



Metro

Los Angeles County
Metropolitan Transportation Authority

One Gateway Plaza
Los Angeles, CA 90012-2952

213.922.9200 Tel
213.922.9201 Fax
metro.net

FEBRUARY 10, 2014

TO: BOARD OF DIRECTORS

THROUGH: ARTHUR T. LEAHY 
CHIEF EXECUTIVE OFFICER

FROM: KRISHNIAH N. MURTHY 
EXECUTIVE DIRECTOR, TRANSIT PROJECT DELIVERY

**SUBJECT: REPORT TO METRO BOARD REGARDING REGIONAL
CONNECTOR PROJECT CONSTRUCTION ON FLOWER
STREET**

ISSUE

On January 23, 2014 at the Metro Board meeting the Flower Street litigants communicated to the Board their concerns regarding Metro's cut and cover construction method on Flower Street between 4th and 6th Streets.

DISCUSSION

In closed session following the public comments from the Flower Street litigants, the Metro Board considered the litigants' request to solicit proposals from the finalist contractors to tunnel the portion of Flower Street that Metro plans to construct by the cut and cover method. As part of the closed session discussion, Metro's Tunnel Advisory Panel advised the Board that, in their opinion, tunneling on Flower Street was too risky.

Enclosed please find written confirmation of the Tunnel Advisory Panel's opinion.

NEXT STEPS

Staff will continue to meet with the litigants, upon their request, to provide information regarding Metro's construction plans. We will keep the Board apprised of any new settlement proposals that we receive from the Flower Street litigants.

Enclosure

Report to Metro Board Regarding Flower Street Construction

by

**The Tunnel Advisory Panel
Los Angeles County Metropolitan Transportation Authority**

February 7, 2014

INTRODUCTION

This report confirms and clarifies comments made to the MTA Board by the Tunnel Advisory Panel (TAP) on Thursday, January 23, 2014.

The TAP has reviewed Metro's reference cut and cover design and numerous alternatives, including a tunneling proposal by litigants, for constructing the Regional Connector guideway on Flower Street. TAP concludes that the safest and most efficient method of dealing with the presence of tiebacks and the shallow depth of the guideway is by using cut and cover excavation on Flower Street.

The litigants propose that tunneling be extended from 4th Street to the 7th Street/Metro Center Station south of 6th Street thereby eliminating cut and cover construction and the removal of any excavated spoil along Flower Street. They have shown an alignment in which the 2nd and Hope Station is lower by approximately 50 feet (to a depth of approximately 150 feet below the ground surface) in order to lower the tunnels between 4th and 5th Streets.

However, in order to meet the existing grade of the upper level light rail platforms and associated tail track structure at 7th Street/Metro Center Station, a tunnel between 5th Street and 6th Street would have its roof at shallow depth in alluvial soils, would intersect rows of tiebacks, and would require a large single cavern excavation to accommodate the double track in the vicinity of the existing tail track structure. As discussed below, it is concluded that the proposal to tunnel throughout the length of Flower Street presents unacceptable risks to Metro related to subsidence and schedule impacts.

METRO TUNNEL PRACTICE

In 1996, in order to reduce the risk of recurring tunneling problems of large ground losses leading to settlement and surface subsidence, the TAP recommended and Metro adopted a practice of improved tunnel methods to reduce risks, which included use of pressurized, closed-face tunnel boring machines (TBMs) for controlling and limiting ground movements in soft and difficult ground conditions. The TBMs have a rotating cutterhead and a closed chamber at the front of the circular tunnel shield in which the excavated ground is pressurized thereby preventing inflow of water and soil and preventing ground loss both ahead of the tunnel face and around the perimeter of the shield. The final tunnel lining is installed within the protection of the circular shield as the TBM advances.

In 2006, pressurized, closed-face TBMs were successfully used to construct the twin tunnels on Metro Gold Line Eastside Extension without significant ground settlement and without damage to structures throughout the entire 1.7-mile twin tunnel alignment. Pressurized closed-face TBMs are required for all current Metro projects in soft and difficult ground including the Crenshaw/LAX, the Regional Connector, and the Purple Line Extension.

ADVERSE SITE AND GROUND CONDITIONS FOR TUNNELING BENEATH FLOWER STREET

The pressurized closed-face tunneling method cannot be used for the current vertical alignment along Flower Street because of the presence of steel tie-backs installed during the excavation of basements for the adjacent properties. Multiple rows of tiebacks extend into the street and the path of the guideway alignment from 4th Street to 6th Street.

Between 5th St. and 6th Streets, the vertical alignment must meet the existing grade of the upper level light rail platforms at 7th Street/Metro Center Station. Thus, the top of rail is approximately 40 feet below the ground surface which would place any possible tunnel roof at shallow depth in alluvial silts and sands. Pressurized closed-face tunneling cannot be used in this section, not only because of the presence of tiebacks but also because of the necessity of constructing a much larger, single excavation to accommodate the narrowing of track centers as the station is approached. (The narrowing of track centers arises from the construction of the existing 7th Street/Metro Center Station where the tracks are in the center between side platforms.)

