ATTACHMENT A

ATTACHMENTS TO COMMENT LETTER AL063

PALMDALE

a place to call home

August 31, 2004

JAMES C. LEDFORD, JR.
Mayor

JAMES A. "JIM" ROOT
Mayor Pro Tem

MIKE DISPENZA
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STEVEN D. HOFBAUER
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Mr. Joseph E. Petrillo
Chairman
California High-Speed Rail Authority
925 L Street, Suite 1425
Sacramento, California 95814

Re: Comments on Draft Program EIR/EIS For Proposed High-Speed Train Project – SCH 2001042045

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Dear Mr. Petrillo:

The City of Palmdale appreciates the opportunity to assist the California High Speed Rail Authority in its consideration of this important project. The decisions made in regard to a high-speed rail system for the State of California will affect the future of our state's transportation system as well as the state's economic viability and growth patterns for many generations.

One of the most critical decisions that will be made is the choice of routes. The Draft Program Environmental Impact Report/Environmental Impact Statement for the High Speed Rail Project ("EIR") will be used to select between two alternative routes connecting Bakersfield and Los Angeles: one following the I-5 Freeway along the Grapevine and the other traveling through the Antelope Valley with a station in Palmdale. It is vitally important that the Authority's choice of routes meets the needs of Southern California and the state by connecting the places where most people live with the places where most people work, by promoting growth in a manner consistent with the state's land use and planning policies, by relieving traffic in congested areas, and by providing cleaner air and more environmentally friendly ways to travel. The City is confident that upon a full and fair consideration of these needs, the Authority will select the Antelope Valley route as the best choice for California.

Auxiliary aids provided for communication accessibility upon 72 hours' notice and request.

Comments on the EIR

The City has participated in every phase of the Authority's proceedings since 1995 and has developed and provided technical and other important information that will assist the Authority in making this critical decision. This information has included the testimony of elected officials, technical experts, and researchers that was presented at the Authority's public meetings held on April 13 and June 23, 2004 in Los Angeles. In addition, the City has developed written technical reports and comments, which together with this letter, are formally submitted for the record in accordance with the public notices establishing the public review period for the EIR.

The following studies, reports and other documents, together with this letter, are presented in support of the City's comments on the EIR and the proposed High Speed Train project:

- Technical Peer Review of the Draft Program EIR/EIS for the Proposed California High-Speed Train System prepared by Michael Brandman & Associates

- Final Report - A Comparative Analysis of Tunnel Construction times, Costs, and Risks Associated with the Choice of High Speed Rail Tunneling Alignment between Los Angeles and Bakersfield prepared by Geodata SpA of Turin, Italy, and Transmetrics of San Jose, California

- Sprawl or Smart Growth - Analysis of High Speed Rail alignments and Smart Growth Prepared For the California High-Speed Rail Authority and the City of Palmdale, California by Dr. Robert H. Freilich

- Legal review of the EIR prepared by Chris Bisgaard and Daniel V. Hyde of the law firm, Lewis, Brisbois, Bisgaard & Smith LLP, and

- Compilation of the City's presentations and information submitted to the Authority made prior to the issuance of the EIR prepared by Robert Schaevitz

The Antelope Valley Route is the Best Choice For California

The California High Speed Rail Act of 1996 provided that the High Speed Rail project should help generate jobs and economic growth, and be integrated with existing transportation networks (Public Utilities Code §185,010(i) and §180,030). The final business plan for the high speed rail project specified that the project should be "economically feasible, publicly popular, and fiscally prudent . . . support economic growth . . . and do so in an environmentally and fiscally responsible way." The statutory mandates also stated that the line should connect underserved population centers and provide for intermodal connectivity.

The Antelope Valley route meets these statutory mandates and represents the best choice for California because it is:

- Cheaper, faster and easier to build
- Better for the environment
- Better for taxpayers generating higher revenues and lower risk of cost overruns
- Relieves congestion on the I-5 and SR-14 freeways
- Links growing population and employment centers
- Protects valuable farmland by promoting growth in accordance with Smart Growth principles
- Connects to the next major Southland airport

The I-5 route, in contrast to the Antelope Valley route, would not generate increased ridership or the associated revenues since it runs through an unpopulated area that doesn't help riders get to where they need to go. The Antelope Valley is estimated to have a population of 750,000 residents and will have 260,000 more jobs by the time the rail line is built, and will then be one of the largest communities in the state. The added ridership on the Antelope Valley route will add up to a projected $900 million more in net benefits than the I-5 route over the first 33 years of operation. The I-5 route would not connect the state's existing infrastructure, so it would not alleviate traffic on the highways or at

Bakersfield, Delano, Visalia, Fresno, Madera, Merced and many others, including Tejon Ranch and Congressmen Bill Thomas, Buck McKeon, and Calvin Dooley. During the hearings on the EIR, no one spoke in favor of the I-5 route.

The City of Palmdale looks forward to the Authority's responses to the City's comments and to an early determination in favor of the Antelope Valley route. Upon the selection of the Antelope Valley route, the City of Palmdale is dedicated to assisting the Authority in implementing this project.

Sincerely,

James C. Ledford, Jr.
Mayor

C: City Council
Robert W. Toone Jr., City Manager
Stephen H. Williams, Assistant City Manager
John Brooks, Sr. Analyst

airports, which means it would not take cars off the road to reduce air pollution. The City proposes to build the Palmdale station at the Palmdale Regional Airport, which is owned by the City of Los Angeles, and is expected to become a major Southland airport in the future and relieve congestion at LAX and other regional airports.

Although both routes require tunneling, the I-5 route involves dangerous conditions, which could significantly increase the chance of cost overruns and completion time. In addition, the I-5 tunnels would run parallel to earthquake fault lines for many miles, which represent much greater earthquake risk than the Antelope Valley route. The tunneling for the I-5 route will take approximately 3 1/2 years longer to build and will be significantly more expensive both to build and to operate. The I-5 route will also promote growth in the Central Valley where it will have an enormous adverse impact resulting in the loss of high value agricultural lands.

By connecting population and business centers, more people will use high-speed rail and more cars will be taken off the already congested highway system. The Antelope Valley route will therefore help alleviate traffic congestion on both the I-5 and SR 14 freeways - two of the most congested freeways in the state and also improve air quality in the LA basin.

The environmental analysis in the EIR supports the conclusion that the Antelope Valley route has less environmental impacts than the I-5 route and that the Antelope Valley route would be the environmentally superior alternative for the project. In general, while there are many gaps in the information supplied in support of the EIR, as detailed in the attached comments, there is substantial evidence contained in the EIR and in the attached reports to support the Authority's decision to eliminate the I-5 route from further review in favor of the Antelope Valley route.

The Antelope Valley route has won unanimous support in Southern California and in many other communities throughout the state. The City has previously presented a large array of resolutions of public agencies in support of the Antelope Valley route. The supporting agencies include the County of Los Angeles, the City of Los Angeles, Los Angeles World Airports, Southern California Association of Governments, Los Angeles County Metropolitan Transportation Authority, the Counties of Kern, Kings, Tulare, and Fresno, and the Cities of Los Angeles, Lancaster, Palmdale,

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August 27, 2004

FILE NO.
26532-2

VIA FIRST CLASS MAIL

Mr. Joseph E. Petrillo
Chairman
California High-Speed Rail Authority
925 L Street, Suite 1425
Sacramento, California 95814

Re: Comments on Draft Program EIR/EIS For
Proposed High-Speed Rail Project - SCH 2001042045

Dear Mr. Petrillo:

This letter supplements the comments and other information submitted by the City of Palmdale (the "City") in connection with the Draft Program Environmental Impact Report/Environmental Impact Statement (the "EIR") for the proposed California High Speed Rail Project (the "Project"). The City requested us to review the adequacy of the EIR and the legal sufficiency of the proceedings of the California High Speed Rail Authority (the "Authority") in connection with the adoption of the Project. Our findings and conclusions are set forth below.

The EIR is a combined document that must comply with the requirements of both the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). For clarity and ease of reference, we have addressed the EIR's compliance with CEQA since that is generally the more stringent enactment. However, many of the deficiencies found in the EIR under CEQA are also violations of NEPA and our comments should be understood to address both acts.

General Requirements for EIR Adequacy

Generally, EIRs must be adequate under CEQA. (*Laurel Heights Improvement Assn. v. Regents of the Univ. of Calif.* (1988) 47 Cal.3d 376, 392.) To be legally adequate, an EIR must

contain all of the required contents set forth in CEQA and the Guidelines, and must comply with statutory and Guideline requirements that apply to the required contents. EIRs must contain 1) an index or table of contents [CEQA §21061; Guidelines §15122], 2) a summary of its contents [CEQA §21061; Guidelines §15123], 3) a list of organizations and persons consulted in the preparation [Guidelines §15129], and 4) a list of persons or organizations involved in the preparation [Guidelines §15129]. An EIR must contain a project description, which must comply with various technical requirements [Guidelines §15124], and must a) constitute an accurate description that does not minimize project impacts, b) include discussion of reasonably foreseeable activities, and c) be fixed and consistent throughout the document.

An EIR must describe the project's environmental setting from both a local and a regional perspective to establish the baseline for analyzing the project's environmental effects and alternatives. (Guidelines §15125.) An EIR must discuss any inconsistencies between the proposed project and any applicable general or regional plans. (Guidelines §15125(b).)

Substantively, an EIR must adequately discuss and analyze the project's significant environmental impacts. (CEQA §21100(b)(1); Guidelines §15126(a).) The EIR must discuss both direct and indirect effects of the project, analyze foreseeable, but not speculative, project impacts, and analyze economic impacts as they may relate to environmental impacts. The scope of analysis must be consistent with the project description, and the EIR must compare the proposed project with existing conditions. CEQA imposes special requirements for the analysis of certain environmental impacts, such as archaeological and historic resources, hazardous waste sites, energy, air quality, and water supply.

The level of detail of an EIR's analysis of environmental impacts should correlate with the type of action or project being evaluated. The EIR must be prepared with a sufficient degree of analysis to provide decision-makers with information needed to make an informed decision concerning the project's environmental consequences. The EIR must set forth an explanation of conclusions in its environmental impact analysis, must describe the project's unavoidable significant impacts, contain a statement of the project's environmental impacts found to be insignificant and indicate reasons for determining them to be insignificant. (Guidelines §15128.) The EIR must discuss and analyze the project's significant cumulative impacts (Guidelines §15130), and analyze a project's growth-inducing impacts. (CEQA §21100(b)(5); Guidelines §15126(f).)

An EIR must describe mitigation measures for each potentially significant impact that it identifies. (CEQA §21100(b)(3); Guidelines §15126(b)(3).) Specific mitigation measures are required for impacts on archaeological and energy consumption. An EIR must describe a reasonable range of project alternatives sufficient to permit informed decision-making and public participation focusing on alternatives that eliminate or reduce significant environmental impacts. (CEQA §21100(b)(4); Guidelines §15126(d). The EIR must analyze a "no-project" alternative.

(*Id.*) Alternatives may be on-site alternatives, alternatives to the project's location, or both. To be legally adequate, an EIR's analysis of project alternatives must a) sufficiently describe each alternative to enable the decision-maker to compare it with the proposed project, analyze the environmental effects of each alternative, identify the environmentally-superior alternative, and describe the basis for selection of the alternative discussed in the EIR and state the reasons for excluding infeasible alternatives. In analyzing project alternatives, the lead agency must evaluate and respond to alternatives that are proposed during the EIR's comment period.

Failure to Promote Public and Agency Review

The EIR is a three-volume document released on a CD ROM disk. It is not available as a hard copy, except at a few listed libraries around the state. It costs over $1500 to have the entire document plus its appendices printed out and collated into three-ring binders. The disk is not readable without acquiring Acrobat 6.0, which is also the case with the version of the EIR that is available on the Authority's website on the Internet. By making the EIR available only on computer disk and over the Internet, without providing complete sets for libraries and others requesting hard copies of the EIR and its supporting documents, the Authority has failed to facilitate meaningful review of the EIR.

The EIR is supported by a number of Technical Studies. These studies are not incorporated by reference into the EIR, and are described merely as "references" and "sources." A CD ROM disk containing some, but not all, of the technical studies was delivered to us on February 14, 2004. The full disk was not delivered until the following Thursday, February 19, 2004. The public review period officially commenced on February 13, 2004 and was extended to conclude on August 31, 2004. Numerous studies, reports, and other documents containing necessary factual information needed to verify and/or understand the analysis in the EIR were not supplied with or incorporated into the EIR. On behalf of the City, we have made several timely requests for this information, but the Authority has not readily produced this information. Given the requirement to respond with all comments within a defined public review period, the extensiveness of the EIR, and the volume of missing documentation, the Authority has not fulfilled its obligation to promote public and agency review as required by CEQA.

Failure to Consult with Agencies with Transportation Facilities

Public Resources Code §21092.4 provides, in pertinent part, as follows:

> (a) For a project of statewide, regional, or areawide significance, the lead agency shall consult with transportation planning agencies and public agencies which have transportation facilities within their jurisdictions which could be affected by the project. Consultation shall be conducted in the same manner as

> for responsible agencies pursuant to this division, and shall be for the purpose of the lead agency obtaining information concerning the project's effect on major local arterials, public transit, freeways, highways, and rail transit service within the jurisdiction of a transportation planning agency or a public agency which is consulted by the lead agency. A transportation planning agency or public agency which provides information to the lead agency shall be notified of, and provided with copies of, environmental documents pertaining to the project.
>
> (b) As used in this section "transportation facilities" includes major local arterials and public transit within five miles of the project site and freeways, highways, and rail transit service within 10 miles of the project site.

In the EIR, the Authority identifies the agencies consulted and the topics discussed with each agency on a list or chart labeled as "Public Outreach." The description of the topics on the "Public Outreach" list, however, does not indicate that the Authority treated each of the listed agencies with transportation facilities as "responsible agencies' as required by CEQA. The extent and nature of the consultation with each such agency is not revealed in the EIR. The City has advised us that even though the Authority met with City staff, the Authority has never sought information from the City concerning the Project's effect on major local arterials, public transit, freeways, highways, and rail transit service within the City's jurisdiction. On March 4, 2004, we forwarded a Public Records Act Request to the Authority requesting the service list for the Notice of Preparation and copies of all consultation-related documents received from several of the other jurisdictions that should have been consulted under section 21092.4 (a). No evidence of the appropriate level of consultation was produced by the Authority.

Failure to Provide an Adequate Description of the Project

A Project Description is an express requirement of CEQA. There is no section of the EIR formally setting forth the description of the Project. HST is portrayed merely as an alternative. There is no detailed discussion of the physical components, characteristics, or attributes of the proposed HST system facilities. The proposed tunnels, as well as at-grade, and above-grade facilities are not discussed. There is no specific discussion of the location of each type of facility. No topographic maps are provided, as recommended.

Reasonably foreseeable future project activities, including line extensions, additional stations (e.g., I-5 at Tejon), linkage with other transportation projects, are not discussed. In general, previous screening and corridor studies were used to arrive at the HST Project. While there is a confusing table that was apparently intended to summarize the stations and alignments eliminated from further consideration at earlier stages of project development, there is no real

narrative discussion of the elimination process and little in the way of objective criteria, environmental or otherwise, for the Authority's previous decision-making.

Failure to Adequately Address Significant Impacts

In Chapter 3, the EIR addresses and compares the significant environmental impacts of each of the project alternatives in reference to 16 different areas of environmental impact. These include: Traffic and Circulation; Travel Conditions; Air Quality; Noise and Vibration; Energy; Electromagnetic Fields and Interference; Land Use; Agricultural lands; Aesthetics and Visual Resources; Public Utilities; Hazardous Materials and Waste; Cultural and Paleontological Resources; Geology and Soils; Hydrology and Water Resources; Biological Resources and Wetlands; and Section 4(f) and 6(f) [Park lands]. These sections each separately address regulatory requirements, environmental setting or "affected environment," and environmental impacts or "consequences." In many instances, as more specifically discussed by MBA, the City's environmental consultant, the environmental setting is not described in sufficient detail to determine the specific impacts that the Project might have on the environment. (See Level of Detail, *infra*.)

There is little if any distinction between the discussion of local, regional, and regulatory project settings in the EIR. The specific resource sections also have a "Comparison of Alternatives by Region." This subsection is used to describe alignment or station alternatives that have not yet been eliminated from review, including the I-5 vs. AV alignment selection. Several subsections, however, do not compare alternatives by region. These include Air Quality and Electomagnetic Fields. Following the comparison are two subsections, one on mitigation "strategies," and another describing the analysis that is still required. The final section addresses "Cumulative Impacts" and revisits each of the previous resource or impact categories. This subsection appears almost as an afterthought, as if someone had realized that addressing cumulative impacts was required after the impact sections had been drafted. Cumulative impacts are generally appropriately addressed with the discussion of each resource area so that a person interested in a project's impacts on, for example, air quality, can determine if the project will have either significant direct impacts or cumulatively significant impacts by referring to the Air Quality section. The EIR requires a reader to look at both the Air Quality section and the Cumulative Impacts section to ascertain the Project's air quality impacts.

The resource sections of Chapter 3 of the EIR do not uniformly identify objective thresholds of significance. Guideline Section 15064(b) requires significance determinations to be carefully made based on "scientific and factual data." The EIR's failure to do this contributes to the annoyingly general and arbitrary tone of the discussion in the EIR. It also renders the comparison of route alignments vague and uncertain. It is frequently difficult to tell if, for example, one alignment will have more impacts on wildlife, how many more impacts will the alignment have, and how significant quantitatively those differences are.

The preponderance of the discussion in the EIR relates to the comparison of significant impacts between the no-project, modal, and HST alternatives. Much less discussion is devoted to the alignment options. Specifically, the analysis of significant environmental impacts is not sufficiently detailed to allow comparison between the two Bakersfield to Sylmar routes. There is a brief comparison of conclusions in the Noise section. In the Aesthetics and Visual Resources section there is a table (Table 3.9-1) that allows some comparison of visual impacts between the two alignments, and there is a discussion on page 3.9-17 in this regard. There is a brief comparison of the impacts on Public Utilities on page 3.10-9 concluding that the I-5 would have the most conflicts. The potential for impacts on archeological sites on the AV alignment is high, while the potential for the I-5 is low. On the other hand, potential impacts on historic structures is medium to high for the I-5 and low to medium for the AV. (See p. 3.12-22.)

Certain obvious impacts are not addressed at all. The Traffic Report for the Bakersfield to Los Angeles segment on the Technical Studies disk addresses the traffic impacts of the No Project, Modal, and HST Alternatives only. There is no analysis or comparison of the traffic impacts between the I-5 and AV routes. Also, Section 6.4.1 of the Program EIR (the alignment comparison for the I-5 and AV routes) does not compare traffic impacts. It would seem that, except for avoided air traffic, HST ridership reduces north-south vehicle traffic on the I-5, regardless of which route is selected. If the AV route were selected, HST would achieve all of the I-5 traffic reductions AND reduce traffic on the 14 freeway. Selecting the I-5 route would not reduce any traffic on the 14 freeway. The AV route should be environmentally superior in this regard, both in terms of traffic and air impacts, and should have been identified as such.

The EIR focuses on impacts derived from pre-draft consultation or scoping, and is clearly geared toward highlighting differences among the no-project, modal, and HST alternatives. The identification of project impacts that may result from the project as applicable between the alignment options is not as detailed or as comprehensive. The EIR fails to address the existence of significant impacts relating to the I-5 alignments, e.g., indirect growth impacts do not appear to be addressed in any quantitative way.

Concerning economics, the discussion of ridership and the assertion that there will be greater ridership system-wide based on the shorter duration of the I-5 alternative is not well documented in the EIR. Cost should play a more significant role in determining ridership than time.

Although one of the goals of the project is to develop a rail service that is fully integrated with the state's existing transportation system, the EIR fails to adequately address the advantages of a potential link to the Palmdale Airport and other transportation systems that are planned to connect with the Palmdale Airport.

Specific sections of the EIR deal with the required discussion of archaeological and historic resources, hazardous waste sites, energy, air quality, and water supply, as required. These sections do not appear specific enough to allow meaningful comparison of alignment alternatives.

Insufficient Level of Detail

The level of detail of an EIR's analysis of environmental impacts is dependant on the decision that is being made. The EIR must be detailed enough to support an informed decision concerning the project's environmental impacts. It appears that for the overall decision on the project vs. the no-project and modal project, there is sufficient information to make such a decision. Concerning the choice of alignment options, there is not sufficient information to decide between the I-5 and AV alignments. The EIR reveals that many alignment options were considered and rejected as a result of studies conducted without environmental review.

To withstand legal challenge, there must be substantial evidence in the record to support the findings made by the agency in support of its decision. If there is no such evidence, the agency's action may be challenged by writ of mandate as an abuse of discretion. Here, there is not sufficient information to support a decision that the I-5 alignment is environmentally superior than the AV route. With the submission of the City's environmental information into the record, there is, however, sufficient substantial evidence that would support a decision excluding the I-5 alignment from further consideration.

Failure to Adequately Address Cumulative Impacts

The Cumulative Impacts section generally attempts to compare the impacts of the three Project Alternatives on an overall basis, but does not represent a legally sufficient cumulative impacts analysis. The growth-inducing aspects of the I-5 Alignment and other elements of the project would be cumulatively significant in the Central Valley because of the large, clearly significant impact that would occur as prime farmland is converted to residential uses, but this cumulative impact is not addressed. The section on Agricultural lands in the Section 3.17, page 3.17-5 compares the total amount of farmland subject to conversion by either the modal or HST alternatives, but does not address the amount of farmland that would be converted through residential conversions and compare that cumulatively significant loss among alternatives.

Inadequate Discussion of Mitigation Measures

An EIR must identify and describe measures needed to reduce or avoid each potentially significant environment effect of the project. The Program EIR/EIS merely identifies a few "mitigation strategies" and does not propose any specific mitigation measures. The various impact sections of the EIR suggest that many of the potentially significant impacts would be

mitigated, but there is no discussion comparing the impacts after mitigation of the AV vs. I-5 alignments. There is therefore no specific factual basis for the selection of the I-5 or AV routes other than the information supplied by the City.

Failure to Address A Reasonable Range of Alternatives

Section 2 of the Draft EIR/EIS describes three alternatives, a no-project alternative (a legal requirement), a modal alternative, which is an alternative constructed to represent a hypothetical expansion of the existing highway and air travel system that would accommodate 2020 intercity travel demand in the area that would be served by the HST, and the HST Alternative. The HST alternative has several optional routes (e.g., AV vs. I-5) and station locations, but most of the initial options were eliminated during scoping (e.g., Altamont Pass), as was Maglev technology, without environmental analysis. There do not appear to be any smaller or larger or phased HST projects discussed.

The alternatives analysis is addressed to the potential decision as to whether to go forward with the project along with its specific alignment options, and does not support a choice among alignment options. The alternatives analysis is not adequate even for the single purpose of going forward with the project. The HST alternative is presented as a one-size, take-it-or-leave-it project. What is missing is the analysis of a bigger project, a middle-sized project, and a smaller project, or the like. Even if the size of the project is determined by previous screening studies, the comparative analysis of bigger and smaller projects nonetheless yields important analytic information, i.e., that if the project is smaller, the project benefits may no longer outweigh the environmental impacts and vice versa. The alternatives analysis in the EIR is a mere rhetorical exercise. The Authority is under a legal mandate to develop an HST project and has no power to adopt the "modal" alternative. The no-project alternative analysis is legally required.

Failure to Disclose Appropriate Criteria For Evaluation of Alternative Routes

Chapter 6 is a long, difficult table that sets forth a High Speed Rail Alignment Options Comparison. There is no analytical foundation provided for the various elements of the options compared. The information on the chart or table is very general and seems to compare features randomly as opposed to systematically or qualitatively. This section suffers from a failure to set out appropriate thresholds of significance and potential for mitigation that could be quantitatively applied to each of the impacts compared.

Failure to Adequately Describe the Input from Responsible and Trustee Agencies

There is no list of persons or agencies consulted per se. The "Outreach" section is in the form of a table that includes what appears to be any type of presentation or contact made by the Authority's staff with anyone during preparation of the draft. The table describes the type of contact under a column labeled "Topic." A 2-page summary of the comments received from agencies in general is provided in section 8, but the draft does not describe or reveal the specific comments of or the level of involvement of any specific responsible or trustee agency for the project. Section 8 is entitled Public and Agency Involvement. Section 8 briefly describes the Authority's actions in conducting informational programs for the public and engaging in legally required pre-draft consultation, including its scoping meetings and meetings with federal cooperating agencies, such as EPA, Fish and Wildlife, the Army Corps of Engineers, the FRA, FTA, FAA, and FHA. The actual comments and input from these agencies is not set forth nor does the EIR describe the Authority's responses to these comments. Section 9 is another lengthy chart attempting to list each organization contacted and the purpose of the contact. This chart lumps together agencies for whom the Authority made informational presentations with agencies that the Agency had a duty to consult in the manner of responsible and trustee agencies and it is not possible to clearly discern whether the Authority in fact consulted with local agencies with transportation facilities that could be affected by HST.

Inadequate Supporting Technical Appendices

Appendices to EIRs generally include the geotechnical studies for the proposed project site, the traffic studies relied upon, any air quality modeling, or noise studies. The Appendices to the EIR do not contain these technical reports. They set forth slightly more detailed summaries of information provided in the body of the EIR. For example, the first few appendices are detailed descriptions--mostly summaries and lists--of highway and aviation projects used to develop the no project and modal alternatives. Appendix 2-H is a long chart or table comparing each of the various alignment and station options that were developed during the screening evaluation. The chart is confusing because it refers to each alignment or station developed during the screening evaluation, many of which were eliminated from future consideration and were not addressed in the EIR analysis.

Appendix 2.0 provides a Screening Evaluation of the Bakersfield to Los Angeles Alignment option. This section appears to be an excerpt from a larger report and describes in more detail the criteria/methodologies and parameters used for the evaluation of the AV vs. I-5 alignment options. Other appendices are summaries of traffic, noise, wetlands and other areas of environmental impact, but these do not include the basic source information or analysis. To the extent that the Authority relied on its prior screening and other reports to reach conclusions in the EIR, such documents should have been made appendices and circulated with the EIR.

The Authority has made available a disk with various Technical Reports. Some of the reports state that the technical reports are intended to be part of the Administrative Record. The Technical Reports are grouped by each of the six segments of the overall alignment plus one group with "Statewide" reports. The Bakersfield to Los Angeles Group contains 14 separate technical evaluations, including: Sections 4 (F) and 6 (F) [park and recreational lands]; Biological Resources; Hazardous Materials/Wastes; Noise and Vibration; Public Utilities; Appendices (traffic); Traffic Figures; Aesthetics and Visual Quality; Cultural Resources; Geology and Soils; Hydrology and Water Quality; Land Use Planning, etc., and Environmental Justice; Paleontological Resources; and Traffic, Transit, Circulation and Parking. The "Statewide" Group includes: Agricultural Lands and Agricultural Figures; Air Quality; Alignment Configuration and Cross Sections; Final Cost Report - Capital and Operations and Maintenance Costs; Statewide Energy; Engineering Criteria; Land Use (affected by right of way acquisitions); Operations; and Tunneling Issues. Each of these evaluations are highly summarized discussions typically citing to other references for the potential for impacts and then summarizing the results into a large table or figure without any type of field verification.

Impacts Found Insignificant.

The EIR does not address insignificant impacts or discuss why such impacts were determined to be insignificant.

Failure to Adequately Address Inconsistencies with General or Regional Plans

The EIR discusses compatibility with existing land uses and planning in section 3.7, but this section does not directly discuss inconsistencies with any individual general or regional plans. There is a statement at the beginning of the analysis that the EIR's discussion of consistency (such as it is) does not imply that the Authority, as a state agency, would be subject to such plans. Apparently, the Authority believes that it is not. While this might be the case, it does not, and should not, relieve the Authority from discussing consistency as required by CEQA. The section refers to the list of plans consulted in the Chapter 12 list of sources, but there is no discussion of the consistency or inconsistency of any individual plan or any statement that the plans listed in the sources chapter were, in fact, all of the applicable plans. (The only exception is one statement that the I-5 alignment may conflict with the Tejon development plans.) Essentially what the draft states is that consistency with plans was taken into account during consultation with individual agencies during consultation over locations for stations, etc. The draft does not therefore directly discuss inconsistencies with general or regional plans as required.

Inadequate Statement of Use of Document

There is no comprehensive discussion of what the regulatory approval process for the Project will be, who the pertinent responsible and trustee agencies for the project are, what their decisions will be based on, or how the draft will function in that process.

Conclusion

Based on the foregoing, the Authority should immediately proceed to confer in good faith with the various agencies that have transportation facilities within their jurisdictions that will be impacted by the Project. As stated above, there is substantial evidence in the record sufficient to support a decision by the Authority to eliminate the I-5 alternative from further consideration in favor of the Antelope Valley route and may proceed to do so upon completion of the current EIR process. In the event that the I-5 alignment is not eliminated from further consideration, the Authority must supplement the EIR to include the missing environmental resource information and environmental analysis necessary to permit a complete evaluation of the Antelope Valley route.

If you have any questions concerning the foregoing, please contact the undersigned.

Very truly yours,

Daniel V. Hyde

Daniel V. Hyde of
LEWIS BRISBOIS BISGAARD & SMITH LLP

DVH:jm
Encl.

cc: Matthew Ditzhazy, Esq. - City Attorney
John Brooks - Senior Administrative Analyst
Frances (Fran) Florez - Vice Chair
Mehdi Morshed - Executive Director
Carrie Pourvahidi - Deputy Director
Christopher Bisgaard, Esq.
Sheldon H. Sloan, Esq.

TECHNICAL PEER REVIEW FOR THE CITY OF PALMDALE

Draft Program EIR/S for the Proposed California High-Speed Train System

Prepared for:
The City of Palmdale
38250 Sierra Highway
Palmdale, CA 93550

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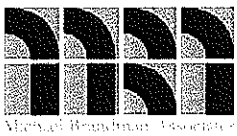

August 26, 2004

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INTRODUCTION

The California High Speed Rail Authority (Authority) has proposed a high-speed train system for intercity travel in California between the major metropolitan centers of Sacramento and the San Francisco Bay Area in the north, through the Central Valley, to Los Angeles and San Diego in the south. The HST system is projected to carry as many as 68 million passengers annually by the year 2020, and is anticipated to be capable of speeds in excess of 200 miles per hour (mph) on a fully grade-separated track.

Before a project of this nature and magnitude can be formally adopted, both the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) require evaluation of the entire project and its individual components to determine if there are any potentially significant impacts to the physical environment. Further, if a determination is made that the characteristics of the project may have a significant impact on the environment, CEQA requires the preparation of an Environmental Impact Report (EIR), and NEPA requires preparation of an Environmental Impact Statement (EIS), that identify the specific impacts resulting from the proposed project, and ways these impacts may be avoided or mitigated. In conformance with these requirements, the Authority as sponsor and CEQA lead agency, and the Federal Railroad Administration (FRA) as federal lead agency for NEPA, commissioned the preparation of a combined Draft EIR/EIS (DEIR/S) for the HST system program and alternatives. the Authority initiated an environmental review process of a proposed HST Alternative, a No Project/ No Action Alternative, and a Modal Alternative (potential improvements to highways and airports serving the same intercity travel demand as the HST Alternative), culminating in release of a DEIR/S in February 2004.

The DEIR/S contains a statement of purpose and need for a high speed train system, a description of alternatives, an analysis of the potential environmental consequences of the project alternatives by identified categories of effect, identification of various mitigation 'strategies' to reduce or avoid potentially significant effects, and a discussion of unavoidable adverse environmental impacts. The DEIR/S also includes a comparative evaluation of HST alignment options for identified segments of the HST route.

The issue of the proper route and alignment for a high-speed train between Bakersfield and the City of Los Angeles, and more specifically the Bakersfield to Sylmar segment, is an issue of vital concern to the City of Palmdale. The City of Palmdale has been an interested party and active participant in responding to technical papers and preliminary evaluations of HST route alternatives since 1995, with the advent of preliminary corridor evaluations and

feasibility studies. Accordingly, with publication of the DEIR/S in February 2004, the City commissioned Michael Brandman Associates (MBA) to review and analyze the DEIR/S and prepare a set of written comments that would be utilized by the City's professional staff in the preparation of comments responding to the DEIR/S. MBA's approach was twofold. First, the DEIR/S was reviewed for overall consistency with requirements of CEQA and NEPA for the type of environmental document, process and objectives sought by the Authority and FRA, as State and federal lead agencies, respectively. Second, the DEIR/S was reviewed and analyzed for content regarding data, methods and findings to support alignment decisions for the Bakersfield to Sylmar HST segment.

