soil, sand, and other loose materials shall be covered (e.g., with tarps or other enclosures that would reduce dust emissions) (refer to Section 4.5.1.1).	Check design contract documents and construction specifications for compliance.	Metro	Final Design	BMPs	AQMD/Metro
		Monitor construction activities for compliance.	Metro	Construction		AQMD/Metro
	AQ-8: Traffic speeds on unpaved roads shall be limited to 15 MPH.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Contract Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	AQ-9: To control fugitive dust, especially during high wind situations, Metro shall require the contractor to implement the following provisions, consistent with the requirements of SCAQMD Rule 403, as they apply to each of the construction activities identified below: When wind gusts exceed 25 MPH, in areas where earth-moving activities are occurring: (1A) Cease all active operations; or (2A) Apply water to soil not more than 15 minutes prior to moving such soil. Disturbed surface areas: (OB) On the last day of active operations prior to a weekend or holiday: apply water with a mixture of chemical stabilizer diluted with not less than 1/20 of the concentration required to maintain a stabilized surface for a period of six months; or (1B) Apply chemical stabilizers prior to wind event; or	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Contract Documents	Metro
	(2B) Apply water to all unstabilized disturbed areas three times per day. If there is evidence of wind driven fugitive dust, watering frequency is increased to a minimum of four times per day; or (3B) Establish a vegetative ground cover within 21 days after active operations have ceased. Ground cover must be sufficient density to expose less than 30 percent of unstabilized ground within 90 days of planting, and at all times thereafter; or (4B) Utilize any combination of control actions (1B), (2B), and (3B) such that, in total, these actions apply to all disturbed surface areas. Unpaved roads: (1C) Apply chemical stabilizers prior to wind event expected to exceed 25 MPH; or (2C) Apply water twice per hour during active operation; or (3C) Stop all vehicular traffic. Open storage piles: (1D) Apply water twice per hour; or (2D) Install temporary coverings. Paved road track-out: (1E) Cover all haul vehicles; or (2E) Comply with vehicle freeboard requirements of Section 23114 of the California Vehicle Code for both public and private roads. All categories: (1F) Any other control measures approved by the Executive Officer and the United States Environmental Protection Agency as equivalent to the methods specified may be used.	Monitor construction activities for compliance.	Metro	Construction	BMPs	AQMD/Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	AQ-10: Heavy equipment operations shall be suspended during second stage smog alerts as issued by SCAQMD.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	BMPs	AQMD/Metro
		Monitor construction activities for compliance.	Metro	Construction		AQMD/Metro
	AQ-11: On-site stockpiles of debris, dirt, or rusty materials shall be covered or watered at least two times per day.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	BMPs	AQMD/Metro
		Monitor construction activities for compliance.	Metro	Construction		AQMD/Metro
	AQ-12: Contractors shall utilize electricity supplied by LADWP rather than temporary diesel or gasoline generators, as feasible.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Construction Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	AQ-13: Heavy-duty trucks shall be prohibited from idling in excess of five minutes, both on- and off-site. Metro shall employ California Air Resources Board anti-idling requirements during construction. Metro shall require the contractor to regularly perform unscheduled inspections of construction equipment and activities to ensure minimization of associated air quality impacts.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	BMPs	AQMD/Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	AQ-14: Construction worker parking shall be configured to minimize traffic interference. This measure would minimize vehicle idling time, which would reduce emissions generated from construction vehicles.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Contract Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	AQ-15: Construction activity that affects traffic flow on the arterial system, including the transportation of excavated materials, shall be primarily limited to off-peak hours. This measure would minimize vehicle idling time, which would reduce emissions generated from construction vehicles.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Traffic Plans	LADOT/Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	AQ-16: Metro shall require ongoing maintenance and adherence to manufacturer's specifications for all construction equipment engines and vehicles.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Construction Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	AQ-17: Dedicated turn lanes for the movement of trucks and equipment to and from construction sites shall be provided where appropriate. This measure would minimize vehicle idling time, which would reduce emissions generated from construction vehicles.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Traffic Plans	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	AQ-18: Metro shall require on-site construction equipment to meet EPA Tier 2 or higher emission standards according to the January 1, 2012 to December 31, 2014 and post-January 15, 2015 criteria.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Construction Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	AQ-19: Metro shall maintain and clean all trucks and construction equipment as needed.	Monitor construction activities for compliance.	Metro	Construction		Contractor/ Metro
	AQ-20: Metro shall use low-sulfur fuel where possible.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Contract Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	AQ-21: The project and stations shall be designed and constructed in a manner consistent with Metro's sustainability policies (such as Metro's Energy and Sustainability Policy and Metro's Sustainability Implementation Plan).	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Construction-related lane closures and intersection improvements would result in increased emissions, particularly CO emissions, at the major points of delay.	AQ-22: Detour routes shall be designed to ensure that traffic does not idle for extended periods of time, thus reducing the potential for localized exceedence of federal CO/CO2 standards.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Traffic Control Plans	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Noise and Vibration						
Sensitive or historic buildings within 21 feet of construction may be susceptible to vibration damage.	NV-1: Mitigation Measure CR/B-2 shall also apply to sensitive, non-historic structures (Category I, II, III, IV buildings as defined in Table 4.7-4) located within 21 feet of vibration producing construction activity. However, design contract documents shall not require input or review by an architectural historian or historical architect under this mitigation measure.	Verify that an adequate survey of sensitive properties has been performed.	Metro	Preliminary Engineering	Noise and Vibration Control Plan	Contractor/ Metro
	See CR/B-2 and CR/B-4.					
	NV-2: A vibration monitoring plan shall be developed during final design to ensure appropriate measures are taken to avoid any damage to sensitive buildings (Category I, II, III, IV buildings as defined by FTA in Table 4.7-4) or historic buildings due to construction--induced vibration. This shall include pre-construction surveys of all buildings within 21 feet of vibration producing construction activity to confirm the building category (Category I, II, III, IV buildings as defined in Table 4.7-4), structural condition of the building, and to provide a baseline for monitoring of ground-borne vibration (GBV) and measuring the potential for GBV to cause damage where needed. Any damage caused by Metro's construction activities shall be repaired.	Verify that pre-construction surveys have been performed where needed.	Metro	Final Design	Noise and Vibration Control Plan	Contractor/ Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Moderate (but not significant) GBV could cause annoyance to sensitive land uses during construction.	NV-3: Distances greater than those provided in EIS/EIR Table 4.7-5 shall be maintained near vibration-sensitive locations to avoid potential construction-related vibration impacts.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	NV-4: Less vibration-intensive construction equipment or techniques shall be used near vibration-sensitive locations.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Contractor/ Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	NV-5: Heavily laden vehicles shall be routed away from vibration-sensitive locations.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	NV-6: Earthmoving equipment shall be operated as far as possible from vibration-sensitive locations.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	NV-7: Construction activities that produce vibration, such as demolition, excavation, earthmoving, and ground impacting shall be sequenced so that the vibration sources do not operate simultaneously.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	NV-8: Nighttime construction activities that produce noticeable vibration shall be avoided near vibration-sensitive locations.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	City of LA/Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	NV-9: Devices with the least impact shall be used to accomplish necessary tasks.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	NV-10: Non-impact demolition and construction methods, such as saw or torch cutting and removal for off-site demolition, chemical splitting, and hydraulic jack splitting, shall be used instead of high impact methods near vibration-sensitive locations.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	NV-11: Building protection measures such as underpinning, soil grouting, or other forms of ground improvement shall be used where needed to prevent deterioration of building condition due to construction.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	NV-12: Pavement breakers, vibratory rollers, and packers shall operate as far as possible from vibration-sensitive locations.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Noise may inadvertently exceed FTA significance criteria during construction.	NV-13: The construction mitigation plan shall prohibit noise levels generated during construction from exceeding the FTA construction noise criteria. This could include prohibiting simultaneous operation of major pieces of construction equipment if simultaneous operation exceeds FTA construction noise criteria. If a noise complaint is filed during project construction, noise monitoring shall be conducted in the vicinity of the area in question. Although it is not expected to do so with the application of appropriate BMPs, if monitored noise levels exceed FTA construction noise criteria, the contractor shall use all or a combination of the following measures (NV-14 through NV-17) to reduce construction noise levels below FTA construction noise criteria.	Monitor construction activities for compliance.	Metro	Construction	Noise Variance	City of LA/Metro
	NV-14: Temporary noise barriers around the construction sites and localized barriers around specific items of equipment or smaller areas shall be provided as needed.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	NV-15: Alternative back-up alarms/warning procedures shall be used where feasible as needed.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	NV-16: Higher performance mufflers shall be used on equipment used during nighttime hours as needed near sensitive land uses.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	NV-17: Portable noise sheds for smaller, noisy equipment, such as air compressors, dewatering pumps, and generators shall be provided as needed.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Noise and Vibration Control Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Significant ground-borne noise (GBN) impacts could occur during construction at Walt Disney Concert Hall, and the Broad Art Foundation Museum, which is currently under construction. Mitigation for the Walt Disney Concert Hall has been modified to cover the Colburn School as well, in an abundance of caution.	NV-18: Construction of the project, in the vicinity of the Walt Disney Concert Hall, shall be done in accordance with the Memorandum of Agreement (MOA) between FTA and the State Historic Preservation Officer (SHPO), which includes stipulations that outline the specific requirements for consultation and decision-making between the lead federal agency and consulting parties, specify the level of Historic American Building Survey/Historic American Engineering Record (HABS/HAER) recordation, and outline specific requirements for pre- and post-construction surveys, geotechnical investigations, building protection measures, and tunnel boring machine (TBM) specifications (for the Walt Disney Concert Hall only).	Confirm provisions of the MOA.	Metro	Preliminary Engineering	MOA	SHPO/Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	Tunnel Boring Machine:					
	NV-19: Maintenance and Operation: The construction contractor shall minimize vibration from jacking or pressing operations (if applicable, the action could be smoothed out to avoid a sharp push), and maintain machinery in good working order.	Monitor construction activities for compliance.	Metro	Construction	Noise and Vibration Control Plan	Metro
	NV-20: Coordination and Notification: There would be times when the Main Auditorium of the Walt Disney Concert Hall is vacant or not used for a noise-sensitive activity, thereby eliminating any noise impact from TBM. Similarly, there would be times at the Los Angeles Philharmonic Association Conference Room (and offices) of the Walt Disney Concert Hall and at the recording/performance halls of the Colburn School when activities are not particularly noise-sensitive. Metro shall coordinate closely with the Walt Disney Concert Hall, the Colburn School, and the Broad Art Foundation Museum, which is currently under construction, to ensure that the noise-generating parts of TBM operations shall be conducted to avoid noise-sensitive periods.	Monitor construction activities for compliance.	Metro	Construction	Noise and Vibration Control Plan	Metro
	Delivery Train:					
	NV-21: Speed: Delivery train speed shall be limited to 5 MPH in the vicinity of the Walt Disney Concert Hall, the Colburn School, and the Broad Art Foundation Museum, currently under construction, which would reduce the GBN to the lower range, or 5 dBA from the maximum range. At the Japanese Village Plaza, one of the following or similar mitigations shall be used: a resilient mat or limiting train speeds to 5 MPH.	Monitor construction activities for compliance.	Metro	Construction	MOA	SHPO/Metro
	NV-22: Resilient Mat: A resilient system to support and fasten the delivery train tracks shall be used during construction, which would reduce GBN levels by at least 4 dBA. Such as system shall include a) resilient mat under the tracks and b) a resilient grommet or bushing under the heads of any track fasteners (assuming some kind of anchor or bolt system). The hardness of the resilient mat shall be in the 40 to 50 durometer range, and be about one to two inches thick, depending on how heavily loaded the cars would be. The contractor shall select the mat thickness so that the rail does not bottom out during a car pass-by.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		
	NV-23: Conveyor: The delivery train shall be replaced with a conveyor system to transport materials in the tunnel if GBN exceeds the FTA annoyance criteria at the Walt Disney Concert Hall, the Colburn School, or the Broad Art Foundation Museum, which is currently under construction. At the Japanese Village Plaza, one of the following or a similar method shall be used: a resilient mat, slower train speeds, or a conveyor system.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		
	NV-24: Coordination and Notification: There would be times when the Main Auditorium and Choral Hall of the Walt Disney Concert Hall and the recording/performance halls of the Colburn School are vacant or not used for noise-sensitive activities, thereby eliminating any noise impact from the delivery train. Metro shall coordinate closely with the Walt Disney Concert Hall, the Colburn School, and the Broad Art Foundation Museum, which is currently under construction, to ensure that the delivery train pass-bys would be conducted to avoid noise-sensitive periods.	Monitor construction activities for compliance.	Metro	Construction	Design Documents	Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Significant GBN impacts and GBV could occur during construction at the Hikari Lofts, offices in JVP, and the Nakamura Tetsujiro Building.	NV-25: Metro shall provide advance notice and coordinate with the affected property owners regarding schedules for tunneling and other activities prior to the commencement of those activities.	Monitor construction activities for compliance.	Metro	Construction	Design Documents	Metro
	NV-26: Metro shall provide advanced notification and coordination by doing the following: • Metro shall establish a Construction Community Relation Program to inform and coordinate construction activities including notification to all occupants at the Hikari Lofts, the interior designer office at the JVP, and the Nakamura Tetsujiro Building about the schedule of tunneling activities at least one month prior to the start of the activities. • Metro shall monitor GBN and GBV levels in the in the building adjacent to TBM activity during its operation in that area. • During the few days the TBM will be operating in this area, should GBN or GBV measurements exceed FTA annoyance criteria for short-term impacts during construction, Metro shall offer to temporarily relocate affected residents.	Monitor construction activities for compliance.	Metro	Construction	Community Outreach Plan	Metro Community Relations
Significant GBN impacts could occur during operations at Walt Disney Concert Hall, Hikari Lofts, offices in JVP, the Nakamura Tetsujiro Building, and the Broad Art Foundation Museum, currently under construction. Mitigation for the Walt Disney Concert Hall has been modified to cover the Colburn School as well, in an abundance of caution.	NV-27: In the vicinity of the Walt Disney Concert Hall and the Colburn School, Metro shall implement resiliently supported fasteners, isolated slab track, or other appropriate measures as needed to eliminate impacts and to reduce GBN below FTA annoyance criteria.	Verify that preliminary engineering studies have been completed.	Metro	Preliminary Engineering	Design Documents	Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
	NV-28: In the vicinity of the Hikari Lofts and Nakamura Tetsujiro Building, Metro shall conduct engineering studies during final design to verify initial estimates of GBN and shall implement high compliance resilient fasteners, floating slab trackbed, or other appropriate measures as needed to eliminate impacts and to reduce GBN below FTA annoyance criteria.	Verify that Final Design studies have been completed.	Metro	Preliminary Engineering	Engineering Study	Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design	Specifications	Metro
	NV-29: In the vicinity of the offices at JVP and the Broad Art Foundation Museum, currently under construction, Metro shall conduct engineering studies during final design to verify initial estimates of GBN and shall implement high compliance resilient fasteners or other appropriate measures as needed to eliminate impacts and reduce GBN below FTA annoyance criteria.	Verify that Final Design studies have been completed.	Metro	Preliminary Engineering	Engineering Study	Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design	Contract Documents	Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Ecosystems/Biological Resources						
Some trees in the project area would be removed or disturbed during construction.	EB-1: The construction contractor shall minimize disturbance to trees through avoidance or fencing.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Documents Landscape Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	EB-2: If disturbance is unavoidable, the construction contractor shall trim individual trees instead of removing them completely where feasible to reduce the scale of disturbance.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Landscape Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	EB-3: The construction contractor shall replant or replace disturbed or removed trees as soon as practicable.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Some tree removal and trimming may need to occur during the bird breeding season, from February 1 to August 31.	EB-4: The construction contractor shall schedule necessary tree removal and trimming activities that would affect bird nesting outside of the bird breeding season, which can extend from February 1 to August 31.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Landscape Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	EB-5: If it is not feasible to avoid tree removal and trimming related to construction during the breeding bird season from February 1 to August 31, breeding bird surveys shall be conducted as recommended by the California Department of Fish and Game. A qualified biologist shall conduct two biological surveys, one 15 days prior and a second 72 hours prior to construction activities that would remove or disturb suitable nesting habitat. The biologist would prepare survey reports documenting the presence or absence of active nests of any protected native bird (as identified in the Migratory Bird Treaty Act) in the habitat to be removed and any other such habitat within 300 feet of the construction work area (within 500 feet for raptors).	Verify qualifications of biologist.	Metro	Pre-Construction	Landscape Plan Bird Survey	Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	EB-6: If an active native bird species nest is located, construction within 300 feet of the nest (500 feet for raptor nests) shall be postponed or modified in consultation with the qualified biologist until the nest is vacated, juveniles have fledged, and there is no evidence of a second attempt at nesting.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Bird Survey	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
		Verify concurrence of qualified biologist.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Some of the trees that need to be removed may be native trees.	EB-7: After detailed engineering and design plans are prepared, a tree survey shall be conducted by a qualified arborist to identify native trees that could be affected by project construction. If construction of the project requires removal of any of the native trees located along the proposed alignment and stations for the approved project, the following mitigation measure shall be applied: A removal permit shall be obtained from the Los Angeles Board of Public Works in accordance with the City of Los Angeles Native Tree Protection Ordinance. Tree replacement shall comply with the ordinance and the terms of the removal permit. If construction would require pruning of any protected native tree, the pruning shall be performed in a manner that does not cause permanent damage or adversely affect the health of the trees.	Verify that permit has been obtained.	Metro	Final Design	Tree Survey	Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	See also EJ-30.					
Geotechnical/Subsurface/Seismic/Hazardous Materials						
Potential exists for ground movement associated with cut and cover construction and potential ground loss due to tunneling.	GT-1: While engineering designs are being finalized, but before any construction, a survey of structures within the anticipated zone of construction influence shall be conducted in order to establish baseline conditions. A geotechnical instrumentation and settlement monitoring plan and mitigation measures shall be developed and adhered to during construction to ensure appropriate measures are taken to address any construction-induced movement.	Verify that design criteria have been established.	Metro	Final Design	Structures Survey	Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Verify that additional geotechnical studies have been completed.	Metro	Final Design		Metro
	GT-1 (Continued): If assessments indicate the necessity to proactively protect nearby structures, additional support for the structures by underpinning or other ground improvement techniques shall be required prior to the underground construction. Metro shall require the construction contractor to limit movement to less than acceptable threshold values for vertical, horizontal, and angular deformation as a performance standard. These acceptable threshold values shall be established such that the risk of damage to buildings and utilities will be negligible to very slight. For buildings, these threshold values will be based on the relationship of building damage to angular distortion and horizontal strain consistent with Boscardin and Cording (1989) and qualitative factors including but not limited to the type of structure and its existing condition. For utility mains, these threshold values shall be those established by the utility owners. Additional data and survey information shall be gathered during final design for each building and utility main to enable assessment of the tolerance of potentially affected structures and utilities. Additional engineering and design level geotechnical studies shall be performed to define the nature of the soils and to refine the means of achieving each performance specification.	Monitor construction activities for compliance.	Metro	Construction	Structures Survey	Metro
	GT-2: Ground improvement such as grouting or other methods shall be required to fill voids where appropriate and offset potential settlement when excess material has been removed during excavation. The criteria for implementing grouting or ground improvement measures shall be based on the analysis described in mitigation measure GT-1.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Structures Survey	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	GT-3: The tunnel alignment shall be grouted in advance to provide adequate soil support and minimize settlement as geotechnical conditions require.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	GT-4: Settlement along the project alignment shall be monitored using a series of measuring devices above the route of the alignment. Leveling surveys shall be conducted prior to tunneling to monitor for possible ground movements.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Structures Survey	Metro
		Verify that adequate leveling surveys have been completed.	Metro	Pre-Construction		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	GT-5: Tunnel construction monitoring requirements shall be described and defined in design contract documents. Additional geotechnical provisions shall be included to the extent feasible, including use of an Earth Pressure Balance or Slurry TBM for tunnel construction to minimize ground loss. During tunnel construction, the soils encountered shall be monitored relative to anticipated soil conditions as described in a Geotechnical Baseline Report.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Contract	Metro
		Verify that an adequate Geotechnical Baseline Report has been prepared.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	See also CR/B-2.					
Contaminated soil or groundwater may be encountered during construction.	GT-6: Once a specific alignment is selected, and detailed engineering plans are being prepared a Contaminated Soil/Groundwater Management Plan shall be implemented during construction to establish procedures to follow if contamination is encountered in order to minimize associated risks to assure that applicable statutory and regulatory standards and requirements are satisfied. The plan shall be prepared during the final design phase of the project, and the construction contractor shall be held to the level of performance specified in the plan. The plan shall include procedures for the implementation of mitigation measures GT-7 through GT-11.	Verify that an adequate Contaminated Soil/Groundwater Management Plan has been prepared.	Metro	Final Design	Contaminated Soil / Ground Water Plan	DTSC/Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	GT-7: Appropriate regulatory agencies, identified in the Contaminated Soil/Groundwater Management Plan, shall be contacted if contaminated soil or groundwater is encountered.	Check construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	GT-8: Sampling and analysis of soil and/or groundwater known or suspected to be impacted by hazardous materials shall be conducted in accordance with the procedures detailed in the Contaminated Soil/Groundwater Management Plan.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	GT-9: Procedures for the legal and proper handling, storage, treatment, transport, and disposal of contaminated soil and/or groundwater shall be delineated and conducted in consultation with regulatory agencies and in accordance with established statutory and regulatory requirements as explained with specificity in the Contaminated Soil/Groundwater Management Plan.	Verify that consultation with appropriate regulatory agencies has occurred.	Metro, regulatory agencies	Final Design	Contaminated Soil / Ground Water Plan	DTSC/Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	GT-10: Dust control measures such as soil wetting, wind screens, etc. shall be implemented for contaminated soil.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Dust Control Plan	AQMD/Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	GT-11: Groundwater collection, treatment, and discharge shall be performed according to applicable standards and procedures (refer to Section 4.10.1).	Check design contract documents and construction specifications for compliance and consistency with Contaminated Soil/Groundwater Management Plan.	Metro	Final Design	RWQCB/ Regulations	RWQCB/Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	GT-12: Worker Health and Safety Plan shall be implemented prior to the start of construction activities. All workers shall be required to review the plan, receive training if necessary, and sign the plan prior to starting work. The plan shall identify properties of concern, the nature and extent of contaminants that could be encountered during excavation activities, appropriate health and environmental protection procedures and equipment, emergency response procedures including the most direct route to a hospital, contact information for the Site Safety Officer.	Verify that an adequate Contaminated Soil/Groundwater Management Plan has been prepared.	Metro	Final Design	Health and Safety Plan	Contractor/ Metro
		Verify that training has occurred and workers have signed the plan.	Metro	Pre-Construction		Contractor/ Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	GT-13: Impermeable grout and other appropriate measures shall be used where necessary to fill gaps between the tunnels and the surrounding earth to address the potential for creation of a preferential pathway and resulting spread of existing contaminated groundwater.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Hazardous Waste Soils/ Ground Water Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Subsurface gases associated with oilfields in the vicinity of the project area may be encountered during construction.	GT-14: Testing for subsurface gases particularly methane shall be conducted before and during construction along all portions of the underground alignment.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Hazardous Waste Soils/ Ground Water Plan	Metro
		Verify that adequate testing has occurred.	Metro	Final Design		Metro
	GT-15: Construction of the project shall be consistent with the City of Los Angeles Methane Mitigation Standards, established in accordance with City of Los Angeles Ordinance No. 175790 and No. 180619, which provide detailed installation procedures, design parameters, and test protocols for the methane gas mitigation system as well as methods to control methane intrusion emanating from geologic formations.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Hazardous Waste Soils/ Ground Water Plan	City / Metro
		Monitor construction activities for compliance.	Metro	Construction	Methane Mitigation	City / Metro
	GT-16: Specialized excavation methods shall be implemented to protect workers and the public from exposure to toxic gases and prevent explosions. For instance, pressurized closed-face TBMs and other equipment outfitted with ventilation systems would be used, as needed, to excavate the tunnels associated with the project, including Slurry Face Machines (SFMs) and Earth Pressure Balance Machines (EPBMs). During tunneling, the volume of gas (or water containing dissolved gas) released from the soil is confined to the excavated material chamber of the TBM because of the closed-face and gas-tight lining that is installed immediately behind the TBM. The project shall also be consistent with the City's Methane Mitigation Standards, which include provisions to protect workers and the public.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		City / Metro
		Monitor construction activities for compliance.	Metro	Construction		City / Metro
Asbestos and lead may be encountered during building demolition.	GT-17: Prior to building demolition, surveys of asbestos containing materials and lead-based paint shall be conducted. If necessary, destructive sampling shall be used. All asbestos containing materials and lead-based paint would be removed or otherwise abated prior to demolition in accordance with all applicable laws and regulations.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Lead and Asbestos Surveys	Metro
		Verify that adequate surveys have been completed.	Metro	Final Design		Metro
		Monitor construction activities for compliance and verify that any necessary abatement has been completed before demolition begins.	Metro	Construction		Metro
Potential exists for accidental release of construction-related hazardous materials.	GT-18: The construction contractor shall be required to implement best management practices (BMPs) for handling hazardous materials in compliance with existing regulations. These shall include requirements for proper use, storage, and disposal of chemical products and hazardous materials used in construction; spill control and countermeasures, including employee spill prevention/response training; vehicle fueling procedures to avoid overtopping construction equipment fuel tanks; procedures for routine maintenance of construction equipment, including the proper containment and removal of grease and oils; procedures for the proper disposal of discarded containers of fuels and other chemicals.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Hazardous Waste Management Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Potential exists for intrusion of subsurface gases into the underground portions of the alignment.	GT-19: Structures within methane zones and buffer zones shall be consistent with municipal code requirements for gas concentration/pressure testing on a specified frequency and, based on the results, appropriate mitigation measures or controls to be included in the design. These measures may include the use of gas-impermeable liners and venting to reduce or eliminate gas intrusion into stations and along the length of the underground segments.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
		Verify that gas concentration and pressure testing is performed according to specified frequency.	Metro	Operation		Metro
Potential exists for hazardous materials to be encountered during excavation and construction activities.	GT-20: Prior to the onset of demolition and construction, Metro shall develop and implement an Environmental Site Assessment program in accordance with appropriate laws and regulations (refer to Section 4.9.1) to assess the potential for hazardous materials that may be encountered during construction.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Environmental Site Assessment Report	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Potential exists for hazardous building materials to be encountered during demolitions.	GT-21: Prior to the onset of demolition and construction, Metro shall develop and implement plans for pre-demolition and demolition abatement of hazardous building materials (i.e., asbestos, lead-based paint, PCB-light ballasts) in accordance with appropriate laws and regulations such as the Toxic Substances Control Act (refer to Section 4.9.1).	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Hazardous Material / Lead and Asbestos Removal Plans	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Water Resources						
Potential exists for excess erosion to occur during construction.	WR-1: An erosion control plan shall be prepared prior to construction and shall specify procedures for implementing mitigation measures WR-2 through WR-5.	Verify that an adequate erosion control plan has been prepared.	Metro	Final Design		Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design	SWPPP/ SUSMPS	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	WR-2: Natural drainage, detention ponds, sediment ponds, or infiltration pits shall be used to allow runoff to collect and reduce or prevent erosion.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	SWPPP/ SUSMPS	City / Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	WR-3: Barriers shall be used to direct and slow the rate of runoff and to filter out large-sized sediments.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	SWPPP	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	WR-4: Down-drains or chutes shall be used to carry runoff from the top of a slope to the bottom.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	SWPPP	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	WR-5: Use of water for irrigation and dust control shall be controlled so as to avoid off-site runoff.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	SWPPP	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Impacts to water quality stemming from both construction and operation of the project could occur.	WR-6: Project design shall include properly designed and maintained biological oil and grease removal systems in new storm drain systems to treat water before it leaves project sites.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	SUSMPS	City / Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	WR-7: Hazardous materials shall be stored properly and in accordance with applicable law to prevent contact with precipitation and runoff.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Hazardous Material Management Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
		Monitor operations and maintenance for compliance.	Metro	Operation		Metro
	WR-8: Prior to the onset of demolition or construction an effective monitoring and cleanup program for spills and leaks of hazardous materials shall be developed and maintained.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Hazardous Material Management Plan	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
		Monitor operations and maintenance for compliance.	Metro	Operation		Metro
	WR-9: Equipment to be repaired or maintained shall be placed in covered areas on a pad of absorbent material to contain leaks, spills, or small discharges.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Hazardous Material Management Plan + SWPPP	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	WR-10: Periodic and consistent removal of landscape and construction debris shall be performed.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Contract Specifications	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
		Monitor operations and maintenance for compliance.	Metro	Operation		Metro
	WR-11: Any significant chemical residue on the project sites shall be removed through appropriate methods.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Hazardous Material Management Plan + SWPPP	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
		Monitor operations and maintenance for compliance.	Metro	Operation		Metro
	WR-12: Non-toxic alternatives for any necessary applications of herbicides or fertilizers shall be used.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
		Monitor operations and maintenance for compliance.	Metro	Operation		Metro
	WR-13: Detention basins shall be installed to remove suspended solids by settlement.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	SUSMPS	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	WR-14: Water quality or runoff shall be periodically monitored before discharge from project sites and into the storm drainage system.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	SWPPP	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Cultural Resources - Built Environment						
Construction-related direct and indirect adverse impacts to historical resources could occur.	CR/B-1: Documentation of historic properties and historical resources adversely affected by the project shall consist of the development of individual HABS/HAER submissions. The appropriate level of recordation shall be established in consultation with the California SHPO and formalized as a part of a Memorandum of Agreement as described in Section 4.12.1.4.5 of the Draft EIS/EIR and included in Appendix 3 of this Final EIS/EIR. The HABS/HAER documents shall be offered to the Library of Congress and the documents shall be prepared so that the original archival-quality documentation would be suitable for inclusion in the Library of Congress if the National Park Service accepts these materials. Archival copies of the documentation shall also be offered for donation to local repositories, including the Los Angeles Central Library and the Los Angeles Conservancy.	Verify that adequate HABS/HAER documents have been prepared.	Metro, SHPO	Preliminary Engineering	CRMMP / Historic Properties Inventory	SHPO / Metro
		Verify level of recordation established by SHPO and MOA has been met.	Metro, SHPO	Preliminary Engineering	CRMMP / SHPO MOA	SHPO / Metro
	CR/B-2: During preliminary engineering and final design of the project, a more detailed survey of historic properties and/or historical resources within 21 feet of vibration producing construction activity shall be conducted to confirm the building category, and to provide a baseline for monitoring of GBV and the potential for GBV to cause damage. The survey shall also be used to establish baseline, pre-construction conditions for historic properties and historical resources. During preliminary engineering and final design of the project, additional subsurface (geotechnical) investigations shall be undertaken to further evaluate soil, groundwater, seismic, and environmental conditions along the alignment. The analysis shall assist in the selection and development of appropriate support mechanisms for cut and cover construction areas and any sequential excavation method (mining) construction areas, in accordance with industry standards and the Building Code. The subsurface investigation shall also identify areas that could experience differential settlement as a result of using a TBM in close proximity to historic properties and/or historical resources. An architectural historian or historical architect who meets the Secretary of Interior's Professional Qualification Standards shall provide input and review of design contract documents prior to implementation of the mitigation measures.	Verify that an adequate survey of historic properties and/or historical resources has been performed.	Metro	Preliminary Engineering	CRMMP / Historic Properties Inventory	SHPO / Metro
		Verify that adequate subsurface investigations have occurred.	Metro	Preliminary Engineering		Metro
		Verify qualifications of architectural historian or historical architect, and ensure that review of design contract documents occurs prior to implementation of mitigation measures.	Metro	Final Design		Metro
	CR/B-3: The historic property and historical resource protection measures as well as the geotechnical and vibration monitoring program shall be reviewed by an architectural historian or historical architect who meets the Secretary of Interior's Professional Qualification Standards to ensure that the measures would adequately protect the properties/resources. A post-construction survey shall also be undertaken to ensure that adverse effects or significant impacts have not occurred to historic properties or historical resources.	Verify qualifications of architectural historian or historical architect, and ensure that review of protection measures has occurred.	Metro	Final Design	CRMMP	SHPO / Metro
		Verify that post-construction survey has occurred and no adverse effects or significant impacts would occur.	Metro	Post-Construction		Metro
	CR/B-4: For those historic properties and historical resources where adverse impacts are anticipated, a MOA has been developed to resolve those adverse effects consistent with 36 CFR 800. This agreement, developed by FTA and Metro in consultation with the California SHPO and other consulting parties shall resolve and/or avoid, minimize, or mitigate potential effects to historic properties and/or historical resources. The agreement includes stipulations that outline the specific requirements for consultation and decision-making between the lead federal agency and consulting parties, specify the level of HABS/HAER recordation, and outline specific requirements for pre- and post-construction surveys, geotechnical investigations, building protection measures, and TBM specifications. See Appendix 3 (MOA) of this Final EIS/EIR for specific requirements.	Confirm provisions of the MOA.	Metro, FTA, SHPO	Preliminary Engineering	CRMMP/ MOA	Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	CR/B-5: The S. Kamada Restaurant, Atomic Café, Señor Fish, and Coast Imports building (to be removed) shall be offered for a period of one year following certification of the Final EIS/EIR for the price of $1 to any party willing to move it off of the 1st/Central Avenue station site at their own expense. Should no parties come forward, Metro shall incorporate materials from the building into the project facilities. Metro shall explore keeping portions of the building intact for use in the 1st/Central Avenue station. Metro shall also offer to provide an exhibit commemorating the building at the JANM, the 1st/Central Avenue station site, or other suitable location. An individual HABS/HAER submission shall be developed.	Verify that the offer to sell is extended for one year.	Metro	Pre-Construction	Real Estate / Construction Specifications	Metro
		Verify that HABS/HAER submission is completed.	Metro	Pre-Construction		Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	CR/B-6: Facades of historic buildings adjacent to the construction areas shall be protected from accumulation of excessive dirt or shall be cleaned in an appropriate manner periodically while construction activities are occurring nearby.	Monitor construction activities for compliance.	Metro	Construction, Post-Construction		Metro
	See also GT-1 through GT-5.					
Significant GBN impacts could occur during construction and operations at Walt Disney Concert Hall.	See NV-18 through NV-24 and NV-27.					
Built environment mitigation measures included in the MOA between the SHPO, Metro, and FTA shall be implemented as part of this MMRP. The full text of the MOA is attached to this MMRP.	See attached MOA.					
Cultural Resources - Archaeology						
Unknown archaeological resources could be disturbed during construction.	CR/A-1: Construction personnel shall be trained on proper procedures by a qualified lead archaeologist.	Verify qualifications of lead archaeologist.	Metro	Pre-Construction	CRMMP	Metro
		Verify that training occurs.	Metro	Pre-Construction		Metro
	CR/A-2: An archaeological monitor shall be present during ground-disturbing activities. The archaeological monitor shall have authority to halt operations to examine potential resources and recover artifacts using professional archaeological methods.	Verify qualifications of archaeological monitor.	Metro	Pre-Construction	CRMMP	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	CR/A-3: A Native American cultural resources consultant from the Gabrielino/Tongva San Gabriel Band of Mission Indians and/or the Tongva Ancestral Territorial Tribal Nation shall be contacted to monitor ground-disturbing work if Native American cultural resources are discovered.	Identify a qualified Native American cultural resources consultant.	Metro, Gabrielino/Tongva San Gabriel Band of Mission Indians, and Tongva Ancestral Territorial Tribal Nation	Pre-Construction	CRMMP	Metro
		Monitor construction activities for compliance.	Metro	Pre-Construction		Metro
	CR/A-4: Work shall stop if human remains are found, and the Los Angeles County Coroner shall be notified immediately. If the remains are determined to be prehistoric, the Coroner shall notify the Native American Heritage Commission (NAHC), which will arrange for a Most Likely Descendent (MLD) to inspect the site within 48 hours and issue recommendations for scientific removal and nondestructive analysis.	Monitor construction activities for compliance.	Metro	Construction	CRMMP	Metro
		Identify MLD and ensure timely inspection occurs.	NAHC	Construction		Metro
	CR/A-5: If no cultural resources are discovered during construction monitoring, the archaeological monitor shall submit a brief letter to that effect. If previously unidentified cultural resources are discovered in the course of construction monitoring, a report shall be prepared following Archaeological Resource Management Report (OHP 1990) guidelines that documents field and analysis results and interprets the data within an appropriate research context.	Verify that a letter or report has been prepared as appropriate.	Metro	Post-Construction	CRMMP	Metro
Disturbance of the Los Angeles Zanja System (CA-LAN-887H and other unnumbered zanjas), and sites CA-LAN-3588, P-19-003338, and P-19-003339 could occur during construction.	CR/A-6: A proactive identification and documentation program that would facilitate preservation or mitigation in a cost-effective manner shall be undertaken. This shall include using documentary research to identify, as accurately as possible, the precise alignments of the zanjas within the area of potential effect. Where these alignments are expected to be affected by the proposed project, particularly where cut and cover or other near-surface construction techniques are planned in the vicinity of mapped zanja segments, full-time archaeological monitoring would be instituted to ensure documentation consistent with Section 4.12.2.4.2 of the Draft EIS/EIR.	Verify that the identification and documentation program has been prepared.	Metro	Final Design	CRMMP	Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Archaeological mitigation measures included in the MOA between the SHPO, Metro, and FTA shall be implemented as part of this MMRP. The full text of the MOA is attached to this MMRP.	See attached MOA.	Verify implementation of MOA mitigation measures.	Metro	Final Design, Construction	CRMMP	Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Cultural Resources - Paleontology						
Previously undiscovered paleontological resources may be disturbed during construction.	CR/P-1: A qualified paleontologist shall prepare a Paleontological Monitoring and Mitigation Plan for the proposed project and supervise monitoring of construction excavations within sensitive geologic sediments. The monitor shall have authority to temporarily divert grading away from exposed fossils to professionally and efficiently recover the fossil specimens and collect associated data.	Verify qualifications of paleontologist.	Metro	Final Design		Metro
		Verify that an adequate Paleontological Monitoring and Mitigation Plan has been prepared.	Metro	Final Design	CRMMP	Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro, Paleontological monitor	Construction		Metro
	CR/P-2: All project-related ground disturbances that could potentially affect the Puente Formation, Fernando Formation, and Quaternary older alluvium and terrace deposits would be monitored by a qualified paleontological monitor on a full-time basis (where feasible) because these geologic sediments are determined to have a high paleontological sensitivity. Very shallow surficial excavations (less than five feet) within Quaternary younger alluvium would be monitored on a part-time basis to ensure that underlying sensitive units are not adversely affected. Construction monitoring during any tunneling activity is not warranted as any potential fossil specimens present within sensitive geologic units would be crushed and destroyed by the nature of tunneling methodology.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	CRMMP	Metro
		Monitor construction activities for compliance.	Metro	Construction	CRMMP	Metro
	CR/P-3: At each fossil locality, field data forms shall be used to record pertinent geologic data, stratigraphic sections shall be measured, and appropriate sediment samples shall be collected and submitted for analysis.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	CRMMP	Metro
		Monitor construction activities for compliance.	Metro, Paleontological monitor	Construction		Metro
	CR/P-4: Due to the likelihood of the presence of microfossils, matrix samples shall be collected and tested within the Puente Formation and Fernando Formation. Testing for microfossils shall consist of screen-washing samples (approximately 30 pounds) to determine if significant fossils are present. Productive tests shall result in screen-washing of additional bulk matrix up to a maximum of 2,000 pounds per locality to ensure recovery of a scientifically significant sample.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro, Paleontological monitor	Construction		Metro
	CR/P-5: Recovered fossils shall be prepared to the point of curation, identified by qualified experts listed in a database to facilitate analysis, and reposited in a designated paleontological curation facility such as the Natural History Museum of Los Angeles County.	Verify that a suitable repository has been identified and recovered fossils are reposited appropriately.	Metro	Construction		Metro
	CR/P-6: The paleontologist shall prepare a final monitoring and mitigation report to be filed, at a minimum, with Metro and the identified repository.	Verify that an adequate report has been filed.	Metro	Post-Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Parklands and Other Community Facilities						
Restriction of access to public services could occur due to construction activities.	PC-1: Where feasible, temporary restriping of the roadway to maximize the vehicular capacity at locations affected by construction closures shall be performed. Metro shall provide notices of closures and relocations on its website, smart phone apps, and other modes typically used to communicate service announcements.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Documents	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	PC-2: Where feasible and necessary, temporary removal of on-street parking to maximize the vehicular capacity at locations affected by construction closures shall be performed. Where temporarily eliminated, parking spaces will be restored to their prior striped or signed condition at the conclusion of the construction period.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Traffic Control Plans	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	See also AQ-15, CN-1, CN-3, CN-5, CN-6, TR-4, TR-5, DR-6, and EJ-1.					
Economic and Fiscal Impacts						
Economic and fiscal impacts of business and parking displacement due to project acquisitions.	See DR-4 through DR-8.					
	EF-1: Metro shall develop measures to assist business owners significantly impacted by construction. These shall include temporary parking, marketing programs, and other measures developed jointly between Metro and affected businesses.	Oversee joint working group between Metro and affected business owners. Work individually with each business.	Metro, Joint working group	Preliminary Engineering, Final Design	Metro Community Outreach Plan	Metro
		Verify that all feasible, appropriate measures identified by the joint effort are implemented.	Metro, Joint working group	Construction		Metro
Safety and Security						
Safety and security concerns should be further minimized during operations through BMPs.	SS-1: Fire alarm protection shall be provided within station areas as required by applicable laws, regulations, and standards.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Verify that system is maintained in working order.	Metro	Operation		Metro
	SS-2: A minimum of two fire emergency routes shall be provided from each station as required by applicable laws, regulations, and standards.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Fire Life Safety Criteria	Metro
		Maintain exits in working order.	Metro	Operation		Metro
	SS-3: Adequate emergency ventilation and lighting shall be provided in each station in accordance with Metro Fire/Life Safety Standards and City of Los Angeles building codes.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Fire Life Safety Criteria	Metro
		Verify that system is maintained in working order.	Metro	Operation		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	SS-4: Communication systems between adjoining fire agencies shall be provided as required by applicable laws, regulations, and standards.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Fire Life Safety Criteria	Metro
		Verify that system is maintained in working order.	Metro	Operation		Metro
	SS-5: A methane detection system shall be provided in each station as required by applicable laws, regulations, and standards.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Fire Life Safety Criteria	Metro
		Verify that system is maintained in working order.	Metro	Operation		Metro
	SS-6: Building construction for underground stations shall not be less than Type I Construction as defined in the Uniform Building Code. All stations with more than two levels below-grade or where the lowest occupied level is more than 80 feet below-grade shall have protected level separation or other protection features to provide safe egress to exits.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Specifications	Metro
	SS-7: All proposed mitigation measures regarding safety and security shall be implemented in a manner conformant to Metro's Rail Transit Design Criteria and Standards and Fire/Life Safety Criteria. A combination of the following measures shall be implemented as indicated by the Threat and Vulnerability Assessment: closed-circuit television system, emergency push-button call system for patrons, intrusion detection system, dedicated security patrol protocols and procedures, and crime prevention through environmental design.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Fire Life Safety Criteria	Metro
	SS-8: Proposed station designs shall not include design elements that obstruct visibility or observation, nor provide discrete locations favorable to crime. Proposed stations shall be lighted to avoid shadows. Pedestrian pathways shall include clear sight lines whenever feasible. Project sidewalk widths and placements shall be appropriately designed to accommodate a wide variety of users. The following criteria shall be used when designing project sidewalks: sidewalk and pedestrian bridge widths shall be designed with the widest dimensions feasible (at least ten feet) in conformance with Metro's adopted land use and transportation policies; minimum sidewalk widths shall not be less than those allowed by the State of California Title 24 access requirements or the ADA design recommendations; where practicable, pedestrian movements and flows shall be favored over other transportation modes, such as automobile access; and stations shall be fully accessible as defined by ADA.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Specifications	Metro
	SS-9: An ADA accessible connection for the 2nd/Hope Street station to Upper Grand Avenue shall be provided. The future Broad Art Foundation Museum, currently under construction, is projected to include a plaza above General Thaddeus Kosciuszko Way connecting to Upper Grand Avenue. In order to provide access from the 2nd/Hope Street station to Upper Grand Avenue, an elevator from the station entrance to the plaza shall be built as part of this alternative if one is not already provided. If the plaza is not built, a pedestrian connection (such as a pedestrian bridge) shall be constructed. The connection shall reduce conflicts between pedestrians and vehicles.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Specifications	Metro
	SS-10: Adequate pedestrian queuing and refuge areas shall be provided at the proposed stations to facilitate pedestrian mobility. Adequately wide crosswalks shall be provided in the areas immediately around the proposed stations.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Specifications	Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	SS-11: All proposed stations shall be equipped with monitoring equipment, which shall primarily consist of video surveillance to monitor strategic areas of the stations and walkways and/or be monitored by Metro security personnel on a regular basis.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design Specifications	Metro
		Verify that system is maintained in working order.	Metro	Operation		
	SS-12: Metro shall implement a security plan for LRT operations to include both in-car and station surveillance by Metro security or other local jurisdiction security personnel. Metro shall coordinate and consult with the Los Angeles Fire Department, Los Angeles Police Department, and the Los Angeles County Sheriff Department as appropriate to develop safety and security plans for the proposed alignment and station areas.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Fire Life Safety Criteria	Metro
		Verify that system is maintained in working order.	Metro	Operation		Metro
	SS-13: Trains and/or platforms shall be equipped with safety features that reduce the potential for persons to contact the vehicle coupler and/or fall under the train.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Verify that features are maintained in working order.	Metro	Operation		Metro
	SS-14: Fire separations shall be provided and maintained in public occupancy areas as required by regulation.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Verify that features are maintained in working order.	Metro	Operation		Metro
Safety and security concerns should be further minimized during construction through BMPs.	SS-15: Metro shall protect public use of work areas involving sidewalks, entrances to buildings, lobbies, corridors, aisles, stairways, and vehicular roadways with appropriate guardrails, barricades, temporary fences, overhead protection, temporary partitions, shields, and adequate visibility. Metro shall keep sidewalks, entrances to buildings, lobbies, corridors, aisles, doors, or exits that remain in use by the public clear of obstructions. Metro shall post appropriate warnings, signs, and instructional safety signs. These requirements shall be included in the construction specifications.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Construction Specifications	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	SS-16: An education safety and outreach campaign shall be implemented during construction to address public safety awareness in the vicinity of the project. The campaign would target the diverse community in the project area to educate them on proper system use and benefits of LRT ridership.	Monitor construction activities for compliance.	Metro	Construction		Metro
	See also CN-1 through CN-3, TR-4, and DR-7.					

