WESTSIDE SUBWAY EXTENSION PROJECT

Contract No. PS-4350-2000

Reply to Exponent Responses

Prepared for:

Metro

Prepared by:

PARSONS BRINCKERHOFF
777 South Figueroa Street
Suite 1100
Los Angeles, California 90017

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ACRONYMS AND ABBREVIATIONS

BHHS	Beverly Hills High School
BHUSD	Beverly Hills Unified School District
DTSC	Department of Toxic Substances Control
HDD	horizontal directional drilling
IRP	Metro's Independent Review Panel
LADBS	Los Angeles Department of Building and Safety
OSHA	Occupational Safety and Health Administration
ppbv	parts per billion by volume
ppmv	parts per million by volume
TAP	(Metro) Tunnel Advisory Panel

1.0 COMMENTS ON EXPONENT RESPONSE TO METRO'S APRIL 6 REPORT

Exponent Failure Analysis Inc. (Exponent) has responded on behalf of the City of Beverly Hills to Metro's April 6 comments on Exponent's February 2012 *Hazard Assessment Study* Report in its document dated April 25, 2012. This reply refers to that document as Exponent's Response to Metro's comments. Metro is obligated to reply to the April 25 document. However, much of the Exponent response is simply a re-statement of the original (unfounded) assertions. For simplification and clarity, this reply summarizes Exponent's responses and refers to previous reports where applicable. The sections below provide Exponent's April 25 Responses and the associated comments by Metro.

Exponent continues to question Metro's evaluation of the Westside Subway alignments and tunneling safety with respect to the following *considerations*:

- The relative risks of the two Century City alignments related to gassy ground conditions vs. active faulting
- The appropriate level of investigation of subsurface gas conditions and the testing standards that were used
- Assessment of tunneling safety based on past experience and new technology—including tunneling in oil fields
- Future development over the tunnels

2.0 RELATIVE RISK: GASSY GROUND VS. ACTIVE FAULTING

Exponent states: ***"Exponent disagrees with Metro's stated approach to dealing with risk and reaffirms that the acceptable way to assess and manage risk is by performing the quantitative risk assessment outlined in Exponent's Hazard Assessment Study, which has been used in many major industrial and infrastructure projects, including tunneling projects."*** (first page Executive Summary)

Metro response: Exponent continues to propose the use of probability-based risk management analyses. Some individual members of Metro's Independent Review Panel (IRP) were personally instrumental in the initial creation and development of the concept of probability-based risk management and have been continuously involved in its implementation for several decades. However, the Independent Review Panel (IRP) believes that the results of the extensive analysis proposed by Exponent would not be transparent and they would be hard to interpret because it would be difficult to understand what factors really control the results.

The IRP believes that Metro's approach to risk management is correct. As presented in its previous response to Exponent, Metro's approach to managing risk is by first eliminating fault rupture risks that are unmanageable. Because it is not possible to ensure life safety for a subway station in an active fault zone, the risk of building a station in the Santa Monica Fault Zone must be removed for the safety and security of the Los Angeles area community. It would be inappropriate to pursue design for this dangerous option.

Metro has developed an alignment at Century City Constellation Station where there are no active faults and the risks associated with soil gas are readily manageable. Soil gas presence is a risk that is mitigated safely on a routine, even daily, basis in the City of Los Angeles. These risks have been managed reliably over 20 years during Metro construction and operation of facilities. Exponent has acknowledged (refer

to Section 3.0) that tunneling or building a station in gassy soils can be accomplished safely when using proper equipment, techniques, and mitigation measures.

Moreover, Shannon & Wilson, consultant for the City of Beverly Hills, in its review of the Century City Area Fault Investigation Report asserts that *"risks associated with ground loss during construction, vibrations during construction and operation, and hazards from methane and other gasses can be mitigated by design plans and specifications for the project."*

The removal of unmanageable risk and its replacement with manageable risk through proven gas detection and mitigation technologies is the cornerstone of Metro's risk management approach. Metro reaffirms that its approach conforms to accepted, best practices of the underground construction industry and embodies the successful risk management procedures used on major civil works, including transit projects, throughout the U.S. and many parts of the world.

Exponent does not provide any new data on the presence of active faulting other than reference to observation of trenches on the Beverly Hills High School (BHHS) Campus. Metro provides comments on the fault studies by others in its report, *Response to Leighton Consulting Report,* May 14, 2012. In addition to that report, Metro has made previous statements about the applicability of trench investigations and the absence of faulting at the Constellation Station site. Refer to Metro's Response to Shannon & Wilson, April 17, 2012, for discussion of trenches.