AUTHORITY TO COMMENT

Environmental review comments on the *Draft Program Environmental Impact Report/Statement for the Proposed California High Speed Train System (February 2004)* are presented in the sections that follow. These comments are submitted to the Lead Agency pursuant to the California Environmental Quality Act, as codified in the Public Resources Code in Section 21000 *et. seq.,* and the State CEQA Guidelines codified in Chapter 3 of Title 14 of the California Code of Regulations (CCR). Comments are also provided in compliance with the National Environmental Policy Act (NEPA) (42 U.S.C. § 4321 et seq.).

REPORT FORMAT AND PREPARERS

The report format is organized with initial presentation of general comments pertaining to DEIR/S conformance with CEQA and NEPA, followed by specific comments related to each chapter and section of the DEIR/S. In many instances, these specific comments underscore general weaknesses and shortcomings of the document described in the general comments section.

The preparer of this report of comments is Michael Brandman Associates (MBA), in association with Mr. Robert Schaevitz of URS Corporation (Traffic/Circulation, Travel Demand, Costs and Operations), and Acentech, Inc. (Noise/vibration).

ADDITIONAL DEIR/S TECHNICAL AND LEGAL REVIEW

This technical review of the DEIR/S is supported by additional comments separately provided by counsel to the City of Palmdale addressing compliance with CEQA and NEPA, and by two separate studies commissioned by the City of Palmdale addressing issues in the DEIR/S. These studies, identified below, are summarized and incorporated by reference with the comments that follow:

- *Sprawl or Smart Growth, Analysis of High Speed Rail Alignments and Smart Growth,* prepared for the California High Speed Rail Authority and the City of Palmdale, by Freilich, Leitner & Carlisle (July 26, 2004)
- *A Comparative Analysis of the Tunnel Construction Times, Costs and Risks Associated with the Choice of High Speed Rail Alignment Between Los Angeles and Bakersfield;* prepared for the City of Palmdale by Transmetrics Inc. and GEODATA S.p.A. (January 31, 2003)
- Economic Risk Analysis of Construction Costs, Schedule, Benefits associated with High-Speed Rail Alignments between Los Angeles and Bakersfield, prepared for the City of Palmdale by HLB Decision Economics, Inc. (March 5, 2003)
- Benefits, Costs and Risks Associated with the Choice of Alignment Between Bakersfield and Sylmar, prepared for the City of Palmdale by HLB Decision Economics, Inc (October 26, 2001)
- Comparison and Summary of California High-Speed Rail Project Peer Reviews, prepared for the City of Palmdale by HLB Decision Economics, Inc (April 4, 2001)
- An Analysis of Benefits, Costs, and Risks Associated with the Choice of High-Speed Rail Alignment Between Los Angeles and Bakersfield, prepared for the City of Palmdale by HLB Decision Economics, Inc (March 25, 2000)
- Financial and Economic Performance of the Antelope Valley High Speed Rail Alignment, prepared for the City of Palmdale by Hickling Lewis Brod (December 2, 1998)

RESULTS OF REVIEW

This review and analysis has identified certain deficiencies in the DEIR/S. The DEIR/S is deficient in the manner in which it was prepared and the manner in which it addresses the potentially significant impacts of the proposed project (or 'proposed action'). The DEIR/S does not fully comply with the requirements of CEQA and the State CEQA Guidelines, and NEPA, its policies and the procedures for implementing NEPA. As evidenced in the comments that follow, the DEIR/S focuses disproportionately upon the overall decision on system alternatives (i.e. HST System vs. Modal Alternative vs. No Project), at the expense of providing sufficient, independently verifiable information to support HST alignment decisions.

The DEIR/S does not construct an accurate and stable project description, provide a clear hierarchy of project objectives, utilize clear and consistent thresholds of impact significance,

accurately and completely analyze potential environmental impacts, develop comprehensive and effective mitigation measures, or provide required information within each of its sections and appendices to support conclusions. These factors make it difficult to make decisions on routing alternatives, one of the goals of the study.

By failing to comply with basic requirements of CEQA and the State CEQA Guidelines in particular, the DEIR/S is a very difficult document to understand and utilize by decision-makers and the public in the manner intended by CEQA. The Lead Agency may argue that many of the deficiencies described in the comments that follow can be explained by the fact that the environmental document has been prepared as a Program-level EIR and Tier 1 EIS, and substantial reliance can therefore be placed upon subsequent project-level environmental reviews to provide additional detail for impact analysis and mitigation. However, the level of detail of the EIR/S analysis of impacts must correlate with the type of project being evaluated and action sought. The EIR/S must be prepared with a sufficient degree of analysis to provide decision-makers with information needed to make an informed decision concerning the environmental consequences of the project.

The summary of the DEIR/S indicates five areas of controversy: Northern Mountain Crossing; Southern Mountain Crossing; Impact on Public Parks, Wildlife Areas and Recreation Resources; Impacts on Coastal Communities; and Station Locations. One of the objectives of the report should have been to resolve or clarify these issues. This review is more focused on resolving the controversy associated with the Southern Mountain Crossing, in particular exploring the differences between the Interstate 5 Alignment (I-5) and the Antelope Valley State 58/Soledad Canyon Alignment option.

Based on the review of the DEIR/S and supporting documentation, there is not sufficient information to support a decision that the I-5 alternative is environmentally superior to the Antelope Valley Alternative. However, substantial evidence indicates that the I-5 Alternative could be removed from further consideration in favor of the Antelope Valley Route. In the event the I-5 alignment *is not* eliminated from further consideration, substantial revisions and additions to the EIR/S are needed before the document can be certified for selection of a specific HST alignment in the Bakersfield to Sylmar segment. In the event the I-5 alignment *is* eliminated from further consideration, minor refinements to the analysis of the Antelope Valley discussion would need to be made, but these would not force re-circulation, prior to a certification action.

GENERAL COMMENTS

The DEIR/S has been prepared as a Program Environmental Document, addressing both broad system alternatives, as well as alignment alternatives within specified segments of the High Speed Train system. Our review identifies problems associated with analytical methods used, informational gaps and lack of detail provided to support alignment decisions. The focus is on the Bakersfield to Los Angeles Segment, however, comments are made on all portions of the document. These deficiencies are summarized below, with specific examples and references provided in the chapter and section comments to follow.

1. THE DEIR/S IS A 'SUMMARY' DOCUMENT LACKING SUFFICIENT DETAIL TO VERIFY CONCLUSIONS

The DEIR/S text is a highly summarized document, typically without specific references or footnotes throughout to indicate where source information is available to the reader to verify data and conclusions. For the most part, the DEIR/S only presents summary analyses, and does not contain information or data sets that would allow for a critical review of the analysis process or verification of the quantitative results.

The figures used in the DEIR/S to present segment and alignment information are not prepared at a sufficiently large scale to verify information described in the text. Where impact conclusions rely upon a clear understanding of the relationship of alternative alignments to adjacent land use, the regional scale figures used (e.g. 1"= 15 miles), mask local land use and resource impacts and preclude a reasonable verification of impact conclusions (i.e. 'high', 'medium' and 'low' impact).

The Appendices should include all of the pertinent regional and statewide studies relied upon in the DEIR/S text documentation. Even so, review of the Regional Studies for the Bakersfield to Los Angeles segment indicates that these studies themselves are highly summarized, frequently lacking adequate mapping of information needed to confirm data and conclusions presented therein. Lack of access to source data and mapping deprives agencies and the public with the ability to give meaningful comments on the adequacy and accuracy of the impact evaluations.

2. THE USE OF SHIFTING TERMS OF REFERENCE FOR RAIL SEGMENTS AND GEOGRAPHIC

Sub-areas Creates Confusion

The DEIR/S frequently and repeatedly uses shifting geographical frames of reference for the alignments (e.g. SR-58/Soledad Canyon v. 'Antelope Valley'; I-5/Wheeler Ridge v. I-5/Tehachapi v. I-5/Grapevine) and segments (e.g. Bakersfield to Los Angeles, Bakersfield to Sylmar) and segments within segments (e.g. Bakersfield to Los Angeles 'north', 'central' and 'south'), which make it difficult to determine whether comparable geographical areas and data sets are being consistently addressed and evaluated. This is further complicated by references to the Southern Mountain Crossing portion of the HST corridor. In some instances references to the 'Antelope Valley' alignment appear to refer to the entire SR-58/Soledad Canyon alignment, whereas in other instances this appears to refer to the non-mountainous portions of the Antelope Valley (i.e., valley floor only). This problem undoubtedly results from the integration of information from previous technical studies and screening evaluations where different alignment sets and study segments have been evaluated.

For clarity, all data sets should be checked to assure a consistent geographical frame of reference, and the entire SR-58/Antelope Valley/Soledad Canyon alignment should be referred to consistently as the Antelope Valley alignment in Final Program EIR/S.

3. THE DESCRIPTION OF THE PROJECT AND PROPOSED ACTION ARE NOT CLEARLY SET FORTH IN THE DEIR/S

An EIR must contain a project description (CEQA Section 15124), that complies with various technical requirements, and must a) constitute an accurate description that sets forth project objectives, b) include discussion of reasonably foreseeable activities, and c) be fixed and consistent throughout the document. NEPA has similar requirements for project descriptions.

Although Purpose and Need and Objectives are described in the DEIR/S, there is no section within the DEIR/S that coherently sets forth the Project Description. The HST is variously described as an Alternative (Section 2.6), the 'Proposed Action' (Section 2.6), and the 'Preferred System Alternative' (S.5.4). The proposed HST must be clearly and unambiguously identified in a Project Description section. This section should provide a consolidated, detailed discussion of the physical components, characteristics, or attributes of the proposed HST system facilities. The proposed tunnels, stations, tracks, grade crossings, locomotors, rail cars and other components should be detailed in this section.

The project description must contain a clearly written statement of objectives to help the lead agency develop a reasonable range of alternatives (CEQA Section 15124(b)). Within Section 1, Purpose and Need and Objectives, there are several different sets of objectives and/or criteria identified. The specific objectives being relied upon to evaluate the project and alternatives should be clearly identified.

4. THE DEIR/S PROVIDES NO MEANINGFUL DISCUSSION OF HST PHASING OR ANALYSIS OF LOGICAL PHASED SEGMENTS

The HST alternative is presented as a one-size, 'take it-or-leave it' project. What is missing is a meaningful analysis of a larger project (i.e. expanded corridors) or a smaller initial project (i.e. phased or staged HST system), with a minimum feasible network identified. Analysis of the latter in the DEIR/S is particularly important given the current state budget situation and uncertainty regarding future state bonds and major capital outlays.

5. THE PROGRAM EIR/S DOES NOT PROVIDE THE LEVEL OF DETAIL TYPICALLY ASSOCIATED WITH A TIER 1 ROUTE SELECTION EVALUATION FOR A TRANSPORTATION PROGRAM.

The DEIR/S appears to have given overwhelming priority to evaluation of the system alternatives (No Project; Modal Alternative; HST Alternative) at the expense of a thorough analysis to support Tier 1 HST alignment decisions, this includes selection of the preferred alignment for the Bakersfield-Sylmar segment.

The document needs to address all environmental impacts associated with each route alignment option in order for decision makers to assess the differences when making a decision on the proposed project. In most cases, the environmental analysis provides only a passing reference or quick overview of the impacts of specific alignments.

The methods described for determining 'low', 'medium' or 'high' impacts for several of the impact categories are based on "known" information. Thus, if an area has been subjected to extensive surveys, there is a greater potential to have a higher impact. Significant portions of the study areas associated with the alignments in the Bakersfield to Sylmar segment have not been surveyed for various resources and might result in a "low" impact rating based on lack of information. A more appropriate evaluation would be to have a number indicating the percent of the route that has been surveyed. Using this number with the number of "known" sites or impacts in an area would be a more defensible method for comparison of alignment impact potentials.

The lack of information and/or meaningful comparative analysis between route alignments makes it difficult for decision makers to choose the environmentally superior alternative. NEPA Guidelines (40 C.F.R. § 15022.22) requires that when information is incomplete or unavailable, the information must be obtained if costs are not exorbitant.

6. STUDY AREAS AND AREAS OF POTENTIAL EFFECT VARY IN SHAPE AND SIZE

The variable widths used for comparison of impacts within and across alignment alternatives are not clearly justified or verifiable through review of mapping in the DEIR/S (see Comment #1 above). Specific mapped HST alignments (1"=200' Plan and Profile sheets) were apparently used for analysis of some impact categories (e.g.. Aesthetics and Visual Resources), but not others (where alignments were merely assumed to occur within broadband 'sensitive areas'). Furthermore, the lack of maps indicating the analysis widths and where or if they change make comparison of segments difficult.

7. THERE IS A LACK OF CLEAR THRESHOLDS OF SIGNIFICANCE TO SUPPORT IMPACT CONCLUSIONS

The Program EIR/S does not establish clear thresholds of significance or make findings of significance for many environmental impacts. CEQA Guidelines Section 15126 requires that an EIR identify potentially significant environmental impacts associated with proposed projects. CEQA Guidelines Section 15064(b) requires that the lead agency make a determination of whether a project may have a significant effect on the environment based to the extent possible on scientific and factual data. CEQA Guidelines Section 15064.7 encourages lead agencies to "develop and publish thresholds of significance . . ." The DEIR/S relies upon customized 'Methods of Evaluation' that deviate from thresholds found in CEQA Guidelines Appendix G, and do not clearly conform with CEQA requirements.

8. THERE IS A FAILURE TO ADEQUATELY INVESTIGATE AVOIDANCE OR MITIGATION POTENTIAL

The descriptions of 'mitigation strategies' presented throughout the document are generally inadequate, often presenting mere descriptions of the next steps in the review process without outlining any specific programmatic mitigation measures, or clear responsibilities for implementing such measures. The DEIR/S should also include additional information on the potential for substantial reduction of environmental impacts through alignment adjustments and refinements. The programmatic level analysis should identify regional impacts and find regional mitigation strategies designed to address those impacts. In this way, a program level analysis is able to take advantage of regional level mitigation that project-level analysis would not be capable of doing.

COMMENTS ON THE DEIR/S

Comments that follow are provided by chapter and section, corresponding to the sequence in the DEIR/S.

As a general statement, the DEIR/S does not appear to include any clear recitation of 'Effects Found Not to be Significant', either in the document itself or by reference to an Initial Study. The Appendices list does not include the Notice of Preparation/Initial Study. These should be included with the Appendices and readily available to any reviewer of the DEIR/S. Finally, the Appendices list does not include any of the Statewide technical studies or Bakersfield-to-Los Angeles segment technical studies prepared to support the DEIR/S. The mere identification of these as 'Sources Used in Documentation Preparation' (Section 12) diminishes the importance of these documents in support of the findings of the Program EIR/S. These and other technical reports must be included in the Appendices and made readily available for public review as part of the DEIR/S.

The statements provided below are specific to each section as identified. In the case of the Summary, the statements reflect both the section in particular and the document in general.

TITLE PAGE/ABSTRACT

1. The Joint Authority/FRA Signature page with Abstract lists only the following potential environmental impacts of the alternatives: displacement of commercial and residential properties; community and neighborhood disruption; increased noise and vibration; local traffic impacts associated with stations; impacts on historic properties and archaeological sites; impacts on parks and recreation resources; visual impacts in scenic areas of state; impacts on sensitive biological resources and wetlands; use of energy; and impacts on agricultural lands. This list is partial, as it does not include all of the potential impacts attributable to the alternatives identified in the DEIR/S text.

2. The Abstract should be amended to identify the major segments of the HST System Alternative and list the alignment alternatives within these major segments. The Abstract does not identify the HSR Bakersfield to Los Angeles alignment alternatives and pending decision regarding alignment choices within this segment.

SUMMARY

1. The last paragraph on page S-1 indicates that the Authority in the Final Program EIR/S ".....*may* select a preferred HST corridor/alignment, general station locations, and recommended mitigation strategies, ...to consider in more detail at the project level". This statement is repeated in Section S.10 Next Steps in the Environmental Process (page S-18). In S.7 HST Alignment and Station Options (page S-16), the document indicates "...the authority *expects to identify* a preferred system of alignment and station options in the Final Program EIR/S." The Summary should clearly indicate if it is the Authority's intent to utilize the information in the Program EIR/S to select preferred HST corridors/alignments for further study at the project-level.

2. Section S.2 Studies Leading to the Program EIR/EIS mentions release of the Notice of Preparation (NOP) and Notice of Intent (NOI), a scoping process, a screening process including key criteria, and the alternatives that emerged from this process. However, this section does not specifically identify any of the studies or reports relied upon in this process. Key studies should be identified here and/or footnoted with appropriate references (including availability for public inspection.) Neither the NOP nor NOI is included in the DEIR/S Appendix. In its March 24, 2004 letter to the High Speed Rail Authority Chairman, Lewis Brisbois Bisgaard & Smith LLP, counsel to the City of Palmdale in this matter, identified the NOP and NOI as key informational documents missing from the DEIR/S and published record. The NOP and NOI were subsequently made available for the City's inspection at the Authority's offices, and copies were later provided. Both the NOP and NOI should be included as part of the EIR/S documentation and made readily available for public review as part of the appendices.

3. Within Section S.2, is the relationship, if any, of the listed key criteria in this to the enumeration of 'Project Objectives' required by CEQA (Guidelines 15124(b)) is not described, nor is it stated where specifically, can these Project Objectives be found.

4. The purposes described in Section S.3, Purpose and Need for a High Speed Train System, support several of the reasons documented in elsewhere in the DEIR/S and in prior City of Palmdale testimony to the Authority, as to why the Antelope Valley HST alignment is the best choice for California... Superior intermodal integration, economic integration, economic viability, and reliability.

5. The discussion under S.4.1 No Project Alternative references the relationship of this alternative to 'purpose and need and objectives regarding congestion, safety, reliability, and travel times'. Are these the Project Objectives required to be identified by CEQA? There is a need to consolidate these within a single section of the EIR/S, to allow a complete and consistent frame of reference for measuring the ability of system and alignment alternatives to achieve basic project objectives.

6. S.4.3 High Speed Train Alternative (page S-4) - Indicates that a higher HST ridership forecast was used in describing HST Alternative and impacts ('representative demand' ridership), but that where high-end ridership forecasts result in potential benefits, additional analysis is included to address the impacts associated with the low-end forecasts. The rationale for this dichotomy is not clearly explained. For example, where high-end ridership may result in potential adverse impacts (rather than benefits), are the low-end ridership forecasts also presented?

7. Section S.4.4 Areas of Controversy, indicates that in choosing HST alignment and station options, the Authority will take into account potential impacts on natural resources, cost, effects on travel time and ridership, and public and agency input. The factors the Authority should take into account should include the full range of environmental impacts, as well as the aforementioned Project Objectives, required by CEQA.

8. Regarding the Northern Mountain Crossing (page S-5), the service/operational, ridership and environmental impact factors cited appear to provide sufficient justification for the decision to remove the Altamont Pass corridor option from further consideration.

9. The discussion of Southern Mountain Crossing options summarizes several of the advantages of the Antelope Valley (AV) alignment that are apparent from the analysis in the DEIR/S text. As discussed in our comments that follow, however, the reference to 10-12 minutes of added travel time with the AV alignment (over the I-5 alignment) is not supported by analysis or explanation. Past travel time estimates provided by the Authority in writing and in public meetings have cited a 6-9 minute difference. This The Antelope Valley SR 58/Soledad Canyon Route (hereafter referred to as the 'Antelope Valley' route for ease of reference) would result in increased intercity ridership (Bakersfield to Palmdale; Palmdale to Los Angeles), and would have fewer impacts in some critical issue areas such as impacts to parklands

and other sensitive issues. Indeed, Authority staff has stated in past public meetings that the ridership difference between the two alignments is "too close to call".

With projected growth in Antelope Valley, the AV will become a first-order intercity destination in and of itself. This section presents an abbreviated listing of environmental benefits of the AV alignment versus the I-5 Grapevine option; a more complete listing is provided in Section 6.4. Based on the prior project environmental record (including the 12/14/01 Final Statewide Scoping Report), it is unclear why an alignment decision in the Southern Mountain Crossing area should be considered an 'Area of Controversy' at all.

10. In S.5.4 Preferred System Alternative, it is indicated that the Authority and the FRA have concluded the HST Alternative is the preferred system alternative, but that "the Authority and FRA continue to consider HST alignment and station options and have not identified a preference among those presented in the Draft Program EIR/EIS." With the environmental information provided for the Bakersfield to Los Angeles segment summarized in Chapters 3 and 6, supplemented by testimony at the Authority's Los Angeles area public hearings on the DEIR/S, it would appear there is sufficient data to support elimination of the I-5 alignment and support the identification of the Antelope Valley alignment and Palmdale Station as the Authority's preferred choices in this segment of the HST corridor.

11. Table S.6-1 Summary of Key Impacts and Benefits for System Alternatives is too brief in its presentation of key system-level environmental issues to provide a meaningful comparison of system-level effects. This summary table should be substantially expanded for each issue area, particularly with regard to growth potential and cumulative effects. Pursuant to CEQA Guidelines 15168 (b), one of the principal advantages of a program EIR is assurance of an adequate consideration of cumulative impacts that may otherwise be slighted on a case-by-case basis. The Table S.6-1 summary of cumulative effects for the system alternatives mentions only two or three impact categories for each of the system alternatives. For the HST alternative, it provides only a brief statement of visual effects, construction-related short-term visual impacts, and farmland impacts. The Program EIR must provide a thorough comparative analysis of cumulative effects.

12. The comment in S.6 System-Wide Environmental Impact Comparison indicating that many of the potential impacts for the system alternatives will fall *within the quantities presented* in Table S.6-1 is an important observation that masks a larger issue with the gross level of analysis and detail in the Program EIR/S. The methods used in the

Program EIR/S tend to define impact 'envelopes' or worst case indices of potential impacts of both the system alternatives and HST alignments. As noted in our comments that follow below with respect to the Bakersfield to Sylmar segment and several key impact sections, (e.g. 3.12 Cultural Resources, 3.14 Hydrology and Water Quality, 3.15 Biological Resources,) the actual impacts of alignment alternatives may be significantly less than what was analyzed in the DEIR/S, thus making it difficult to make accurate alignment comparisons.

13. S.8 Least Environmentally Damaging Preferred Alternative (LEDPA). This section Indicates that the EPA and U.S. Army Corps of Engineers (USACE) have participated in the preparation of the DEIR/S and will be consulted in identification of preferred corridor and route that will be discussed in Final Program EIR/S. Where is this participation evident in the DEIR/S and what comments/concerns have been expressed by these agencies? The DEIR/S needs to identify those factors that determine designation of the LEDPA, and what the significance of this designation is for route selection and implementation.

14. S.9 Public and Agency Involvement. This highly abbreviated statement provides no real measure of the impact that such public involvement has had on the EIR/S process or content. (Section 8 of the DEIR/S merely reflects a recitation of the number of meetings and locations where the project was discussed, but provides little indication of the issues raised, and resolution of such issues through the DEIR/S.) The DEIR/S Appendices should include the NOP/NOI and a complete summary of the proceedings of the scoping meetings. The DEIR/S should indicate where additional information, including agency correspondence is available for public review.

15. In S.6 System-Wide Environmental Impact Comparison (page S-9), the observation is made that "For many of the environmental areas discussed in Table S.6-1, the quantities presented represent areas within which potential impacts might occur." Although the meaning of this statement is not entirely clear, it would appear to suggest that the quantities identified represent 'worst-case' impact scenarios, within which actual impact levels as determined by specific system plans will fall. If this is an accurate interpretation, the same observation should also be made for many, if not all, of the quantities attributed to the HST alignment alternatives throughout the document. The fact that the actual impacts could be significantly less than what was analyzed makes it very difficult to make accurate comparisons, since it is difficult to

determine if the differences between a "worst case" and a "best case" are equivalent. (page S-9)

CHAPTER 1:
PURPOSE AND NEED AND OBJECTIVES

1. THE OBJECTIVES AND PURPOSES NEED TO ADDRESS HIGHER-ORDER STATEWIDE MOBILITY GOALS.

This section presents various *purposes of a high-speed train system* (1.2.1), but is not entirely clear whether these are intended to be the specific project objectives required to be identified by CEQA Guidelines 15124(b) in the EIR. In this regard, the purposes listed on pages 1-3 and 1-4 are focused on the HST system alternative only. If the DEIR/S is intended to differentiate between the broader system alternatives, the objectives (e.g. purposes) should address higher-order statewide mobility and environmental goals that are not defined specifically for an HST system alternative.

2. THE RELATIONSHIP BETWEEN CRITERIA AND SCREENING EVALUATIONS IS UNCLEAR.

Also unclear is the relationship between various standardized criteria and objectives identified in association with prior screening evaluations (see Chapter 2; page 2-8, 2-9) and the broader project objectives and system alternatives. The standardized criteria are identified (on page 2-8) as Construction; Environment; Land Use Compatibility; Right-of-Way; Connectivity/Accessibility; and Ridership/Revenue criteria. The HST screening evaluations objectives were identified (on page 2-9) to include the following:

- Maximize ridership and revenue potential
- Maximize connectivity and accessibility
- Maximize compatibility with existing and planned developments
- Maximize avoidance of areas with geological and soils constraints
- Maximize avoidance of areas with potential hazardous materials
- Minimize operating and capital costs
- Minimize impacts on natural resources
- Minimize impacts on social and economic resources
- Minimize impacts of cultural resources

The DEIR/S thus lacks a clear definition and hierarchy of project objectives to support findings for selection of a travel mode system alternative, as well as identification of preferred alignment alternatives should the HST system be selected for implementation. Perhaps not surprisingly, review of the discussion of Purpose and Need and Objectives, as

well as discussion of Alternatives, reflects an apparent bias toward the High Speed Train System Alternative.

3. THE TRAVEL YEAR HORIZON SHOULD BE REDEFINED TO YEAR 2025.

The DEIR/S utilizes year 2020 as the horizon year for virtually all projections and comparisons of system impacts at buildout. Most local and regional agencies are already utilizing year 2025 for long-range planning, General Plans and regional transportation planning purposes, while some are looking as far as 2030. Given the long lead times for potential HST system implementation on a statewide basis, and the uncertainties regarding availability and timing of funding to support full HST system implementation, the horizon year and projections in the DEIR/S should be systematically updated to reflect year 2025 buildout and cumulative conditions.

4. THE NEED FOR IMPROVED INTERCITY DAILY COMMUTING IS NOT ADDRESSED IN THIS SECTION.

There is no discussion of the potential benefits of an HST system in meeting a portion of future intercity commuting demand. There should be some discussion on the need for high speed connections from San Francisco to San Jose; San Francisco to Sacramento; San Jose to Sacramento; Bakersfield to LA; Lancaster/Palmdale to LA; and Lancaster/Palmdale to Bakersfield. This function is consistent with and required by the goals and objectives for high speed rail set forth in the Authority's enabling legislation.

5. THE SECTION MISREPRESENTS VARIOUS FACTORS RELATED TO AVIATION

The section attributes much of the purpose of the HST to fulfilling the unmet needs for inter-city travel created by a lack of aviation facilities, and the increasingly longer point-to-point travel times. The section asserts that most long distance inter-city travelers currently rely on aviation, that aviation facilities are strained now and that new expensive facilities are necessary to keep up with the demand. Thus, an HST would serve a need, particularly among business travelers who are more apt to pay higher fares. In making this argument, the document presents some questionable data and in the process omits some arguments favorable to the HST.

6. THE DEIR/S UNDERREPRESENTS THE CAPACITY OF SOUTHERN CALIFORNIA AIRPORTS.

The DEIR/S fails to mention the availability of currently underutilized airports and uses outdated and erroneous data to represent the existing and proposed capacity of existing

airports. Text on Page 2-12 and **in** Table 2.4-2 Total Programmed, Funded, and Operational Airport Improvements do not list several existing airports and do not mention airport capacity enhancement projects currently underway. The document narrowly defines the criteria for considering airports by including only those that currently host scheduled air service (page 2-21 and Appendix 2-B Detailed Description of No Project Alternative), and the document includes only those airport projects that are contained in an existing capital improvement program. By doing so, the document vastly underestimates the prospects for additional airport capacity and only recognizes improvements located at Ontario Airport. For example, the analysis in the document (page 1-6) indicates that LAX is limited to 78 Million Air Passengers (MAP). . However, at LAX, a draft Master Plan calls for proposed runway improvements to serve nearly 90 MAP. Considering the current level of 55 MAP, that would provide for an 82% increase.

The document also states that no improvements are slated for John Wayne Airport (JWA) (page 2-14, Table 2.4-3 Programmed, Funded and Operational Improvements) and that service will not increase above a level of 7.5 MAP. However, JWA served 8.5 MAP in 2003 and is slated to increase to 10.8 MAP and to add 6 more gates owing to a recently FAA approved change to the court ordered Settlement Agreement. JWA is also sized to accommodate medium air carrier aircraft, not only small aircraft as indicated in the document (Appendix 2-G Table 2-G-1 Airport Capacity to Accommodate Larger Aircraft.) The terminal, gates and runway at JWA are designed to accommodate B767 and A300 aircraft, which could add even more passenger capacity to JWA beyond the 10.8 MAP after the current Settlement Agreement extension expires in 2011.

Ontario Airport is considered in the document to add terminal space and gates. (page 2-14, Table 2.4-3 Programmed, Funded and Operational Improvements) However the analysis misses the fact that Ontario Airport has the ability to increase its service from the current 6.5 MAP to 14 MAP under existing plans, and the draft Aviation Element of the 2004 Regional Transportation Plan (RTP) calls for it to be expanded to 30 MAP.

Other airports not considered in the DEIR/S, despite not doing so now, definitely have the potential to provide commercial air service. The Aviation Element of the Regional Transportation Plan (RTP) entitled *"DESTINATION 2030"* released November 3, 2003 produced by Southern California Association of Governments (SCAG) echoes this sentiment. The document proposes a new decentralized aviation plan called the "Preferred Aviation Plan" that would accommodate a total of 170 MAP. Rather than relying on expanding existing urban airports, future demand will be served using available capacity at existing airports. Ontario Airport, March Air Reserve Base, San Bernardino International

Airport, the Southern California Logistics Airports and, most importantly, Palmdale Airport have the backing and support of their owners and communities to use their vast acreages of runways and facilities to serve passengers. The draft RTP calls for Ontario to serve 30 MAP, for Palmdale to serve 12.8 MAP, for March to serve 8 MAP, for San Bernardino to serve 8.7 MAP and for SCL to serve 4 MAP. Reconsideration of all these facts in the DEIR/S would lead to a conclusion that there are ample physical facilities in southern California to accommodate air travel far into the future.

7. THE DOCUMENT OVER REPRESENTS AIR TRAVEL DEMAND FOR THE YEAR 2020.

The document uses forecast data indicating large increases in air passenger demand by the year 2020. On page S-7, the document states that the 173 million air passengers within the state during 1999 will double to 346 million by 2020. This data overstates the rate of increase by not adequately reflecting the decreases in air travel experienced in southern California during the past few years. The current draft of the SCAG Aviation Element states that demand will not double until the year 2030.

Air travel at LAX is down 20% from its peak and only lately demonstrates some little inclination to assume its former rate of increases. From its peak of 67.3 Million Air Passengers (MAP) in 2000, LAX travel declined to 61.6 MAP in 2001, 56.2 MAP in 2002 and 54.97 MAP in 2003. The rebound after the events of 9/11 is not occurring as stated in the document on page 1-6. The forecast of 98 MAP referenced in the LAX DEIR/S will not be realized until much past 2020. The most recent FAA Terminal Area Forecasts for LAX indicate that service levels at LAX will not reach the year 2000 levels (64 MAP) until the year 2008 and that service levels in 2015 will be approximately 81.6 MAP.

While it is true that other airports have seen increases, the overall trend is still down. Long Beach has experienced an increase of over 1.2 MAP owing solely to the introduction of JetBlue. John Wayne has rebounded since 9/11 and has experienced increases of 1 to 2 MAP. In, 2003, Burbank Airport re-achieved its 2000 peak of 4.7 MAP. However, Ontario is down to 6.5 MAP in 2003 from its peak of 6.7 MAP in 2000. From a peak of 89 MAP in 2000, air travel throughout the region declined to 76.2 MAP in 2003. It will be some time before previous levels are achieved and new levels attained.

While air travel demand in Southern California will eventually increase to levels equaling or exceeding those stated in the DEIR/S (the RTP forecasts 170 MAP by 2030), it is clear that the levels of demand forecast in the DEIR/S will not occur until much later than 2020, thus calling into question this "purpose" of the HST project.

8. THE DOCUMENT DOES NOT DISCUSS THE POTENTIAL BENEFITS FROM THE PROPOSED HST TO THE SOUTHERN CALIFORNIA AIRPORT SYSTEM.

The densely populated San Fernando Valley contributes heavily to regional air transport demand, and the Burbank Airport is clearly overburdened. Data contained in the LAX Master Plan documents indicate that air travel demand for domestic Origin and Destination travel in the San Fernando Valley and the City of Burbank achieve the highest levels of 20,000 to over 80,000 passengers per year per square mile. (These are higher than the downtown area of Los Angeles.) Travel time and expense from the Valley to LAX is very high requiring use of congested freeways passing through the heart of the metropolitan west side of Los Angeles.

