Proposed Vibration Measurement Program In A Parallel Tunnel

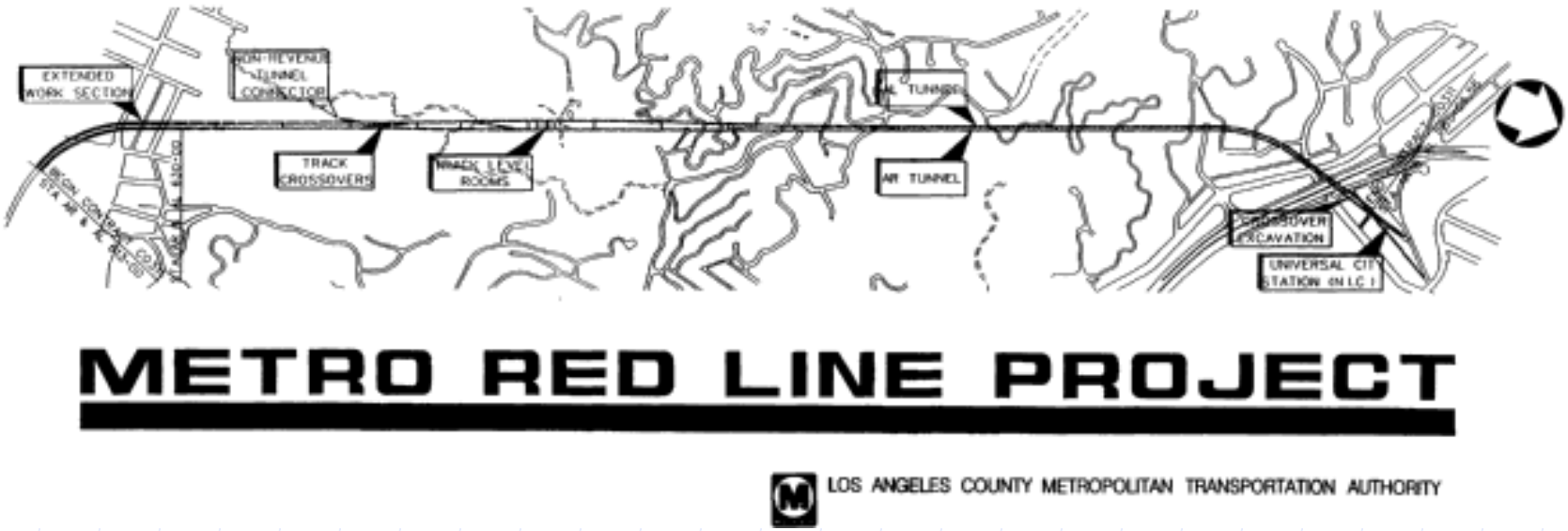
Introduction

- NLC Site Investigation Plan for Next Year
  - Prepare an accurate and consistent cost comparison of all NLC representative sites (3-IL, 2-CA)
  - Identify the cost "delta" for cut and cover vs. tunneling construction methods for 2-CA sites (CA-135 vs. CA-127)
- Goal; Reduce the Number of Sites for Concept Phase (CD-0)
- Trade-Off; Tunnel Provides a More Stable and or Quiet Environment (Insufficient data available)
- Trade-Study; Perform Vibration Measurement in a Parallel Tunnel