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Environmental Justice						
Temporary bus re-routing or stop closures may be needed in Little Tokyo during construction.	See TR-12 and TR-13.					
Disproportionate amounts of parking spaces would be temporarily removed in Little Tokyo during construction (i.e., more parking spaces would be removed in Little Tokyo than in other parts of the project area). This could impact the community, including businesses.	EJ-1: The temporary displacement of three bus loading spaces on Alameda Street for the JANM shall be replaced nearby for the duration of construction activities. Metro shall work with JANM to confirm locations of temporary loading spaces.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Traffic Control Plans	City / Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	EJ-2: Any unmet demand for parking spaces eliminated in Little Tokyo during construction shall be temporarily replaced within one block of the land uses that rely on those spaces, or through a combination of measures DR-4, and EJ-3 through EJ-9.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Traffic Control Plans	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	EJ-3: Metro shall provide two acres of land on the Mangrove property (northeast of 1st and Alameda Streets) for the purposes of providing alternative parking services during construction, which could include satellite parking served by shuttle buses, valet parking from vehicle pick-up/drop-off in the central business areas of Little Tokyo, and standard self-parking. The number of spaces provided would range from 200 standard spaces to approximately 300 spaces when supplemental parking services are operating. Any parking services shall be operated by a licensed/bonded parking company and shall be selected through a competitive request for proposal (RFP) process. Cost to park shall be comparable with current cost to park. The appropriate parking service provided will be determined with the participation of the Regional Connector Community Leadership Council (RCCLC) and/or other subcommittee. Through the RCCLC, LTCC, and other community groups it shall be assessed the feasibility of establishing a shuttle service connecting local parking lots and Little Tokyo/Arts District with destinations in downtown. This shall offset the temporary loss of parking available to patrons of Little Tokyo businesses, and other visitors, during construction.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Lease	Metro/Real Estate
		Monitor construction activities for compliance.	Metro, Parking Contractor	Construction		Metro
	EJ-4: Metro shall provide notices of traffic control plans and parking relocations on its website, smart phone apps, and other modes typically used to communicate service announcements.	Verify implementation of noticing procedures.	Metro	Construction	Community Outreach Plan	Metro Community Relations
	EJ-5: Metro shall support efforts to curb non-legitimate use of disabled parking spaces.	Verify agency support.	Metro	Construction, Operation		Metro
	EJ-6: Metro shall work with LADOT, owners of private parking lots, and businesses to develop an advanced parking reservation system at cooperative and suitable locations during construction.	Verify that agency and community coordination has occurred.	Metro, LADOT, Little Tokyo stakeholders	Final Design		LADOT / Metro
		Verify implementation and maintenance of system.	Metro	Construction		LADOT / Metro
	EJ-7: Metro shall work with LADOT to open city parking lots for short-term use on evenings and weekends during construction in the vicinity of Little Tokyo.	Verify that agency coordination has occurred.	Metro	Final Design		LADOT / Metro
		Verify parking lot adherence to extended hours.	Metro	Construction		LADOT / Metro
	EJ-8: Metro shall work with the City of Los Angeles to reduce impacts of government vehicles parking on 2nd Street during construction, such as identification of alternate parking areas.	Verify that agency coordination has occurred.	Metro	Final Design		LADOT / Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
	EJ-9: Metro shall work with the City of Los Angeles and the Little Tokyo Business Improvement District to facilitate creation of financial incentives such as parking validation programs to prioritize parking for Little Tokyo customers, residents, and businesses during construction.	Verify that agency coordination has occurred.	Metro	Final Design		LADOT / Metro
		Monitor implementation of any financial incentive parking programs.	Metro	Construction		Metro
	EJ-10: Metro shall identify which restaurants within Little Tokyo would be interested in establishing curbside pickup. Metro shall work with the City of Los Angeles to allow temporary curbside parking during construction, which would allow Metro to establish curbside pickup for Little Tokyo restaurants.	Verify that community and City of Los Angeles coordination has occurred.	Metro, LADOT, Little Tokyo stakeholders	Final Design	Community Outreach Plan	Metro
		Check design contract documents for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	EJ-11: Prior to construction, Metro shall conduct an annual parking needs assessment in Little Tokyo. Metro shall provide replacement parking for spaces lost as a result of the project as described in EJ-3 and to respond to the needs identified in the parking needs assessment. Metro shall work with Little Tokyo and surrounding communities to educate visitors and residents where parking is available during construction. Metro shall monitor parking, and the parking analysis shall be conducted on an annual basis throughout the duration of construction. This effort shall include new signage and other wayfinding features as appropriate.	Verify that an independent parking needs assessment has been performed.	Metro	Final Design	Parking Plan	Metro
		If demand exceeds supply, check design contract documents for permanent replacement parking provisions.	Metro	Final Design		Metro
		If demand exceeds supply, verify that replacement parking has been opened.	Metro	Pre-Construction		Metro
		If demand exceeds supply, verify that replacement parking is maintained.	Metro	Construction		Metro
		If supply exceeds demand, verify that meetings with the Little Tokyo community and surrounding communities have occurred.	Metro	Final Design		Metro
		If supply exceeds demand, verify that signage and any other appropriate way finding features have been placed and are maintained.	Metro	Pre-Construction, Construction		Metro
	See also DR-4 through DR-5.					
Disproportionate community and neighborhood impacts could occur in Little Tokyo during construction.	EJ-12: Metro shall provide assistance for businesses to maintain visibility during construction, including signage and advertisements.	Verify that signage and advertisements have been placed and are maintained.	Metro	Construction	Traffic Control Plans	Metro
	See also CN-1 through CN-7, DR-6, DR-7, TR-1, TR-2, TR-4, TR-5, EJ-2 through EJ-10, EJ-15, EJ-16, EJ-17, and EJ-19.					