The proposed HST has the potential to fulfill a long sought objective to provide a high speed transit link to the vastly underused Palmdale Airport. HST stations are proposed to be located adjacent to the Palmdale Airport and directly adjacent to Burbank Airport. (The Union Station terminus is important but less so than Burbank is.) The concept of a high speed transit link to Palmdale Airport has been openly proposed by LA City Council members and is implicitly included in the Regional Transportation Plan and the LAX Master Plan now under development. Los Angeles World Airports (the department of the City of Los Angeles that owns and operates both LAX and Palmdale) conducted a study of the passenger demand for the Palmdale Airport with the inclusion of improvements to Highway 14. The current Master Plan concept envisioned by Mayor Hahn includes limited expansion of LAX and increased expansion of regional airports.

An additional benefit of using the Palmdale Airport is its ability to serve what is known as the New Large Aircraft (NLA), the Airbus 380, which will carry 500 to 600 passengers. LAX will require expensive refitting to accommodate that aircraft while Palmdale would not. A high speed transit link to Palmdale would enhance the ability of the region to accommodate this aircraft.

9. THE PURPOSE AND NEED DO NOT CONSIDER THE IMPACT OF ELECTRONIC COMMERCE OR "TELEWORKING".

The DEIR/S and the Business Plan speak in several places of the intercity business travelers who mostly fly, are willing to pay higher fares and who would be potential HST riders. However, there is an increasing body of evidence, often cited in aviation planning, indicating that the availability of increasingly sophisticated and reliable electronic communications are supplanting the need for business travel. The Southern California Association of Governments (SCAG) indicated in their 2003 State of the Region Report, that some 3.2 % of the work force are "teleworking" and that these workers tend to be highly

educated and paid—exactly the same as business air travelers. The document must consider the implications of this trend on the potential ridership of the HST.

CHAPTER 2: ALTERNATIVES

1. THE CAPABILITY OF THE HST TO CARRY FREIGHT IS NOT ADDRESSED.

Not addressed in the DEIR/S, (often overnight) transfer of packages and mail between California cities is a growing need that could be served by HSR. Advances in high speed sorting and containerization of cargo are equally applicable to rail as to aviation. Inter-city truck traffic is an increasing factor in the congestion levels of the state's highways. While the DEIR/S acknowledges the potential for HST freight service in Section 2.6.3, it indicates such service has been given no consideration in the analysis. The benefits of extension of HST freight service to a growing Antelope Valley, with connections to the Palmdale Airport, should be explored. The Program EIR level is appropriate for some analysis of this HST system opportunity. The capability of HST to carry freight should be more fully evaluated in the DEIR/S.

2. THE CONCEPTUAL SERVICE PLAN SHOULD INDENTIFY INTERCITY SERVICE BETWEEN THE ANTELOPE VALLEY AND OTHER MAJOR DESTINATIONS

For purposes of alignment comparison, Section 2.6.2 Conceptual Service Plan (page 2-25), should include service to the Antelope Valley with the five types of intercity trains identified. This section makes no mention of the benefits associated with a station in Palmdale connecting with the Central Valley or Los Angeles. This connectivity would result in enhanced HST ridership, reduced impacts to air quality in the air basins, and reduced traffic impacts on SR-14 and I-5 within the Bakersfield to Sylmar segment (page 2-25).

3. THERE IS A NEED TO CLARIFY THE RELATIVE LENGTH OF TUNNELS

In the discussion of 'Bakersfield to Los Angeles Options Carried Forward' (page 2-73), the amount of tunneling that would be needed for the I-5 (3.5% maximum grade) route is identified as 18 miles with a maximum tunnel length of 6 miles. For the SR 58/Soledad Canyon alignment (3.5% maximum grade), it indicates the need for tunneling would be *reduced to 20.7 miles* of total tunneling. Yet in the Final Cost Report, Appendix F, HST Segment Cost, figures on pages 65-66 of 73 indicate lengths of 37 km (22.9 miles) for the I-5 alignment and 21.6 km (13.4 miles) for the AV alignment. Clarification is needed throughout the DEIR/S document as to how much tunneling would take place on these routes. This is further confused by the Tunneling Study conducted by Transmetrics and Geodata that indicates that tunneling lengths would be roughly equivalent on the two alignments.

4. THE SOLEDAD CANYON CORRIDOR NEEDS TO BE CONSISTENTLY DEFINED AND EVALUATED

Included in the discussion of the SR 58/Soledad Canyon (3.5% maximum grade) alternative carried forward (page 2-73) is a note explaining that 'Soledad Canyon refers to a relatively wide corridor area that included both the SR-14 and UPRR alignments between Antelope Valley and Santa Clarita.' A footnote indicates that, while the SR-14 between Antelope Valley and Santa Clarita was previously recommended for elimination, it was subsequently determined that the Soledad Canyon corridor should be defined to include the SR-14 alignment option. This observation is particularly significant in assessing the ability to further reduce impacts identified for the Antelope Valley alignment in the DEIR/S. Prior screening evaluations indicated that many of the biological, hydrology/water quality, cultural and other natural resource impacts associated with the Soledad Canyon alignment *(as mapped in all of the figures in the DEIR/s to generally align with Soledad Canyon Road from Acton to Soledad)* would be reduced with an alignment following SR-14 through this reach. Conversely, the SR-14 alignment within this reach was identified as having proportionately higher potential land use, property and noise impacts.

Given the wide band of potential specific HST alignments through the Soledad Canyon corridor, all figures in the DEIR/S that depict the Soledad Canyon alignment should be modified to depict the actual width of this study corridor. Further, the impact analyses within each section of Chapter 3 should be modified to specifically discuss the potential to further mitigate impacts with alignment adjustments.

CHAPTER 3: AFFECTED ENVIRONMENT, ENVIRONMENTAL CONSEQUENCES, AND MITIGATION STRATEGIES

SECTION 3.1 - TRAFFIC AND CIRCULATION

The traffic impacts of the No Project, Modal and HST system alternatives are broadly identified in Section 3.1. However, there is no meaningful comparison of the HST system impacts on the I-5 and AV routes between Bakersfield and LA, other than to say that without a Palmdale station, localized traffic impacts in the vicinity of the station would be avoided. The capacity of the Antelope Valley HST alignment to reduce commuter traffic on an increasingly congested SR-14 needs to be specifically evaluated in this section, and in the Bakersfield to Los Angeles Segment Traffic and Circulation technical study.

The Metropolitan Transportation Agency (MTA) recently concluded a three year $4.7 million dollar North County Combined Highway Corridor Study (NCCHCS), which is incorporated by reference. The study evaluated the growth in the North County including the Santa Clarita region and developed a blueprint for regional transportation. One of the earlier tests was the effect that high speed transit would have on the SR-14 Level of Service (LOS). The screening found that the volume to capacity ratio (V/C) was reduced from 1.8 to 1.3 with the addition of high speed transit to the Antelope Valley but had a very marginal affect on North County traffic via the I-5 corridor. Since the North County did not have control over the development of a statewide or Multi-county high speed transit project, this option was not formally adopted. However, it is very high on the priority list for the North County jurisdictions that participated in the study.

This information should have been included in the document. Similar problems with methods, assumptions and sources are also revealed in the comments that follow.

3.1.1 Regulatory Requirements and Methods of Evaluation

1. COMPLIANCE WITH NEPA AND CEQA REQUIREMENTS IS NOT DEMONSTRATED

This section of the DEIR/S (3.1) does not describe the relevant NEPA requirements for preparation of this document, and does not address whether those NEPA requirements were complied with. Rather, it provides a simple bulleted list of items to be addressed under CEQA. It appears that some of these items were either not addressed or inadequately

addressed in the document. A clarification is needed whether the requirements listed are CEQA-only requirements, Caltrans requirements, or a combination of both CEQA and Caltrans requirements. The source documents of the listed requirements should be cited.

2. QUANTIFICATION OF TRAFFIC CHANGES ON INTERCITY AND LOCAL ROADWAYS VERSUS ROADWAY CAPACITIES IS NOT PROVIDED

The DEIR/S does not provide quantification of changes in traffic volumes on intercity and local roadways as a result of the HST project versus the capacities of those roadways, as measured by volume-to-capacity (V/C) and associated level of service designation (LOS A through F). This is essential in order to make a determination of traffic impacts based on adopted traffic thresholds of significance. At a minimum, the Document must provide references to any analysis conducted or documentation addressing CEQA and/or NEPA requirements.

There is no indication in the DEIR/S that affected intercity and local roadways were evaluated according to local county congestion management agencies' level of service (LOS) standards. At a minimum, the Document must provide references to any analysis conducted or documentation addressing CEQA and/or NEPA requirements.

3. NO REFERENCE TO CONSIDERATION OF DESIGN FEATURES, HAZARDS, INCOMPATIBLE USES OR ADEQUACY OF EMERGENCY ACCESS

There is no reference in the DEIR/S document that the proposed corridor alignments were evaluated in terms of design features, including consideration of hazards or incompatibility of uses along the proposed alignments. At a minimum, the Document must provide references to any analysis conducted or documentation addressing CEQA and/or NEPA requirements.

There is no discussion in DEIR/S document on the adequacy of emergency access. At a minimum, the Document should provide references to any analysis conducted or documentation addressing CEQA and/or NEPA requirements.

4. POTENTIAL CONFLICTS WITH ADOPTED PLANS AND PROGRAMS SUPPORTING ALTERNATIVE TRANSPORTATION ARE NOT DISCUSSED

The DEIR/S document does not address potential conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks). At a minimum, the Document should provide references to any analysis conducted or documentation addressing CEQA and/or NEPA requirements.

5. POTENTIAL RAIL, WATERBORNE OR AIR TRAFFIC IMPACTS NOT DISCUSSED

The DEIR/S document did not address potential rail, waterborne, or air traffic impacts. At a minimum, the Document should provide references to any analysis conducted or documentation addressing CEQA and/or NEPA requirements.

B. METHODS OF EVALUATION OF IMPACTS

6. JUSTIFICATION FOR USE OF AM PEAK HOUR CONDITION IS NEEDED

The DEIR/S document does not provide an explanation of why AM peak hour condition was used for the screenline analysis in the evaluation of impacts on intercity highway links. Typically, the PM peak hour condition is the preferred analysis time period for either Tier 1 or project specific traffic impact analysis, as the PM peak hour typically represents the worst possible (most highly congested) condition. The DEIR/S should provide backup information to clarify whether the AM peak hour was considered the worst case condition and why it was adopted as the analysis period of choice. Should the PM peak hour conditions be found to the worst-case condition, the traffic impact findings of the DEIR/S using the AM peak hour conditions could be understated and therefore potential invalid.

3.1.2 Affected Environment

B. GENERAL DISCUSSION OF TRAFFIC AND CIRCULATION

7. EVALUATIONS OF INTERCITY TRAVEL AND MODAL VERSUS HST ALTERNATIVE ARE LIMITED

The evaluation of the impact on intercity travel is extremely limited, especially given the acknowledgement that study area highway and roadway corridors experience some of the worst traffic conditions in the nation.

Discussion of Modal Alternative versus HST Alternative is limited, and discussion of potential impacts of these alternatives is lacking and appears to have been deferred for subsequent analysis.

C. TRAFFIC AND CIRCULATION RESOURCES BY REGION

BAKERSFIELD TO LOS ANGELES

8. CRITERIA FOR INCLUSION OF AIRPORTS NEEDS TO BE CLEARLY STATED

The DEIR/S does not state what criteria were used for inclusion of airports in the Modal Alternative. For this segment, the Burbank-Glendale- Pasadena Airport (BUR) is the only facility considered. There are other regional airports within the study area, most notably Palmdale International (PMD).

3.1.3 Environmental Consequences

A. EXISTING CONDITIONS COMPARED TO NO PROJECT ALTERNATIVE

9. REFERENCES TO SUPPORTING ANALYSES ARE NEEDED

The DEIR/S does not provide references to supporting analysis comparing existing conditions and the No Project alternative. The discussion in the Document is, by itself, inadequate. Table 3.1-2, in the DEIR/S does not adequately discuss or provide references explaining the calculation of "V/C Average Change from Existing."

BAKERSFIELD TO LOS ANGELES

10. CLARIFICATION OF TRANSIT, GOODS MOVEMENT AND PARKING IMPACTS FOR NO PROJECT ALTERNATIVE IS NEEDED

In the section on Transit, Goods Movement, and Parking, no change is projected for transit and parking conditions under the No Project Alternative. Further, the overall potential impact on goods movement under the No Project Alternative is low. Further clarification is needed to support these statements, including the sources of data and references to technical analysis.

B. NO PROJECT ALTERNATIVE COMPARED TO MODAL AND HIGH-SPEED TRAIN ALTERNATIVE

11. CLARIFICATION OF MODAL AND HST ALTERNATIVE CONCLUSION SOURCES AND REFERENCES IS NEEDED

The discussion on page 3.1-12 suggests that "Modal Alternative" may be over-defined, resulting in excessively high costs. The method or approach that was taken to specify the Modal Alternative should be clarified.

In the last paragraph on page 3.1-13, the document states: "Goods movement and transit have some minor regional or local impacts; however, on a statewide basis, the potential effects of the Modal and HST Alternatives would be negligible. ... there should be little effect on the existing parking supplies." Additional discussion is needed to support these conclusions. The DEIR/S document should identify the sources of data employed and either describe the analytical process used or make reference to supporting documentation.

The DEIR/S document should identify the source of data and references for the planning provisions that were made for parking at airports and station areas under the Modal and HST Alternatives

3.1.4 Comparison of Alternatives by Region

C. BAKERSFIELD TO LOS ANGELES

12. DESCRIPTIONS OF PROPOSED IMPROVEMENTS WITHIN SEGMENTS ARE NEEDED

On pages 3.1-14 *et seq.*, for each project segment, no descriptions of actual improvements are provided. This makes it almost impossible to evaluate the findings presented.

13. STATUS OF STATIONS UNDER MODAL ALTERNATIVE IS UNCLEAR

It is unclear whether the Palmdale and Sylmar Stations were included in the Modal Alternative evaluation. The DEIR/S should describe this analysis in more detail or make references to supporting documentation.

14. METHODS, SOURCES AND ASSUMPTIONS FOR HIGH-SPEED TRAIN ALTERNATIVE EVALUATION ARE LACKING

In reading through the comparison of alternatives by region for the HST Alternative, it is not possible to discern which alignment is being discussed at any given point in the text. Moreover, the DEIR/S does not adequately describe the methodology and source of the trip generation assumption used for the HST Rail Stations under the High Speed Train Alternative. References should be provided.

The DEIR/S document did not adequately describe the methodology and assumptions used in the trip distribution for the HST Rail Stations under the High Speed Train Alternative. Specifically, the DEIR/S should clarify whether the trips assignments were conducted via a transportation model or if the trips were manually assigned. The discussion in the DEIR/S

should include technical data in support of the trip assignment assumptions. References to supporting documents should be provided.

No substantiation is provided for the following conclusions: "The HST Alternative is expected to improve goods movement by grade separating many Metrolink and freight crossings that would be at grade under the No Project Alternative. This outcome would positively affect both train operations that use the grade separation and bus operations that are currently delayed at grade crossings." These conclusions are difficult understand, given that the HST project would be built almost entirely on new alignment and would have only minimal interaction with existing trackage. (If the Authority were considering grade separating the entire length of existing freight trackage within shared corridors – an immensely costly and complicated effort – this is not described in the DEIR/S, nor are costs for such improvements included in the project cost estimate. In addition, it should be noted that Metrolink provides passenger service, not freight service.

15. THE HIGH-SPEED TRAIN ALIGNMENT OPTIONS COMPARISON LACKS SUFFICIENT DETAIL

The summary of High-Speed Train alignments for the Bakersfield to Los Angeles segment in the DEIR/S lacks sufficient detail needed to support the alignment comparisons.. The selection of an alignment in this project segment is a stated goal of the DEIR/S process, and this critical component of the environmental study should exhibit substantially greater detail and background information to underpin a competent, informed decision. There is substantial evidence to eliminate the I-5 Alternative from further consideration in favor of the Antelope Valley Route

The DEIR/S should, but does not, provide a side-by-side comparison of the traffic impacts/benefits of the I-5 and SR-58/Soledad Canyon Options, in terms such as reducing or adding traffic and resultant levels of service along the intercity study segments.

The DEIR/S states that if SR-58/Soledad Canyon option were chosen, there would be a slight increase in the "aggregate V/C ratio" (from 1.20 to 1.22) in the study area, primarily on the roads that provide direct access to the Palmdale station. "Aggregate "V/C ratio" as used in the Document is simply the simple average of several V/C measurements on several roadway segments. This approach is not a standard method to describe congestion in an area, as it does not reflect the relative volume of traffic being measured on each of the various roadway segments.

The DEIR/S contains no discussion of the potential impact of the HST Alternative on traffic volumes along SR-14, I-5, and other intercity roadways that could be realized with either the I-5 Option or SR-58/Soledad Canyon Option. This information is highly relevant to the alignment selection process, and its omission is a serious limitation that must be corrected.

3.1.5 Mitigation Strategies

16. THE PROGRAMMATIC MITIGATION STRATEGIES LACK SUFFICIENT DETAIL

Given the magnitude, diversity and far-reaching influence of proposed project, the traffic mitigation strategies presented in DEIR/S lack sufficient detail, even given the programmatic nature of the document.

17. THE TRAFFIC CUMULATIVE ANALYSIS DOES NOT ADDRESS UNAPPROVED PLANS CURRENTLY UNDER ENVIRONMENTAL REVIEW

When analyzing the cumulative impacts of a project under 15130 (b)(1)(A) of the CEQA Guidelines, the Lead Agency is required to discuss not only approved projects under construction, and approved related projects not yet under construction, but also unapproved projects currently under environmental review with related impacts or which result in significant cumulative impacts. The DEIR/S analysis should include a discussion of projects under review by the Lead Agency and projects under review by other relevant public agencies, using reasonable efforts to discover, disclose, and discuss the other related projects.

In March of 2004, the County of Los Angeles released the Notice of Preparation for an EIR on the Centennial Specific Plan. The Centennial Specific Plan is proposed on approximately 12,000 acres of land located in the northwestern portion of the Antelope Valley in Los Angeles County, approximately 38 miles northwest of the City of Lancaster and 32 miles north of the Santa Clarita Valley. No consideration is given to this project in the DEIR/S, despite the fact that it would likely have a substantial influence on travel patterns along SR-14, SR-138, and I-5.

TRAFFIC DATA (APPENDIX 3.1 – A)

18. TRAFFIC ANALYSIS METHODOLOGY SHOULD BE CURRENT AND EXPANDED TO PROVIDE MEANINGFUL OPPORTUNITY TO COMMENT

The Level of Service (LOS) and Volume-to-Capacity (V/C) Ratio Definition Table used to assess traffic impacts and compare alignments is sourced as "Transportation Research

Board, 1980." By contrast, the latest traffic analysis tool from the TRB is the 2000 Highway Capacity Manual. The earlier basis for level of service might not necessarily be inferior, if shown to be still compatible with currently acceptable standards; however, it raises a serious concern that the traffic impact analysis for this truly unprecedented project was conducted based on a 24-year old traffic analysis methodology.

The discussion of the traffic impact analysis methodology, assumptions, and calculations must be expanded in order to provide the public, government agencies, and local jurisdictions the opportunity to comment on the appropriateness of the analysis in relation to existing technical standards.

TRAFFIC DATA (APPENDIX 3.1 – A) – CONFORMITY WITH LOS ANGLES COUNTY CONGESTION MANAGEMENT PROGRAM (CMP)

19. CONFORMITY WITH LA COUNTY CMP GUIDELINES SHOULD BE VERIFIED

The DEIR/S analysis apparently uses LOS and V/C Ratio definitions different than those in the Los Angeles County CMP Guidelines. The DEIR/S should verify whether the traffic analysis complied with local congestion management agency requirements. When a sample DEIR/S V/C value was evaluated with LA County CMP LOS threshold, the resulting level of service designation is not the same (e.g., LOS A versus LOS C).

The DEIR/S should clarify what traffic impact thresholds are used in the study and whether those thresholds equal or exceed federal, regional, and local congestion management agency requirements. This is important, since using less stringent thresholds could potentially affect the findings of the DEIR/S as well as potentially understate either traffic impacts or traffic improvement benefits of the project alternatives. The DEIR/S findings may be vulnerable to challenges when competing corridor segment alternatives are compared from either a traffic impact or traffic benefit (congestion relief) standpoint.

SECTION 3.2 – TRAVEL CONDITIONS

This section of the DEIR/S contains methodological errors and requires substantial clarification in order to be understood by the public and traffic professionals. The information also appears to demonstrate a bias toward the HST system alternative.

1. THE METHODS OF EVALUATION MUST BE CLARIFIED AND REWRITTEN

3.2.1 Methods of Evaluation

This entire section makes repeated reference to the 2000 Business Plan. It would greatly facilitate review and understanding of the analysis if relevant portions of that document were brought into the DEIR/S.

Most of the measures ("travel factors") discussed in this section are merely determinants of the ridership and traffic impacts described previously. For example, connectivity is just another input to travel time, reliability, etc. This entire section appears to be aimed at justifying purpose and need, and if so, should be relocated to Chapter 1.

Total project cost (capital and O&M) should be part of the set of "travel factors" shown on page 3.2-1, not just passenger cost.

The descriptions of the various "travel factors" provided on pages 3.1-1 and 3.1-2 appear to describe potential problems most associated with auto and air travel (e.g., "congestion," "roadwork," "time to check in," etc.). This gives a strong impression, if not factual evidence, of bias in the environmental analysis and the DEIR/S. The comment that air travel "remains a safe mode compared to the private automobile" is not relevant and is clearly prejudicial.

It is not clear why "connectivity" is defined only in terms of airports and mass transit. Mass transit is not an alternative mode for intercity travel, while auto travel is. Highways are clearly the most interconnected mode of all those under consideration.

The statement "Due to poor connectivity, limited services, and weather impacts, travel options to and from Central Valley cities are limited, travel times are long, and the potential for delay is high." on page 3.2-2 does not appear to make sense. It is not clear why this is relevant to "geographic connectivity." Further, travel throughout the Central Valley, as measured by congestion and unexpected delay, is in fact highly reliable.

It is unclear what "sustainable capacity" is measuring other than simply surplus capacity. This measure would appear to be defined in a way that only shows the HST alternative in a positive light. Indeed, one could argue that creating a mode with high surplus capacity represents an inefficient use of resources.

"Cost," as described on page 3.2-2,is used to estimate travel demand, but is not a comprehensive impact measure that can be used to evaluate the relative impact of the HST and Modal alternatives. An appropriate "cost" measure should include all costs – capital and O&M – incurred by all parties in supplying/making a passenger trip.

In the first paragraph on page 3.2-3, the term "long distance commute trips" is not a standard transportation planning concept, and should be defined for readers.

The relationships shown in Table 3.2-1 are in many ways either redundant or incomplete. For example, most of the goals listed under "Project Need" are already addressed under "Project Purpose." Also, "Passenger Cost" should apply to many of the goals, but does not, while "Connectivity" is applied to far too many. Given that the relationships depicted in this table set up the context and structure of the environmental analysis, there are potentially numerous logical problems with the analysis that must be addressed.

In Table 3.2-2, "reliability" should be measured simply as the variance in actual travel time relative to expected travel time. All of the "measurements" shown for that factor are in fact "causes" of delay, not measures of it. Further, "sustainable capacity" should be contrasted with a measure of investment efficiency. Having excess capacity is a benefit, but one that comes with an associated cost. Finally, "passenger cost" is an incomplete measure of impact.

2. ANALYTICAL METHODS AND CONCLUSIONS LACK SUFFICIENT SUPPORT

3.2.2 Affected Environment

B. GENERAL DISCUSSION OF TRAVEL CONDITIONS

The highway element of this section appears to cover much of the same ground as Section 3.1, Traffic and Circulation. Again, the text appears to be written more as a justification of the HST project that as a technical description of existing conditions.

On page 3.2-7, it is not correct to state, "... the [highway] accident rate will not change appreciably..." Accident rates have declined dramatically over the past 40 years, and there is no indication by the NTSB or others that they will not continue to do so in the future.

The conclusion that Sustainable Capacity will "deteriorate" under the No Project Alternative appears incorrect. As with connectivity, the appropriate conclusion is that it will not change.

The conclusion that "Airfares are anticipated to increase beyond their current fare structures relative to other modal options" is unsupported and almost certainly incorrect. Airfares are lower today even in *nominal* terms than they were 30 years ago. And thus are dramatically lower on a *real* basis. Trends in the airline industry favor existing and new low-cost carriers, which is further evidenced by the major airlines either lowering their fares or launching new low fare divisions.

The 30-minute "delay penalty" used for the travel time analysis (page 3.2-9) is unsupported in the DEIR/S and associated technical documentation.

The methodology underpinning the travel time analysis summarized in Table 3.2-5 is not described or discussed in the DEIR/S, and no reference is made to any explanation in the supporting technical documentation. For example, the statement that diversion of 200,000 intercity trips onto HST *statewide* would result in an overall 4.1% reduction in auto travel time does not appear reasonable. Though this could be correct, more explanation and documentation is needed.

The 1-, 15- and 30-minute travel time penalties used for the air travel analysis (Table 3.2-6) are unsupported and appear arbitrary. Also, it is unclear why the Modal/HST comparison in that table shows a one-minute *increase* in the travel time for the LA/San Diego pair, while other the other comparisons show a one-minute *decrease*.

The description of HST mode characteristics (pages 3.2-10 & 11) makes numerous assertions without underlying justification or documentation, some of which appear incorrect. For example, European experience for high-speed rail mode share is simply not applicable to California for several reasons, including relative mode costs, degree of government subsidy or pricing by mode, and personal preferences. Also, the assumption that passenger processing at rail stations can be accomplished in dramatically less time because of different security requirements is unfounded.

It is not clear how a hypothetical distinction between air and HST modes on the use of electronic devices applies to the comparison of total travel time between them, which is what this section is addressing. Further, the assumptions used to estimate time available for use of electronic devices are not explained or justified.

The analysis of reliability is qualitative in nature and does not support conclusions regarding the relative reliability of the three modes under analysis.

The reliability analysis for auto travel appears to be written as addressing *all* auto travel, not just intercity travel. Reliability for intercity travel (variance around expected travel time) is much better than for urban travel generally. This has the effect of understating the performance of the highway system for *intercity* travel.

The reliability assumptions used for the HST alternative are, again, based on European and Japanese experience, and are simply not appropriate for use in extrapolating conditions in California. The entire analysis of reliability is, again, written more in the style of advocacy than neutral analysis.

The entire safety analysis is qualitative and written in an advocacy style and format. First, the safety records for auto and air are not compared directly – that is, incidents or fatalities *per trip*, not per mile. Second, no comparable HST data for the United States are available. Third, much of the supporting discussion is either redundant or not applicable to the question being addressed. As with reliability, the entire analysis of safety is written more in the style of advocacy than neutral analysis.

"Connectivity" is not an independent measure of utility, but rather is a contributor to measures of travel time and reliability. As such, the analysis of relative connectivity does not add to understanding of the relative costs and benefits of the three modes.

The purpose of the tables provided in the "Connectivity" analysis is unclear. This entire section appears to be devoted to presentation of travel demand by mode under the three alternatives. That analysis should be developed and presented in much greater detail that currently provided in the DEIR/S.

The comparisons of travel demand by mode (Tables 3.2-12, 13, and 14) do not include any data for the No Project and Modal Alternatives. It is not possible to evaluate the implications

– nor the reasonableness – of the HST Alternative figures (Tables 13 and 14) without these other data.

On page 3.2-30, it is not clear what is meant by "high-end representative intercity demand trips"(Footnote 10).

The analysis of required new highway capacity on page 3.2-31 cannot be understood as written. It appears that the hourly demand figure is based on *total* demand 2020, not incremental demand. Also, it appears that the analysis is based on the simplification that demand is constant between all city-pairs and that all city-pairs are served by a single highway. If these observations are correct, then this entire analysis is completely invalid and should be discarded.

The use of three-minute headways for the HST service is not explained (page 3.2-32). This figure does not conform to any rail operating experience in the United States, intercity or urban, passenger or freight, involving speeds only 15-25% as great as those planned for the HST system. This assumption is simply not credible

It is not clear how the conclusion regarding the HST Alternative on page 3.2-34 ("The HST Alternative would provide a train system with sufficient infrastructure to meet the projected demand and to allow for capacity expansion beyond the design year requirements.") was reached. No calculations are provided on what residual capacity would exist beyond the 2020 level of demand. Further, there is no assessment of the cost of providing this residual capacity so far into the future.

The analysis of auto costs on page 3.2-35 should use *marginal* costs for the comparison of traveler costs. Fixed costs are incurred whether or not a trip is made on HST (or air). Thus, when $194 is shown as the auto cost of a trip from San Francisco to Los Angeles, the actual marginal cost is approximately $73 per vehicle, or $30 per passenger. (Note that these figures do reflect half of the stated depreciation cost of 18 cents per mile to account for mileage-based depreciation.)

The HST and air mode costs do not include a factor for auto rental, taxi and/or at-station parking, which are major components of business travel cost.

As stated elsewhere in these comments, the 12-minute travel time difference between the I-5 and Antelope Valley Alignments cited on page 3.2-41 is not supported in the DEIR/S or

through reference to a technical document. It is also not consistent with past written and oral statements made by Authority staff and consultants.

SECTION 3.3 - AIR QUALITY

1. THE AIR QUALITY TECHNICAL EVALUATION DID NOT ASSESS HST IMPACTS FOR EACH ROUTE ALIGNMENT OF THE PROPOSED PROJECT.

The Air Quality Technical Evaluation addressed only the three system alternatives: No Project alternative, Modal alternative, and the High Speed Train alternative (hereafter referred to as the proposed project). Thus there is no separate analysis of the alternative HST alignments between Bakersfield and LA. Traffic data was available for these alignments in the "Bakersfield-to-Los Angeles Traffic, Transit, Circulation & Parking Technical Evaluation." This can create differing air quality impacts. For example, it is likely that potential passengers in the Palmdale area will ride the California High Speed Train rather than commute the Antelope Valley alignment is selected. These potential passengers would be bypassed and unable to utilize the proposed project if the lead agency chooses the Grapevine Route. By not evaluating each route option, decision makers within the lead agency are unable to know the air quality impacts associated with each of these routing options and will, therefore, not be able to make an informed decision. Accordingly, air quality analysis should be conducted to display the relative merits between the Grape Vine and Antelope Valley alignment alternatives.

2. IT IS UNCLEAR HOW THE ROUTE OPTIONS AFFECT THE VARIOUS AIR BASINS.

The Air Quality Technical Evaluation provides analysis for each of the affected air basins, but does not identify which of the route options it used in evaluating the impacts of the proposed HST system. This is particularly relevant given that the alternate alignments affect separate air basins. Approximately one-half of the Antelope Valley alignment is located in the Mojave Desert basin, one-quarter in the San Joaquin Valley Air Basin and one-quarter in the South Coast Air Basin. With the I-5/Grapevine alignment, approximately one-half of the alignment is in the San Joaquin Air Basin and one-half in the South Coast Air Basin. Because no separate analysis was conducted on the individual routes, it is impossible to discern their respective impacts on the various air basins. Again, a separate analysis must be conducted of each alignment option.

3. THE AIR QUALITY TECHNICAL EVALUATION ONLY SUMMARIZES THE ANALYSIS AND DOES NOT CONTAIN INFORMATION OR DATA SETS THAT WOULD ALLOW FOR A CRITICAL REVIEW OF THE ANALYSIS PROCESS OR VERIFY THE QUANTITATIVE RESULTS.

Information lacking includes emission factors used for the various mobile and stationary sources (motor vehicles, diesel locomotives, aircraft, and electric generating stations),

number of vehicles assumed for each of the alternatives, average speed of the vehicles, atmospheric conditions (primarily the range of temperature and humidity variations) assumed, and whether or not the on-road pollutant burden calculated for each of the alternatives took into account cold start emissions, warm start emissions, hot start emissions, evaporative emissions, and diurnal emissions. Similarly, the number of plane operations and number of train movements were not quantified for each of the alternatives. These assumptions need to be presented in the Air Quality Technical Evaluation report supporting the findings in the California High-Speed Train Program EIR/EIS in order to provide public agencies and the public the ability to give meaningful comments on the adequacy and accuracy of the air quality evaluation.

4. IT IS UNCLEAR HOW THE ANALYSIS IN THE AIR QUALITY TECHNICAL EVALUATION ASSESSED ON-ROAD POLLUTANT BURDENS FOR EACH OF THE ALTERNATIVES.