3.0 MANAGEMENT OF RISKS RELATED TO SUBSURFACE GASSES

Exponent maintains that risks associated with soil gas may be comparable to, or greater than, those associated with active faulting. Metro disagrees. As discussed above, active faulting along Santa Monica Boulevard is a source of unmanageable risk that must be avoided. In contrast, soil gas risks can be mitigated safely and are done so on a routine basis. Modern soil gas mitigation measures for subterranean structures are well established and have proven to be highly effective. Several excavations for subterranean parking, some even deeper than the proposed Century City Constellation Station, have been constructed and operated safely in the immediate vicinity of the proposed station. Metro has compiled data on these projects in conjunction with its alignment assessment activities. The data show that previous rudimentary gas mitigation measures have been effective. Moreover, gas mitigation technology has improved substantially in recent years. The modern gas mitigation technology, which will be incorporated into the Constellation Station, operates with additional levels of redundancy that reduce the risk of gas intrusion to insignificant levels. Exponent apparently agrees, as it states, "***Exponent did not contend that tunneling or building a station in gassy soils could not be accomplished safely"*** (page 9).

Exponent (pages 9 and 10) expressed concern about the sufficiency of soil gas data west of BHHS near the proposed Constellation Station. It should be recognized that many gas probes have been installed and monitored in this area in addition to those associated with Metro's investigation activities. Predominantly, these subsurface gas investigations were performed in accordance with the Los Angeles Department of Building and Safety (LADBS) testing guidelines referenced by Exponent. Metro's consultants have researched and compiled over 20 years of measurements from gas probes installed near the Constellation site—as well as a large number of boring logs with stratigraphic and hydrologic information. This database, combined with Metro's Westside field data, is substantial and more than sufficient for the assessment of station alternatives. Note that Plate 2 (reproduced in Appendix A) in the

Century City Fault Investigation Report shows the locations of more than 100 borings in the vicinity of the proposed Constellation Station. This figure illustrates the vast amount of relevant subsurface data that has been collected and reviewed with respect to the Constellation Station.

From all the data collected and reviewed in the Century City/Beverly Hills area to date, Metro is confident that the gas levels at BHHS are lower than those found in some other areas of the city where safe and successful tunneling has been performed. In over 20 years there have been no safety-related problems with gas during Metro tunneling and subsequent tunnel operations.

Metro has requested access to the BHHS site for independent installation of soil gas probes. Beverly Hills Unified School District (BHUSD) has not yet agreed to allow Metro to proceed with the proposed additional installations. Accordingly, these measurements will be done during final design to determine what protective measures or monitoring are required to ensure the safety of students. Gas concentrations alone do not confirm that a hazard exists at a site. Other factors, such as pressures and potential flow volumes, are even more important. Nevertheless, the gas concentrations reported in the vicinity of BHHS are lower than concentrations found in other areas of the city that have been successfully tunneled by Metro or excavated by Metro for stations and other underground facilities.

As a further note, Metro is aware of much misinformation about soil gas is being disseminated. Appendix B presents additional information about soil gas and constructing in gassy ground.

4.0 METHANE TESTING STANDARDS

Exponent states (regarding testing standards for subsurface gases)**: *"….The Metro reports (including information contained in Appendix L of the Metro Final EIS/EIR) do not present specific justification (in the form of a standard or guideline) for the selection of the locations or spacing between the gas monitoring wells or borings. It appears that no gas investigation standards were followed as none were referenced in Metro's Tunneling Safety Report."***

Metro response: Based upon the above assumption, Exponent further suggests that *high quality* soil gas data does not exist for the project. Exponent references three publications that contain soil gas testing guidelines that it asserts were not followed. It should be noted that Metro's soil gas consultants were involved with the development of all three of the referenced guidelines. Each of the guidelines is not applicable to the Westside Subway project. The testing guidelines cited by Exponent were developed for specific types of projects, such as for the assessment of new buildings on-grade or with basements. The guidelines were not developed for application to *tunneling* projects.

For example, Exponent referenced a 100-foot grid testing protocol for methane investigations at school sites that is for identification of potential methane source areas such as *settling ponds* and *manure pile areas,* and is not appropriate to assess gas for a tunneling project.

Metro and its consultants have implemented appropriate project-specific soil gas testing procedures for the Westside Subway Extension Project with consideration given to applicable testing guidelines. The soil gas vadose zone probe installations for the Westside Subway Extension Project are consistent with the specifications that are provided in the referenced guidelines, with the understanding that Metro testing is for a linear tunnel project rather than a surface development. Groundwater monitoring wells are also included in the Metro study, whereas only shallow vadose monitoring is required by DTSC and LADBS. In many ways, the sampling and testing procedures used on the Westside Subway Extension

Project are more rigorous and detailed than the procedures referenced by Exponent. The amount, diversity, duration, redundancy, and quality of the soil gas data that have been compiled for the Westside Subway Extension Project meet, or exceed, the objectives that are set forth in the references cited by Exponent and are sufficient for tunnel alignment selection. Moreover, additional soil gas testing will be conducted during final design. Accordingly, there is no basis for Exponent's suggestion that appropriate guidelines were not followed or that high quality data was not collected.