Proposed Vibration Measurement

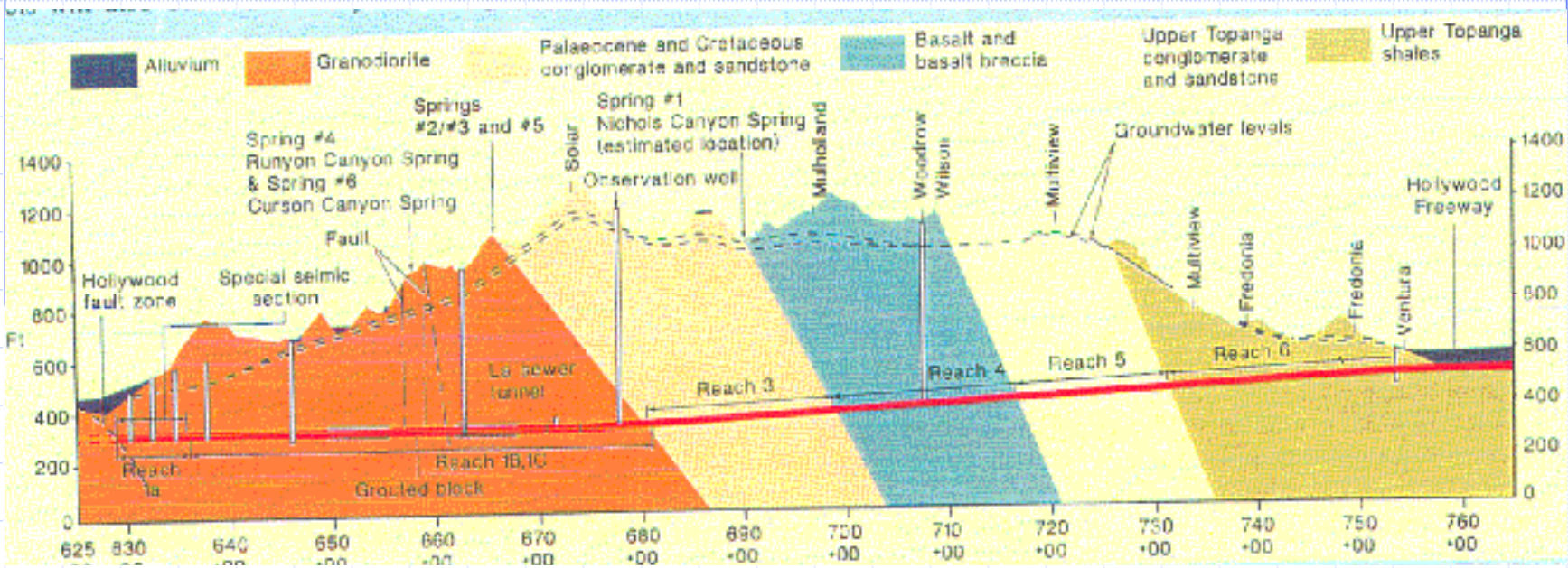
- Perform vibration measurement in a parallel tunnel constructed with a similar configuration and in a similar geological formation as CA-127 site
- Intent, to obtain vibration data associated with:
  - Transmission of vibration from the surface to the tunnel floor; and
  - Vibration transmission from a parallel tunnel to the adjacent tunnel as well as along the tunnel