On page 3.3-56 of the Air Quality Technical Evaluation the statement is made that "On-road pollutant burdens were calculated as a ratio of baseline VMT [Vehicle Miles Traveled] to estimated VMT changes under each alternative." Calculating ratios of baseline VMT to estimate changes under each alternative is an inappropriate approach in that it is not consistent with the traffic data in the Program EIR/EIS, and does not accurately assess vehicle miles traveled under each alternative. The "Emission Inventory Procedural Manual" published by the California Air Resources Board requires that the EMFAC2002 computer model is used in determining on-road emissions inventories. The analysis needs to utilize the traffic data in the "Traffic, Transit, Circulation & Parking Technical Evaluation" as input to the California Air Resources Board emissions computer model "EMFAC2002" to predict on-road pollutant burdens for each of the alternatives. This suggested methodology will benefit the air quality analysis in that the air quality evaluation will be much more accurate than the ratio approach. The analysis will be consistent with the traffic data used in other portions of the Program EIR/EIS, and will follow long established procedure consistent with the recommendations of the California Air Resources Board for estimating on-road emissions burdens.

On page 3.3-8 of the Program EIR/EIS, the discussion states that "detailed intersection information has not been generated" to facilitate an analysis of localized air quality impacts. This statement is false. In Appendices Q through U of the "Traffic, Transit, Circulation & Parking Technical Evaluations" for each segment of the proposed project there is detailed intersection analysis that shows estimated volumes of traffic during the peak hour, estimated volume to capacity (V/C) ratios, and estimated level of service (LOS) values for each alternative. This information combined with emissions data from the EMFAC2002 computer model, and climate data (average temperature and wind speed) is all that is needed to

conduct an analysis of localized air quality impacts. The California Department of Transportation describes the state and national guidelines for conducting localized air quality impacts in a publication titled "Carbon Monoxide Protocol" (hereafter referred to as the Protocol). The protocol requires that intersections impacted by the proposed project with LOS D or below conduct a detailed localized air quality impact analysis using the CALINE4 computer model. The Air Quality Technical Evaluation failed to conduct this analysis. CEQA Guidelines Section 15064 (d) requires that lead agencies consider both direct and indirect physical impacts when evaluating the potential for significant impacts.

5. THE AIR QUALITY ANALYSIS DID NOT ADDRESS SHORT-TERM CONSTRUCTION IMPACTS THAT WOULD BE ASSOCIATED WITH THE PROPOSED PROJECT.

CEQA Guidelines Section 15126 states that "All phases of a project must be considered when evaluating its impact on the environment: planning, acquisition, development [i.e. construction], and operation." On page 7-2 of the Program EIR/EIS, the discussion states that "The potential impacts of this construction activity would be addressed in more detail during project-level analysis." While additional analysis may be required on a project by project-level analysis in the future, information is currently available to assess construction activities as a result of the proposed project on a programmatic level. For example, rail alignments, rail configurations, tunneling alignments, and terminal station configurations are all described in "Alignment Configuration and Cross Sections" and "Engineering Criteria" reports for the proposed project. This information could be used in evaluating potential construction impacts and proposing programmatic level mitigation measures. In this way, the project is afforded the opportunity to address regional impacts and overall project phasing that would not be possible in individual future project by project-level analyses.

While most of the other sections of the Program EIR/EIS provide at least a brief discussion of construction impacts, these impacts are dismissed entirely as a subject for future study in the Air Quality section. The Air Quality evaluation in the Program DEIR/S needs to address construction impacts on a programmatic level and propose programmatic mitigation measures.

7. THE AIR QUALITY SECTION DOES NOT ESTABLISH CLEAR THRESHOLDS OF SIGNIFICANCE OR MAKE SIGNIFICANCE FINDINGS FOR AIR QUALITY IMPACTS.

CEQA Guidelines Section 15126 requires that an EIR identify potentially significant environmental impacts associated with proposed projects. CEQA Guidelines Section 15064(b) requires that the lead agency make a determination of whether a project may have

a significant effect on the environment based to the extent possible on scientific and factual data. CEQA Guidelines Section 15064.7 encourages lead agencies to "develop and publish thresholds of significance . . .". On page 7 4 of the Program EIR/S the discussion states that "Given the planning-level impact analysis considered in this Program EIR/S, the Authority has not developed project-specific significance thresholds." While it may be true that the "Authority" has not developed its own significance thresholds, this does not alleviate the Program EIR/S from using significance thresholds in its evaluation and making a determination of significance related to air quality impacts.

If the "Authority" is unable to develop and publish its own significance thresholds, the "Authority" may use thresholds established by the Air Quality Management Districts for regional air pollutant criteria in each air basin so long as the "Authority" explains how the thresholds are pertinent to project impacts. In either case, revisions to the Program EIR/S are required to determine the significance of air quality impacts.

SECTION 3.4 - NOISE AND VIBRATION

1. THE DEIR/S DOES NOT PROVIDE THRESHOLDS OF SIGNIFICANCE.

This section does not provide clear standards to judge the significance of the level of noise and vibration impacts.

2. THE DEIR/S DOES NOT PRESENT A SEPARATE ANALYSIS FOR THE ALIGNMENT ALTERNATIVES.

This section provides an assessment only of the system alternatives and makes only passing reference to alignment alternatives between Bakersfield and LA by saying that the noise impacts are generally the same because both alternatives traverse relatively undeveloped terrain. The basis for this statement is questioned given that the assessment method is based on miles, that one alignment is much longer than the other and that one alignment passes through two fast growing incorporated cities. Also, the technical report included as an Appendix provides information on the relative differences in noise impacts between alternative alignments, but this analysis is not brought forward into the DEIR/S. Again, a separate analysis of each route alternative is necessary in order for decision makers to make an informed choice.

3. THE DEIR/S USES NON-STANDARD METHODS AND CRITERIA FOR EVALUATION OF NOISE IMPACTS

In place of accepted methods, the document uses a screening method to determine the number of miles along each segment of the route that would create high, medium or low noise impacts. The accepted methods and criteria used for evaluating noise and vibration are based upon procedures in two documents prepared by the U.S. Department of Transportation (USDOT):

1. Federal Railroad Administration, "High-Speed Ground Transportation Noise and Vibration Assessment, Final Draft," December 1998.

2. Federal Transit Administration, "Transit Noise and Vibration Impact Assessment," April 1995.

The two USDOT publications use the same noise impact criteria and application method. This include Ldn to quantify the noise environment of residential communities, including hospitals and hotels,[1] and the noisiest hour Leq(h) to

[1] **Day-Night Average Sound Level (L_{dn})** - Ten times the logarithm to the base 10 of the ratio of the *day-night average sound pressure* to the reference sound pressure of 20 micropascals. The *day-night average sound pressure* exposure is

evaluate other land use categories.[2]The use of LDN and Leq to evaluate environmental noise impacts is the accepted standard for rail projects.

These criteria utilize existing estimates of community noise to compare the noise from project sources to calculate the relative difference between the project noise and the existing ambient noise level. The criteria use three ratings: No Impact; Impact; and Severe impact. For higher existing noise environments the allowable increase in the cumulative noise is decreased. For noise environments where the existing Ldn is less than 55 dBA, the project noise may be higher than existing noise environments and where the noise environment is greater than 55 dBA the project noise must be less than existing noise.

The DEIR/S, however, did not use these criteria in the analysis. Instead, screening distances that are presented in the FRA and FTA documents were utilized to define regions of potential impact. These screening distances were categorized by train speed (indicates how much noise is produced), type of corridor (an indication of existing noise environment) and land use (an indication of existing noise environment).

In order to assess the validity of using these screening distances the report performed "typology" evaluations for eleven locations between Bakersfield and Sylmar station within the screening distances between 50 and 900 ft. The report estimated ambient noise levels to be between 50 and 62 dBA. The analysis found "significant impact" at all locations. This may underestimate the number of people potentially impacted since "Significant Impact" is 5 dB above the threshold of "Impact," and therefore screening distance may not be adequate to include all populations that are "Impacted."

Comments on Bakersfield to Los Angeles Region Noise and Vibration Technical Evaluation (2004)

4. THE APPLICATION OF IMPACT CRITERIA IS UNCLEAR.

It is not clear how the HST impact criteria, which uses a sliding scale depending upon ambient noise, can be compared to airport impacts that use a single number of Ldn 65 dBA to define populations impacted. The method of quantifying potential noise impacts from

defined for a 24 hour calendar day and calculated by adding the sound exposure during the daytime (0700 to 2200 hours) to 10 time the sound exposure obtained during the nighttime (2200 to 0700 hours).

[2] **Equivalent Sound Level (L_{eq}) - The** equivalent sound level, L_{eq}, is the level of a constant sound which, in the given situation and time period, has the same sound energy as does a time-varying sound. Technically, equivalent sound level is the level of the time-weighted, mean, square, A-weighted sound pressure. The time interval over which the measurement is taken should always be specified.

highways was not explained sufficiently to be able to evaluate the adequacy of the numbers that were presented in the technical report.

5. VIBRATION SCREENING CRITERIA WERE NOT APPLIED DIRECTLY

The two USDOT publications use the same vibration impact criteria and application method. These criteria use ground-borne vibration levels (VdB) and ground-borne noise levels (dBA) to evaluate vibration impact on land use categories.

The use of VdB and dBA to evaluate vibration impacts is the accepted standard for rail projects. These criteria use absolute values of vibration and ground-borne noise to assess impacts for three land use categories. The values listed in the HST documents correspond to those in the USDOT documents.

However, these criteria are never applied directly. Screening distance developed by FRA and FTA for two speed ranges, < 100 mph and 100 to 200 mph, (labeled as < 125 mph and □ 125 mph in the HST documents) were used to define regions of potential impact. The amount of ground-borne vibration goes up 6 VdB with doubling of speed (FRA, p 8-7) and goes down approximately 7 VdB for each doubling of distance (FRA, p 8-4). Consequently screening distances may under or over estimate the area of effect depending upon speed of the train depending upon how different the operating speeds are from the average in these ranges.

6. SCREENING DISTANCES MAY BE TOO LARGE NEAR STATIONS.

Train speeds near stations would be slower and noise would be correspondingly lower. The analysis used consistent screening distances along the entire route, and this may overestimate impacts near stations.

7. BASE DATA WAS NOT AVAILABLE FOR REVIEW.

The population density contained in the GIS database was not available for review. The accuracy and applicability to the range of land uses along the alternative corridors is unknown.

8. THE SCREENING SYSTEM FOR ANALYZING VIBRATION IS UNCLEAR.

In order to compare alternatives, the HST report introduced "Impact Metric" (IM) in terms of number of people per mile impacted. IM used the screening distances, land use

designation, and the corresponding population density to estimate the number of residences. The analysis used a GIS database containing two Anderson Land Use categories, 11 (residential) and 16 (mixed use). The number of schools and hospitals within the screening distances were also identified. Parkland and hotels were excluded in the IM scheme.

The IM weighted these numbers as shown below:

Description	Weighting	Result of Weighting
Residential	1	Number of people
Mixed Use	0.3	30% of population residential
Hospitals	100	100 persons per hospital
Schools	250	250 persons per school

The IM uses *people per mile* inside the screening distance. It is difficult to understand how using number impacted per mile to compare with other modal systems such as airports, where at best one would use impacts per square mile, is appropriate. In addition, use of a "density" in either case can hide information on the total population impacted. The total number of people potentially impacted by each alternative should be the base for evaluating alternative corridors and the alternatives to the project.

Once the number of people impacted per mile (IM) was determined for each segment, an Impact Rating Scheme (IR) for both noise and vibration was used to assign a High, Medium or Low impact for that segment. The IR assignment method is summarized in the table below:

IR	Noise	Vibration
High	IM > 200	IM > 100
Medium	80 < IM < 200	40 < IM < 100
Low	IM< 80	IM < 40

The necessity of this scheme is not clear nor is its application. There is no justification that to get the same rating twice as many people must be impacted by noise as by vibration.

9. THE IM AND IR SCHEMES DISGUISE THE MAGNITUDE OF THE IMPACTS.

The comparison should be "Number of People Impacted" by either noise or vibration, not number per mile. In addition, total impacted population of the other modes of transportation can be quickly compared. The analysis does quantify the potential number of people impacted by noise and vibration.

The impact rating scheme was applied to sections of each corridor rather than to a corridor. The only justification for a "High," "Medium" or "Low" qualitative assessment would be for comparing alternative alignments, not sections in an alignment.

10. IMPACT NUMBERS IN THE DOCUMENT AND IN THE APPENDIX DO NOT AGREE.

The population potentially impacted is addressed in Table 4.5.1, Table 5.5.1 and the tables in Appendix A of the noise report, pages A-1 to A-7. Unfortunately, the populations presented in these tables for the alternative routes between Bakersfield and Sylmar do not agree:

	Noise			Vibration		
Alternative	Table 4.5.1	A-1	A-6	Table 5.5.1	A-3	A-8
Union Ave + Tehachapi	1153	853	1153	654	354	654
Wheeler Ridge + Tehachapi	1418	1268	1418	199	199	199
SR-58 + Soledad Canyon	477	613	477	240	238	240

Some of the disagreement is whether or not three buildings were either schools or hospitals. Section 3.4 of the DEIR/S identifies them as schools.

There also seems to be an error in counting residential populations along at least two of the alignments. For noise, the range of screening distances for residential land uses is 375 to 900 ft, whereas for vibration it is 200 to 220 ft. Therefore, the number of residents potentially impacted by noise should always be greater than or equal to the number impacted by vibration. However, comparing the tables on page A-1 and A-3 of the technical report, two segments (I-5: Tehachapi Corridor and SR-58 Corridor) have more residents identified as potentially impacted for vibration than for noise:

Alignment	People Impacted by Noise, (A-1)	People Impacted by Vibration, (A-3)
I-5:/Tehachapi Corridor	70	109
SR-58 Corridor	40	118

SECTION 3.5 - ENERGY

1. THE ANALYSIS DOES NOT DISTINGUISH BETWEEN THE ENERGY IMPACTS OF ALTERNATIVE HST ALIGNMENTS

The discussion on energy demands and uses is general and covers the entire project rather than individual route segments. The energy evaluation does not indicate which route alignment options it used in the analysis of the proposed 'baseline' HST project. The Program EIR/S needs to address the direct and indirect energy impacts associated with the system alternatives *and* alternative HST alignment in order for decision makers to assess the differences when making a decision on the proposed project.

2. THE ENERGY SECTION DOES NOT INCLUED CLEAR THRESHOLDS OF SIGNIFICANCE OR MAKE A DETERMINATION AS TO THE SIGNIFICANCE OF ENERGY IMPACTS

CEQA Guidelines Section 15126 requires that an EIR identify potentially significant environmental impacts associated with proposed projects. CEQA Guidelines Section 15064(b) requires that the lead agency make a determination of whether a project may have a significant effect on the environment based to the extent possible on scientific and factual data. Since the Program EIR/S failed to make significance findings or establish significance thresholds for energy impacts, the Program EIR/S needs to be revised to include these findings

3. ENERGY MITIGATION STRATEGIES LACK SPECIFICITY

The DEIR/S presents mitigation strategies for energy conservation. These mitigation strategies are so vague as to be meaningless. As an example, on page 3.5-22 of the DEIR/S one mitigation strategy listed is "Use energy-saving equipment and faculties to reduce electricity demand." While the DEIR/S is a broad program-level analysis reviewing potential energy use statewide, mitigation strategies this broad are useless. The programmatic level analysis should identify regional impacts and find regional mitigation strategies designed to address those impacts. In this way, a program level analysis is able to take advantage of regional level mitigation that project-level analysis would not be capable of doing.

4. THE 'DRAFT STATEWIDE ENERGY TECHNICAL EVALUATION' MERELY SUMMARIZES THE ANALYSIS AND DOES NOT CONTAIN SUFFICIENT INFORMATION OR DATA SETS

The "Draft Statewide Energy Technical Evaluation" only addresses the three system alternatives: the No Project alternative, Modal alternative, and the High Speed Train alternative (hereafter referred to as the proposed project). As indicated in the comments on air quality, the proposed project has several differing alignment alternatives. Although traffic data was available in the "Transit, Circulation & Parking Technical Evaluation" for each of the route alignment options, the "Draft Statewide Energy Technical Evaluation" did not assess impacts for each route alignment of the proposed project.

The "Draft Statewide Energy Technical Evaluation" only summarizes the analysis and does not contain information or data sets that would allow for a critical review of the analysis process or verify the quantitative results. The data sets and assumptions used in the energy analysis needs to be presented in the "Draft Statewide Energy Technical Evaluation" or the Program EIR/EIS in order to provide public agencies and the public the ability to give meaningful comments on the adequacy and accuracy of the energy evaluation.

SECTION 3.6 - ELECTROMAGNETIC FIELDS AND ELECTROMAGNETIC INTERFERENCE

1. THE ANALYSIS DOES NOT DISTINGUISH BETWEEN THE EMF IMPACTS OF ALTERNATIVE HST ALIGNMENTS

A Comparison of Alternatives by Region is completely lacking in this section, and no justification is provided. For consistency with other sections of the DEIR/S and objectives of the Tier 1 analysis, a characterization of sensitive land uses and potential population exposure to electromagnetic fields (EMF) and electromagnetic interference (ELI) should be provided within each region, followed by a relative assessment of exposure associated with each of the HST alignment alternatives. Methods used in Section 3.7 Land Use and Planning, Communities and Neighborhoods, Property and Environmental Justice to evaluate relative land use impacts, or methods used in Section 3.4 Noise and Vibration to evaluate relative noise exposure of alternative HST alignments could be utilized or readily adapted for use in this EMF EMI section.

2. THE JUSTIFICATION FOR EMF MITIGATION IS NOT PROVIDED

Section 3.6.3 concludes by indicating "....the HST Alternative would introduce additional EMF exposures or EMI at levels for which there are no established adverse impacts (page 3.6-5). Given this is the case, it is unclear why implementation of any of the mitigation strategies identified in Section 3.6.4 are warranted or necessary.

3. NO DISCUSSION OF POSSIBLE EFFECTS OF TUNNELS ON EMF EXPOSURE

This section mentions the potential for shielding of ELF electric fields from populations surrounding the HST corridor, but provides no discussion of any differential EMF or EMI effects to passengers or train personnel from exposure within proposed tunnels.

SECTION 3.7 - LAND USE AND PLANNING, COMMUNITIES AND NEIGHBORHOODS, PROPERTY, AND ENVIRONMENTAL JUSTICE

1. SHIFTING FRAMES OF REFERENCE CREATE CONFUSION.

As with other sections of the DEIR/S, the shifting frame of references to the alignments (e.g. SR-58/Soledad Canyon v. 'Antelope Valley'; I-5/Wheeler Ridge v. I-5/Tehachapi) and segments (e.g. Bakersfield to Los Angeles, Bakersfield to Sylmar) and segments within segments (e.g. Bakersfield to Los Angeles 'north', 'central' and 'south'), in the Land Use section makes it very difficult to ascertain whether comparable geographical areas are being addressed and evaluated in the presentation of data and impact ratings. For example, do references to the 'Antelope Valley' alignment consistently refer to the entire SR-58/Soledad Canyon alignment, or merely that portion of the alignment that traverses the Antelope Valley?

2. THE EVALUATION METHODS ARE BROAD AND IMPRECISE.

The method of evaluation of land use compatibility and property impacts rely upon very broad and potentially imprecise assessments of land use types, density categories and proximity to Modal and HST alternatives. The definitions of low, medium and high compatibility and property impact rankings are so highly generalized as to make them almost meaningless without exhibits, mapping and/or some form of quantification (i.e. residential density, as in dwelling units per acre).

3. LAND USE THRESHOLDS IN THE CEQA GUIDELINES ARE NOT USED.

Although similar with respect to reliance upon regional and local general plans as a broad measure of compatibility, the method of evaluation used in this section does not conform specifically to the CEQA Guidelines Appendix G Land Use and Planning criteria, generally relied upon as the measures of land use and planning thresholds of impact significance. These criteria are:

a) physically divide an established community;

b) conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including , but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect; and

c) conflict with any applicable habitat conservation plan or natural community conservation plan.

4. ANALYSIS OF CONSISTENCY WITH PLANS AND POLICIES IS INADEQUATE

Other than mention of general policies of many jurisdictions (unnamed) to promote transit and transit-oriented development, there is no meaningful discussion of local land use policies in this section. The document discusses compatibility with existing land use plans but does not reference individual plans of counties, cities or regions. There is no specific mention of any specific plans or zoning designations anywhere in this section. The section refers to the list of plans in Chapter 12, but does not discuss the consistency with such plans.

Other than cities and counties, agencies with jurisdiction over the project would certainly include state agencies, and federal agencies, such as the U.S. Forest Service. Certainly the HST alignments, and I-5/Tehachapi alignment in particular, should be discussed with regard to management plans, policies or regulations of the Forest Service, where such alignments directly or indirectly effect national forest lands. Similarly, impacts on lands included within habitat conservation plans should be addressed (or if the analysis is included elsewhere, cross-referenced to other sections of the DEIR/S where an adequate consideration of these issues is included.)

5. THE DEIR/S DOES NOT ADDRESS THE SMART GROWTH IMPLICATIONS OF ALTERNATIVE ALIGNMENTS BETWEEN BAKERSFIELD AND LOS ANGELES.

A comprehensive document entitled *SPRAWL OR SMART GROWTH, Analysis of High Speed Rail Alignments and Smart Growth*, prepared for the California High Speed Rail Authority and the City of Palmdale, California, dated July 26, 2004 by Dr. Robert H. Freilich is submitted apart from these comments and incorporated by reference. Dr. Freilich is the nation's leading authority on this subject and has argued seminal cases before the U.S. Supreme Court.

The essence of Dr. Freilich's argument is that the Antelope Valley alignment places important transportation infrastructure in an area that is poised and prepared for additional urbanization and that bypassing this area would force development into the San Joaquin Valley where prime farmland would be urbanized. A summary of the argument is as follows:

The Antelope Valley Alignment Furthers Smart Growth Policies Embodied In State, Regional And Local Land Use Plans. In California and nationally "sprawl" refers to

unplanned, single use, auto dependent development built without regard to availability of infrastructure whose need is generated by new growth. "Smart Growth" is the antithesis of sprawl. It channels growth either into compact sustainable development patterns within regional growth boundaries already served with infrastructure or within discrete compact planned outlying new towns or communities with appropriate densities, mixed uses, affordable housing, sustainable walkable environments and adequate public facilities. The Antelope Valley alignment will encourage Smart Growth. The Grapevine alignment accomplishes the opposite - eliminating a station in the Antelope Valley, it will disperse development beyond existing infrastructure on large lots destroying critical agricultural land in the Central Valley. Despite its separation from the city of Los Angeles by the Angeles National Forest, the Antelope Valley is the antithesis of leap-frog development. It is connected to Los Angeles by high-capacity road and now rail infrastructure, and is an important mixed- use regional center with complete infrastructure systems. It will accommodate the large increases in population anticipated in all regional forecasts.

The Antelope Valley Alignment Is Consistent With State, Regional And Local Agricultural Preservation Policies. Agricultural preservation is not only a key element of Smart Growth, it is particularly important to southern California and the Central Valley because of the vast economic importance of farming to the state's economy. Protection of the sensitive and valuable agricultural resources of the Central Valley through reduction of the conversion of prime agricultural lands to urban development, and preservation of open space and environmentally sensitive lands is a key part of state, regional and local policy.

The Antelope Valley Alignment Addresses The Population Impacts Of High Speed Rail Infrastructure In A Way That Supports Regional Smart Growth Policies. Without the Antelope Valley alignment, excessive growth occurs in the Central Valley. The Grapevine Alignment passes over the areas of north Los Angeles that are needed and capable of accommodating future growth and development and substitutes excessive growth in the Central Valley. This promoted the efficient and equitable distribution of population on a regional basis between Southern California and the Central Valley.

The Antelope Valley Alignment Places Transportation Facilities And Related Growth In Places Where Infrastructure Is Already In Place. Locating high capacity infrastructure only in remote locations would disperse growth patterns and create sprawl. Reducing urban sprawl is achieved by promoting redevelopment and infill of existing incorporated built up areas. This is discussed in detail in Part V of the Freilich Report (July 26, 2004). .In summary the report states that

State and regional policy calls for the prevention of urban sprawl and "leapfrog" development into areas not served by infrastructure. In fact, the high-speed rail statute itself expressly provides that "the high-speed train system shall be planned and constructed in a manner that *minimizes urban sprawl* and impacts on the natural environment" (California Streets And Highways Code § 2704.09). There is sufficient capacity in the Antelope Valley to handle a significant portion of the rapid growth in Southern California and the Central Valley. Metropolitan Los Angeles is running out of land to accommodate an expected 6 million new residents over the next 20 years. The Antelope Valley has an abundant supply of vacant undeveloped land already served by transportation infrastructure (including arterials, transit, and airports), water, sewer, and other public utilities. By placing high capacity transportation infrastructure in the Antelope Valley, the region can absorb additional growth without extending new infrastructure beyond presently served areas. The Antelope Valley will accommodate this growth without further loss of agricultural lands, environmental resources, significant increases in trip lengths, air quality degradation, and declines in infrastructure capacity.

The Antelope Valley Alignment Positions The Palmdale Transportation Center and Airport As A True Mixed Use Transportation Corridor Center. The Antelope Valley has developed the range of uses needed to support transportation and land use policies embodied in state laws such as the Transit Village Planning Act. The Palmdale transportation center or airport can generate substantial long-term leasehold revenue and concession income through joint public-private development that will directly mitigate high speed rail alignment costs. The Antelope Valley alignment provides integration with transportation and infrastructure policies for Lancaster and Palmdale by (a) rerouting a percentage of commuter traffic off Rte 14; (b) establishment of a transit hub to increase transit ridership reducing projected traffic volume increases along Interstate 5, particularly on the highly congested segments south of Rte 14; and (c) creating major public capital and service cost savings for infrastructure, operation, maintenance and public service costs, through having adequate public facilities at time of development, eliminating the major concerns related to discontinuous development.

Local Land Use Policies Support High Speed Rail Infrastructure. Palmdale's general plan and zoning regulations accommodate transit supportive land uses and densities, as well as a wide range of uses within the station influence area. These uses are uniquely supportive of the intercity rail system that the high speed rail network will provide.

The report concludes:

- The Antelope Valley alignment is superior to the Grapevine alignment on all of the local, regional, state and federal land use environmental and smart growth policies. It protects agricultural resources from accelerated spillover growth, maximizes ridership, and supports regional and local land use patterns. To bypass Antelope Valley would create an enormous gap between the high speed rail infrastructure and a large population searching for alternative transportation options. The Authority should approve the Antelope Valley alignment as it moves forward with this project.
- The Palmdale development does not reflect or promote urban sprawl or leapfrog development. On the contrary, it promotes all of the county's existing and draft General Plan objectives by introducing the full complement of Smart Growth techniques.
- The Antelope Valley station should be included in order to comply with state smart growth mandates. First, the Antelope Valley alignment furthers state, regional and local smart growth policies. Second, it protects the state's valuable agricultural land from excessive conversion to urban uses. Third, it allocates the population impacts of high speed rail infrastructure in a way that supports regional smart growth policies. Fourth, it puts transportation facilities and related growth in places where infrastructure is already in place. Fifth, it positions the Palmdale Transportation Center and airport as a mixed-use transportation corridor center. Finally, it takes advantage of local land use policies that already support high speed rail infrastructure and joint development opportunities that will generate revenue and ridership for the system. The Antelope Valley alignment will take an important step to implement the state's essential smart growth policies.

6. CLARIFICATION OF IMPACT STATEMENTS, SEGMENT REFERENCES AND FIGURES ARE NEEDED.

On p.3.7-5 (1st paragraph; 2nd to last sentence): The basis for the conclusion that the proposed HST system as a whole would not result in disproportionate impacts on minority and low-income populations is not explained here.

Figure 3.7-3 Existing Land Use-Bakersfield to Los Angeles. The regional scale and relatively indistinguishable pale colors make this exhibit almost useless as a tool in assessing or verifying land use compatibility impacts. What is the percentage of the alignment that is included in each land use category?

Figure 3.7-12 Potential Property Impacts Bakersfield to Los Angeles-HST Alternative. The regional scale of this exhibit makes it difficult to distinguish specific segments within each category (high, medium, low). In some instances, it appears as if two or three categories may be overlapping, although these cannot be clearly distinguished. What is the percentage of each alignment that is included in each land use category?

Table 3.7-1 Compatibility of Land Use Types. Multifamily residential is included under both 'medium compatibility' and 'high compatibility' categories. What explains this duplication?

On p.3.7-8, Bakersfield to Los Angeles. The 'three distinct sub-regions' referenced in this section—north, central, and south, are not clearly distinguishable based upon the descriptions here and at the top of page 3.7-9. Please indicate the limits of these sub-regions on one of the Figures in the EIR/S. It should be noted that much of the central sub-region as it applies to the Antelope Valley alignment is not included in national forest, as described on these pages.

On p.3.7-11 A. Existing Conditions Compared to No Project Alternative. As the No Project Alternative described herein includes funded and programmed improvements, these improvements are presumably already known, and the impacts stemming from them could be discerned and generally described in this section, albeit at a program EIR level of detail. Therefore, this assessment would not be a speculative undertaking, as suggested here.

On p. 3.7-12 Environmental Justice (3rd sentence). As on page 3.7-5 previously, the basis for the conclusion that either the Modal or HST Alternatives as a whole would not result in disproportionate impacts on minority and low-income populations is not explained here.

On p.3.7-18 High Speed Train Alternative it states "most of the proposed alignment options in this region would be constructed outside of existing transportation right-of-way,...." What alignment options other than the Wheeler Ridge/I-5/Tehachapi, the Union Station/I-5/Tehachapi, and SR-58/Antelope Valley/Soledad Canyon proposed options is this statement referring to?

Verification of the property impacts described under Property-HST Alternative is difficult without clear mapping that illustrates those segments of each alignment that are included in the very broad, and potentially overlapping seven development-type categories included in prior Table 3.7-2 (i.e. Rural/Suburban, Suburban/Rural, Urban, Rural Developed, Suburban Industrial/Commercial, Urban Business Parks/Regional Commercial, Rural Non-developed).

Mapping of this data layer at a suitable scale is needed to be able to independently confirm the mileages, percentages of alignment and impact ratings associated with each alignment in this discussion and on Figure 3.7-12. In viewing this figure, it would appear the percentage of alignment included within the 'high' property impact category for the Union Avenue/I-5 alignment is approximately the same or higher than the corresponding percentage for the SR-58/Soledad Canyon (Antelope Valley) alignment.

On p.3.7-20, under Environmental Justice - HST Alternative and Alignment Options Comparison, the shifting and confusing references to segments or portions of segments in these passages make it very difficult to understand the relative impacts of the basic alignment alternatives on minority populations. The reference to the proposed I-5 (Union Avenue and Wheeler Ridge) options as being potentially more compatible with existing land use than the SR-58 option (SR-58 only or entire SR-58/Soledad Canyon alignment?), would appear to be in conflict with conclusions reached for Union Avenue/I-5 under land use compatibility, communities and neighborhoods, and property impacts.

7. FURTHER ANALYSIS OF CONFLICTS WITH TEJON RANCH PLANS ARE NEEDED.

On p.3.7-19. it is noted here that the I-5 Tehachapi Mountain potential cut and fill crossing near Tejon Lake in Castaic Valley may be in conflict with Tejon Ranch plans to build a low density residential village near Tejon Lake. Additional discussion and analysis of this conflict are needed in this section. Also, In March of 2004, the County of Los Angeles released the Notice of Preparation for an EIR on the Centennial Specific Plan. The Centennial Specific Plan is proposed on approximately 12,000 acres of land located in the northwestern portion of the Antelope Valley in Los Angeles County, approximately 38 miles northwest of the City of Lancaster and 32 miles north of the Santa Clarita Valley. No consideration is given to this project in the DEIR/S, despite the fact that it would likely have a substantial influence on travel patterns along SR-14, SR-138, and I-5. The DEIR/S does not discuss consistency with individual development plans, general plans or regional plans.

8. MITIGATION STRATEGIES ARE INADEQUATE.

Land Use Compatibility (page 3.7-26). This brief statement merely addresses the scope of the subsequent review process in alignment and station location selection, but says nothing about strategies to mitigate land use impacts.

Environmental Justice (page 3.7-27). No justification or explanation is provided for the conclusion that the HST system would not result in disproportionate adverse effects to minority or low-income populations.

SECTION 3.8 - AGRICULTURAL LANDS

1. THIS SECTION IS VERY BROAD AND USES INADEQUATE THRESHOLDS OF SIGNIFICANCE.

This section of the DEIR/S provides only a very broad measure of potential impacts on farmlands and relies on an incomplete measure of thresholds of impact significance for agricultural resources, pursuant to the CEQA Guidelines.