5.0 TUNNELING IN OIL FIELDS

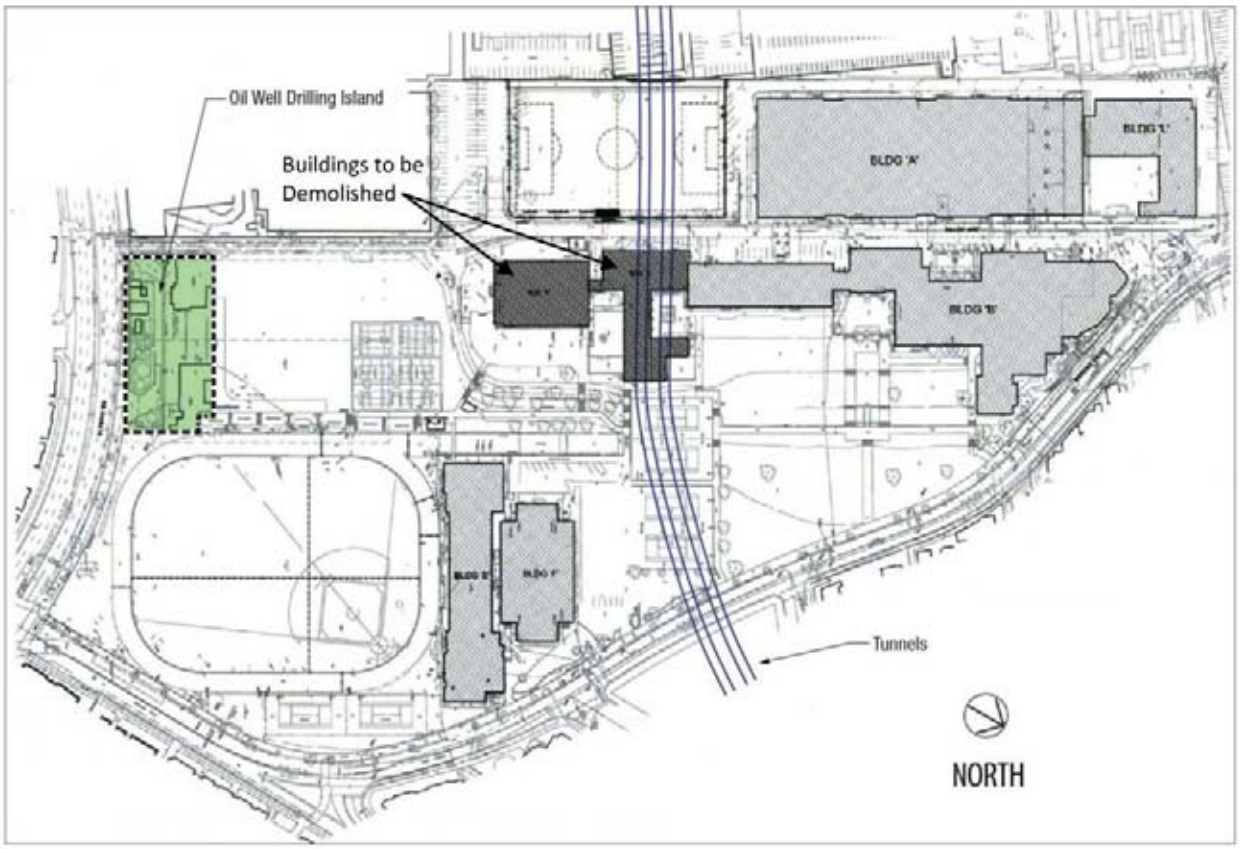
Exponent states: ***"The Metro Response Report mentions that horizontal directional drilling (HDD) will take place for exploration beneath BHHS buildings during the next phases of design (i.e. after the tunnel alignment has already been selected). It is Exponent's opinion that the HDD should occur during the preliminary design phase in order to consider all risks associated with a particular alignment option."*** (Section 6, Page 11)

Metro response: Exponent agrees with Metro's plan to use horizontal directional drilling (HDD) to probe using magnetometers to locate any abandoned oil well casings along the tunnel alignment prior to tunneling. Metro has investigated the methods and plans to proceed with HDD during final design. If a well casing is located, there would be sufficient time to remove it or depending on the well location adjust the alignment slightly to avoid it - before the tunnel boring machine reaches the area.

Exponent states: ***"Exponent expresses concern for potential ground settlements and impacts on the BHHS building if the TBM is stopped beneath the building in order to abandon an oil well casing."***

Metro response: Should an oil well casing be found to be located along the alignment and beneath a current BHHS building, several alternatives will be considered. The situation lends itself to full cooperation between Metro and BHUSD for an opportunity to explore the site conditions for the purpose of mutually optimizing the interaction of tunneling and future development of the high school. BHHS plans for future development (Modernization Plan 2009, Figure 1) show that the portion of the building beneath which the tunnel would be advanced would be removed. In this case, access for well abandonment and casing removal would be gained from the surface prior to tunneling. If the existing building were to remain in place, should a well casing be detected, consideration would be given to either adjusting alignment slightly to avoid a casing or to gaining access using ground control procedures, such as grouting or freezing, to excavate and remove the casing prior to tunneling without impacting the buildings above. It is emphasized that the probability of encountering an oil well on the tunnel alignment and directly under the school buildings is very low. There is no evidence from available Division of Oil, Gas, and Geothermal Resources records or from historic photos of the existence of oil wells under the BHHS buildings along the proposed alignment.