Proposed Location; Vicinity Map



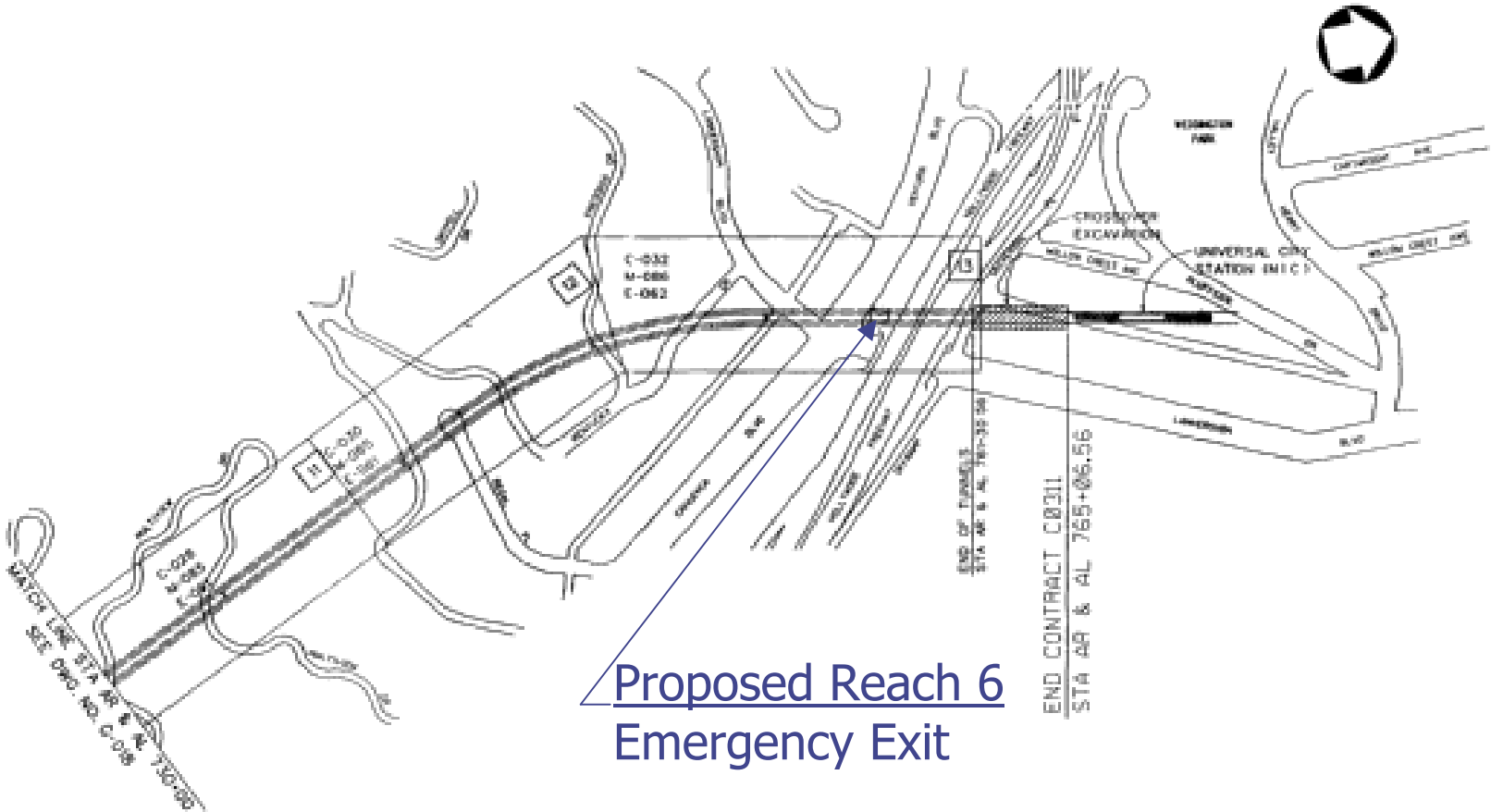
Alignment of the tunnels from Hollywood Blvd. To Universal City

Proposed Location; Geological Conditions



A cross-section through the Santa Monica mountains showing the different geological conditions. Reach 6 might be a potential test site.