Other tunneling alternatives, such as open face shields and sequential excavation methods leave the ground exposed in the face of the tunnel rather than supporting it continuously as does the pressurized closed-face TBM. For the sequential excavation method, the ground is exposed in the face and top of the tunnel during excavation and the support, consisting of steel reinforcement and sprayed concrete, is placed directly against the exposed ground rather than being installed beneath a protective shield.

To tunnel from 5th to 6th Streets would require the sequential excavation of caverns ranging from 40 to 60 feet in width with the roof of the cavern in alluvial sands and silts only 20 feet below the surface and 10 feet below major utilities and loose fill. Clearances reduce even further at 6th Street and approaching the end of the 7th Street/Metro Center Station, where the geometry of the underground structures are such that a stable cavern arch geometry would be unlikely to fit below the fill soils and utilities.

Less soil cover above a tunnel excavation means greater risk. In these alluvial soils, sequential excavation methods pose a risk of running or flowing of soil into the front and top of the advancing cavern excavation which, with the shallow depth, would result in voids rapidly chimneying upward to the utilities and street surface before they could be arrested.

When sequential excavation and open face shields are not capable by themselves of maintaining stability, ground improvement methods, such as grouting and freezing, may be used. For the alluvial soils, and large spans and shallow depth of the caverns between 5th Street and the 7th Street/Metro Center Station, suitable ground improvement methods that can be efficiently installed from within the advancing tunnel are limited and risks of large ground settlement remain. Employing these methods during tunneling increases the risk, further slows the advance, extends the schedule, and increases the potential for schedule delays impacting the entire Regional Connector project. The alternative of installing ground improvement from the surface or from shafts placed in the street would have significant impact on the use of the street, would have the potential for as much or more impact than cut and cover excavation, and would not eliminate risks of large ground loss.

The tiebacks are not only an obstruction but a potential preferential pathway for groundwater and soil to flow into the excavation. In 1987, one of our TAP members worked on a project with similar tieback obstructions using an open shield. Difficulties with soil stability and removal of tiebacks ahead of the open tunnel face resulted in two sinkholes and maximum street settlements were in the range of 2 inches, even after extensive filling of voids with compaction grout.

Tunneling over the full length of Flower Street and the elimination of shafts for removal of excavated soil material (muck) on Flower Street requires that the excavated material be taken through the entire tunnel length to the Mangrove construction site. Thus, the excavation on Flower St cannot be started until the TBM tunnels reach Flower Street. In addition the remainder of the tunnel and the three stations cannot be completed until the slower sequentially excavated caverns on Flower Street are excavated. The inability to decouple the Flower Street construction from the tunneling and station construction on the remainder of the project would have a major impact on project schedule and cost as well as a risk of schedule delays that would impact the entire project.

CUT AND COVER CONSTRUCTION

The relatively narrow excavation and shallow guideway alignment on Flower Street favors the cut and cover method. The excavation side walls are formed by vertical beams installed in pre-drilled holes, as are most excavation walls constructed for building basements and subways throughout Los Angeles. Unlike building excavations, the cut and cover excavation is decked so that traffic is maintained during construction.

The excavation width along most of Flower Street is less than the full width of the street. Generally a minimum of three lanes of traffic is maintained on Flower Street through the construction period. However, because the underground cut and cover structure is relatively narrow, an access lane for through traffic can be maintained even during the short periods for each increment of the decking installation and removal. A low profile composite decking has been designed that can be rapidly installed above utilities during off-peak periods. Once the decking is in place, the bulk of the excavation is performed beneath the decking allowing restoration of traffic on Flower Street throughout the construction period. Shafts adjacent to the cut and cover excavation are used to remove the excavated material rather than transporting it through the tunnels and three station excavations to the Mangrove site. Thus the excavation on Flower Street can proceed independently of the construction on 2nd Street.

RISK MANAGEMENT

Metro and the Federal Transit Administration have met regularly to evaluate and mitigate risks to the Regional Connector project. Although the design-build (DB) team will have flexibility to prepare designs and select construction methods, the project has been laid out and the DB scope and performance requirements prepared to reflect the results of Metro's risk assessment and mitigation process. Many of the tunneling and ground improvement methods that are possible are not suitable when considered in terms of the ground conditions, project constraints, and the risks that must be controlled and assumed by Metro. The question is not whether any given method might be able to be used in tunneling beneath Flower Street but what are the risks that Metro is willing to assume.

In applying the above risk mitigation measures to Flower Street, the TAP concludes that tunneling throughout the length of Flower Street presents unacceptable risk to Metro related to subsidence and schedule impacts. The safest and most efficient method of dealing with the presence of tiebacks and the shallow depth and existing soil conditions of the guideway is by using cut and cover excavation.