3.8.1 Regulatory Requirements and Methods of Evaluation. This section cites PRC 21060.1 and CEQA Guideline 21095[a] as references for consideration of agricultural land conversions in the environmental review process. PRC 21060.1 defines 'Agricultural Land' as prime farmland, farmland of statewide importance, or unique farmland. CEQA 'Guideline' 21095[a] is actually the citation from the CEQA statute, not the Guidelines. PRC 21095[a] identifies the LESA Model as an optional method to ensure that significant effects on the environment of agricultural land conversion are quantitatively and consistently considered in the environmental review process. However, the method of evaluation of impacts that follows in Section 3.8.1, 3.8.2 and 3.8.3 does not utilize the LESA model to distinguish significant effects.

Where the LESA model is not utilized, reliance should be placed upon CEQA Guidelines Appendix G criteria for impact significance (i.e. 'thresholds of significance'). In addition to conversion of prime farmland, unique farmland or farmland of statewide importance, the CEQA Guidelines Appendix G criteria for Agricultural Resources include 'conflicts with existing zoning for agricultural use or a Williamson Act contract' as an explicit factor to be addressed. Although the Williamson Act is described in Section 3.8.1, there is no further discussion or quantification of conflicts with Williamson Act contracts in DEIR/S Section 3.8. The number of parcels under such contracts that are impacted by the Modal and HST System Alternatives, including the HST alignment options, should be identified, even at this Program EIR level of review. [Note: Section 7.3.1 CEQA Significance Thresholds indicates the CEQA checklist thresholds (Appendix G) have been used to evaluate the significance of effects of the HST Alternative.]

2. THE I-5/GRAPEVINE ALIGNMENT ALTERNATIVE DISPLAYS GREATER IMPACTS ON AGRICULTURAL RESOURCES.

On p. 3.8-16 and Table 3.8-1, the I-5 alignment HST options within the Bakersfield to Sylmar segment are identified as having the greatest potential farmland impacts (63 acres). This is in contrast with the *SR-58/Soledad Canyon* (Antelope Valley) alignment, which is identified

as having no impact on farmlands. As demonstrated in a comprehensive document entitled *SPRAWL OR SMART GROWTH, Analysis of High Speed Rail Alignments and Smart Growth*, prepared for the California High Speed Rail Authority and the City of Palmdale, California, dated July 26, 2004 by Dr. Robert H. Freilich, The Antelope Valley alignment is superior to the I-5/Grapevine alignment with respect to all of the local, regional, state and federal land use environmental and smart growth policies. It protects agricultural resources from accelerated spillover growth, maximizes ridership, and supports regional and local land use patterns. The study by Dr. Freilich is submitted apart from these comments by the City of Palmdale, and is incorporated by reference

3. PROPOSED MITIGATION MAY BE INFEASIBLE.

Section 3.8.5 Mitigation Strategies suggests that specific farmland mitigation strategies should consider measures such as 'protection or preservation off-site lands to mitigate conversion of farmlands or acquiring easements, or payment of an in-lieu fee'. In this instance, the ability to mitigate the I-5 HST alignment's impact on farmlands through creation of agricultural easements or other identified measures may be limited by appellate court findings in *Friends of the Kangaroo Rat v. California Department of Corrections [111 Cal.App.4th 1400 (2003)]*. In this case, the court held that the creation of an agricultural easement does not fall within the definition of "mitigation" set forth in CEQA Guidelines 15370. Prime farmland is considered a finite resource, the loss of which cannot be mitigated by payments to continue farming on other lands already being farmed. Further, the court noted that acquiring undeveloped land for conversion to agricultural use would likely have natural habitat impacts that are not environmentally beneficial, and converting developed land to farmland was infeasible for obvious reasons.

Short of avoidance of important farmlands altogether, the impacts of the I-5 HST alignment option within the Bakersfield to Sylmar segment are likely to be found to be significant and unavoidable, should this alternative be carried forward to project-level environmental review.

SECTION 3.9 - AESTHETICS AND VISUAL RESOURCES

1. VISUAL IMPACTS OF TUNNEL CONSTRUCTION ARE NOT ADDRESSED

The DEIR/S fails to mention any of the potential HST visual impacts associated with the tunnel portals, construction stockpiles, and/or the roadways necessary for access.

2. VISUAL ANALYSIS AND CONCLUSIONS LACK SUPPORT

The analysis of the relative aesthetic and visual impacts of the HST alignment alternatives in the Bakersfield to Los Angeles segment (page 3.9-17) is confusing and the conclusions lack support. The I-5/Wheeler Ridge alignment is identified as having the lowest aesthetics/visual quality impacts of the alignments in the Bakersfield to Sylmar segment, yet the Wheeler Ridge and Union Avenue alignment options are both identified as having high-contrast impacts related to aerial structures. This section also indicates "the landform in the mountainous areas on the Antelope Valley corridor would be largely unaltered", yet the next sentence indicates "visual contrast related to cut and fill in these areas would therefore be greater than along the I-5 corridor"—an apparent contradiction.

3. I-5/GRAPEVINE VISUAL IMPACTS TO RECREATION AREAS AND NATIONAL FOREST VIEWSHEDS ARE UNDERSTATED

The section also fails to mention the potential HST visual impacts to the recreation areas along the I-5 corridor and the potential impacts to the Angeles National Forest viewshed. The resulting visual impacts along the I-5 route would be visible to many more people than the SR 58 Corridor Route.

Given the high visual amenity and sensitivity of the I-5 corridor, particularly between the Grapevine to Santa Clarita section that includes scenic national forest lands within the viewshed, it is difficult to justify the conclusion that either of the I-5 alignment options would be superior to an Antelope Valley alignment. As noted above, the visual impact of a HST construction and operation along an I-5 alignment would likely be visible to more people along non-tunnel segments than with the Antelope Valley alignment.

4. NO ANALYSIS OF HST VISUAL IMPACTS IN THE SYLMAR TO LOS ANGELES SEGMENT

In the Bakersfield to Los Angeles section (page 3.9-17), there is no analysis of impacts in the Sylmar to Los Angeles segment.

5. VISUAL SIMULATION OF HST ALONG I-5/GRAPEVINE IS NEEDED

Although a photo simulation of a potential extensive cut slope in Soledad Canyon is depicted in Figure 3.9-18B, no corresponding photo simulation of visual impact of the HST is provided for the I-5 alignment within the Bakersfield to Sylmar segment. To portray visual impact in a balanced light, such a simulation should be provided in this section depicting a 'worst-case' I-5 scenario.

6. BAKERSFIELD TO LOS ANGELES AESTHETICS AND VISUAL QUALITY TECHNICAL EVALUATION IS MISSING SIMULATION INFORMATION

This report is missing the photo visual simulations for all locations on the route. Of particular interest, however, are the maps of the visual simulation areas showing rather precise route locations. See for example Figure 4.3-1; 4.3-3; 4.3-4; 4.3-5; 4.3-6 and 4.3-8. If this level of route detail and alignment specificity was available for the visual simulations, why was not it used for the other environmental disciplines in the DEIR/S? The document also fails to include photo simulations discussed in the technical report. Figure 4.3-2 on page 39 of the document is blank. The caption states that the figure is of existing conditions and photo-simulations. There are no such figures in the document.

The assessment that both routes have similar types and levels of visual impacts (page 49) is misleading. The impacts associated with the I-5/Tehachapi Corridor would be to State Parks and Recreation areas and lands within the Angeles National Forest that have strict guidelines for visual degradation. This route would also be visible by a higher number of people on a daily basis when compared to the SR58 route.

SECTION 3.10 - PUBLIC UTILITIES

1. ANALYSIS OF HST UTILITY CONFLICTS LACKS DETAIL

The Analysis of impacts to public utilities is very general and lacks sufficient data to support utility conflict information for HST alternatives. The DEIR/S relies upon the broad programmatic analysis, addressing only representative major utilities and does not address local details. Table 3.10-2, Summary of Potential Public Utilities Conflicts for Alternatives, quantifies a wide range in the number of major utilities affected by HST alternatives in the Bakersfield to Los Angeles segment, but provides no breakdown by specific alignment alternative.

However, the Bakersfield to Los Angeles segment comparison states that The SR-58/Soledad Canyon corridor option would have the fewest overall utility conflicts while the I-5 Tehachapi corridor option would have the most conflicts (page 3.10-9).

2. SPECIFIC INFORMATION ON UTILITY AVOIDANCE OPTIONS IS NEEDED

The primary method for mitigation to Public Utility impacts is avoidance, by either routing the public utility or the transportation line around over, or under the facility. This approach would be limited by constrained corridors such as the I-5 Tehachapi corridor option. The DEIR/S does not provide a comparison of any of the routing alternatives. This item added into the analysis would allow for better comparisons between all routing options.

SECTION 3.11 - HAZARDOUS MATERIALS AND WASTES

1. HAZARDS OTHER THAN HAZARDOUS MATERIALS AND WASTES ARE NOT DISCUSSED

This section is focused on the topics of hazardous materials and wastes, and does not discuss other hazards listed in CEQA Guidelines Appendix G (VII. Hazards and Hazardous Materials) that may result in significant impacts.

For example, issues associated with 'potential impairment or interference with an adopted emergency response plan or emergency evacuation plan' (CEQA Guidelines Appendix G-VII.g) are not addressed here. Although various 'safety' considerations associated with the system alternatives are addressed in DEIR/S Section 3.2 Travel Conditions, there is no apparent discussion anywhere in the DEIR/S text of emergency response or emergency evacuation impacts associated with the tunneling requirements of various HST alignments. Neither Section 3.2 Travel Conditions, nor Section 3.13 Geology and Soils deal with this aspect of the HST system and alignment alternatives. It would appear that the closest the Environmental Document comes to dealing with this potentially significant impact of emergency response and evacuation of the HST in a tunnel mode is on page 3.2-22 (Travel Conditions), where it is noted that no HST injuries or fatalities have ever occurred in Japan as a result of a seismic event.

2. ANALYSIS LACKS SUFFICIENT DETAIL TO DISTINGUISH HST ALIGNMENT ALTERNATIVES

The information in Section 3.11 is so broad and preliminary as to make hazardous materials and wastes considerations insignificant in the selection of a system alternative or selection of HST alignments for further consideration.

Figure 3.11-1 Hazardous Material and Waste Locations in the Study Area. Table 3.11.3-1 Potential Hazardous Material and Waste Sites Comparison—Modal and High Speed Train Alternatives. Due to the statewide scale of the figure, it is difficult to correlate the mapped sites with the numbers of identified sites in the table, for the Bakersfield to Los Angeles region (and Bakersfield to Sylmar segment). For ease of reference and consistency with other sections of the DEIR/S, a Bakersfield to Los Angeles region base map is needed.

Appendix 3.11-A. Results of Hazardous Materials Database Searches. An SPL Listing site is identified for the I-5 Grapevine Corridor (via Union Avenue Corridor) that does not appear on Figure 3.11-1 Hazardous Materials and Waste Locations in the Study Area.

There is relatively little to distinguish between the alignment alternatives in the Bakersfield to Los Angeles segment in terms of the number of sites identified. As a result, the identification of alignments in this segment with 'greatest potential for impact' and 'least potential for impact' is not particularly meaningful.

3. USE OF HAZARDOUS MATERIALS IN HST CONSTRUCTION AND OPERATIONS SHOULD BE DISCUSSED

Hazardous Materials/Wastes Technical Evaluation, Bakersfield to Los Angeles Region; P&D Consultants (2004). In Section 2.3 Hazardous Materials Used in Operation, Maintenance and Construction of the Alternatives, it is indicated that a 'qualitative review' of these impacts will be included in the Program DEIR/S. However, Section 3.11 appears to discuss only the impacts of existing or potential hazardous materials and wastes sites upon construction, operations and maintenance activities (page 3.11-3). Hazardous materials used are not identified or characterized in the DEIR/S.

It is apparent in review of the tabulated breakdown of sites in the NPL/Superfund, SPL Listings, and SWLF Listings that a single recorded site can fall into one or more listing categories. This should be clarified in DEIR/S Section 3.11 and Appendix 3.11-A with regard to the quantification of sites.

The information in Table 4.0-1 Detailed Analysis/Comparison Table and the summary in Section 4.3 for the HST Alternatives is helpful in understanding the nature, type and location of hazardous materials and waste sites within this segment. This information should have been included in Section 3.11 of the DEIR/S to facilitate the review.

SECTION 3.12 - CULTURAL AND PALEONTOLOGICAL RESOURCES

The programmatic level of analysis conducted for cultural and paleontological resources makes it difficult to make selections without very specific criteria of comparison. The comments below address some of these issues and attempt to provide a more accurate depiction of the resources for comparative purposes.

1. LACK OF CULTURAL AND HISTORIC SURVEYS SKEWS IMPACT RESULTS

This section presents a potentially skewed assessment of cultural resources impacts by failing to clearly factor in the percentage of each HST alignment alternative that has not been surveyed. In so doing, the estimation of the number of cultural sites potentially impacted can be very misleading.

Also, use of a methodology for assessment of historic impacts based primarily upon the percentage of each alternative corridor that passes through areas that originally developed in specific predefined historic time periods is highly unorthodox, and provides a poor substitute for preliminary surveys for historic structures and/or quantification of the number of sites listed on the National Register of Historic Places (NRHP) that may be impacted.

2. I-5/GRAPEVINE HST IMPACTS TO FORT TEJON AREA A POTENTIAL CONCERN

Traditional Cultural Resources Properties concerns seem to be focused on the I-5 Route between Grapevine and Frazier Park. There are known traditional properties along the route. Cultural resources along the I-5 route and impacts to Fort Tejon and other sites could be of concern. Impacts to Fort Tejon, even indirect would be severe as it is a NRHP site as well as Park and State Historic Landmark. (pages 3.12-3 and -4)

3. METHODS OF EVALUATION ARE UNORTHODOX

The methodology for determining low, medium or high impacts is based on "known" information (pages 3.12-4). Thus if an area has been subjected to extensive surveys, there is a greater potential to have a high impact. This might not be the case in the real world. Portions of the Tejon Ranch have not been surveyed. A more appropriate way to evaluate would be to have a number indicating the percent of the route that has been surveyed. Using this number with the number of sites in an area would be a better method for comparison.

The methods of analysis for historic structures is unorthodox. It basically says that any developed areas might have impacts based on nothing other than being built more than 50 years ago. It states that "Specific structures from the historic period were not identified for this program level analysis. Instead, the percentage based on linear miles of each alternative corridor that passed through areas that originally developed in specific predefined historic time periods (before 1900, 1900 to 1929, and 1930 to 1958) was determined from historical maps, aerial photographs, and local planning documents of the history of the region." (page 3.12-5).

Again using a methodology that documents what percentage of a route has been surveyed, what types of sites have been identified and what number of existing NRHP sites are present on a route would be a more comparable approach.

4. AREAS OF POTENTIAL EFFECT (APE) NEED CLARIFICATION

Affected Environment A. Study Area Defined: Area of Potential Effect: There is no reference as to where the APEs are defined for the routes. Does the I-5 corridor have the same width the entire length? How about SR58/Soledad Canyon? The document states (page 3.12-6) that the APE for cultural resources for the proposed HST Alternative is as follows:

- 500 ft (152 m) on each side of the centerline of proposed new rail routes where additional right-of-way could be needed.
- 100 ft (30 m) on each side of the centerline for routes along existing highways and railroads where very little additional right-of-way would be needed.
- 100 ft (30 m) around station locations.

This does not indicate if similar areas were examined for each alternative. It may be possible that one route was primarily analyzed at 100 ft and another was done at 500 feet.

5. THERE IS A HIGH POTENTIAL FOR BURIED CULTURAL RESOURCES ALONG I-5/GRAPEVINE ROUTE

Based on the text (page 3.12-22), there is a high potential for unidentified buried resources along the I-5 route. These resources could have significance to Native American Groups and might be difficult to mitigate. There are also NRHP sites along this portion of the route that could be affected by construction activities.

The SR58/Soledad route has a low potential for archaeological sites and there is little mention of Native American concerns. The corridor through the Antelope Valley has the potential to impact 68 recorded archaeological sites in an undefined corridor width (Note - the Technical Report indicates that there are only 20 sites). The report states that most of the sites in the Antelope Valley corridor are historic trash scatters along the railroad (these would be unlikely to be NRHP eligible).

6. THE HIGH-SPEED TRAIN ALIGNMENT COMPARISON NEEDS CLARIFICATION

High-Speed Train Alignment Comparison (pages 3.12-21, -22, -23) This section includes conflicting information and it is difficult to tell what is being said. The first paragraph discussion is on archaeological sites (presumably prehistoric); however, it then says that there are historic trash scatters along the rail corridors in the Antelope Valley (page 3.12.-22). The historic documentation is the opposite. The I-5 corridor has a number of historic structures - some which are on the NRHP and some Historic Landmark Sites.

Generally, it is difficult to determine what has been studied, what the widths of study are, whether they are the same width between the two lines and if different, where? This coupled with no way of determining if the lack of sites on a portion of the route is due to little or no survey coverage or the true lack of archaeological materials.

7. THE CULTURAL RESOURCES TECHNICAL REPORT NEEDS CLARIFICATION

The following comments apply to the Bakersfield to Los Angeles Cultural Resources Technical Report, listed in Section 12 of the DEIR/S.

Figure 2.2-1 (page 15) Approximate Location of Native American Groups. In Project Region at the Time of European Contact. Based on following territories, this map should have included the tribes west of the Tatavium (possibly Emigdiano Chumash?) and north of the Kitanemuk.

Page 32 indicates that response from Native American groups has either not been received, or have not been sent out. There are some known issues along the I-5 Tehachapi Corridor in the vicinity of the Grapevine. This would be associated with the Sebastian (Tejon) Indian Reservation CHL and other known proto-historic to historic village sites at the Grapevine split in I-5.

Rankings considered the number of known sites per mile, accounting for the percentage of each segment that had been subjected to archaeological survey in the past. (page 35)

Specific structures from the historic period were not identified at this Tier 1 programmatic level of analysis. Instead, the percentage, based on miles, of each alternative route that passed through areas that originally developed in specific, pre-defined historical time periods (before 1900, 1900 to 1929, and 1930 to 1958) was determined from historical maps and knowledge of the history of the region. The percentages were used as indicators of the potential for a particular alternative to impact or affect potentially eligible structures from the historical time periods. Percentages of route lengths that developed in various periods were then translated into qualitative rankings of Low, Medium, and High, with greater weight given for structures or districts known to be listed on or eligible for the National Register of Historic Places, and for segments that were developed in earlier periods. (page 35). Nowhere does this document define what is low, medium or high. The reader is unable to tell if the lows are equal to one another.

The High Speed Train Alternative lists the Antelope Valley as having 120 archaeological sites. The text on page 40 indicates that there are 20 sites. Based on the addition in the DEIR/S, the 20 sites is the correct number.

Section 4.3.1 Alignments. The percentage of surveyed area of the Antelope Valley Corridor (50% page 40) may explain the higher number of sites and the higher number of sites per mile (page 40). If percentage of the Corridors surveyed were included in the calculations used to document for all segments, it would be easier to assess the information presented in the Technical Evaluation. Another useful tool would be the number of NRHP listed and eligible sites. Several sites in the SR 58 and Antelope Valley segments are not eligible for NRHP and thus their significance to the count is diminished.

8. THE PALEONTOLOGICAL RESOURCES TECHNICAL EVALUATION FAILS TO DISCUSS POTENTIAL HST TUNNELING IMPACTS ON THESE RESOURCES

The following comment applies to the Bakersfield to Los Angeles Cultural Resources Technical Report, listed in Section 12 of the DEIR/S.

None of the report sections discuss tunneling impacts on paleontological resources, or provide a comparative evaluation of alignments in this regard. This is one of several issue areas in the DEIR/S where the subsurface impacts could be more severe than surface impacts. Based on the information provided, it is impossible to make a comparative finding

of impact, other than the fact that the I-5 Tehachapi Corridor has more miles of tunneling than the SR 58/Antelope Valley/Soledad Canyon Corridor.

SECTION 3.13 - GEOLOGY AND SOILS

This section misses an opportunity to clearly differentiate the environmental acceptability between route alternatives.

1. THE RANKING SYSTEM FOR COMPARING IMPACTS IS BASED ON PERCENTAGE OF LENGTH RATHER THAN ON ABSOLUTE VOLUMES.

Table 3.13-1 Ranking System for Comparing Impacts Related to Geology/Soils/Seismicity, page 3.13-2 is misleading and possibly flawed. Impact ratings for "Seismic Hazards," "Slope Instability," "Difficult Excavation" and "Oil and Gas Fields" are based on the percentage of the length of the segment that is affected rather than the absolute magnitude of the impact. Thus a longer segment with high volumes of impacts might receive a lower impact rating than a shorter segment with a higher percentage of impact but lower overall volumes. The outcome of this rating system is unclear, but it would be more illustrative of impact levels to utilize actual lengths, volumes or acreage.

2. THE ANALYSIS FAILS TO IDENTIFY CRITICAL DIFFERENCES BETWEEN ALTERNATE ROUTES LINKING BAKERSFIELD TO LA.

The most critical difference between the I-5 corridor and the AV corridor is their constructability through difficult terrain. Yet this section provides scant evidence of the major differences in their geologic attributes. While Table 3.13-2 Summary of Geology (sic) Potential Impact Rankings by Alternative and Segment provides some comparative rankings between the Modal Alternatives, it lumps together the attributes of the route alternatives between Bakersfield to LA. Similarly, the text on page 3-13-11 indicates no significant differences between the I-5, SR-58, SR-138 and Wheeler Ridge Alignments. However, a mere glance at Figure 3.13-2 shows quite graphically that the I-5 route hugs fault lines along most of its length. Furthermore, the alignment options comparison contained in Chapter 6 indicates that construction of the I-5 corridor would require 23 miles of tunnels with some more than 5 miles long and construction costs would be $76 million per mile. Conversely, the AV route through "less abrupt" terrain would require only 13 miles of tunnels with none over 3.4 miles long and construction costs would be only $54 million per mile. These radical differences in constructability are directly attributable to the respective geologic environments and this section must clearly define the respective impacts. This information is contradicted by the Transmetrics and Geodata report entitled "A Comparative Analysis of Tunnel Construction Times, Costs, and Risks Associated with the Choice of High Speed Rail Tunneling Alignment between Los Angeles and Bakersfield (2003). The conclusions of the report indicate the "although the amount of tunneling work involved in the I-5 and the AV alignment are almost the same, be it the 2.5% grade or the 3.5% grade option, the ground

conditions along the AV are relatively more stable and hence involve less construction risks, financial risks, and contractual risks." (page 83)

3. THE ANALYSIS FAILS TO TAKE INTO ACCOUNT THE DIFFICULT TUNNELING CONDITIONS IN THE I-5/GRAPEVINE CORRIDOR.

A study completed in January 2003 by GEODATA and Transmetrics, specialists in tunnel construction noted the extensive faulting, steep terrain, shallow ground water tables and oil and gas fields along the I-5 route. The study concluded that in comparison to that required for the AV route, the tunneling on the I-5 route would take twice as long, be subject to substantially more face failures due to ground shifting or squeezing, be subject to more groundwater and or toxic gas infiltration and, of course, be more costly. These results are consistent with earlier findings showing the risk of tunneling cost overrun to be dramatically higher on the I-5 Alignment (HLB Decision Economics; see references in Introduction). The results of these studies,(copies provided) must be integrated into the geologic analysis contained in this section.

4. THE SECTION INCLUDES NO THRESHOLDS OF SIGNIFICANCE

The analysis in this section provides only comparative levels of impact between the alternatives and provides neither thresholds of significance nor an assessment of the level of impacts.

SECTION 3.14 - HYDROLOGY AND WATER RESOURCES

1. GROUNDWATER IMPACT IN MOUNTAINOUS REGIONS AND TUNNEL SEGMENTS NOT DISCUSSED

Groundwater in the mountainous regions of the Bakersfield to Sylmar segment, between the points represented by the San Gabriel and Tehachapi Mountains is highly variable, affected by fracture permeability in rock units and local alluvial valleys that are relatively restricted in their extent. This is the area where the largest expanse of tunnels on the entire project is located. This type of impact has the potential to be significant. Currently, there is little discussion of this issue and any mitigation that may be available.

Bakersfield to Los Angeles

Groundwater (page 3.14-7). Groundwater in the mountainous regions between the points represented by the San Gabriel and Tehachapi Mountains is highly variable, affected by fracture permeability in rock units and local alluvial valleys that are relatively restricted in their extent. This is the area where the largest expanse of tunnels on the entire project is located. This type of impact has the potential to be extremely significant and currently little discussion is available and little in the way of mitigation could be developed.

The document mentions that it is impossible to determine which alternative would effect more groundwater resources. At the Program EIR level, however, the amount of tunneling could be compared and used as an indicator of the potential significance of this effect for each alignment (page 3.14-15).

2. METHOD FOR EVALUATING STREAM IMPACTS IS FLAWED

Use of the total number of linear feet of streams that may be impacted is an inappropriate measure of impact significance. The text indicates that the I-5 corridor has a higher potential to impact 30,000 linear feet of streams, while the SR 58 route would impact 60,000 linear feet. The report does not mention anything on the types of streams, flow rates, length of downstream impacts. An appropriate number for analysis might be stream crossings (perennial vs. intermittent or ephemeral). This impact could be quantified and could result in a number that could be calculated into acres.

B. METHOD OF EVALUATION OF IMPACTS

Quantitative Assessment (page 3.14-2 and -3) Acreage of surface waters and linear feet of surface waters measurement methodology has no relevance (second bullet on page 3.14-

2). Measuring the number of linear feet of streams within the analysis corridor has no value unless the number is for downstream impacts only.

3.14.4 Comparison of Alternatives by Region

Bakersfield to Los Angeles--High-Speed Train Alternative (page 3.14-15)

The number of linear feet of impacts to streams is a meaningless number in this analysis. The text indicates that the I-5 corridor has a higher potential to impact 30,000 linear feet of streams, while the SR 58 route would impact 60,000 linear feet. The report does not mention anything on the types of streams, flow rates, length of downstream impacts. An appropriate number for analysis might be stream crossings (perennial vs. intermittent or ephemeral). This impact could be quantified and could result in a number that could be calculated into acres.

3. I-5/GRAPEVINE HST ALIGNMENT WITH POTENTIAL IMPACT TO LAKES

Hydrology and Water Resources by Region (page 3.14-15). The discussion indicates that the SR 58 HST alignment would not encroach on any lakes, whereas both of the I-5 Tehachapi alignment(s) would potentially encroach on 18 ac (7 ha) of lakes including Castaic Lake in the Castaic Valley of the Tehachapi, and Upper Van Norman Lake south of the San Fernando Pass. The existing conditions section does not mention Castaic Lake and the impacts discussion fails to mention Pyramid Lake.

4. THE HYDROLOGICAL RESOURCES TECHNICAL REPORT INCLUDES VARIOUS INCONSISTENCIES

Section 2.2.2 State Regulations. This section does not reflect the latest CDFG Stream Alteration regulations. (page 9)

Section 2.3.4 Groundwater - There is no discussion of aquifers in section other than to mention that there are three major aquifers types in the region. The potential to intercept groundwater aquifers might be a factor in differentiating between the tunneling impacts of the I-5 Corridor and the SR 58/Antelope Valley Corridor.

Table 2.3-1 Summary of Affected Area for Hydrology and Water Quality. This table has little value unless some explanation and documentation as to how these impacts were assessed is provided. Also, It is misplaced and should be in Section 3.

SECTION 3.15 - BIOLOGICAL RESOURCES AND WETLANDS

Confidence in the accuracy of the assessment of biological resources and wetlands impacts in the Bakersfield to Sylmar segment is lacking due to inherent weaknesses in the database coverage and methodology used in the DEIR/S. These flaws are described in the specific comments that follow.

1. VARIABLE STUDY AREA WIDTHS REQUIRE FURTHER JUSTIFICATION

The biological resources study area was 1,000 ft in urbanized areas, 0.25 miles in undeveloped areas, and 0.50 miles in sensitive areas. The criteria for urbanized, undeveloped, and sensitive is not defined in the DEIR/S. The DEIR/S goes on to state that the study area in the Bakersfield to Los Angeles region was 0.5 miles, which was supposed to be used in sensitive areas. The document further states that the broader study area was used due to the Tehachapi mountain crossings. The urbanized area study area does not appear to have been used in the highly urbanized area of Los Angeles. The use of each buffer area differed from segment to segment based upon the judgment of the technical report team. This judgment cannot be reproduced by other reviewers, and a method that can be reproduced or evaluated equally should be developed.

2. DATA SOURCES ARE UNRELIABLE

The data used to compare the potential impacts to biological resources in the DEIR/S was limited to available digitized data that was dated or inherently unreliable. These data sources are described below.

Data sources used to determine which sensitive vegetation communities, and special status plant and wildlife species may occur within the buffer zone were limited to the California Gap Analysis and California Natural Diversity Database (CNDDB). It should be noted that USFWS designated critical habitat was reported for other HST sections, but not for the Los Angeles-Bakersfield section, although it is sure to include areas with such designation. Additionally, Appendix 3-15C states that the California Native Plant Society (CNPS) database was also not included in the analysis since digital GIS data was not available.

3. NO FIELD VERIFICATION OF CALIFORNIA GAP ANALYSIS DATA WAS PROVIDED

California Gap Analysis - The California GAP Analysis project was conducted by the University of California, Santa Barbara in coordination with the USGS Biological Resources

Division. The maps were created through photointerpretation of digital satellite data guided by overlays of existing vegetation maps, land use maps, and forest inventory data. Unlike the NWI maps, specific standards for resolution and scale, accuracy, and format were set. However, it should be noted that no field verification was conducted.

This data set was used in the EIR/S to determine what sensitive vegetation communities exist within the buffer area. Sensitive vegetation communities include coastal sage scrub, willow riparian woodland, and alluvial fan sage scrub that could require mitigation for impacts under CEQA. The maps are expected to provide a regional context for vegetation and habitat, but may not provide information at a suitable scale for basing alignment recommendations or decisions on.

4. LIMITATIONS OF RELIANCE UPON CNDDB DATA BASE

CNDDB - The CNDDB database is an inventory of special status habitats, plants, and wildlife. The CNDDB records are submitted by biologists who observe the species during surveys, or are historical records. Therefore, the areas that have been surveyed for several projects or large projects, or are considered biologically sensitive would have more recorded occurrences of sensitive species.

Each occurrence in the CNDDB database is recorded on a USGS 7.5-minute quadrangle, which encompasses an area of 49 to 70 square miles. In many segments of the HST alignments, an area this large would include several habitat types and elevations. The CNDDB database lists the habitat type for each species, and often includes a detailed description of its location, however, it does not appear that these factors were taken into consideration during the preparation of the DEIR/S.

As shown in Figure 3-15-05, the CNDDB GIS data contains large polygons of different shapes that apparently depict threatened and endangered species habitat. How these polygons are designed based upon submitted records is not explained.

5. DIFFERENT WETLAND DATA SOURCES USED IN OTHER SEGMENTS

The data used to calculate the amount of jurisdictional waters resources within the buffer area was limited to the National Wetland Inventory maps and United States Geological Survey (USGS) topographic maps. It should be noted that different sources of data were used in each segment. For example, data sources used in the San Diego to Inland Empire segment included Thomas Brothers Guide maps and USFWS vernal pool maps.

6. TOPOGRAPHIC MAP SOURCES USED FOR WETLANDS IDENTIFICATION ARE DATED

National Wetlands Inventory Maps - The U.S. Fish and Wildlife Service (USFWS) created the NWI maps, which are provided on a USGS 7.5-minute quadrangle base. The metadata provided with the maps clearly states that the NWI does not show all wetlands or riparian areas since the maps are derived from aerial photo-interpretation of maps of varying scale and quality, and dated between 1971 to 1997. These aerial photos include older 1970s-era black and white photography at a scale of 1:80,000 and more recent color infrared photography. The maps are inventoried using different techniques depending upon the interpreter, and no field verification was conducted. The USFWS clearly states in the metadata that information provided by the NWI is limited and users should not rely solely on the NWI maps, but consult other information, such as soil survey reports and local and state government wetland information.

Additionally, 24 of the quadrangles that comprise the Los Angeles to Bakersfield study area were not available. Therefore, the final analysis may not include wetland data for approximately one-half of the study area.

USGS Topographic Maps -According to Appendix 3.15-C, a manual review of USGS topographic maps were used to calculate the linear feet length of perennial, intermittent, and ephemeral drainages within the study area. USGS maps are based upon information compiled in the 1960's and 1970's with some updates in the 1980's.

7. INAPPROPRIATE METHODS OF EVALUATING IMPACTS TO STREAMBEDS AND WATERBODIES

Reporting potential impacts to streambeds in linear feet is not appropriate since these impacts are permitted by resource agencies based upon acreage of impacts. The different streambed types were reported in the Technical Report, but not used in the EIR/S alternatives comparison table, which includes all streambed types as "non-wetland waters".