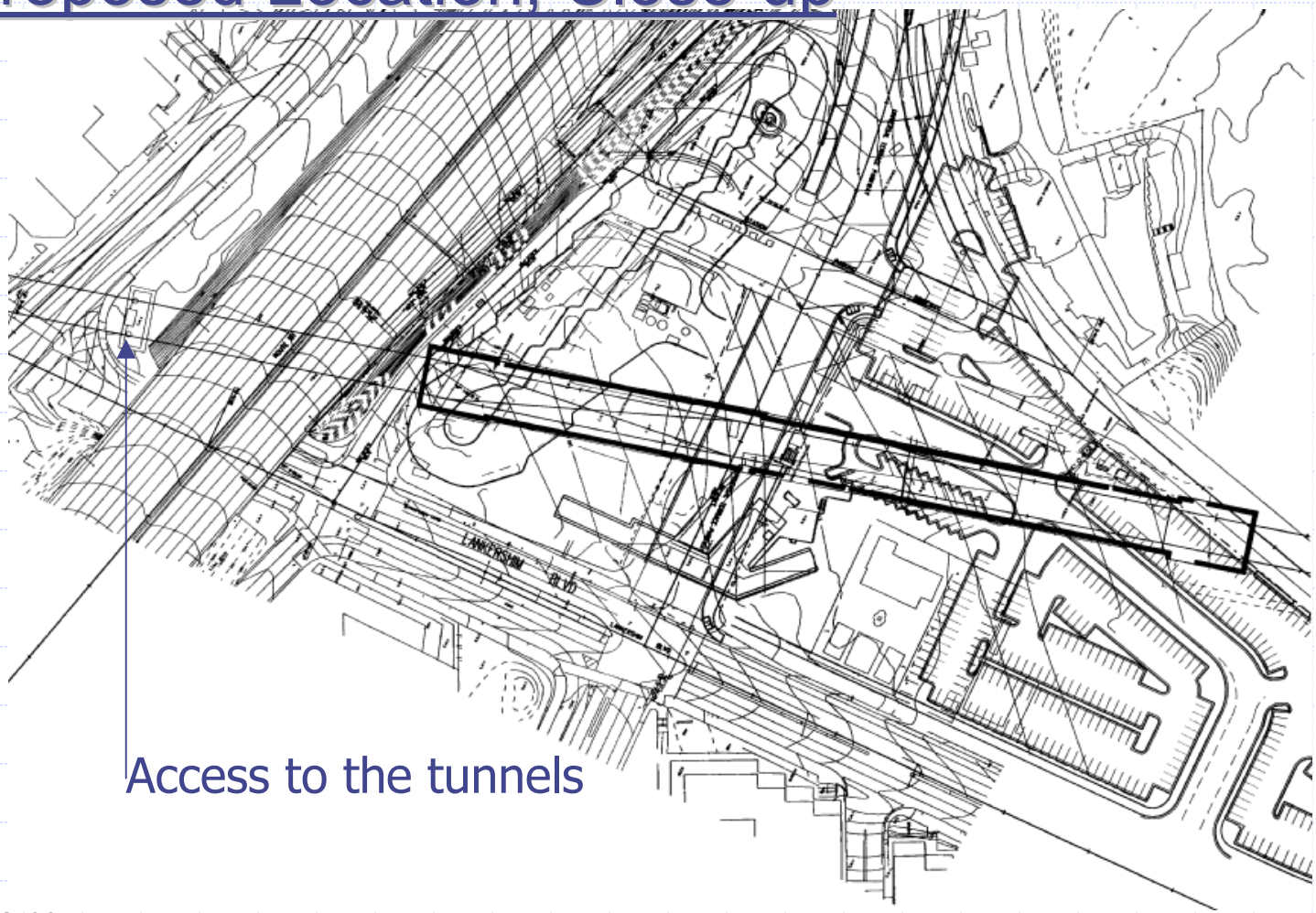
Proposed Location; Access to Tunnels



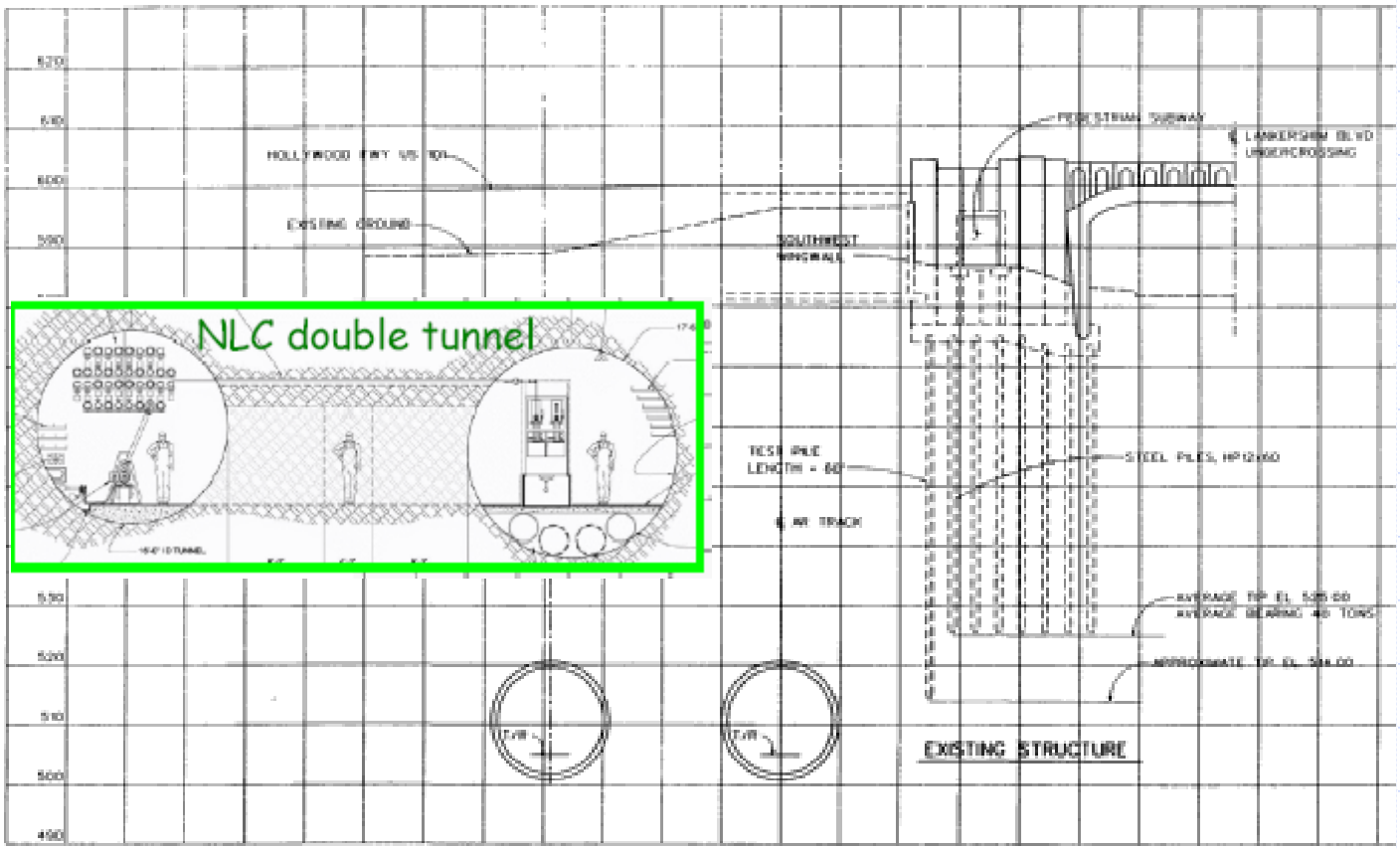
Geological Information

- Geologic conditions at Reach 6
  - Upper Topanga Formation; Sandstone and shale has a shear wave velocity of between 3,000 and 4,000 ft/sec
  - Further south, sandstone with conglomerate imbedded shear wave velocity of between 4,800 and 7,800 ft/sec
- Geologic conditions at CA-127 site
  - Sites Formation; Sandstone with intervals of interbedded clay-stone and siltstone (shear wave velocity > 2500 ft/sec)