Figure 1: Buildings Indicated to Be Demolished at BHHS



6.0 ASSESSMENT OF TUNNELING SAFETY BASED ON PAST EXPERIENCE

Exponent states (with respect to Section 5 of their Hazard Assessment Study): ***"The purpose of discussing past projects was not to draw comparisons between different tunneling methods, but to show what can occur when proper procedures are not followed or when unexpected ground conditions or work stoppages are encountered."***

Metro response: As Metro noted in its April 11 response, Exponent referenced past tunnels driven with open face shields. Open face shields are no longer used on Metro projects. Potential issues related to their use are not relevant to pressurized face shields that are now required on Metro projects. It is again emphasized that the proper procedure is to require the use of the pressurized face shields and provide criteria and monitor performance to ensure that requirements are met.

Exponent states: ***"Small values of surface settlement may indeed be possible with current tunneling technology" but they assert that these assessments are "very optimistic" and that they "…are reliant on flawless control of the TBM."***

Metro response: Metro reemphasizes that achieving surface volume loss of less than 0.5 percent and settlements less than 0.5 inch are realistic requirements and will be specified for the tunneling at Century City. It is not coincidental that settlements significantly less than 0.5 inch were *achieved*

throughout the entire 1.7-mile length of each of the two EPB tunnels driven on Metro's MGLEE project in 2006. The result was achieved with normal operation of the TBM, which includes control of machine performance and monitoring to confirm that ground movements are being controlled to required levels.

Further, as noted in Metro's previous response, ground loss of less than 0.5 percent is now routine on pressure face tunneling projects—recent examples include City of Portland East and Westside CSO tunnels and the University Link transit tunnels in Seattle, where most of the four tunnel drives were beneath buildings. A prime international example is the experience on Line 9 of the Barcelona Metro. The achievement was particularly impressive because it was with large-diameter shields (31 and 39 feet diameter) driven over most of the alignment, beneath buildings. Bono, et al (2008), with the contractor Paymacotas, state:

> *"According to our experience in Barcelona, even in very different geological contests (sic) ranging from Pliocene clay/sands to Olocenic low consolidated silts with covers ranging from 1.5 to 2 diameters, it is currently possible to reach a negligible surface settlement, maintaining the apparent volume losses well below the 0.5%.*
>
> *"This has been possible with the implementation of a detailed ground monitoring which is continuously feeding a back analysis process to set the EPB shield excavation parameters jointly with a strict control carried out directly in the EPB shield."*

With respect to BHHS, Shannon & Wilson, consultant for the City of Beverly Hills, in its review of the Century City Area Fault Investigation Report, asserts that *"the tunnel is not likely to directly impact the campus facilities."* They further indicate that the *"risks associated with ground loss during construction, vibrations during construction and operation, and hazards from methane and other gasses can be mitigated by design plans and specifications for the project."*

Exponent states: ***"the absence of past incidents does not, by itself, ensure that future tunneling in "similar" conditions is inherently safe."***

Metro response: The above statement is correct if the requirements and conditions necessary to achieve the previous good performance are not understood and properly applied on the future project. However, this is not the case. Ground control requirements are well understood and are being applied for the current and future Metro tunnel projects.

Exponent states: ***"Furthermore, tunnel alignment comparisons and necessary precautions cannot be made without incorporating possible outcomes of excessive settlement into an overall framework for quantitative risk assessment."***

Metro response: Metro disagrees. Rather than conducting a quantitative risk assessment of the outcomes of excessive settlement, the *necessary precautions* employed by Metro are to monitor, control, and make adjustments and apply corrections to ensure that ground movements are controlled. Metro employs a series of steps in the planning, design, and construction to ensure ground control. As noted in Metro's previous response, these include:

- Prequalification of contractor and senior personnel, requiring experience in pressurized face tunneling
- Contract specifications for pressurized face tunneling and ground control

- Contractor work plan submittals for controlling operation, including target and warning levels for key machine functions
- Monitoring of ground movements around shield and feedback to machine operation

Exponent states: ***"However, the risks always exist for unexpected conditions. Several sources of ground displacement, specific to pressurized, closed-face TBMs, include the following (Boone, 2008)."***

Metro response: The Boone reference outlines sources of ground movement around the face, body, and tail of the shield. Many are conditions that are not unexpected risks but are dealt with in the design and operation of the shield. Metro's consultants have evaluated and summarized sources of ground loss, including those outlined in the Boone reference, based on their own pioneering field investigations with open shields as well as recent investigations of pressure face shields that have demonstrated their capability to limit ground movements around the face and perimeter of the shield. Most importantly, proven procedures for controlling these conditions have been identified and applied.