Because the NWI maps included any ponds, rivers, and lakes that were visible in the aerial photographs used, many of the waterbodies within the buffer areas may have been counted twice in the analysis. They would have been counted first in acre-feet from the NWI maps and then in linear feet from the USGS topographic maps.

8. SPECIFIC WEAKNESSES IN METHODS OF EVALUATION

Specific comments concerning the methodologies used to evaluate biological resources impacts are provided below. The comments highlight the difficulty in drawing reliable impact conclusions from the data and methods relied upon.

3.15.1 REGULATORY REQUIREMENTS AND METHODS OF EVALUATION

B. METHOD OF EVALUATION OF IMPACTS (PAGE 3.15-1 AND -2)

Wetlands were determined from NWI maps. The report admits that the information was incomplete in some areas, but does not specifically spell out where areas of deficiency occur. This section states that detailed information should be carried forward into the next phase of analysis.

No field studies were completed and all biological activity is based on database information. That means that if a resource were somewhere within a search area, the species or vegetation type would be represented in the data. This could over represent impacts in some areas if there is a high biological diversity in the area. The SR58/Soledad Canyon Route is such an area with multiple zones that could or could not contain sensitive species.

The document states that ". . . the identification of a potential impact on a specific resource is intended to be conservative and in some instances may be an overstatement, because neither habitat that is sensitive or species of concern may be found in or near the footprint of the proposed corridor or actual alignment."(page 3.15-3) Again they recommend this analysis at the next level of analysis.

3.15.2 AFFECTED ENVIRONMENT

The study area for the I-5 corridor is defined as 0.5 miles on either side of the highway and rail corridors and around stations (page 3.15-4). We presume this is for both the I-5 and SR 58 segments. This number potentially over-inflates impacts. It is impossible to tell if the overrepresentation is equal on both routes due to the different nature of the terrain and routes.

3.15.4 COMPARISON OF ALTERNATIVE BY REGION

C. BAKERSFIELD TO LOS ANGELES

General Comment

The High-Speed Train Alignment Option Comparison states that the SR-58/Soledad Canyon route would have a slightly greater potential for impacts on biological resources than for the I-5 route. This determination appears to have been based upon the fact that the SR-58/Soledad Canyon alignment had a higher total number of special status species and more linear feet of waters of the U.S. than the I-5 alternative. Special status species include federal and state listed threatened and endangered species, species of special concern, and CNPS 1B listed plants. As the names and status of these species is not provided, it is not possible to determine which alignment has the highest number of state and federally listed threatened and endangered species. Threatened and endangered species have a higher level of sensitivity and protection than species of special concern and CNPS 1B listed plants.

The two routes are roughly equivalent on impacts to biological resources. However it is difficult to know within the report what species are potentially impacted and where. Based on the information provided, it is impossible to make any kind of meaningful comparison. On page 3.15-31 the document states that alignments could be adjusted to reduce impacts. This would be the case in most instances. In fact, the footnote on page 2-73 of the DEIR/S indicating the SR-14 alignment has been carried forward along with the Soledad Canyon alignment suggests that the ability of this alignment variation to further reduce biological resource impacts has not even been considered in Section 3.15 at all. The DEIR/S also states that the broad range of information may not accurately correspond to actual field conditions.

The SR-58/Soledad Canyon route includes more than 700,000 linear feet of streambed than the I-5 alignment. Much of this disparity is due to the fact no avoidance or minimization methods were assumed for the SR-58 Soledad Canyon route, but the segments of the I-5 alignment that involved tunneling were assumed to avoid all impacts to jurisdictional waters and wetlands without addressing the potential for biological impacts resulting from dewatering. The comparison of linear feet of potential streambed impacts is meaningless, since impacts are reported in acres and the width of streambeds and riparian corridors differ significantly. Additionally, there is a huge unexplained disparity between the linear feet of non-wetland waters (streambeds) reported in the Biological Resources section and the linear feet of streams reported in the Hydrology and Water Resources section. However, both sections reference 1:24,000 scale (7.5 minute) USGS topographic maps as the source of data.

LEDPA Definition

Because construction of the HST project will involve temporary and permanent fills in waters of the U.S., issuance of a permit under Section 404 of the Clean Water Act from the U.S. Army Corps of Engineers (Corps) will be required. In accordance with the Clean Water Act, the Corps "cannot permit a discharge of dredged or fill material into waters of the U.S. if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." The least environmentally damaging practicable alternative is known as the LEDPA.

When an individual 404 authorization is requested from the Corps, the LEDPA is determined through the preparation of an alternatives analysis. The alternative analysis must "rigorously explore and objectively evaluate" all reasonable and practicable off- and on-site alternatives capable of achieving the purpose of the proposed activity. *Practicable* is defined by *cost*, *technical* and *logistic factors*. The Corps has developed specific criteria to evaluate practicability of alternatives. As a consequence, the project must be:

- Environmentally Sensitive
- Logistically Feasible.
- Feasible by Engineering Practices/Standards.

The Biological Resources section of the DEIR/S needs to provide substantial evidence to support identification of the LEDPA for the HST system preferred corridor and alignments in the Final Program EIR/S.

9. COMMENTS ON METHODS USED IN THE BIOLOGICAL RESOURCES AND WETLANDS TECHNICAL REPORT

Biological Resources General Comments

The specific starting point for the Bakersfield to Los Angeles Segment of the report does not start at the same location in Bakersfield for each three routes. The lack of a common start point could have a localized difference on effects in the Sacramento to Bakersfield Segment Studies.

The Biological Resources section of the EIR/S compared the number of sensitive species that could occur within each alignment. Twenty-three (23) species were recorded for the SR58/Soledad Canyon alignment and thirteen (13) to fourteen (14) species were recorded for the I-5 alignment, depending upon the segment chosen (Union Station or Wheeler Ridge). However, both of the alignments are divided into several segments that were

analyzed separately in the technical document. This resulted in multiple counts of the same species for each alignment. When analyzed by alignment, the potential impacts to special status species is summarized below:

	I-5 Alignment		SR58/Soledad Canyon
	Union Station Segment	Wheeler Ridge Segment	
Special Status Plants	5	3	11
Special Status Wildlife	8	9	9
Total Number of Special Status Species	13	12	20

The analysis of potential impacts to special status species in the EIR/S is limited to a comparison of the total number of species, which as demonstrated above, is reduced when the entire alignments are compared rather than segments. However, a more suitable analysis would be a comparison of potential impacts to the most sensitive species, indicated by its state and federal status and the level of probability for it to occur. A species may be protected at different levels at the state and federal level, or more commonly, included on the CNPS list, simultaneously. Therefore, the table below includes a count based upon the highest level of protection granted for each species.

	I-5 Alignment		SR58/Soledad Canyon
	Union Station Segment	Wheeler Ridge Segment	
Federal or State Threatened or Endangered Species	9	8	10
Federal or State Species of Special Concern	4	4	7
CNPS List 1 Plant Species	0	0	2
CNPS List 3 Plant Species	0	0	1

It should be noted that one plant species, Parry's spineflower, included in the SR58/Soledad Canyon alignment is only included on the CNPS List 3 species (page 27). This designation indicates that CNPS needs more information on the plant. Therefore, it may not be appropriate to include this species in the list.

The technical documents include the types of habitat and elevations associated with each species and their potential to occur within the alignment from low to high. The potential to occur was based upon records of occurrence in the CNDDB and CNPS databases and occurrence of suitable vegetation based upon the CNDDB Gap Analysis maps. These records often consisted of undated herbarium records that ranged from the 1920's to the mid-1990's. More recent information provided by the CNPS online inventory indicates that many historic occurrences of Bakersfield smallscale, Bakersfield cactus, Lancaster milk vetch, San Joaquin woollythreads and San Fernando Valley spineflower have been extirpated. No field work was conducted to confirm that suitable soils, vegetation, or other habitat constituents exist. Additionally, the elevations at each segment of the alignment were not compared to the elevational range associated with each species, as is common with biological reviews, especially to determine the potential occurrence of plant species. However, based upon the designations assigned in the technical document, the number of threatened or endangered species that could occur within each of the alignments are comparable as indicated in the table below. The differences between the SR58/Soledad Canyon alignment and I-5 alignment would not appear to be substantial enough to justify selection of one alignment over another on the basis of biological resources considerations, at the Program EIR level of review.

	I-5 Alignment						SR58/Soledad Canyon		
	Union Station Segment			Wheeler Ridge Segment					
	Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
Federal or State Threatened/ Endangered	1	4	4	1	4	3	1	4	5
Federal or State SOC	0	1	3	0	1	3	0	0	7
CNPS List 1 Plant Species	0	0	0	0	0	0	0	1	1

Section 3.3 Impacts Assessment (page 62) talks about the lack of sensitive area and indicates that buffers examined varied from 305 meters to 0.4 kilometers. Nowhere does the report indicate where the changes occur and if the changes shifted back and forth along the routes.

The Technical Document states that . . . ."Where feasible, construction type was factored into the impacts assessment. Because the segment type and construction type occurred in

two separate GIS layers, it was not possible to conduct the impacts analysis on both segment and construction type. That is, we could quantify impacts of each segment or each construction type from Bakersfield-to-Los Angeles, but not both. To remedy this situation, biological resources from the CNDDB were overlain on construction type to determine which of these resources occurred in tunnel and noting which construction segment or segments the tunnel areas corresponded to. Then, for a given segment, if all occurrences of a particular resource (sensitive plant community, for example) were only identified within tunnel areas, then impacts to this resource were assumed to be non-existent. If some occurrences of a particular resource were identified in tunnel areas and some in areas of a different construction type (cut and fill, for example), then qualifying statements were added to Section 4.0 identifying that impacts to the resource would be reduced due to tunneling where some of these resources were located. Acreages of plant communities occurring within tunnel sections for a given segment were estimated by taking the fraction of the acreage of the plant community polygon occurring within the tunnel segment. However, this was not done for jurisdictional waters and wetlands due to the nature of the database. For the purposes of this analysis, it was assumed that tunneling would not result in impacts to biological resources within tunnel sections because the tunnel will be lined and sealed as construction with a tunnel boring machine takes place, with no impacts on groundwater levels and no potential for dewatering impacts on surface resources. Some surface disturbance associated with tunnel portal construction would occur, but this disturbance would only occur for a minimal distance (approximately 100 feet, for instance) at the beginning and end of the tunnel sections (page 63)."

How does this take into account the roads leading to tunnel segments, the portal areas which we presume are wider that the construction ROW and the spoils from tunneling? This could be a significant issue when comparing the greater length of tunneling associated with the I-5 Tehachapi Corridor as compared with the SR58/Soledad Corridor.

The report states that . . . ."For the purposes of this analysis, it was assumed that tunneling would not result in impacts to biological resources within tunnel sections because the tunnel will be lined and sealed as construction with a tunnel boring machine takes place, with no impacts on groundwater levels and no potential for dewatering impacts on surface resources." (page 63). [This is a huge assumption to make considering results of some of the studies for tunneling under the Cleveland National Forest associated with the MWD Inland Feeder tunneling project.]

Section 4.3.1 Impacts to Biological Resources from the I-5 Tehachapi Corridor (page 83) indicates that the corridor construction and operation would impact Santa Ana sucker, San

Joaquin antelope squirrel, San Joaquin kit fox, California condor, and unarmored threespine stickleback.

Depending on the exact location of the at grade sections at the Grapevine, there is a potential for impacting the Tehachapi slender salamander as well. Specimens of the salamander have been observed in the Grapevine Creek vicinity of the northbound runaway truck ramp along I-5. The Modal Alternative also indicates potential impacts to the arroyo toad. The arroyo toad could also be impacted by construction of the HSR alternative in this area of the I-5 corridor.

SECTION 3.16 - SECTION 4(F) AND 6(F) RESOURCES (PUBLIC PARKS AND RECREATION)

This section of the DEIR/S indicates the SR 58/Soledad Canyon alignment alternative (Antelope Valley alignment) within the Bakersfield to Sylmar segment is environmentally superior with respect to 4(f) and 6(f) resources, and provides a clear rationale for its selection over either of the I-5/Tehachapi alignments (Wheeler Ridge and Union Station).

1. SECTION 4(F) AND 6(F) RESOURCE REQUIREMENTS ARE IDENTIFIED

3.16.1 REGULATORY REQUIREMENTS AND METHODS OF EVALUATION

The requirements for this section of the Department of Transportation Act of 1966 spells out procedures for preserving the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites.

Section 4(f) (c) states that "The Secretary may approve a transportation program or project (other than a project for a park road or roadway under Section 204 of Title 23) requiring the use of publicly owned land of a public park, recreation area, or wildlife and waterfowl refuge of national, state, or local officials; or land of an historic site of national, state, or local significance,(as determined by the federal, state, or local officials having jurisdiction over the park, area refuge, or site) only if,

(1) There is no prudent and feasible alternative to using the land; and

(2) The program or project includes all possible planning to minimize harm to the park, recreation area, wildlife and waterfowl refuge, or historic site resulting from the use. (page 3.16-1)

Section 6(f) of the Land and Water Conservation Fund Act has similar provisions that prohibit the conversion to non-recreational purposes of property acquired or developed with these grants without the approval of the U.S. Department of the Interior's (DOI) National Park Service. Section 6(f) directs DOI to ensure that replacement lands of equal value (monetary), location, and usefulness are provided as conditions to such conversions. (pages 3.16-1 and -2)

2. ANTELOPE VALLEY ALIGNMENT MINIMIZES IMPACTS TO 4(F) AND 6(F) RESOURCES

3.16.4 COMPARISON OF ALTERNATIVES BY REGION--BAKERSFIELD TO LOS ANGELES

High-Speed Train Alignment Options Comparison

This section clearly indicates that the SR 58/Soledad Canyon Alignment would result in the fewest potential impacts (one) (page 3.16-9). The general comment in Section 3.16-1 suggests that the I-5 corridor might not meet the intent of Sections 4(f) and 6(f) and the alternative route (SR 58) would be the preferred alternative.

The text on page 3.16-4 in this section mentions Vasquez Rocks County Park, however the Map (Figure 3.16-2) does not show the park location.

3.16.5 Impact Avoidance Strategies, Including Alternatives Screened from Further Consideration

Page 3.16-10 states that "Based on the overall screening evaluation, several segments in the Bakersfield to Los Angeles region were removed from further consideration, in part due to potential impacts on Section 4(f) and 6(f) resources (see Figure 3.16-2). The figure references show no removal of impacts. The routes are certainly within several 100 feet of the resources on the I-5 Tehachapi Corridor. The SR 58 Route would have significantly fewer impacts to Section 4(f) and 6(f) resources and thus would be the preferred alternative.

3. SECTION 4(F) AND 6(F) TECHNICAL EVALUATIONS SUPPORT SELECTION OF THE ANTELOPE VALLEY ALIGNMENT

Bakersfield to Los Angeles Section 4(f) and 6(f) Technical Evaluations

This section is very favorable to the SR58/Soledad Canyon Routing. Page 18 of the document states that . . . . "As shown in Table 3.1-2, the HST segment on Wheeler Ridge/I-5: Tehachapi would result in high potential for use of eight Section 4(f) resources; medium potential for constructive use of ten Section 4(f) resources and high potential for use and constructive use impacts on NRHP listed and eligible resources. The Union Avenue/I-5: Tehachapi segment would result in substantially reduced impacts with high potential for use of five Section 4(f) resources; medium potential for constructive use of two Section 4(f) resources and high potential for use and constructive use impacts on NRHP listed and eligible resources."

Page 18-19 further states that . . . "SR58/Antelope Valley/Palmdale Station Siding/Soledad Canyon alignment would result in the least impacts, with high potential for use of only one

Section 4(f) resource; high potential for constructive use of one Section 4(f) resource; medium potential for constructive use of one Section 4(f) resource and medium potential for use and constructive use impacts on NRHP listed and eligible resources. Based on the potential for impacts on Sections 4(f), 6(f) and 106 resources, the SR-58/Antelope Valley/Palmdale Station Siding/Soledad Canyon alignment would result in the least impacts of the HST alignments considered for the Bakersfield to Sylmar segment".

Table 3.2-1 indicates that resources would be at varying distances from the three I-5 routings. The Wheeler Ridge Corridor would have the highest potential impact to Fort Tejon State Historical Park. The I-5 Tehachapi Corridor would have high potential impact to Hungry Valley State Vehicle Recreation Area; Pyramid Lake; and the Angeles National Forest. The Table states that the impacts would be adjacent; however impacts at Pyramid Lake; the Angeles National Forest; and Santa Clarita Woodlands Park and Towsley Canyon would be across lands rather than adjacent. It appears from the maps that tunneling would not occur in these localities.

Table 3.3-1 fails to mention the types of NRHP and CHL Sites on the Wheeler Ridge Route. The Table also fails to mention Fort Tejon State Park as either an NRHP or CHL site.

Section 3.5 (mislabled as Section 6.5) on Avoidance Alternatives or Reasons For No Prudent Or Feasible Alternative For 4(f) Or 6(f) Use. This section spells out the criteria for 4(f) and 6(f) classification. Based on the criteria, the I-5 Tehachapi Corridor would not be selected because the SR58/Antelope Valley/Soledad Valley route would be less impacting. Table 3.4-1 provides a clear summary of the impacts.

SECTION 3.17 - CUMULATIVE IMPACTS EVALUATION

1. NO ANALYSIS OF CUMULATIVE IMPACTS OF ALTERNATIVE HST ALIGNMENTS IS PROVIDED

This section provides only a superficial discussion of cumulative impacts for the System Alternatives, and provides no information on the cumulative impacts of HST alignment alternatives. Appendix 3.17a provides information on cumulative projects on the SR 58 corridor, but nothing for any of the other alignments between Bakersfield and Los Angeles.

2. THE CUMULATIVE ANALYSIS DOES NOT MEET THE INTENT OF CEQA FOR A PROGRAM LEVEL EIR

The analysis of system alternatives cumulative effects for each impact topic is quite brief. The discussion indicates on page 3.17-1 that cumulative impacts are addressed separately for each environmental topic *as appropriate for a program-level environmental analysis.* However, review of these topical sections indicates these impacts are typically not identified in the topical text sections (i.e. with a heading), and cannot be readily distinguished from the general analyses of 'environmental consequences'. Contrary to the intent of CEQA Guidelines 15168(b)(2), the Program EIR does not reflect a thorough consideration of cumulative effects associated with the HST alignment alternatives.

3. THE CUMULATIVE ANALYSIS DOES NOT PROVIDE ANY DISCUSSIN ON THE HST ALTERNATIVE IMPACTS TO AIR TRAVEL

The DEIR/S states that potential improvements to existing highways and airports under the Modal Alternative would worsen congestion on surface streets between intercity highways and airports, resulting in adverse cumulative traffic impacts. The document presents no justification of this finding. Indeed, there is no mention of the Modal Alternative's potential impact on air travel at all.

The document also contains no discussion of the HST Alternative's potential impacts on air travel within California. This omission compares with the statement that the HST Alternative could result in 38.5 million fewer long-distance auto passenger trips annually than under the Modal Alternative. The effect of the HST on air travel demand is a key "objective" of the project, and one that is sure to generate intense controversy. The environmental document must provide a thorough analysis and discussion of this issue.

The derivation of data regarding changes in travel by mode on page 3.17-2 is not explained or discussed. Even with reference to Section 3.1 and 3.2, a full No-Project trip table cannot

be constructed, and therefore it is impossible to verify or validate the stated impacts of the HST Alternative on highway and air travel.

CHAPTER 4: COSTS AND OPERATIONS

This brief chapter presents a highly summarized version of the information contained in the Statewide Operations Technical Report and Statewide Cost Technical Report. For the analysis of the high speed train Alternative (Section 4.2.2), it is indicated that the system of alignment and station options that represent the "highest return on investment system", as presented in the Business Plan, is represented in the cost data and ranges presented. As with other sections of the DEIR/S, it is unclear specifically which combination of alignment and station options this represents.

SECTION 4.2 - CAPITAL COSTS—MODAL ALTERNATIVE (4.2.1)

1. THE METHODS USED TO DETERMINE SPECIFIC NEEDS FOR THE MODAL ALTERNATIVE HIGHWAY AND AVIATION COMPONENTS ARE NOT ADEQUATELY DESCRIBED

A. HIGHWAY COMPONENT

It is not clear whether or how costs were compared for urban solutions involving either structure or acquisition of additional right-of-way. The methodology used to determine specific needs for new roadway facilities is not adequately described, nor are the calculations underpinning the results. The information presented in Chapter 2, Appendix 2-D, Appendix 2-F, and Appendix 4-A does not adequately address these issues, either. See other comments for Appendix 4-A.

B. AVIATION COMPONENT

The methodology used to determine specific needs for new runways, gates, and other facilities at specific airports is not adequately described, nor are the calculations underpinning the results. The information presented in Chapter 2, Appendix 2-E, Appendix 2-G, and Appendix 4-B does not adequately address these issues, either.

See other comments for Appendix 4-B.

2. HST UNIT COSTS ARE QUESTIONABLE

Capital Costs--High-Speed Train Alternative (4.2.2)

A. UNIT COST ESTIMATES

On page 4-3, the statement, "Many of the cost elements were reviewed by HST owners and operators as part of the peer review of the corridor evaluation study commissioned by the Authority (DE-Consult Deutsche Eisenbahn-Consulting GmbH 2000)." does not appear to be correct, based on independent checking with European and Japanese high-speed rail operators. In addition, many of the unit costs have been questioned by an independent consultant retained by the City of Palmdale to review Project tunneling assumptions and analysis (Geodata, SPA).

B. ADJUSTMENTS TO UNIT COSTS

The description of the "tunneling conference" held in December 2001 strongly implies that participants gave explicit guidance regarding particular unit costs. The tunneling conference summary document does not substantiate this implication. The conference dealt generally with geologic conditions, constructability, and alignment selection, and most of the non-US participants were not in a position to evaluate the reasonableness of US construction costs.

SECTION 4.3 - OPERATIONS AND MAINTENANCE COSTS-- HST ALTERNATIVE (4.3.2)

3. O&M UNIT COSTS REQUIRE INDEPENDENT VERIFICATION

F. OPERATIONS AND MAINTENANCE ANNUAL COSTS

The sum of all unit costs in Tables 4.3-2 and 4.3-3 equals $26.01/train-mile. This is approximately half (50%) of the cost now be used for planning conventional rail service in northern California. It is unclear why there is such a large discrepancy, and careful review of these costs by a third party should be undertaken.

In Table 4.3-3 (page 4-7), it appears that the heading of the second (middle) column should not contain the word "Annual".

4. A COMPARISON OF ACTUAL OPERATING COSTS OF ALTERNATIVES IS NEEDED

Operations and Maintenance Costs--Operating Cost Comparison of the Alternatives (4.3.3)

The comparison of costs as presented in this section (Table 4.3-4) is misleading, in that costs are limited to "infrastructure maintenance" only. The DEIR/S does not provide any comparison of actual *operating* costs for the alternatives, and thus it is not possible to make a total O&M cost comparison among them.

Review of Appendices 4-A, 4-B and 4-C (Capital Costs)

5. THE REPORT DEFINING ROADWAY PROJECTS NEEDS TO BE MADE AVAILABLE

Appendix 4-A (Capital Costs: Highway Element)

The *System Alternatives Definition Report* cited on page 4-A-4 has not been provided by the Authority for review. This report is critical in understanding how the specific roadway projects were defined. Without it, the reported cost of $66 billion cannot be checked for reasonableness and accuracy. In particular, it appears that a standard widening of the entire length of facilities such as I-5 and SR-99 was used, rather than selective widening in urban/congestion locations. This assumption could greatly bias the final cost estimate, and cannot be evaluated with the information provided in either the DEIR/S or appendices.

The right-of-way cost definitions are not consistent between (1) the Highway element and (2) the Aviation and HST elements (Appendices 4-A, 4-B, and 4-C, respectively).

6. AVIATION ELEMENT COST ANALYSIS APPEARS TO ASSUME NO RESIDUAL CAPACITY IN PRESENT SYSTEM

Appendix 4-B (Capital Costs: Aviation Element)

The analysis appears to assume that no residual capacity at all exists in the present system – landside or airside; all projected growth is translated into additional capacity with associated costs. The basis for this very important assumption is not provided, and it would appear to be incorrect in at least some locations.

Assumption of need to acquire land for runways (1 mile x ~2,100 ft) is undocumented and appears to be excessive.

7. HIGHWAY, AVIATION AND HIGH SPEED TRAIN ALTERNATIVE 'CONTINGENCY' AND 'SOFT COST' FACTORS APPEAR TO BE UNDERSTATED (APPENDICES 4-A, 4-B, 4-C)

It appears that "contingency" (25%) and most "soft cost" factors (preliminary engineering – 2.5%, final design – 5%, design management – 5%, construction management – 5%, agency and force account costs – 2%, and risk management (insurance) – 6%) are significantly understated. At this point in project development, contingency should be at least 35-40%. The following soft cost factors are too low, as well: final design, design management, construction management, and force account costs.

Financing costs are not included anywhere in the DEIR/S or in any of the cost technical reports. A financial analysis prepared in 1999 apparently has not been updated.

Comments on the Statewide Operations Technical Report and Statewide Cost Technical Report follow.

Operations Technical Report (Statewide)

1. There is no comparative analysis of Bakersfield-Sylmar alignment alternatives (Antelope Valley and I-5) provided in this report.

Cost Technical Report (Statewide)

1. There is no place in the Cost Report where all HST costs are totaled. Thus, it is not possible to understand the basis for the $33-37 billion estimate presented in the DEIR/S Summary on page S-5.

2. The tunneling cost figures in the spreadsheets do not agree with those in the main Cost Report. As well, the costs in provided Cost Report do not agree with those in the DEIR/S.

3. The segment lengths provided in the Cost Report do not agree with those in the DEIR/S.

4. There are no references to maps showing alignment segments in the Cost Report. It Is difficult, if not impossible, to understand the cost figures presented in Appendix E and Appendix F without being able to refer to alignment maps.

5. Aside from a single mention of $44 million per trainset (Cost Report, Appendix E), there is no accounting of vehicle costs (locomotives, coaches, other vehicles and equipment) anywhere in the Cost Report or DEIR/S.

6. Right-of-way costs used in the analysis appear to be significantly understated. The figures used are equivalent to $1.5 million/acre for "dense urban," or $34.44 /square foot, and $160 thousand/acre for "suburban," or $3.67 /square foot.

7. Contingency (25%) and most "soft cost" factors (preliminary engineering – 2.5%, final design – 5%, design management – 5%, construction management – 5%, agency and force account costs – 2%, and risk management (insurance) – 6%) are significantly understated. At this point in project development, contingency should be at least 35-40%. The following soft cost factors are too low, as well: final design, design management, construction management, and force account costs. In particular, the force account provision is off by an order of magnitude with respect to costs involving the railroads.

8. Financing costs are not included anywhere in the DEIR/S or in any of the cost technical reports. A financial analysis prepared in 1999 apparently has not been updated.

9. Operations and maintenance costs are not described, explained, or discussed in the DEIR/S. The discussion in the Cost Report provides only limited detail regarding the buildup of costs. The comparison of so-called "infrastructure costs" does not present a complete view to analysts and decision-makers. Though not stated directly, the total estimated annual O&M cost for the HST totals more than $700 million ($703.2

million). There is no attempt to compare this cost with total costs associated with the "No Project" and "Modal" alternatives. Further, it is difficult to comprehend how maintenance of way for 700 miles of highly-engineered, low-tolerance HST facilities ($76.5 million / year) could be only slightly more than half (56%) of the cost of maintaining 740 linear miles of four-lane concrete highway ($135.6 million / year). In addition, an annual insurance premium of 0.1% of the value of the completed facility also appears low, as does an annual station maintenance budget of $500 thousand per station.

CHAPTER 5: ECONOMIC GROWTH AND RELATED IMPACTS

This section provides comments on Chapter 5: Economic Growth and Related Impacts and the background technical report by Cambridge Systematics entitled: *Economic Growth Effects of the System Alternatives for the Program Environmental Impact Report/Environmental Impact Statement.* (Cambridge report) These documents were reviewed 1) to determine consistency with CEQA requirements for discussion of growth-inducing effects (CEQA Guidelines Section 15126.2 (d)), 2) to determine the basis and source of information in support of the broad conclusions identified for 'growth induced impacts' attributable to the I-5 and SR-58/Soledad Canyon Corridor (Antelope Valley) alignments in Section 6.4.1 of the DEIR/S, and 3) to determine if a fair and accurate assessment of regional growth attributable to HST service to the Antelope Valley has been presented

1. THE DEIR/S INCLUDES NO DISCUSSION OF GROWTH-INDUCING EFFECTS (PER CEQA GUIDELINES SEC. 15126.2(D))

Chapter 5 makes no reference to its intent to comply with this provision of the Guidelines. However, the discussion included would appear to comply *at the System-level* with the intent of this section of the Guidelines.

2. THE DOCUMENTS CONCLUDE, BASED SOLELY ON AN ANALYSIS OF INTER-COUNTY TRIPS, THAT THE PALMDALE DESIGN OPTION WILL REDUCE ECONOMIC BENEFITS STATEWIDE.

The analysis in these documents predicts that (in comparison to the base HST Alternative) the Palmdale Design Option will result in a statewide reduction of 14,000 jobs and 22,000 people due to the longer HST travel times associated with this alignment. The analysis predicts that 60 percent of this decrease will occur in Southern California and most of the remainder in the Bay Area. However, the analysis also predicts that the Palmdale Design Option will result in an additional 25,000 people and 15,000 jobs (in comparison to the No Project Alternative) for the Antelope Valley. In other words, the Palmdale Design Option will increase economic growth in the Antelope Valley at the expense of decreases in economic growth in LA County, Southern California and statewide.

The background for these finding is as follows:

Economic activities (including employment, productivity, population and urbanization) stemming from construction and operation of the HST are analyzed in the Cambridge Report. Analysis is conducted using five separate regions of the state—four of which are traversed by the HST and one termed merely "rest of State." The level of detail is on a County level. Current population, employment and urbanized land area are cited for 21 of the State's 58 counties (DEIR/S section 5.2.1 pp 5-1 and 5-2).

Sophisticated macroeconomic simulation models were used including Regional Economic Models, Inc (REMI), a business attraction model, an employment allocation model and a residential spatial allocation model. Eight specific growth parameters were projected (see DEIR/S page 5-6). In general, the analysis predicts that, in comparison to the No Project Alternative, population and employment both statewide and in LA County, in the year 2035, will increase by 1% under the Modal Alternative and 2% under the HST Alternative. (DEIR/S Table 5.3-5, p. 5-15). The analysis predicts that urbanized acres in the year 2035, in comparison to the No Project Alternative, will increase by 1.41% Statewide under the Modal Alternative and decrease by 0.6 % under the HST Alternative. In Los Angeles County, urbanized area is predicted to increase by 1.07% under the Modal Alternative and decrease by 3.81% under the HST Alternative. (Table 5.3-6 p. 5-21) (This is regarded as a positive impact-better utilization of land.)

Alignment options were analyzed for differences in economic growth, and the DEIR/S (p. 5-21) states that the alignment options would <u>not</u> create meaningful differences in overall urban area size or station-area density. The Cambridge Report (p 5-10,11) reflects this statement by indicating that *"...all HST design options exhibit <u>county-level</u>* (emphasis added) *growth and land consumption effects that are of the same general magnitude as the primary system alternatives, and there is no meaningful differences in these results to distinguish between design options."*

However, the Cambridge report (p. 4-9) acknowledges some minor differences between the design options in the range of 17,000 jobs and 29,000 people or about 0.06%. Also, a footnote in the DEIR/S (p. 5-21) reads: *"For the Palmdale scenario analysis, results suggest that the likely growth effect in the Antelope Valley (including potential station sites in both Palmdale and Sylmar) would be on the order of 25,000 people and 15,000 jobs relative to the No Project Alternative, and 3,000 people and 1,000 additional jobs relative to the base HST scenario."*

Clarification detail appears in the Cambridge report on tables 4.7 through 4.11 and is summarized (p. 4-14) as follows:

"4.2.1 Palmdale Design Option

The Palmdale design option includes an additional station at Palmdale... This somewhat slower alignment between Los Angeles and Bakersfield increases travel times between Southern California ant the Central Valley and Bay Area regions. The longer travel times translate into slightly reduced ridership and travel efficiency benefits compared to the base HST Alternative. Taken together, these differences lead to a state reduction of 14,000 jobs and 22,000 people compared to the base HST Alternative in 2035. Nearly 60 percent of this reduction is expected in occur in the Southern California region, while most of the rest is expected to occur in the Bay Area. "

While Section 4 of the Cambridge report indicates that overall state growth will be less with the Palmdale Option, Section 5 indicates that despite the statewide losses, there will be increases in the Antelope Valley. The detailed numbers are presented on Tables 5. 8 through 5.11 and are summarized (p.5-16) as follows:

"Palmdale Design Option

... By adding a station at Palmdale, the primary effect of this design option is to increase projected urbanized land requirements in Los Angeles County by more than 2,250 acres (0.3 percent). Due to increased travel times involved with an Antelope Valley alignment, the Palmdale design option also slightly reduces requirements for urbanized land in nearly every study area county as a result of reduced population and employment growth. In total, the reductions in other counties outweigh the increase in Los Angeles County, resulting in a net decrease in statewide urbanized area of approximately 2,100 acres in 2035.