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Disproportionate reductions of access to community facilities and businesses could occur in Little Tokyo during construction.	See TR-1 and EJ-1.					
Disproportionate property acquisitions and business relocations would occur in Little Tokyo.	EJ-13: Should parcels used for construction staging be proposed for redevelopment in the future, Metro is committed to involving the community in the redevelopment of construction staging areas following completion of construction activities. Metro shall do this through its established Joint Development Policy.	Verify that community input has been incorporated into redevelopment proposals.	Metro, Little Tokyo stakeholders	Construction, Post-Construction		Metro
	See also DR-8 and EJ-15.					
Disproportionate long-term displacement of commercial space could result in Little Tokyo.	EJ-14: Displaced commercial space in Little Tokyo shall be replaced with high quality commercial development opportunities consistent with Little Tokyo's community identity. This could include development at the 1st/Central Avenue station site. Depending on the type of new development, it would potentially create at least as many jobs as had been displaced.	Verify that opportunities for development of the 1st/Central Avenue station site and the Mangrove property are being actively sought.	Metro	Post-Construction		Metro / Joint Development
	EJ-15: Metro shall work with the Little Tokyo and Arts District communities and the Community Redevelopment Agency of the City of Los Angeles (CRA/LA) to create joint development opportunities for the 1st/Central Avenue station site.	Verify that input from CRA/LA and the Little Tokyo community has been received and incorporated into potential joint development opportunities.	Metro, CRA/LA, Little Tokyo stakeholders	Construction, Post-Construction		Metro / Joint Development
	See also EJ-13.					
Disproportionate visual alteration of the Little Tokyo neighborhood could occur due to removal of structures for the 1st/Central Avenue station.	See CN-7, EJ-14 and EJ-15.					
Disproportionate GBV impacts could occur in Little Tokyo during construction.	See NV-25 and NV-26.					