7.0 FUTURE DEVELOPMENT OVER THE TUNNELS

Exponent states: "***On page 7-1 of their Response Report, Metro states that special foundations would not be required for structures placed above the tunnels. However, this would be true only for future structures that lie above or outside of Metro's Right-of-Way Envelope. The preliminary tunnel profiles under BHHS show the tunnel crown to be approximately 55 to 70 feet below grade, leaving approximately 30 to 50 feet of clearance for underground structures and foundations. This amount of clearance may be sufficient for two to four levels of underground parking on a mat foundation. However, other types of structures may require different foundations that consist of piles or drilled piers that extend into Metro's Right-of-Way Envelope. In the Response Report, Metro states that 'Any future project to be developed adjacent to Metro right-of-way will need Metro approval prior to construction.' Closer guidance and expectations should be provided by Metro about any construction approval processes required by them."***

Metro response: This topic was covered in Metro's Tunneling Safety report (Section 8.0), but it appears that there are misconceptions regarding Metro's Right-of-Way Envelope and requirements for locating structures above and adjacent to Metro tunnels. Guidance on the construction approval process can be found in Metro's *Adjacent Construction Design Manual* (R9-DE303-3.00). Review of proposed designs that could have a direct impact on a Metro facility or structure is required, but specific requirements for offsets and stand-off distances from the tunnels are not given because each project—and its relationship to the Metro facility—is unique and solutions need to be made on a case-by-case basis. Metro looks forward to the opportunity to work with BHHS to develop acceptable solutions for proposed foundations or underground facilities in the vicinity of the tunnels.

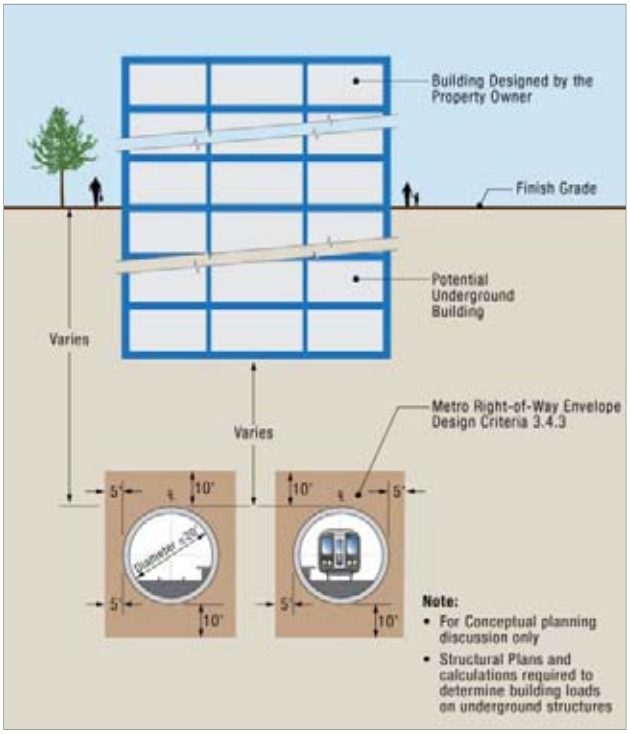
Metro Rail Civil Design Criteria defines right-of-way limits for earth tunnels for real estate acquisition purposes, as shown in Figure 2 reproduced from the Metro Tunneling Safety Report.

Some facts about tunneling under buildings or building above tunnels are as follows:

- Major bridge-like structures with wide spans to support foundations above the tunnels are generally not required.

- Near-surface structures with shallow foundations and basements can be constructed above the tunnels. Clearances above the proposed tunnel crown are sufficient for multiple levels of underground parking.
- Construction of basements or underground parking structures on mat foundations reduces the load on underlying structures, making it feasible to place the foundation mat in close proximity to the crown of the underlying tunnel. The weight of the soil removed is usually more than the weight of the structure.
- Deep foundations, such as drilled piers, can be placed adjacent to, and between, the tunnels.

Figure 2: Figure 8-1 from Metro Tunneling Safety Report



As an additional note, Metro researched where tunnels have been safely constructed under schools or where schools have been constructed above tunnels. A few examples in North America are listed in Table 1.

Table 1. List of Schools above Transit Tunnels

Name of School	Location	Building Date	Date Tunnel Constructed
Camino Nuevo Charter Academy	Los Angeles, CA	~ 1994	1993
The Northwest School	Seattle, WA	1905	2012
Bentley School	Oakland, CA	~1928	1970's
East Sylvan Middle School	Portland, OR	Prior to tunnel	1990's
West Portal Elementary School	San Francisco, CA	1927	1918
Rooftop Elementary School	San Francisco, CA	1953	1918

8.0 SUMMARY

Metro reconfirms the conclusions provided in the two Century City Investigation reports and in its Tunnel Advisory Panel (TAP) Report issued on October 19, 2011:

- Metro's approach to Risk Management is correct.
- Because of known active faulting, station sites along Santa Monica Boulevard are unacceptable for a subway station. Further discussion of faulting is provided in Metro's responses to Leighton Consulting and Shannon and Wilson.
- There is no active faulting at the Constellation Station site and the location is suitable for a station.
- Tunneling can be safely accomplished along the Constellation alignment and under BHHS and adjacent properties. This includes construction in gassy ground and oil producing areas.
- The presence of the tunnels will not preclude expansion and development of the High school.