Although specific land consumption results were not generated at a subcounty level, the county-level results can be used to draw general inferences about the potential extent of growth in the Antelope Valley with this design option. As noted, this design option has decreased overall population and employment in Los Angeles County (emphasis added) due to longer travel times. At the same time, it has slightly increased land consumption suggesting an increased amount of development in lower density areas (e.g., the Antelope Valley). The total year 2035 incremental growth (relative to the No-Project Alternative) in Los Angeles County is about 147,000 people and 90,000 jobs. If this incremental population and employment increase were to be spatially allocated in proportion to HST station boardings, the growth effect for the Antelope Valley with this design option would be on the order of

25,000 additional people and 15,000 jobs relative to the No-Project Alternative." (The Cambridge report also acknowledges in a footnote (p. 5-16) that some of the growth at Sylmar and Santa Clarita under the base HST Alternative may spill over into the Antelope Valley.)

Accordingly, it can be inferred from these passages that under the Palmdale Design Option, the Antelope Valley will experience increases in economic activity while the remainder of LA County, Southern California and the state will experience decreases.

3. THE DOCUMENTS DO NOT TAKE INTO ACCOUNT THE POTENTIAL ECONOMIC BENEFITS FROM INTRA-COUNTY TRIPS.

An exhaustive review of the Cambridge report and all its appendices reveals no consideration of intra-county effects related to HST trips. There are no variables or input data within the multitude of tables that refer only to inter-county HST trips.

The analysis does not appear to consider any HST inter-city trips between destinations within LA County or within other regions (e.g. San Jose to San Francisco). The analysis does not appear to consider commuter traffic between Antelope Valley and Burbank/Downtown LA even though the comparison of alignment options in Chapter 6 of the DEIR/S on page 6-49 mentions that an AV alignment would serve the population there and that trip time between Palmdale and LA would be 26 minutes.

One reference document located is entitled: *Traffic, Transit, Circulation and Parking Technical Evaluation, January, 2004.* (It can be found on the web site under Regional Studies/ Bakersfield to Los Angeles.) The document primarily addresses vehicle traffic and parking needs. The origin and destination tables that comprise this Appendix include no origin or destination passengers for intra-county trips. If no traffic or passengers were considered on these routes, it can be surmised that the potential for economic benefits resulting from such trips was similarly not considered.

4. THE DOCUMENTS FAIL TO CONSIDER THE ECONOMIC BENEFITS ARISING FROM THE POTENTIAL OF THE HST TO PROVIDE AN IMPETUS TO DEVELOP PALMDALE AIRPORT.

The needs of the region for additional airport capacity and the desire to speed development of Palmdale Airport are well documented. SCAG's final version of the Regional Transportation Plan calls for 13 million annual passengers at Palmdale Airport. The City of LA has promoted expansion of Palmdale Airport with a high speed travel connection for

years. Furthermore, there is growing evidence (including traffic analysis in the HST EIR) showing increased vehicle congestion on Highway 14. Development of existing airports is hampered by political and environmental concerns not evident at Palmdale. The emergence of viable air service at Palmdale Airport will have vast economic implications for the Antelope Valley and the region.

Despite this need, the DEIR/S does not acknowledge the potential effects of an HST connection between urbanized areas of LA County and Palmdale Airport. Despite several passing references made to inter-modal benefits, the analysis throughout the documents ignores Palmdale Airport because it does not now service air passengers. The DEIR/S (page 5-23) under Transportation states: "*The potential impacts of the induced growth, to the degree that they can be detected, would be most apparent around urban HST stations and airports, (*emphasis added*) where the additional traffic generated by induced growth is expected to be concentrated.*" Similarly, on page 5-24 the DEIR/S states: "*To the degree they are concentrated, (growth) impacts are likely to be focused on property surrounding freeway interchanges and airports (*emphasis added*).*" Furthermore, in Chapter 6 (p. 6-67), the evaluation matrix states: *"The Palmdale Transportation Center would potentially serve the Antelope Valley population. The station option maximizes opportunities for intermodal connectivity. It is close to Palmdale Airport, with the opportunity for convenient shuttle or people-mover service, and it is the Metrolink station for Palmdale and a hub for local bus service."* It could be surmised that any increases in economic activity in the Antelope Valley would stem from commuters between the housing rich Antelope Valley and the job rich Burbank and Downtown area, and from air travelers at the Palmdale Airport. However, no documents or references could be found to confirm that any such analysis was performed.

In section *4.2.1 Trip Generation by Airport*, (p. 73), the Burbank Airport station is forecast to add 665,807 HST trips due to air traffic. There are several other Figures and Tables referring to the Burbank Airport Station, but there is no corresponding mention of the Palmdale Airport in this section even though there is passing reference to it in other sections. Under General Description, (p.10), the document mentions that the proposed HST station in Palmdale is 2.3 miles from Palmdale Airport. However, the most telling aspect of this report is in *Appendix G: Intercity HST Ridership by Source*. The origin and destination tables that comprise this Appendix include no origin or destination passengers for the Palmdale Station to or from anywhere else in LA County.

The above comments indicate that the EIR does not consider the potential that the HST will serve air passengers or commuters between the Antelope Valley and either Burbank or Downtown LA. It also appears that the report ignores any impetus to the growth of

Palmdale Airport. If this is true, as it appears to be, then it follows that the economic analysis also does not analyze this potential.

The apparent failure of the Economic Analysis to mention intra-County HST travel seems to indicate that a significant potential for economic growth has been overlooked, and that the conclusions regarding a decrease in economic activity with the Palmdale Design Option could be reversed.

5. THE REPORT FAILS TO CONSIDER THE ECONOMIC BENEFITS ASSOCIATED WITH SMART GROWTH

The Smart Growth document (Freilich) incorporated by reference and introduced in earlier comments (see section 3. 7 Land Use) includes persuasive evidence related to the economic benefits of reducing sprawl and maintaining prime agricultural lands. These include better job creation, higher tax revenues and reduced infrastructure costs. The economic growth portion of the HST report confirms this aspect by drawing attention to the better utilization of land in its analytical methods. (Lower acreages of urbanized land are treated as a benefit.) The full implications of these benefits need to be considered and added into the calculations in this section.

CHAPTER 6: HIGH SPEED TRAIN ALIGNMENT OPTIONS COMPARISON

1. CONSTRUCABILITY AND COST REGARDING UTILIZING EXISTING FREIGHT RAILROAD CORRIDORS

The Document does not provide any explanation or discussion regarding how the HST facility might be constructed within existing UPRR and BNSF rights-of-way. There are no references to discussions with the railroads, nor to how those companies' operations would be protected. The "Statewide Property Impacts Technical Evaluation Memo" does not address this question. It is also relevant that (1) the assumed speeds throughout the Central Valley are not consistent with the existing freight railroad corridor geometry, and (2) that the capital cost estimates presume largely at-grade construction. It is not clear whether those costs include the extensive relocation of freight railroad facilities that would be required.

The following comments are focused upon the summary table for the Bakersfield to Los Angeles Region (Section 6.4), and the Bakersfield to Sylmar Alignment Options (Section 6.4.1).

2. THE SUMMARY TABLE IS SUPERFICIAL AND LACKS REFERENCES AND SOURCES TO SUPPORT THE COMPARISONS

The summary table used in Section 6.4 is very brief and masks problems associated with the methodologies used to derive impact conclusions in several key impact categories. No references and sources are provided to support the entries in the comparison tables

On page 6-48 under 'Ridership', it is difficult to understand how and why the increase in commuter ridership would exactly equal the decrease in intercity ridership (1.7 million each). The DEIR/S provides no description of the methods used to arrive at these figures, and no references to where such descriptions might be found.

The statement in the 'Constructability' row of the table on page 6-48, that this segment of the project "would be one of the most challenging sections in the HST system to construct," while true, does not provide the reader with any tangible information by which to evaluate the difficulty, risk, and cost of the various options. More detailed information must be provided in this section and throughout the EIR/S document.

On page 6-49, under "Travel Conditions," the Documents notes that "The I-5 alignment options would not *directly* serve the Antelope Valley." (Emphasis added.) This is a misstatement, as the I-5 alignment would provide *no* service to the Antelope Valley.

The data presented for Biological Resources on page 6-52 does not match the numbers identified for these same alignments in the Biological Resources Section 3.15 (page 3.15-25). In particular, the impact to 835,296 linear ft. of 'waters' (158 miles) attributed to the SR-58/Soledad Canyon Corridor on page 6-52 is absurd on its surface.

3. ON BALANCE THE ANTELOPE VALLEY ALIGNMENT IS ENVIRONMENTALLY SUPERIOR

The table presents the SR-58/Soledad Canyon Corridor (Antelope Valley) alignment in a relatively favorable light as compared with the I-5 alternatives. Environmental Impact categories which identify the Antelope Valley alignment as either *comparable or superior* to the I-5 alternatives include the following:

- Travel Conditions (connectivity/access to Antelope Valley)
- Noise and Vibration (overall segment comparisons)
- Farmlands (superior to I-5 alignments)
- Aesthetics and Visual Resources (overall comparable impacts/localized impacts with all alignments)
- Hydrology and Water Quality (floodplains/lakes/lower overall potential for water-related impacts)
- Biological Impacts (wetlands/sensitive vegetation)
- Section 4(f) and 6(f) Resources (superior to I-5 alignments)
- Growth Induced Impacts (low potential/comparable impacts with I-5)

The DEIR/S also identifies environmental impact categories which identify the Antelope Valley alignment as *inferior* to the I-5 alternatives include the following:

- Travel Conditions (travel time)
- Noise and Vibration (impacts in the Palmdale area)
- Land Use and Planning ("not compatible in Palmdale"/potential property impacts in Palmdale and Lancaster)

- Cultural and Paleontological Resources (known sites per mile/higher sensitivity for Antelope Valley)*
- Hydrology and Water Resources (streams)*
- Biological Resources (number of special status species impacted/'waters')*

However, additional support for these conclusions needs to be provided in this and other sections of the DEIR/S, particularly in light of the information provided in the foregoing comments concerning 1) the Smart Growth advantages of the Antelope Valley alignment, 2) the tunneling risks associated with the I-5/Grapevine alignment, and 3) identified methodological problems associated with various resource impact conclusions (e.g. Hydrology and Wetlands, Biological Resources, Cultural Resources, and Aesthetic and Visual Resources.

CHAPTER 7: UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

This brief section appears to have been prepared to reconcile the DEIR/S document format and content with a number of the required contents of EIRs and EISs, pursuant to CEQA and NEPA, respectively. The first paragraph on page 7-1 notes the chapter has been prepared to "...describe any significant irreversible or irretrievable commitments of resources or foreclosures of future options that would result from the proposed HST system or the alternatives"—an apparent reference to requirements in CEQA that these issues be specifically discussed in EIRs where a plan is being adopted by a public agency, or a project where an EIS is also being prepared pursuant to NEPA (CEQA Guidelines §§ 15126, subd. (c), 15126.2, subd. (c),15127). This requirement should be cited and separately discussed under a separate subheading in this chapter of the DEIR/S.

SECTION 7.1 - UNAVOIDABLE POTENTIALLY SIGNIFICANT IMPACTS

1. RELIANCE ON GENERAL STATEMENTS OF IMPACTS WEAKEN THE DEIR/S

Biological Resources and Wetlands, Agricultural Land, Section 4(f) and 6(f) Resources, Cultural and Paleontological Resources, and Visual Resources (7.1.2)

On page 7-2, the statement is made that "Only general statements of potential impacts can be made at this program level of review because field studies were not conducted and the buffer area used for the analysis was many times larger that the actual right-of-way for the alternatives under consideration in most instances." This statement goes to the heart of the deficiencies of the DEIR/S, as revealed in our prior comments on each of the resource sections of the DEIR/S. The lack of any field verification of alignment information, the use of highly variable and overly broad potential zones of impact, and implied recognition that impacts may therefore be overstated for particular alignments renders the document suspect, even at the program-level of review.

2. UNAVOIDABLE CONSTRUCTION IMPACTS ARE NOT ADEQUATELY DESCRIBED FOR HST ALIGNMENT ALTERNATIVES

Construction Impacts (7.1.3)

As noted in previous comments, an adequate analysis of construction impacts by topic (i.e. air quality, geology/soils, traffic and circulation, noise) is lacking in the document. Here, the unavoidable construction impacts of the project and alternatives are only briefly mentioned, again with the caveat that more detail will be provided during project-level analysis. More information on the nature, location and duration of these unavoidable impacts, by impact

category for each alternative and alternative HST alignment, can and should be provided in the program EIR/S.

3. DISCUSSION OF CEQA THRESHOLDS OF SIGNIFICANCE NEEDS TO BE DIRECTLY LINKED TO IMPACT ANALYSIS SECTIONS OF THE DEIR/S

California Environmental Quality Act Significance

The introduction to this section on page 7-3 discusses different uses of the term 'significant' under CEQA and NEPA, and attempts to provide a justification for discussing CEQA significance criteria (i.e. thresholds of significance) separately in this section. There is no valid justification for detaching the identification of impact thresholds from the sections of the DEIR/S where the analysis of impacts occurs. The determination of significance based on clear thresholds is an underpinning of CEQA that is circumvented by this approach.

CEQA Significance Thresholds (7.3.1)

On page 7-4 under further discussion of thresholds, the DEIR/S indicates "In the current analysis, the CEQA checklist thresholds have been used to evaluate the significance of effects of the HST Alternative." Our review of this chapter and each of the impact sections of the DEIR/S indicates that this is clearly not the case.

4. STATEMENTS WEAKEN THE ABILITY TO USE THE DEIR/S TO MAKE HST ALIGNMENT DECISIONS

Significant Unavoidable Adverse Effects (7.3.2)

This section includes statements that undercut the adequacy and use of the current DEIR/S, The section needs to be rewritten, and the deficiencies noted in response need to be remedied.

> "The planning level of environmental review presented in this Program EIR/EIS does not seek to quantify impacts as would typically be done at a project level. Instead, this Program EIR/EIS evaluates the potential for significant effects for each alternative based on the density or resources and/or sensitive receptors within the project vicinity and ranks the potential for impact as high, medium or low. This is an appropriate assessment of potential impacts at this stage of such a large, statewide undertaking." (page 7-4)

The program or planning level of review does not relieve the EIR/S preparer from the need to quantify data and impacts to support conclusions. Our previous comments have highlighted how methods which rely upon regional assessments of densities of resources

with data gaps, and broad-band Areas of Potential Effects without field verification or survey, can mislead or distort the comparison of alignment impacts.

> "Based on this planning level of analysis, potentially significant unavoidable impacts are only identified generally." (page 7-4)

Pursuant to CEQA, all such impacts should be clearly identified in the EIR, even if they can only be generally described.

> "Depending on the alignment options that may ultimately be selected, potentially significant unavoidable effects can be expected at some locations within the proposed HST system in the general environmental categories of agricultural lands, biological resources and wetlands, hydrology and water resources, and cultural resources. However, neither the extent of such potential impacts, nor the potential locations for such impacts, can be determined at this level of analysis." (page 7-4)

There is no practicable reason why the general location and extent of such impacts (i.e. other than 'high', 'medium' or 'low') for alignment options cannot be determined within this Program DEIR/S. Aerial photo sets of 1"=200" scale Plan and Profile sheets for alignment options are available and have been used in preliminary alignment studies by the Authority's consultants.

> "For several of the environmental categories listed in the table below (including agricultural lands, wetlands, hydrology, and cultural resources), the quantities presented represent areas within which potential impacts might occur by including all the potentially affected resources or acreage in the study area for the resource topic listed." (pages 7-4, 7-5)

By including all of the acreage or resources within these broad study areas, this method of evaluation exceeds even a reasonable 'worst case' impact scenario for alignment impacts, and can distort the alignment comparisons.

CEQA Environmentally Superior Alternative (7.3.3)

This section fails to identify an environmentally superior alternative from among the HST alignment options. Provided that additional documentation and support for this conclusion can be provided in Chapter 3, such as the Tunneling Study and the Smart Growth Study, the Final Program EIR/S should make this determination.

CHAPTER 8: PUBLIC AND AGENCY INVOLVEMENT

1. LACK OF PUBLIC MEETINGS IN ANTELOPE VALLEY

The apparent lack of any public meetings in the Antelope Valley during this entire California High Speed Train environmental process is a notable omission.

2. INTERAGENCY INPUT TO ENVIRONMENTAL PROCESS IS NOT ADEQUATELY DISCUSSED IN SCOPING SUMMARY OR SCOPING REPORT

Neither this section nor the Final Statewide Scoping Report (12/14/01) evidence the substantive interagency input to the environmental review process that is referenced on page 8-5. In particular, there is no summary provided of the interagency input derived from the 27 interested federal and state agencies that participated in the nine consultation meetings and six federal cooperating agencies meetings identified in the Section 8.2.2.

The Final Scoping Report was not made available with NOP/NOI in the DEIR/S Appendices, as it should have been for wider public review, and was only obtained by the City of Palmdale during the DEIR/S public review period after a specific request and trip to the Authority's Sacramento offices. The copy of the Final Scoping Report thus obtained is missing several Appendices, including Appendix C-Scoping Meetings Announcement, Regional Mailing Lists within Appendix D, Regional Attendance Lists within Appendix F, Appendix I-Written Public Scoping Period Comments, and Appendix K-Record of Verbal Comments.

CHAPTER 9: ORGANIZATION, AGENCY AND BUSINESS OUTREACH

The outreach listing is noticeably lacking in organizations and agencies from the Antelope Valley. Only one contact (Antelope Valley Board of Trade) is identified from among approximately 300 contacts listed statewide in this section.

CHAPTER 11: DRAFT PROGRAM EIR/EIS DISTRIBUTION

On page 11-1 the statement is made that "the entire Draft Program EIR/EIS, Appendices, and supporting reports are available on the Internet at the Authority's web site". Many of the supporting reports listed in Section 12 of the DEIR/S were not initially available following release of the DEIR/S in February 2004, either on the web site, on CD, or in hard copy. The City of Palmdale was able to obtain most of these key source documents, including key regional technical reports, only after a specific written Public Records Act request was made to the Authority. Even so, at least one document (The System Alternatives Definition Report, cited on page 4-A-4 of Appendix 4-A) was not available for reviewers.

CHAPTER 12: SOURCES USED IN DOCUMENT PREPARATION

'Sources' listed in this section include statewide and regional technical studies that were not initially available at the outset of the DEIR/S public review period. These should have been listed and included as Appendices to the DEIR/S. The efforts of the City of Palmdale to obtain an accurate and complete set of documents relied upon by the Authority in the drafting of the DEIR/S are detailed in a separate comment letter from counsel to the City of Palmdale.

A Comparative Analysis of Tunnel Construction Times, Costs, and Risks Associated with the Choice of High-Speed Rail Alignment Between Los Angeles and Bakersfield

Summary Report

Prepared for the

City of Palmdale, California

Prepared by

TRANSMETRICS Inc.
Campbell, California

GEODATA S.p.A.
Turin, ITALY

and

HLB Decision Economics, Inc.
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Summary Report

California High-Speed Rail Project – Background and Context

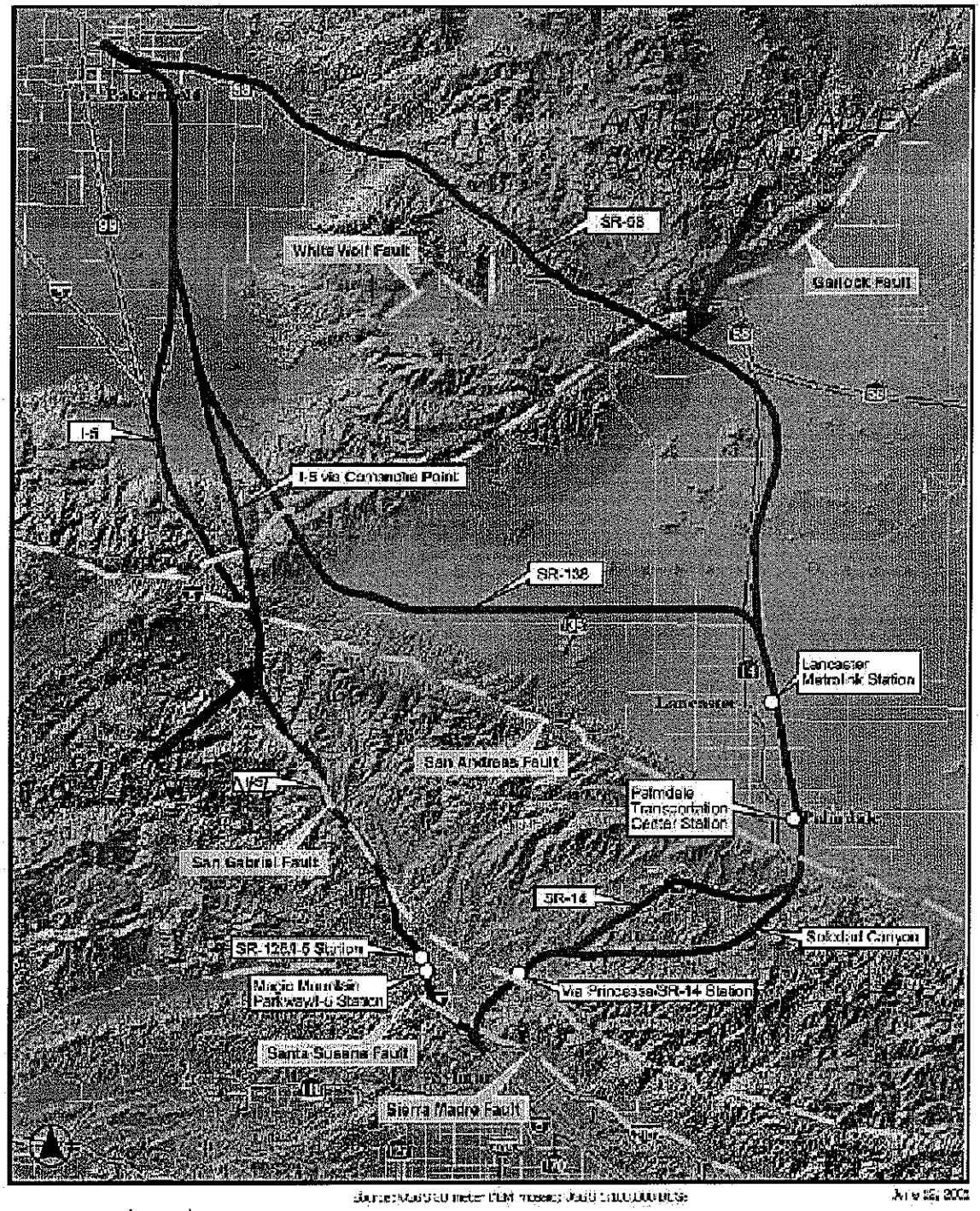
The California High-Speed Rail Authority (the "Authority") has been authorized by the state of California to pursue development of a high-speed rail system to connect the cities of San Diego, Los Angeles, San Francisco, and Sacramento. The proposed HSR system would be similar to those currently in place in Germany, France, Italy, Spain, and Japan.

In order to connect southern and northern California, the HSR system must pass the Tehachapi Mountain Range north of Los Angeles, an area of steep terrain and complex geology that is crossed by several active earthquake faults. The choice of route alignment through this region is a complex task, and must take into account, among other things, length, grade (steepness), ground conditions, ventilation, surface access, and the aforementioned earthquake faults. Any route would require extensive use of tunnels, structures, and major sections of cut and fill.

Over the past several years, the Authority and its predecessor agency (California High-Speed Rail Commission) have considered two principal corridors for crossing the Tehachapi Mountains between Sylmar (north of downtown Los Angeles) and Bakersfield – an alignment generally following I-5 freeway over the Grapevine ("I-5 alignment"), and one through the Antelope Valley ("Antelope Valley alignment"), generally following (going north from Union Station) I-5, SR-14, and SR-58. The two alignments differ principally in terms of length, accessibility, and construction complexity and risk (see Figure 1, below).

To date, the Authority has not formally adopted a preferred alignment. However, several Authority members and staff – including the Authority Chair and the Executive Director – have frequently expressed support for the I-5 alignment in both open public forums and in written communications. The stated reasoning for this position is principally tied to their perception that the shorter I-5 alignment, with a 6-9 minute travel time advantage, would significantly increase ridership in what they consider to be their key market – that between San Francisco and Los Angeles.

Figure 1


SR-58
White Wolf Fault
Garlock Fault
I-5
I-5 via Comanche Point
SR-138
Lancaster Metrolink Station
Lancaster
San Andreas Fault
Palmdale Transportation Center Station
Palmdale
San Gabriel Fault
SR-14
Soledad Canyon
SR-126/I-5 Station
Magic Mountain Parkway/I-5 Station
Via Princessa/SR-14 Station
Santa Susana Fault
Sierra Madre Fault
Legend
Alignments to be Evaluated
Station Locations to be Evaluated
Fault

It is the collective view of local governments and stakeholder groups in the Los Angeles Basin that this stated bias for the I-5 alignment by key Authority members and staff ignores numerous important considerations.[1] One of these is the fact that the Antelope Valley alignment would provide high-speed rail service to at least 440,000 additional residents and 165,000 employees today (the entire length of the I-5 alignment between Sylmar and Bakersfield is virtually unpopulated), thereby generating significant additional ridership and associated economic benefits to the region and the state. Even more critically, the Antelope Valley alignment would significantly reduce the need for construction of costly, high-risk tunnels and structures, and thereby improve the financial feasibility of the project and help garner essential public support.

Purpose and Scope of this Study

The City of Palmdale, in expression of the concerns raised by numerous government agencies and private stakeholders, commissioned this study to (1) investigate tunneling-related risks and their potential effect on high-speed rail project cost and schedule; and (2) identify the best route alignment through the Tehachapi Mountains with respect to minimizing capital cost, risk of construction cost overrun, and project delay. Specific study tasks were:

1. Define risk assessment model and establish primary output measures:
   - Number, length, size, and location of tunnels, and related surface structures;
   - General rock mass type and quality;
   - Proximity to favorable or adverse geotechnical conditions, including faults and fault zones, water-saturated zones, and surface instabilities; and
   - Location/impact of surface facilities and structure (e.g., portals, ventilation facilities).
2. Analyze geologic and project engineering data.
3. Estimate costs and risk assessment values.
4. Prepare a general discussion of tunneling risks and risk minimization strategies.
5. Prepare a technical report.

Alternatives Considered

Consistent with alternatives development and analysis conducted by the Authority, the analysis conducted in this study considered four alignment alternatives in total, defined by location and maximum permitted grade, as shown in the following figure.

[1] Local governments expressing support on the record for the Antelope Valley alignment include Los Angeles County Board of Supervisors, Kern County Board of Supervisors, Los Angeles City Council, Mayor of Los Angeles, Los Angeles World Airports, and the Southern California Association of Governments (SCAG).

Alternatives Considered

I-5/Grapevine – 2.5% maximum grade	Antelope Valley – 2.5% maximum grade
I-5/Grapevine – 3.5% maximum grade	Antelope Valley – 3.5% maximum grade

The maximum grades were defined by currently available and potentially available technology (2.5% and 3.5%, respectively). Also, while the Antelope Valley alignment actually consists of two independent tunneling sections separated by the Antelope Valley itself, the two sections were analyzed as though they were joined consecutively in order to simplify the presentation of results.

Assessment of Previous Analysis and Approach to Risk Minimization

California High-Speed Rail Project planning and feasibility studies, environmental impact assessment, and selection of the system's route alignment are currently at the stage of final screening evaluation of alignment options. While there has been considerable investigation of ridership and potential environmental impact, to date, detailed technical consideration of the costs and risks associated with the two alignment alternatives between Los Angeles and Bakersfield has been limited to two activities:

- In late 2001, the Authority engaged the developer of a newly-designed, automated alignment optimization system ("QUANTM") to refine and optimize, on a very fast-track basis, previous alignment studies that employed standard "best practices" methods for conceptual engineering, using only readily available geologic information from secondary sources. The results of that analysis were released in April 2002.
- Also in late 2001, the Authority convened a two-day workshop of mostly American tunneling contractors and engineers to discuss tunneling issues associated with the California High-speed Rail Project. While the Authority has expressed satisfaction with the usefulness of this exercise, documentation of the workshop to date has been limited to a brief summary.

Recent Authority screening evaluations for alignment alternatives have focused on minimizing potential environmental impacts, while the QUANTM study and workshop attempted to minimize tunneling length and computed capital costs. In general, the Authority has chosen to avoid known fault and shear zones and water-saturated zones wherever possible by deviating horizontally or by shifting the alignment from underground to surface. However, this might not be an optimum choice, as tunnels can actually be more resistant to seismic events than surface structures, as demonstrated in the Kobe, Japan, and Loma Prieta, California earthquake events.

There are, however, other important tunneling risks and potential costs that have not been explicitly addressed in previous Authority studies and analyses including, but not limited to:

- Risk of encountering unknown adverse ground and groundwater conditions, leading to significant cost overruns and project delay;

- Construction risks, including design errors (such as selecting the wrong type of tunnel boring machine[2]), other human error, rock squeezing behavior, face collapses, water intrusion, and production of materials causing hazardous environmental conditions;
- Costs associated with use of high embankments and deep trenches (instead of tunnels) including trench support, embankment-slope protection, and maintenance.
- Financial risks to the owner, such as delay in contract completion, cost overruns, or lower than projected rates of capital return;
- Contractual risks, such as additional work not covered, time delays, disputes, claims and litigation; and
- Operation risks, including time and cost involved in rehabilitating an earthquake-damaged surface structures versus tunnel sections, including loss of revenue while service is suspended.

Critically, the approach followed in this study to comprehensive cost and risk analysis included:

1. Estimation of most likely values and possible variation of construction time and cost as a function of expected geologic conditions and associated uncertainties; and
2. Estimation of impact of construction duration on economic and financial issues.

The comparison of alignments was further detailed by utilizing a multi-criteria analysis process, taking into account the following key factors:

- Total construction cost and risk of cost overruns;
- Construction duration and the risk of delays;
- Performance of alignment alternative in dealing with risks during operation;
- Environmental impact; and
- Capital investment and the related financial risks.

Engineering Assumptions, Analysis, and Findings

Conceptual Design and Construction Schemes

The I-5 and Antelope Valley alignments differ principally in relation to (1) length, (2) accessibility, and (3) construction complexity and risk. In order to perform the proposed alignment-specific risk analyses, it was necessary to prepare a conceptual design and construction scheme for each alignment alternative, making relevant assumptions for those aspects not yet defined in previous studies.

The position of each single tunnel was fixed using orthophotos and adjusted to conform to maximum permitted grades (2.5% and 3.5%). The main tunnels were assumed to be twin bores, with each bore housing a single rail track. For long tunnels whose lengths

[2] Each tunnel boring machine (TBM) is unique, individually designed to accommodate expected conditions at a tunnel site. These complex and expensive machines take up to 12 months to build and deliver to a job site; a major error in specification can delay a project by a year or more and cost tens of millions of dollars.

were greater than 6 miles, a third ("service") tunnel for ventilation, evacuation and construction access was assumed, which would be located between the two main tunnel bores.

The construction scheme for each tunnel was defined according to recent industry practice and experience. Each maximum grade option was studied independently, with the intent of reducing construction risk without neglecting technical feasibility. However, the use of double-shield tunnel boring machines (TBMs) was assumed for all major tunnel sections. For short tunnels, conventional excavation was assumed in those situations where its application would significantly reduce overall construction duration.

Where a tunnel would cross a major potential earthquake inducing fault zone (e.g., the San Andreas Fault and the Garlock Fault), an at-grade is preferred wherever the allowable maximum grade permits in order to limit construction costs and reduce risks. Alternatively, construction of a large chamber would allow for restoration of the rail tracks in case of a major lateral shift at the fault location. For this analysis, the seismic chamber design conceived by the Authority was analyzed.[3]

Description Of DAT (Decision Aids In Tunneling) Model

The Decision Aids in Tunneling modeling system ("DAT") was used to define and assess the potential risks and costs of the two alignment alternatives.[4] DAT, and the associated computer code SIMSUPER, have been developed over a period of 20 years by MIT (Massachusetts Institute of Technology) and EPFL (École Polytéchnique Fédérale de Lausanne), with the participation of the US National Science Foundation, the Swiss Federal Office for Transportation, the Swiss Science Foundation, and Geodata SpA (the tunneling consultant for this study).