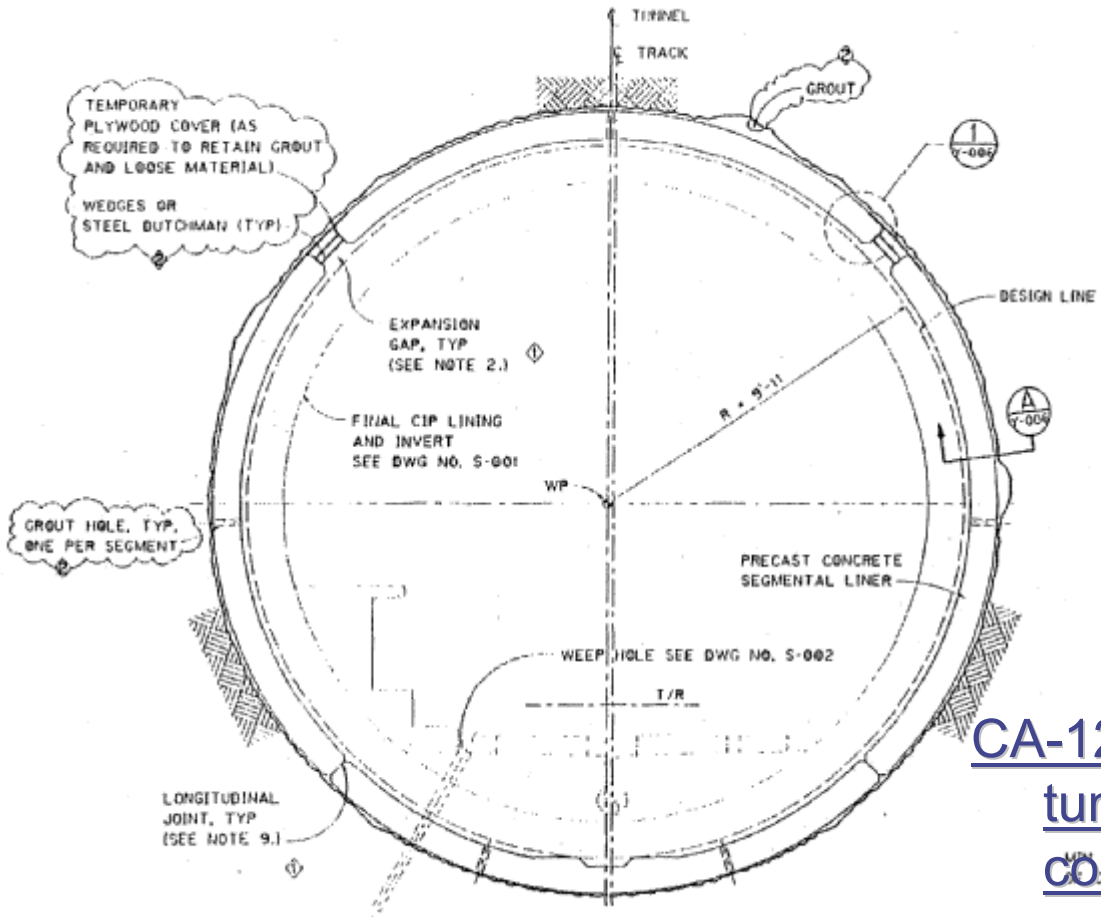
Proposed Location; Close-up



Typical Cross-Section of the MTA Tunnels



Typical Cross-Section of the MTA Tunnel



CA-127 proposed tunnel is similar in configuration

Purpose of This Vibration Measurement

- To provide data associated with:
  - Transmission of vibration from the surface to the tunnel floor:and
  - Vibration transmission from a parallel tunnel at the same depth as the tunnel
  - Characterize the attenuation or amplification as a function of frequency, in another word;
    - *Establish the Transfer Function (Frequency Response Function or FRF) between the "source" and the "receiver" for each case*

Proposed Vibration Measurement

- Surface-to-depth measurement will be obtained using:
  - Traffic-as-source: It will measure the surface ambient and the tunnel simultaneously, using the excitation at surface (traffic,etc)
  - Data will be taken simultaneously over relatively long periods
  - Impulsive-source: Measurement will use the same instrument setup, using a controlled source, such as instrumented hammer
    - A “FRF” will be obtained, showing attenuation provided by ground (part of FRF is “coherence” measurement)
  - Rail-as-source: Same discussion as “Traffic-as- source”, except the source and receiver would be reversed in the computations
    - Rationale: Small amount of traffic, not enough to get a signal with adequate coherence may be the case in the middle of the night (provides a check of the validity of measurement)

Proposed Vibration Measurement

- Tunnel-to-tunnel measurement will be obtained using:
  - Electro-magnetic shaker: It will generate steady-state vibration for frequency range from 2 Hz to 100Hz (frequency sweep) in "source" tunnel with sensors placed near and along the tunnel as well as in the adjacent tunnel
  - Impulsive-source: Measurement will use the same instrument setup, using a controlled source, such as instrumented hammer
    - Shaker and hammer will simulate broad range of vibration sources in the NLC service tunnel, such as activities, ventilation equipment, cooling water, modulator, pumps, etc
  - A transfer function (FRF) will be obtained, showing attenuation or amplification of vibration between the tunnels

DMJM and Colin Gorden & Associates (CG &A) Proposal

- Well known A & E firm with over 50 years experienced in major scientific project such as;
  - Lead A-E for the initial planning design and construction of FNAL
  - A-E for the design of Jefferson National Accelerator Lab. (Cebaf)
  - Engineering management consultant for Los Angeles Metro
    - The Red Line, 17 –mile , twin-tunnel subway
- CG&A specialized in vibration and acoustic solutions for low-vibration facilities for the research and fabrication of integrated circuit
- Estimated cost to perform all the test, analyze and present the result in an acceptable format as well as all coordination and any permits; Not to exceed $60K

A Tentative Proposed Plan

- Refinement of the proposed measurement program;
  - Meeting with the DMJM and CG&A principals at SLAC next week (may be on May 30, 2002)
  - Discuss and refine the proposed vibration measurement program to meet the NLC vibration goals and needs
  - Discuss the logistics and schedule to draft a Statement of Work
- Prepare and process the purchase order document by June 7,2002
- Reconnaissance trip to the site (may be week of June 10, 2002)
  - Measurement and processing locations as well as paths of cabling to be identified
  - Meet with the LA MTA and DMJM to resolve the logistics as well as to get a feel for the train schedule and the traffic patterns
  - Finalize the details of vibration measurement program