9.0 REFERENCES

Bono et. al., 2008, "Surface Settlement Minimization in Soft Soil when Excavating with and Earth Pressure Balance Shield," (Paper in English), Journada Technical: Tuneles Con EPB: Simulatcion y Control de la Tuneladora, Univeritat Politecnica de Catalunya Universidad

Los Angeles County Metropolitan Transportation Authority. *Adjacent Construction Design Manual* (R9-DE303-3.00)

Los Angeles County Metropolitan Transportation Authority. November 2011. *Westside Subway Extension Project Century City Area Tunneling Safety Report.*

Los Angeles County Metropolitan Transportation Authority. November 2011. *Westside Subway Extension Project Century City Area Fault Investigation Report.*

Los Angeles County Metropolitan Transportation Authority. May 2012. *Westside Subway Extension Project Response to Leighton Consulting Report (DRAFT).*

Los Angeles County Metropolitan Transportation Authority. April 4, 2012. *Westside Subway Extension Project Response to Hazard Assessment Study by Exponent.*

Los Angeles County Metropolitan Transportation Authority. April 17, 2012. *Westside Subway Extension Project Response to Preliminary Review comments of Century City Area Fault Investigation Report by Shannon & Wilson.*

APPENDIX A DATA LOCATIONS IN CENTURY CITY

APPENDIX A DATA LOCATIONS IN CENTURY CITY

Plate 2 From Century City Tunneling Safety Report

APPENDIX B ADDITIONAL INFORMATION ABOUT SOIL GAS

APPENDIX B ADDITIONAL INFORMATION ABOUT SOIL GAS

It is clear that many people have sincere concern regarding gas safety at Beverly Hills High School.

It is important to know that an extensive body of information is available regarding the control of methane soil gas and hydrogen sulfide, including regulatory guidelines and the historical experience at many project sites in Southern California and indeed around the nation. These guidelines have been successfully employed for many years. Based upon this knowledge and guidance, decisions can be made confidently. It should be noted that even the high-profile soil gas sites in Los Angeles over the last several decades have been successfully mitigated and are currently occupied.

It is important to understand that the gas hazard or risk during tunneling is related to the volume, concentration, and pressure of the gas in the surrounding soil. Gas concentrations are not the same in the tunnel as they are in the soil because the soil permeability and the presence of the tunnel lining limits the flow of gas into the tunnel and because ventilation is provided to dilute and remove gases that enter the tunnel.

Experience in Los Angeles, and in other cities in the United States and world-wide, has shown that the proper combination of design, modern tunneling equipment and methods, and a supply of sufficient ventilation lead to successful tunnel construction and operations in gassy ground.