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Disproportionate economic and fiscal impacts to businesses in Little Tokyo could occur during construction.	EJ-16: Metro shall provide services to support affected Little Tokyo businesses and organizations during construction such as targeted advertising and marketing campaigns, Metro-sponsored coupons, incentives for construction worker patronage, and Metro-sponsored community events. Metro shall provide free technical support assistance (i.e., website development) to local businesses on strategies for business development that can minimize any adverse impacts of construction. This can include, but not be limited to, assistance with accounting or advertising. Metro shall work with the RCCLC including businesses, tenants, property owners, and government agencies with jurisdiction to make policy to resolve issues arising from adverse business issues during all phases of construction. The committee shall work to develop an implementation plan for these services and determine their content. The committee shall also be kept apprised of construction progress and upcoming transit, parking, or access changes. Metro shall provide maps showing existing and planned access during all phases of construction. Metro shall also provide directional signage to temporary parking facilities. An MOU agreement shall be developed to implement and compensate the process. The MOU will include but not be limited to provide the following: marketing and merchant support, technical and business assistance, Business Interruption Program to provide an expeditious standard for claims resolution and reimbursement, marketing services and branding campaign, merchant discounts and incentives/rewards program, signage (for business and access), and special event planning (including support). These activities shall be conducted in a manner consistent with the similar program developed for the Crenshaw Transit Corridor Project.	Verify that community input has been incorporated into implementation plan.	Metro, Little Tokyo stakeholders	Final Design	Community Outreach Plan	Metro / Community Relations
		Verify implementation of specified services and ongoing involvement of the RCCLC.	Metro	Construction		Metro / Community Relations
	EJ-17: Surface level construction activities shall be curtailed to the extent feasible during major Little Tokyo festivals and outdoor events to ensure that noise, air quality, traffic, and parking issues do not adversely affect these economically vital events. Metro shall request a list of events and festivities from the Little Tokyo community.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro / Community Relations
		Verify that community has provided a schedule of events.	Metro, Little Tokyo stakeholders	Final Design, Construction		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	See also CN-3 and EJ-2 through EJ-12.					
	EJ-18: Metro shall work with the Little Tokyo Business Association to help offset the neighborhood impacts associated with reduced revenue from the Business Improvement District funds during construction due to the removal of acquired businesses. Metro shall also offer the services described in EJ-16. Metro shall use Metro's existing claims process to address physical damage (utility interruption, for example).	Verify that community input has been incorporated into implementation plan.	Metro, Little Tokyo stakeholders	Final Design		Metro / Community Relations
		Verify implementation of specified services.	Metro	Construction		Metro
	EJ-19: Metro shall work with the Little Tokyo community businesses to minimize adverse impacts to business operations associated with utility relocation and protection of existing utilities. Metro shall offer the services described in TR-4, EJ-12, and CN-4.	Verify that community input has been incorporated into implementation plan.	Metro, Little Tokyo stakeholders	Final Design		Metro
		Verify implementation of specified services.	Metro	Construction		Metro