APPENDIX C FIGURES LOCATION OF SCHOOLS ABOVE TUNNELS

Metro Subway Tunnels

7th Street

Macarthur Park Station

Esperanza Public Elementary School

Camino Nuevo Charter Academy

RECORD DRAWING

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT

LA CBD TO NORTH HOLLYWOOD
WILSHIRE / ALVARADO LINE
TRACK ALIGNMENT PLAN
STA AR 248+00 TO STA AR 257+00

INITIAL ISSUE

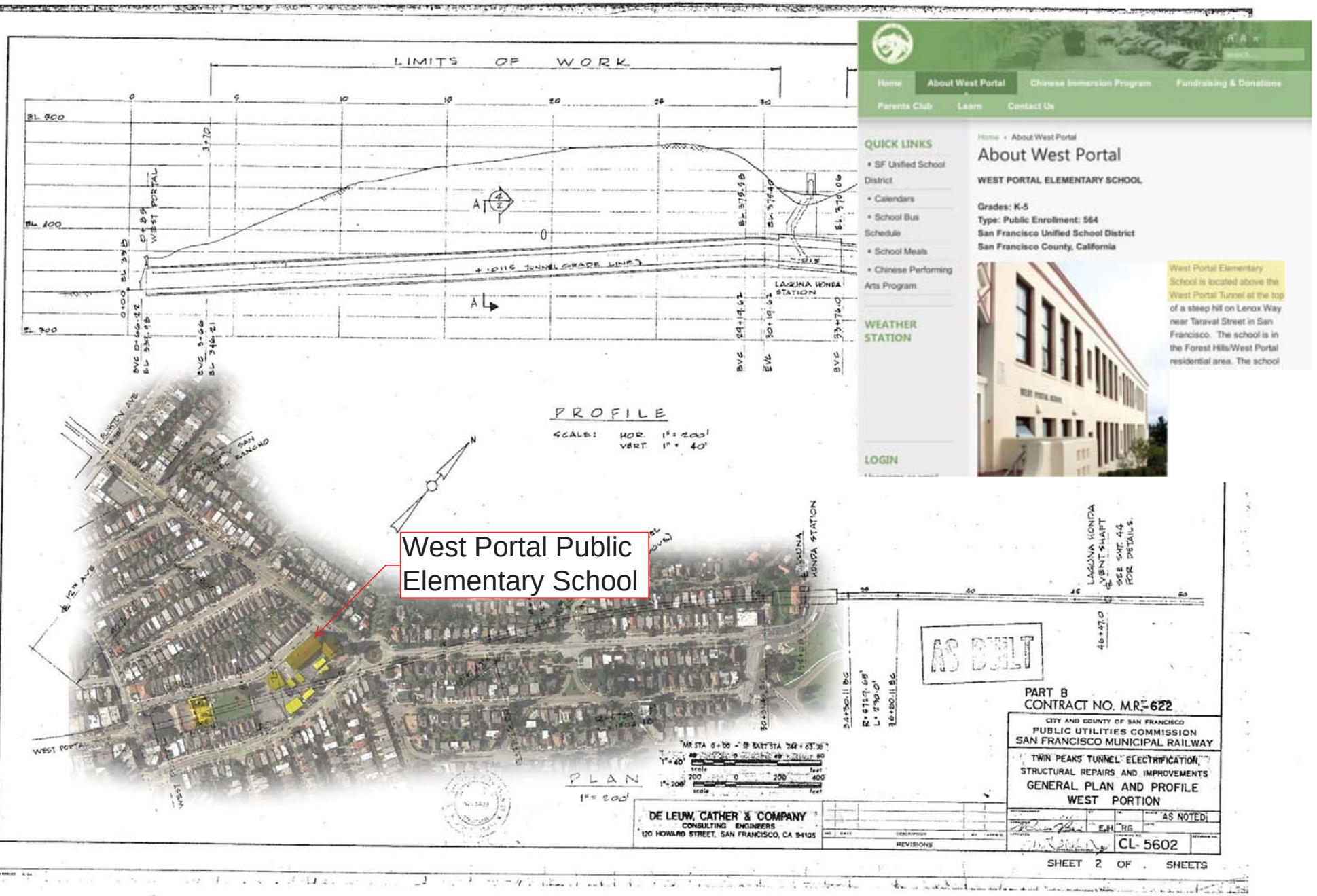
NOTES:

1. SEE FIGURE 3 FOR LEGEND

NTP Northlink Transit Partners

SOUNDTRANSIT

University Link
U230 Geotechnical Baseline Report
Site & Exploration Plan
Figure 2 (sheet 1 of 3)



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- SF Unified School District
- Calendars
- School Bus Schedule
- School Meals
- Chinese Performing Arts Program

WEATHER STATION

LOGIN

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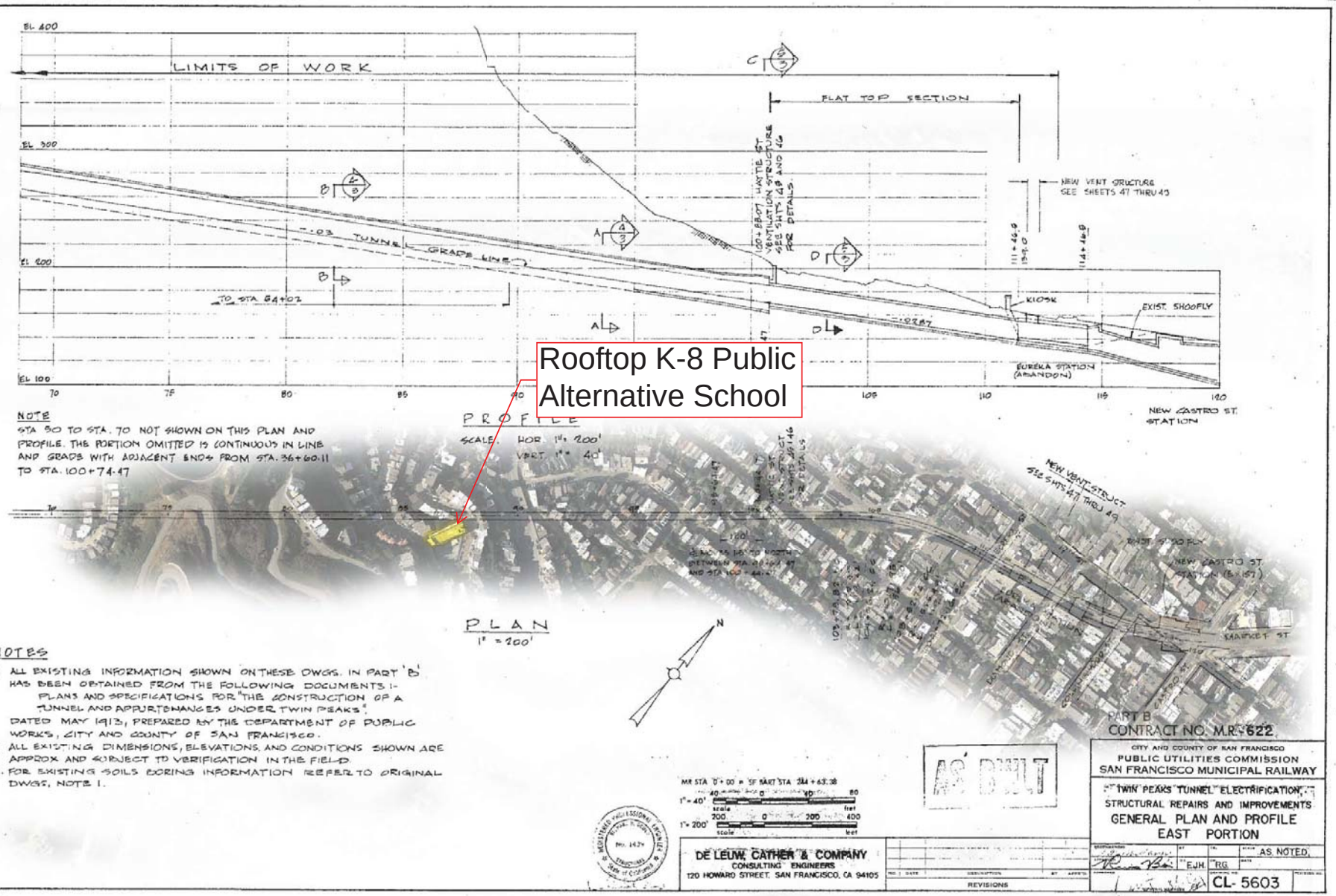
About West Portal