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Disproportionate adverse transportation impacts could occur in Little Tokyo during construction.	EJ-20: Metro shall provide advertising on its transit buses and other typical means of communication publicizing construction plans and alternatives to travel and park in Little Tokyo during the construction period. Metro shall also place these advertisements on construction site walls if the community desires.	Verify implementation of advertisement services.	Metro	Construction		Metro
	EJ-21: Metro shall avoid haul routes along 1st Street or along Alameda Street between 3rd Street and US 101 where possible. Haul routes shall be confirmed with the input of the community.	Verify that community input into haul routes has occurred.	Metro	Final Design	Haul Routes	Metro
		Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	See also EJ-1, EJ-2 through EJ-12, EJ-16, EJ-17, CN-3, and CN-7.					
Construction activities would be disproportionately centered in Little Tokyo, as would the associated safety and security needs.	EJ-22: Metro shall publish safety and security information at stations in Japanese, Korean, and Spanish. This includes both written and verbal announcements at stations.	Verify implementation and maintenance of signage and announcements.	Metro	Construction, Operation	Safety and Security Plans	Metro / Community Outreach
	EJ-23: Metro shall publish materials for the project's safety education campaign in Japanese, Korean, and Spanish.	Verify publication of materials.	Metro	Construction, Operation		Metro / Community Outreach
	EJ-24: Metro shall involve the Little Tokyo Public Safety Association in the development of safety and security plans.	Verify that input from Little Tokyo Public Safety Association has been incorporated.	Metro, Little Tokyo Public Safety Association	Final Design, Construction	Safety and Security Plans	Metro
		Monitor construction and operation for compliance.	Metro	Construction, Operation		Metro
	EJ-25: Metro shall monitor and ensure implementation of committed mitigation measures designed to address safety and security concerns.	Verify implementation and maintenance of measures.	Metro	Construction		Metro
	See also EJ-18.					
More operation noise may be audible in Little Tokyo than other parts of the alignment due to the portals and open-roof station.	EJ-26: Depending on the potential location and scope of the system's ventilation equipment, orient the exhaust away from downwind receptors to minimize noise from ventilation as well as underground train horns and related operational sounds.	Check design contract documents and construction specifications for compliance.	Metro	Final Design	Design	Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
Construction activities would be disproportionately centered in Little Tokyo, as would the associated air quality impacts.	EJ-27: Metro shall implement receptor-based mitigation where needed to reduce construction-related pollutant levels below significance thresholds. This could include installation of high efficiency particulate air filters on HVAC equipment at downwind receptors during construction activities.	Verify implementation of receptor-based mitigation measures.	Metro	Pre-Construction, Construction		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	See also AQ-1 through AQ-5, AQ-7, AQ-8, AQ-10, EJ-17, and EJ-26.					

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Land use impacts could occur in Little Tokyo.	EJ-28: Metro shall maximize opportunities to the extent feasible for enhancing access from existing land uses to the new station.	Verify implementation of program.	Metro	Final Design, Construction		Metro
	See also EJ-15 and EJ-26.					
Tunneling beneath existing buildings in Little Tokyo would introduce the potential risk of subsurface impacts.	EJ-29: Design of underground facilities shall avoid potential subsurface impacts to adjacent buildings.	Check preliminary engineering documents for compliance.	Metro	Preliminary Engineering	Design	Metro
	See also GT-1 through GT-5.					
Tree removal would occur in Little Tokyo.	EJ-30: New trees planted at station locations shall be regularly monitored by Metro to ensure healthy growth and development. Metro shall replace trees as close as possible to original locations.	Monitor trees.	Metro	Operation	Landscape Plan	Metro ECSD
	EJ-31: Metro shall provide the Little Tokyo and Arts District communities with opportunities for input into the development of landscape plans for the 1st/Central Avenue station throughout the preliminary engineering and final design processes.	Verify incorporation of Little Tokyo Community Council input into landscape plans.	Metro	Preliminary Engineering, Final Design	Landscape Plan	Metro ECSD
Foreign-language speakers would need to access project meetings and information.	EJ-32: Information shall be made available in Japanese and Korean, and flyers for project meetings shall indicate that there will be both Japanese and Korean translators present.	Verify provision of information in Japanese and Korean.	Metro	Ongoing		Metro Community Relations
TBM operations would be disproportionately concentrated in the vicinity of Little Tokyo.	EJ-33: Metro shall require the construction contractor to perform TBM operations for a period not extending beyond 48 months. This limit may need to be raised should circumstances arise that are beyond the control of Metro and the construction contractor. The community shall be notified if such a situation occurs.	Monitor construction activities for compliance.	Metro	Construction	Contract Documents	Metro
	EJ-34: Metro shall prepare a procedure for rapid shut-down of construction should maximum acceptable vibration thresholds be reached.	Check design contract documents and construction specifications for compliance.	Metro	Final Design		Metro
		Monitor construction activities for compliance.	Metro	Construction		Metro
	EJ-35: Metro shall prepare a cost-benefit analysis of using one versus two TBMs, and shall select the least impactful cost-effective solution.	Check preliminary engineering documents for compliance.	Metro	Preliminary Engineering		Metro
Construction Impacts						
Mitigation measures for construction-related impacts are discussed in the preceding sections.						