WEST PORTAL ELEMENTARY SCHOOL

Grades: K-5
Type: Public Enrollment: 564
San Francisco Unified School District
San Francisco County, California

West Portal Elementary School is located above the West Portal Tunnel at the top of a steep hill on Lenox Way near Taraval Street in San Francisco. The school is in the Forest Hills/West Portal residential area. The school


EL 400
LIMITS OF WORK
EL 300
EL 200
EL 100
TUNNEL GRADE LINE
TO STA 64+02
FLAT TOP SECTION
100+88.07 HATTIE ST VENTILATION STRUCTURE SEE SHTS 48 AND 49 FOR DETAILS.
NEW VENT STRUCTURE SEE SHEETS 47 THRU 49
KIOSK
EXIST. SHOOFLY
EUREKA STATION (ABANDON)
NEW CASTRO ST. STATION
Rooftop K-8 Public Alternative School
PROFILE
SCALE: HOR. 1" = 200'
VERT. 1" = 40'
NOTE
STA 80 TO STA. 70 NOT SHOWN ON THIS PLAN AND PROFILE. THE PORTION OMITTED IS CONTINUOUS IN LINE AND GRADE WITH ADJACENT ENDS FROM STA. 36+60.11 TO STA. 100+74.47
NEW VENT STRUCT SEE SHTS 47 THRU 49
EXIST. TO BE REM.
NEW CASTRO ST STATION (EXIST.)
MARKET ST
PLAN
1" = 200'
N
NOTES
1. ALL EXISTING INFORMATION SHOWN ON THESE DWGS. IN PART 'B' HAS BEEN OBTAINED FROM THE FOLLOWING DOCUMENTS:- PLANS AND SPECIFICATIONS FOR "THE CONSTRUCTION OF A TUNNEL AND APPURTENANCES UNDER TWIN PEAKS", DATED MAY 1913, PREPARED BY THE DEPARTMENT OF PUBLIC WORKS, CITY AND COUNTY OF SAN FRANCISCO.
2. ALL EXISTING DIMENSIONS, ELEVATIONS, AND CONDITIONS SHOWN ARE APPROX AND SUBJECT TO VERIFICATION IN THE FIELD.
3. FOR EXISTING SOILS BORING INFORMATION REFER TO ORIGINAL DWGS, NOTE 1.
AS BUILT
MR STA 0+00 = SF BART STA 344+63.38
1" = 40'
1" = 200'
scale feet
DE LEUW, CATHER & COMPANY
CONSULTING ENGINEERS
120 HOWARD STREET, SAN FRANCISCO, CA 94105
REVISIONS
PART B
CONTRACT NO. M.R.-622
CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
SAN FRANCISCO MUNICIPAL RAILWAY
"TWIN PEAKS TUNNEL" ELECTRIFICATION, STRUCTURAL REPAIRS AND IMPROVEMENTS
GENERAL PLAN AND PROFILE
EAST PORTION
AS NOTED
E.J.H.
R.G.
CL- 5603
SHEET 3 OF SHEETS