Impact	Mitigation Measure(s)	Monitoring Action(s)	Responsible Party	Project Phase	Deliverable	Enforcement Agency/Timing
Per Board Action (April 26,2012)						
74.A.1	Create an enhanced pedestrian walkway along the east side of Flower Street between 4th and 7th Streets.					
74.A.2	Relocate the Little Tokyo/Arts District underground station to minimize property required and eliminate the cut-and-cover segment on 2nd Street in Little Tokyo originally required for construction.					
74.A.3	Launch TBM from northeast corner of 1st and Alameda (Mangrove) instead of 2nd Street.					
74.A.4	Tunnel to Flower and 4th Streets in the Financial District to further reduce cut/cover in the area.					
74.A.5	Maintain access from Flower Street between 5th and 6th Streets to the West Lawn Garage.					
74.A.6	Any areas adjacent to the Maguire Gardens and Central Library impacted by construction will be returned to their original or improved state, with oversight by the Library Gardens Committee.					
74.A.7	The width and length of any construction worksite on Flower Street south of 4th Street will be minimized to the greatest extent feasible.					
74.A.8	South of 4th Street, construction decking shall be no higher than 10", if feasible, above the existing grade, and flush with existing curb on the east and west side of Flower Street with a maximum cross gradient of 3%.					
74.A.9	No construction worker parking on Flower and adjacent streets during construction. Consider obtaining temporary parking in the West Lawn Garage for construction workers.					
74.A.10	Enhancements to the pedestrian walkway along the east side of Flower Street between 4th and 7th Streets shall not permanently eliminate a southbound traffic land on Flower Street.					
74.A.11	Preserve the opportunity to install a future station north of 5th and Flower Streets.					
74.A.12	Restore Flower Street travel lanes after construction to the existing six lane condition from 4th to 6th Streets and the existing four lane condition from 6th to 7th Streets.					
74.A.13	Along Flower Street, accelerate the construction schedule to the greatest extent feasible, consistent with budgetary and other constraints.					
74.A.14	Minimize surface disruptions along Flower Street from truck trips, utility relocation, decking installation and removal, street restoration, or TBM removal, when feasible.					
74.A.15	Detailed surveys of Flower Street properties shall be performed prior to and at the end of construction.					
74.A.16	Shoring design for cut and cover construction along Flower Street will account for adjacent buildings.					
74.A.17	Noise and vibration levels will be monitored at Flower Street properties.					
74.A.18	If construction and/or operational ground-borne noise limits or ground-borne vibration limits are exceeded according to CEQA's significance thresholds, Metro will take action to reduce noise and vibration to less than significant levels at the property lines of sensitive uses.					
74.A.19	No pile drivers will be used along Flower Street during construction. If necessary, piles will be drilled or vibrated, but not driven.					
74.A.20	With property owners' consent, install and monitor deformation monitoring systems along Flower Street during construction.					
74.A.21	Reduced noise mufflers, air-inlet silencers, shrouds or sound walls will be used for generators, compressors, fans, exhaust systems and other inherently noisy construction equipment.					
74.A.22	Provide assistance for Flower Street businesses to maintain visibility during construction, including signage and advertisements.					
74.A.23	Ensure there is daily cleaning/washing during non-peak hours of Financial District streets affected by excavation and hauling.					
74.A.24	Provide protective measures, such as pipe and conduit support systems, vibration and settlement monitoring, trench sheeting, and shoring to avoid potential damage to utilities during construction.					
74.A.25	Maintain access to utilities for technicians, at all times during construction.					
74.A.26	Assign a full-time ombudsperson who is authorized to resolve complaints relative to the Project.					
74.C.1	Extend the use of a tunnel boring machine (TBM) under Flower Street to include the area between 4th and 5th Streets up to the intersection of 5th Street and Flower Street.					
74.C.2	On Flower Street between 5th and 6th Streets, where cut and cover is necessary, maintain four travel lanes between 6 AM and 8PM during weekdays during the "steady state". The steady state is defined as the period between the completion of the decking installation to the commencement of removal of decking.					
74.C.3	On Flower Street between 5th and 6th Streets, maintain no less than two travel lanes between 8pm and 6am, except for those times when further street restrictions are reqiured to facilitate decking installation and removal.					
74.C.4	Require that any public spaces, gardens, plaza, walkways, sidewalks, trees, street furniture, landscaping, hardscaping or pedestrian areas, including but not limited to the Library Gardens and the Citigroup Plaza, which are impacted, damaged or altered as a result of construction activity and/or staging, be reconstructed, replanted, repaired, and replaced like-for-like at the end of construction activity in that vicinity.					
74.C.5	Conduct various value engineering and cost methods determine if the aforementioned mitigation methods can be incorporated without an increase in the Life of Project 9 (LOP) Budget and report back in 60 days.					
74.C.6	Amend the LPA to include the design features if it can be completed within the current LOP budget. If staff determines that inclusion of these design features will exceed the LOP budget, the design features shall be included as proposal options during the construction procurement to allow proposers a process to include each feature and deterimine if it can be accomplished within the LOP budget.					
74.D.5	The designation of a Construction Relations Manager to serve as the point person for all community concerns regarding the project prior to construction. This person will be responsible for the entire project area and funded from the project budget.					
74.D.6	Reports will be made to the Board in June and August 2012 with the implementation strategy for the above activities, with quarterly reports to the Board thereafter, and throughout the duration of the construction period.					

LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

NOTICE OF AVAILABILITY
FOR THE
REGIONAL CONNECTOR TRANSIT CORRIDOR PROJECT
DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

The Federal Transit Administration (FTA) and the Los Angeles County Metropolitan Transportation Authority (Metro) have prepared a Draft Supplemental Environmental Impact Statement (DSEIS) for the Regional Connector Transit Corridor Project, a proposed underground light rail system that will connect the existing Metro Gold, Blue, and Expo Lines in downtown Los Angeles, California. FTA and Metro have prepared a DSEIS for the Regional Connector Transit Corridor Project pursuant to FTA National Environmental Policy Act (NEPA) implementation procedures (23 CFR 771.130). FTA is serving as the federal lead agency for the purpose of NEPA environmental clearance. As directed by U.S. District Court Judge Kronstadt on May 29, 2014, the DSEIS has been prepared solely to provide additional detail on tunneling methods not selected along the Flower Street portion of the Project between 4th Street and the 7th Street/Metro Center Station. The tunneling methods discussed are Open Face Shield and Sequential Excavation Method (SEM).

This notice shall alert interested parties to the availability of the DSEIS, describe the two tunneling method alternatives evaluated in the DSEIS, explain why they were not selected as the Locally Preferred Alternative (LPA), and invite public comments. This notice shall alert interested Federal, State, tribal, regional, and local government agencies of the availability of the DSEIS, and invite agency comments on the DSEIS.

The FTA may issue a single Final Supplemental Environmental Impact Statement and Record of Decision document pursuant to Pub. L. 112-141, 126 Stat. 405, Section 1319(b) unless the FTA determines statutory criteria or practicability considerations preclude issuance of the combined document pursuant to Section 1319. In that case, FTA would issue a Final Supplemental Environmental Impact Statement followed by a supplement to the Record of Decision, as needed.

PROJECT BACKGROUND: The light rail transit (LRT) project lies entirely within the City of Los Angeles. It is generally bound by U.S. Highway 101 on the north, 7th Street on the south, Alameda Street on the east, and State Route 110 on the west. The length of the proposed light rail project would be just under two miles. It would have three new stations (2nd/Hope, 2nd/Broadway, and 1st/Central). The Regional Connector Transit Corridor Project would provide a direct link connecting several light rail lines in operation or in construction, including the Metro Gold Line to Pasadena, the Metro Gold Line Eastside Extension, the Metro Blue Line, and the Metro Expo Line. The proposed project would provide a rail link through downtown Los Angeles such that LRT service would provide a one-seat ride for travel from East Los Angeles to Santa Monica, and from Azusa to Long Beach. With implementation of the Project, these LRT lines would share tracks and stations in downtown Los Angeles.

The LPA remains as identified in the certified 2012 Final Environmental Impact Statement/Environmental Impact Report (Final EIS/EIR) and the Record of Decision (ROD) certified by FTA on June 29, 2012. The LPA will be constructed with cut and cover construction along Flower Street from south of 4th Street to the 7th Street/Metro Center Station. It would constructed entirely underground until connecting with existing above grade lines, and would traverse under Flower Street north from existing LRT tail tracks located north of the existing underground 7th Street/Metro Center Station. At 3rd Street, it would begin to turn east to operate under 2nd Street between Flower Street and

Central Avenue serving stations at 2nd/Hope and 2nd/Broadway. At Central Avenue, it would connect to a new station (1st/Central) located between Central Avenue and Alameda Street in Little Tokyo.

ALTERNATIVES: The DSEIS provides additional detail on tunneling methods not selected along Flower Street, specifically Open Face Shield and SEM tunneling. The remainder of the project alignment is not changed and is not under consideration as part of the DSEIS.

EPBM/Open Face Shield/SEM LPA Profile Alternative (Alternative A): Alternative A would replace cut and cover construction by tunneling south to the 7th Street/Metro Center Station through the use of a combination of Open Face Shield tunnel boring and sequential excavation method (SEM) construction techniques. This alternative proposes the use of an earth pressure balance boring machine (EPBM) to bore twin tunnels generally following the horizontal and vertical alignment of the LPA from 3rd Street to south of 4th Street, with Open Face Shield tunnel excavation from 4th Street to 5th Street, and SEM tunnel construction from 5th Street to the existing 7th Street/Metro Center Station tail tracks structure.

EPBM/ SEM Low Alignment Alternative (Alternative B): Alternative B would replace cut and cover construction by tunneling south to the 7th Street/Metro Center Station through the use of a combination of EPBM and SEM construction techniques. This alternative proposes the use of EPBM to bore twin tunnels generally following the horizontal alignment of the LPA, but with a deeper vertical alignment than the LPA. The EPBM method would be used to tunnel to just south of 5th Street, with SEM tunnel construction from south of 5th Street to the 7th Street/Metro Center Station tail tracks structure.

DATES: The public review and comment period for the DEIS begins on June 12, 2015 and lasts for 45 days, ending on July 27, 2015. Please provide written comments to Ms. Dolores Roybal Saltarelli of Metro at One Gateway Plaza, MS 99-22-2, Los Angeles, CA 90012, or send email comments to regionalconnector@metro.net. Comments must be received by 5pm on July 27, 2015.

PUBLIC MEETINGS: Comments may also be submitted at two public hearings. One public hearing will be held on June 30, 2015 from 12:00pm to 1:30pm at the Los Angeles Central Library, Mark Taper Auditorium, 630 W. 5th Street, Los Angeles, CA 90071, and one will be held on July 7, 2015 from 6:30pm to 8:00pm at the Japanese American National Museum, 100 N. Central Avenue, Los Angeles, CA 90012.

DOCUMENT LOCATIONS: The DSEIS will be available for public review at the Metro Transportation Library at One Gateway Plaza, 15th floor, Los Angeles, CA 90012; and at the following public library locations:

- Los Angeles Central Library, 630 W. 5th Street, Los Angeles, CA 90071
- Little Tokyo Branch Library, 203 S. Los Angeles Street, Los Angeles, CA 90012
- Chinatown Branch Library, 639 N. Hill Street, Los Angeles, CA 90012
- Von KleinSmid Center (VKC), University of Southern California, University Park Campus, Los Angeles, CA 90089
- Pasadena Central Library, 285 E. Walnut Street, Pasadena, CA 91101
- East Los Angeles Library, 4837 E. 3rd Street, Los Angeles, CA 90022
- Culver City Julian Dixon Library, 4975 Overland Avenue, Culver City, CA 90230
- Santa Monica Public Library, 601 Santa Monica Boulevard, Santa Monica, CA 90401
- Long Beach Public Library (Main Library), 101 Pacific Avenue, Long Beach, CA 90822

It will also be available on Metro's website at www.metro.net/projects/connector.

FOR FURTHER INFORMATION CONTACT: Ms. Mary Nguyen, Environmental Protection Specialist, Los Angeles Metropolitan Office, Federal Transit Administration, Region IX, 888 South Figueroa

Street, Suite 2170, Los Angeles, CA 90017, phone (213) 202-3950, email mary.nguyen@dot.gov; or Ms. Dolores Roybal Saltarelli, Project Manager, Los Angeles County Metropolitan Transportation Authority (Metro), One Gateway Plaza, MS 99-22-2, Los Angeles, CA 90012, phone (213) 922-3024, email roybald@metro.net.

CONTACT THE PROJECT TEAM OR OBTAIN FURTHER INFORMATION FROM:
Project hotline: (213) 922-7277
Project e-mail: regionalconnector@metro.net
Project website: metro.net/connector.