DAT consists of two interrelated simulation modules, Geology and Construction. In the Geology module, the geotechnical conditions are organized in an approach similar to that of defining a geotechnical profile. The user's task is to identify and define parameters and their possible states. The Construction module consists of two principal components: (1) construction methods, and (2) tunnel network, which defines the sequence of construction activities.

[3] To date, Authority studies have considered seismic chambers oriented only in the direction of the potential lateral movement predicted based on the past movement records of the fault concerned. However, recent scientific discoveries have revealed that "faults go backwards." Reported first in the September 2002 issue of "Science" and then in the November 2002 issue of "Geoscientist" the magazine of the Geological Society of London, this suggests there is a risk that the seismic chamber solution may not serve its intended purpose.

[4] DAT is a tool for making probabilistic estimates of the time and cost of constructing a tunnel, or network of tunnels, taking into account the uncertainties in the geologic and construction variables. The DAT model allows simulation of several random processes simultaneously. Given that it is not possible to find analytically determinate results for processes involved in the construction of tunnels, simulating a construction process is the only solution to obtain statistical information about the total time and cost. This information gives a good idea on the average, minimum, and maximum expected values.

DAT Model Input Data

Geological profiles and essential geo-mechanical parameters were defined based on US Geological Survey (USGS) maps of the corridor areas. A range of "geo-events" that could cause delays and extra costs were considered as well, particularly where a tunnel would be excavated by a TBM. The events considered were:

- Unstable conditions;
- Problematic water inflows;
- Presence of gas; and
- Unusual rock abrasiveness.

Construction-related information used average rates of advance (progress per day) and costs per linear foot of tunnel for each construction method employed (e.g., TBM, conventional drill and blast). The rates of advance for excavation by TBMs were based on the Colorado School of Mines Model (Clark, 1987 and Howart, 1987). Rates of advance and costs per foot for other excavation techniques were based on other recent tunnel projects. Cost values included overhead and profit rates. All conditions that could negatively affect the tunnel construction were quantified in terms of their economic impact. Financial costs (e.g., interest, carrying costs) were not included.

A maximum number of simultaneous working sites was not fixed, nor were limitations in the TBM fabrication market considered. It was assumed that delivery times would run to approximately 12 months for 9.5 meter TBMs, and 8 months for 5.0 meter TBMs.

DAT Model Analysis and Results

Prior to running the DAT model simulations, several pre-modeling activities were undertaken:

- A deterministic (manual) estimate of minimum, total construction cost and duration was made for each alignment-and-maximum grade option. These served as a guide for checking the output of the DAT model.
- A limited number of DAT model simulations were compared with the manual estimates, in order to calibrate the DAT process.
- The sensitivity of the DAT model simulations to the number of simulation iterations was tested. It was observed that there was practically no further benefit to increasing the number of simulation iterations to more than 1000. As a result, the number of simulation iterations was fixed at 1000.

Following completion of the DAT model analysis, a number of general relationships were observed. First, considering the variation in the total construction costs amongst the options considered, it was observed that, for both the I-5 and Antelope Valley alternatives, there is a clear relationship between the increase in average cost and the total length of tunneling, as would normally be expected.

Second, both of the grade options (2.5% and 3.5%) of the I-5 alignment show higher potential variation (uncertainty) than those of the corresponding Antelope Valley

alignment, which can be attributed to the anticipated, more adverse, geologic conditions along the I-5 alignment.

Third, the extended tunneling length for the 2.5% maximum grade Antelope Valley alignment implies an increase in the variation of results, which is consistent with an increase in uncertainty associated with a longer tunnel stretch. For the I-5 alignment, the opposite trend resulted, as the actual tunnels configurations do not differ significantly between the 2.5% and 3.5% maximum grade options.

Fourth and last, there was a reduced average total construction time for the 2.5% maximum grade configurations, despite approximately 1.5 miles of more tunneling than the 3.5% configuration, due to the different construction scheme adopted.

In addition, a number of specific results were observed:

1. With respect to mean (average) construction cost, the 3.5% maximum grade option of the Antelope Valley alignment is about 40% less expensive than that of the corresponding I-5 alignment, and about 15% less expensive in the case of the 2.5% maximum grade option. The differences vary between the two grade options due to the total length of tunneling involved with the flatter (2.5%) option. Despite the smaller difference between I-5 and Antelope Valley at the 2.5% grade, it should be noted that the longer tunnel length at the 2.5% maximum grade means savings in costs for construction of the external (surface) works and associated mitigation of environmental impacts.
2. The cost and time (delay) variations for the Antelope Valley alignment are more constrained than those of the I-5 alignment (at both 3.5% and 2.5% grades), implying that uncertainty associated with I-5 alignment is much higher than with the Antelope Valley alignment.
3. For both grade options, the Antelope Valley alignment has an extremely "slim" variation in potential cost, with quite small differences between the projected 95% maximum value and minimum value ($76 million for the 3.5% maximum grade option and $137 million for the 2.5% maximum grade option). The results are much more uncertain for the I-5 alignment, with very large differences between the 95% and minimum values ($500 million and $400 million for the 3.5% and 2.5% maximum grade options, respectively.)
4. Analysis of the 2.5% maximum grade option for the Antelope Valley alignment produced a consistently lower range of variation in the total construction time (a difference of 990 working days between the 95% value and the minimum value) than did the I-5 alignment alternative at the same grade (1608 days). The Antelope Valley 3.5% maximum grade option yielded an even lower range of variation (288 working days) as compared with 1430 days for the equivalent I-5 option. These differences between the Antelope Valley and the I-5 alignments derive from the differences in the total length of tunneling and the number of short tunnels involved. (Shorter and shallower tunnels are generally associated with fewer geological difficulties and thus present a lower degree of uncertainty.)
5. Mean construction time required for the I-5 3.5% maximum grade option was almost twice as much as that required for the Antelope Valley alignment at the same grade

(2,218 working days versus 1,125 working days, respectively). The same relationship also resulted for the 2.5% maximum grade options, though with a slight increase in the mean construction time for the Antelope Valley alignment due to increased total length of tunneling.

Economics Analysis and Findings

Overview

An economic risk analysis of the two alignment alternatives and two maximum grade options was conducted, based on the results of the technical analysis reported in the preceding section. This analysis consisted of a review of the technical literature on high-speed rail cost estimating methods, analysis of key economic and financial risk factors, a separate computer simulation of various cost and schedule risk scenarios, and a combined economic benefit/cost assessment of the project.

Literature Review

The review of existing literature on high-speed rail cost methods found that estimates from other countries or corridors within the United States are only of limited usefulness in predicting costs for the California project. Published cost estimates for high-speed transit systems range from as little as $10 million per mile to more than $100 million per mile. Several factors affect high-speed project costs, including local conditions, the local economy, and differences in assumed technologies – e.g., conventional rail vs. Maglev technology. Thus, in the case of high-speed rail projects, it is unusually important to use local, project-specific data when estimating costs and predicting risks.

Risk Analysis

Four risk factors were considered in the economic analysis:

- Tunneling and geological risk (derived from the technical analysis);
- Cost escalation risk (increases resulting from unforeseen schedule slippage);
- Financial costs of delay (not considered in the technical analysis); and
- Methodological uncertainty.

Computer simulation results for construction cost are shown below for the Tehachapi Crossing segment (Table 1) and total high-speed rail project (Table 2).

The total project cost in Table 2 includes construction and contingency, plus vehicle acquisition, stations, support facilities, and program implementation.

Risk analysis simulation results for project completion time for the Tehachapi Crossing segment are shown in Table 3, below, in terms of total workdays and years to complete.

Economic Benefit/Cost Analysis

In addition to considerations of cost, it is noteworthy that the California High-Speed Rail Act of 1996 calls for completion of a high-speed rail network that will generate jobs and

Table 1

Construction Cost Risk Analysis – Tehachapi Crossing Segment

($2003 in Millions)

Alignment / Maximum Grade	Mean Expected Outcome	80% Confidence Interval	
		Lower Bound	Upper Bound
With 3.5% Maximum Grade			
I-5	$2,594	$2,315	$2,887
Antelope Valley	$2,342	$2,106	$2,597
Difference (I-5 less Antelope Valley)	***$252***	***$209***	***$289***
With 2.5% Maximum Grade			
I-5	$2,969	$2,621	$3,331
Antelope Valley	$3,001	$2,724	$3,287
Difference (I-5 less Antelope Valley)	***-$31***	***-$102***	***$44***

Table 2

Construction Cost Risk Analysis – Entire High-Speed Rail Project

($2003 in Millions)

Alignment / Maximum Grade	Mean Expected Outcome	80% Confidence Interval	
		Lower Bound	Upper Bound
With 3.5% Maximum Grade			
I-5	$27,808	$24,691	$31,210
Antelope Valley	$26,830	$24,116	$29,598
Difference (I-5 less Antelope Valley)	***$977***	***$575***	***$1,612***
With 2.5% Maximum Grade			
I-5	$27,966	$25,086	$31,153
Antelope Valley	$27,610	$24,945	$30,393
Difference (I-5 less Antelope Valley)	***$356***	***$141***	***$760***

Table 3

Completion Schedule Risk Analysis – Tehachapi Crossing Segment
(Workdays / Years to Complete)

Alignment / Maximum Grade	Mean Expected Outcome	80% Confidence Interval	
		Lower Bound	Upper Bound
With 3.5% Maximum Grades			
I-5	2,250 (7.5)	1,731 (5.8)	2,814 (9.4)
Antelope Valley	1,111 (3.7)	1,023 (3.4)	1,207 (4)
Difference (I-5 less Antelope Valley)	**1,138 (3.8)**	**708 (2.4)**	**1,606 (5.4)**
With 2.5% Maximum Grades			
I-5	2,157 (7.2)	1,694 (5.6)	2,662 (8.9)
Antelope Valley	1,460 (4.9)	1,175 (3.9)	1,789 (6)
Difference (I-5 less Antelope Valley)	**697 (2.3)**	**519 (1.7)**	**873 (2.9)**

economic growth. An economic benefit/cost analysis was conducted to determine which alignment would offer the best prospects for maximizing ridership and revenue, transportation and economic integration, and economic viability.

Ridership and Revenue. Assessing the trade-off between length and accessibility to users (number and location of stations) is key to selecting an alignment that will maximize ridership and fare revenue. The analysis indicates that the additional ridership generated by the greater access to residents and employers under the Antelope Valley option will more than offset the potential ridership advantage of a modestly shorter (6-9 minutes) end-to-end journey time using along the I-5 alignment. Total cumulative life-cycle ridership (33 years) under the Antelope Valley alternative would exceed that under the I-5 option by over 3 percent.

Economic Integration. This is the extent to which a new transportation investment will connect with, complement, and support other transportation modes and the businesses they serve, thereby maximizing the multiplicative economic benefits of these resources. Trackage through the Antelope Valley will provide two kinds of modal connectivity, namely an inter-modal connection for air travelers using the Palmdale Regional Airport, and a modal choice for long-distance auto users in the Antelope Valley growth corridor.

Due principally to the added accessibility afforded by the Antelope Valley over the I-5 option, the former is stronger in relation to intermodal connectivity and industrial agglomeration, which creates wealth and improved living standards at a regional scale. The estimated value of agglomeration economies associated with the Antelope Valley alignment is $540 to $818 million over the initial 33-year project life cycle.

Economic Viability (Benefit/Cost). The Antelope Valley option offers a greater promise of economic benefits that exceed the costs of achieving them. The benefits of the high-speed rail project would occur in the form of travel time savings and vehicle operating

cost savings for both rail passengers and other travelers; reduced accident-related costs; and diminished emissions of air pollutants and greenhouse gases. Over the first 33 years of operation, a high-speed rail system employing the Antelope Valley alignment would generate approximately $900 million in net benefits above that expected under the I-5 alternative.

Total Economic Impact. One of the factors supporting the Antelope Valley alignment is the potential for high-speed rail to generate significant long-term economic development impacts. The Antelope Valley is a natural location to accommodate future population and housing growth in California, and the high-speed rail system through the Antelope Valley would provide quick access to major cities both north and south of the valley.

The total economic impact associated with the Antelope Valley alignment over a period of thirty years could reach $3.1 billion, with an expected 38,000 additional jobs and over $2 billion in earnings. The investment would result in attracting about 17,000 new households to the Antelope Valley region, rather than to other locations in already crowded southern California areas.

Conclusions and Recommendations

To facilitate the comparison of the geological and construction risks involved in the two alternative alignments (I-5 and Antelope Valley) and overcome the problem of limited field data, a probabilistic model was adopted that incorporates the impact of different geological factors on the risks and productivity. The specific model employed was developed at the Massachusetts Institute of Technology and is called Decision Aids in Tunneling (DAT). The model allows for the comparison, in terms of construction time and cost, of various, feasible, design and construction solutions for a tunneling project, and for quantification of risks related to each solution. Through the use of this model, the analysis conducted during the study demonstrates the following:

- Although the total lengths of tunneling involved in the I-5 and the Antelope Valley alignments are similar, the ground conditions along the Antelope Valley are relatively more favorable and thus would involve less construction, financial, and contractual risk.
- For the 3.5% maximum grade option, the mean (average) construction time required for the I-5 alignment is almost twice that required for the Antelope Valley alignment. The same result applies for the 2.5% maximum grade option, with a slight increase in the mean construction time for the Antelope Valley alignment due to a somewhat greater total length of tunneling.
- Further, the Antelope Valley alignment is about 40% less expensive than the I-5 alignment under 3.5% maximum grade option, and 15% less expensive under the 2.5% maximum grade option, again due to increased total length of the tunneling. However, the increased tunnel length for the Antelope Valley alignment under 2.5% maximum grade would also reduce costs for corresponding external construction and environmental impact.

In general, the findings of this study confirm the concerns expressed by the City of Palmdale and other southern California stakeholders over the relative risks involved in

the two alternative alignments. These findings should permit the Authority to make a more informed decision regarding the choice of alignment, including the process to be followed in making that decision.

Further, it should be noted that the DAT model analysis did not simulate the financial consequences associated with increased construction duration. If the financial impact due to longer construction duration is taken into consideration, the final results significantly magnify the construction cost advantage of the Antelope Valley alignment.

On the basis of the analysis conducted, the following recommendations are offered:

1. Employ all Feasible Means to Reduce Uncertainties. Reducing uncertainties through site investigations, especially the preliminary investigation, for mechanized tunneling, is a key investment strategy for project sponsors. Site investigations designed to reduce geological uncertainties and thus confirm relative geological and construction risks should be conducted before a final choice of alignment is made.

2. Employ New, Innovative Technologies. Significant payoff can be realized through the use of technological innovation and risk management in complex underground projects with difficult and unexplored geology and employing relatively untested design concepts. For example, the technical feasibility and cost of constructing large seismic chambers in very wide fault zones is as yet unknown. Innovation means that the new concepts are competently developed, consistent with the limits of current knowledge and experience, and carefully matched to the specific conditions of the project.

3. Employ Best Contracting Practices. It is now almost universally accepted that project sponsors "own the ground" – that is, are responsible for the effects of the difficult geologic conditions which will be encountered. Sophisticated sponsors recognize this and seek ways to equitably share and allocate risk to the best entity that can foresee or control any particular risk. It is now accepted by many project developers that the contracting practice of accepting a fixed-cost low bid from a group of "qualified" contractors should not be adopted when the jobs are large, the geology uncertain, and potential for extremely high cost overruns escalate. Negotiated contracts with fair allocation of risks among the parties involved could be more cost effective and equitable.

4. Employ Risk Management Throughout Project Development and Implementation. Traditionally, potential risks associated with large tunneling projects have been managed indirectly through engineering decisions made during project development. However, many recent case histories have demonstrated this approach to be inadequate once construction has begun. Active risk management throughout the project can ensure that most potential problems are identified and addressed in a timely fashion so that appropriate and cost effective risk reduction measures can be implemented. The use of risk management in the early stages of a tunnel project is essential, particularly at the beginning of the planning process where major decisions, such as choice of alignment and selection of construction methods, can be influenced.

Technical Study Team

The study Team was a joint effort of Transmetrics Inc., a civil engineering firm based in Campbell, California, and Geodata S.p.A. of Turin, Italy. Both firms have previously teamed together for work on projects of similar nature. Geodata is a geo-engineering company with particular expertise in the design of underground structures in complex and difficult ground conditions. Since its beginning in 1984, Geodata's activities have involved one or more of the various technical phases (lab and in-situ characterization, feasibility study, preliminary design, final design, performance monitoring, design optimization during construction, resident engineering, independent design checks) for over1500 km of tunnels (for transportation, water supply, and sewage disposal).

Since 1990, Geodata has teamed with Professor H. E. Einstein of MIT in applying DAT to identify the optimum tunnel alignment relative to geologic and construction risks in various projects around the world. The more recent (1999-2002) applications of DAT involved the following projects:

1. Guardarrama High Speed Rail Tunnel in Spain. Geodata made an independent assessment of the basic design and the associated risks for the Minister of Public Works.
2. PAJARAS High Speed Rail Tunnel in Spain. Geodata made an independent design check and risk analysis. The design was prepared by the joint venture, INECO S.A. and Geoconsult Ingeneieros Consultores S.A.
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The team of experts contributing to this study includes:

- Dr. Shulin Xu (Ph.D. in Engineering Geology from Imperial College, London, England) has performed DAT applications for Geodata since 1990. Dr. Xu is Geodata's Technical Director and is the coordinator of this study.
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Economic Study Team

HLB Decision Economics, Inc. offers services in the areas of transportation economics and policy, and risk analysis consulting to government and industry throughout North America. Their staff of professional economists, transportation planners, engineers, and statisticians brings a practical approach to each assignment, supported by up-to-date analytical techniques.

HLB has conducted numerous feasibility and risk analysis studies, including multiple studies for the Federal Railroad Administration to assess rail project feasibility in over ten states nationwide, as well as major investment studies for large capital projects such as airport improvements and new toll highways.

This project was managed by Dr. Khalid Bekka, an applied economist with skills in transportation research, quantitative analysis, and regulation. Dr. Bekka holds Ph.D. and M.A. degrees in economics, an M.B.A. in operations management, and a B.S. in international business management. He has published and presented several articles in the transportation field in the U.S. and Europe.

Dr. Bekka was assisted by Dr. Stéphane Gros, a statistician and an applied economist with skills in research, computer programming, quantitative analysis, and survey design. Dr. Gros holds a Ph.D. degree in economics, an M.S. in economics, an M.S. degree in applied statistics, and a B.S. in econometrics.

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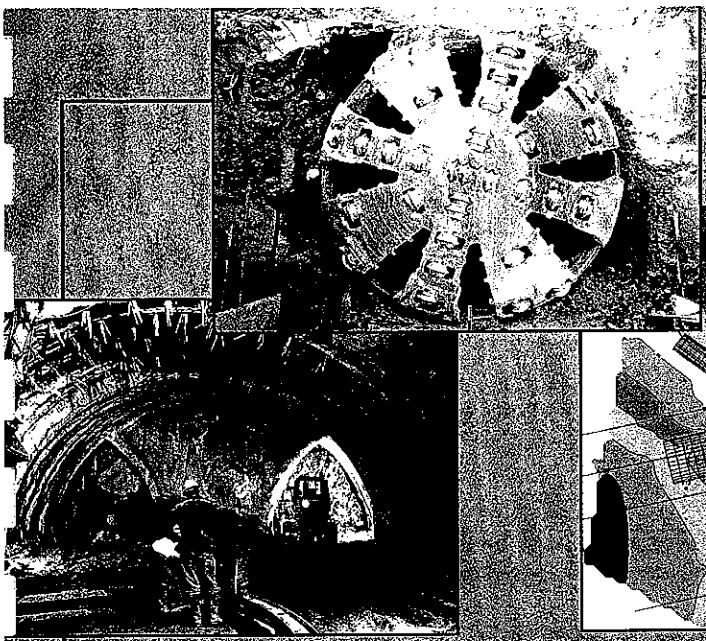
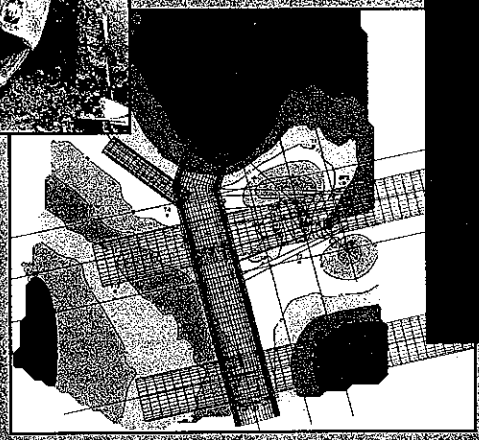




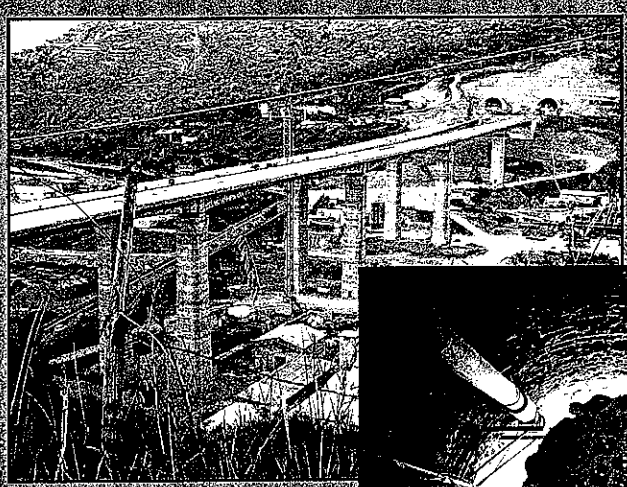
FINAL REPORT

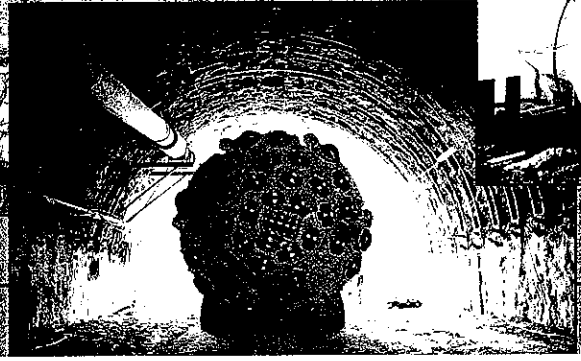
A comparative analysis of Tunnel Construction Times, Costs, and Risks Associated with the choice of High Speed Rail Tunneling Alignment between Los Angeles and Bakersfield.

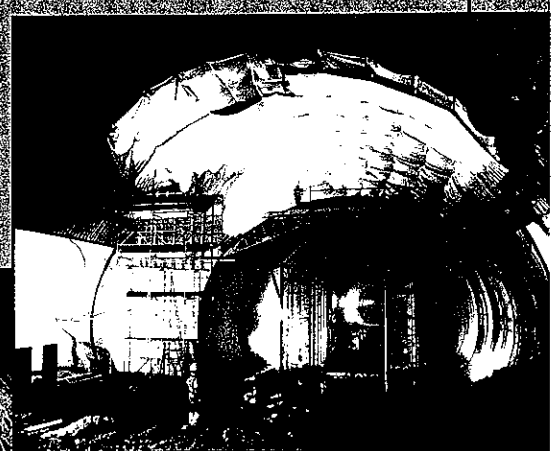
Submitted to the City of Palmdale — January 31, 2003

TRANSMETRICS
Engineering & Construction Management

GEODATA





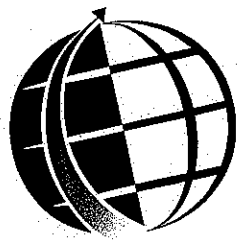


TRANSMETRICS, INC. is a civil engineering firm providing engineering, transportation planning, and construction management services to public and private sector clients. In business since 1982, TRANSMETRICS primarily serves the transportation industry. However, in the past ten years, TRANSMETRICS has expanded its services to include major private and public projects such as educational, medical, and municipal facilities, and the design and relocation of interstate utilities.

TRANSMETRICS offers a wide range of construction management services. Our engineers have the experience to lead a project from the planning and design stage to construction in an efficient and cost effective manner.

Because of its diversified workload and clientele, TRANSMETRICS actively participates in a variety of industry organizations which include:

- American Railway Engineering and Maintenance Association (AREMA)
- American Public Transportation Association (APTA)
- American Society of Civil Engineers (ASCE)
- International Association of Public Transport (UITP)
- American Public Works Association (APWA)
- National Society of Professional Engineers (NSPE)



TRANSMETRICS
Engineering & Construction Management

Transforming ideas into projects and monitoring them until completion: this is our daily task. During more than 16 years activity in the field of geo-engineering we have intensified and diversified our competence, following a strategy of multi-disciplinary growth.

Geodata is an independent geo-engineering company which, since it was founded in 1984, has grown and developed in Italy and throughout the world. Geodata employs more than one hundred professionals who specialize in geo-engineering and subsurface projects. Their skills and extensive experience has made Geodata S.p.A. one of the most respected names in the tunneling industry worldwide.

Geodata works with construction companies and public or private authorities in planning subsurface works and in various sectors of ground engineering. Geo-engineering is our core business; it is our specialization and our strength. Geodata is in a position to supervise this work throughout the specific stages: from preliminary surveys and territorial planning to design and from the optimization of the conventional and mechanized construction techniques to monitoring of the construction progress.

Geodata management has been an active participant in the International Tunneling Association where they present various reports and lead workshop discussions. Its key advisor, *Sebastiano Pelizza* served as President of the International Tunneling Association from 1995-1998.

GEODATA

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January 31, 2003

Mr. Stephen H. Williams, Director
City of Palmdale, Department of Public Works
38250 Sierra Highway
Palmdale, CA 93550

Subject: Final Report: Comparative Analysis of the Tunnel Construction Times, Costs, and Risks associated with two alignments for the High Speed Rail crossing of the Tehachapi Mountain Range between Los Angeles to Bakersfield

Dear Mr. Williams:

Transmetrics/Geodata having completed the subject analysis, is pleased to submit its final report to the City of Palmdale.

This report outlines the geologic challenges involved in the two tunneling options under consideration by the California High Speed Rail Authority. It is intended to assist everyone involved in a decision making role, to consider all the risks and costs inherent in the selection of one alignment over the other.

Prior to the start of the analysis, the study team members made a site visit, obtained extensive mapping and documentation from the U.S. Geological Survey and the California Geologic Survey, and held a teleconference with the program manager retained by the California High Speed Rail Authority.

On behalf of the study team, I would like to thank you and your staff, all the individuals and agencies contacted, and the consultants and staff of the California High Speed Rail Authority for your cooperation and assistance during the conduct of our work.

We look forward to working with you and your staff in the weeks to come and will respond to any questions regarding the analysis.

Very truly yours,

TRANSMETRICS, INC.

Jack Ybarra
President

A Comparative Analysis of the Tunnel-Construction Times and Costs as well as Risks Associated with the Choice of High-Speed Rail Alignment Between Los Angeles and Bakersfield

Final Report

Prepared for the

City of Palmdale

by

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2155 South Bascom Ave
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and

GEODATA S.p.A.
Corso Duca Degli Abruzzi 48/E
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January 31, 2003

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EXECUTIVE SUMMARY

The California High-Speed Rail Authority (HSRA) is making a comparative evaluation of two alignment alternatives, I-5 (Grapevine) and AV (Antelope Valley), for the high-speed rail connection between Sylmar and Bakersfield.

The earlier studies of the Authority have focused on minimizing tunnel requirements and cost (Corridor Evaluation study of 1999 and QUANTM study of 2002) and minimizing potential environmental impacts (the Screening Evaluation) by avoiding sensitive zones in identifying the potentially suitable routes. However, there is a limit to these reductions due to the constraints imposed by the specific topography and tectonic setting of the region as well as the high-speed train technology. Furthermore, for the limited number of potentially suitable routes identified by the previous screening studies, and subsequently confirmed by the QUANTM analysis, the various categories of risks, especially the geological and construction risks, were not considered. In the opinion of Transmetrics and Geodata, these other risks are as important as those already considered by the Authority and its consultants; they are also critical in the final choice of the optimum alignment/route for the mega tunneling project.

The potential, typical risks that may be encountered in a mega tunneling project include risk of encountering adverse geologic conditions, constructions risks, such as choice of a wrong type of TBM, ground-squeezing behavior, and face collapses. Financial risks, such as delay in completion of the contract or cost overruns, and contractual risks such as time delays and disputes are also a typical problem.

The city of Palmdale believes that specific uncertainties in tunneling should be adequately integrated into the various studies commissioned by the Authority. Risks associated with the I-5 alignment should be adequately examined with those associated with the Antelope Valley alignment. This study is intended to continue the concept development process to an all encompassing conclusion.

Consequently, the City of Palmdale retained Transmetrics/Geodata to provide a complementary risk assessment to assist in the project development process.

The purpose of this risk analysis study is to identify the optimum alignment with respect to minimizing the capital investment and the risk of construction-cost overruns and delays, and to review specific uncertainties in the tunneling that should be adequately incorporated into the overall decision making effort.

Sufficient site-specific data was not available. Experience judgment, was used for the study model and USGS data and reports were utilized in lieu of precise, in-situ explorations and measurements. Full use was made of the information contained in the 1994 Preliminary Engineering Feasibility Study conducted for Caltrans. Relevant reports and maps were obtained from the USGS to study the geomorphological, geological, hydrogeological, and geotechnical conditions of the two alternative alignment-corridors, establishing foreseeable ground models. A preliminary model of both alignments was made to define the corresponding construction schemes based on Geodata's experience for similar projects in Europe.

The number of tunnel segments (or tunnel zones, TZ) in the I-5 and AV alternatives are 4 and 7, respectively, with the maximum anticipated grade of 2.5% or 3.5%. The geologic horizons crossed by the various tunnel zones will vary from metamorphic and igneous rocks to sedimentary rocks and gravel deposits. Numerous faults intersect the two alignments. Some of these faults have a tectonically active character and a potential for plastic slippage of the fault faces.

The construction methodology selected for the two alignments is the use of tunnel boring machines (TBMs) except in some instances, such as excavation of portals, where conventional drill and blast techniques is selected. In addition to the main, twin tunnels of 9.5m diameter, a service tunnel of 6.5m diameter and seismic chambers (in major fault zones) are the principal components of underground excavation.

The comparative analyses of the two alternative alignments were performed using the tool called DAT, or Decision Aids in Tunneling.

A unique feature of DAT is its capability for a comparative evaluation of the performance of various project alternatives. Construction schemes, alignments and methods of construction are incorporated parameters. The potential of these alternatives in managing geotechnical and construction uncertainties within prescribed, or acceptable values of time and cost is also incorporated.

A DAT run is essentially a computer simulation of several random processes. The idea of using computer simulations derives from the fact that it is not possible to find analytically resulting random functions when processes are too complicated, like the construction of tunnels. So simulating a construction process is the only solution to obtain statistical information about the total time and cost. This information gives a good estimate of the average, minimum and maximum expected values. By definition the simulation of a random process uses a random number generator.

DAT and the associated computer SIMSUPER have been developed over a period of 20 years by MIT (Massachusetts Institute of Technology) and EPFL (Ecole Polytechnique Federale de Lausanne), with the participation of Geodata for practical application of the code in various international tunneling projects.

DAT simulates the tunnel construction process cycle for TBM, with its various rounds of drilling and blasting. A simulated, probabilistically ground class profile is assembled. For each cycle or round, the program selects a cost-time pair from the cost and time distributions and the ground class associated with the particular location.

The ground class assigned to a location (or a given tunnel segment) is a function of the following parameters: behavioral category, potential instability conditions, potential problematic water, possible presence of gas, and (anomalous) abrasivity of the rock mass. The behavioral category is defined by combining the strength index of the ground with its deformation index.

The total cost and time for a particular tunnel-simulation run represents a single point in the cost-versus-time plot. By conducting a statistically significant number of runs, many points are obtained and a scattergram (or cloud) is formed, expressing explicitly the inherent variability in the estimated construction cost and time.

The construction simulation requires input regarding advance rates and costs (for various elements of construction) for different behavioral categories. Costs and advance rates are influenced by geo-events such as water inflow, and consequences related to occurrence of instability phenomena.

The results of DAT simulation for each alignment (at max grades of 2.5% and 3.5%) are given in Sec. 6 as histograms and statistics of the construction time and cost as well as the scattergram formed by 1000 points in the cost-time frame. A super-imposed comparative scattergram for the two alternative alignments, and a comparative construction time and cost table, are also provided.

Finally, the results exclude the construction risks and costs of surface structures such as bridges and surface railbed. These costs are included in the HLB Report.

The results of the analyses demonstrate the following:

- Although the amount of tunneling work involved in the I-5 and AV alignment are almost the same, be it the 2.5% grade or the 3.5% grade option, ground conditions along the AV alignments are relatively more favorable and hence involving less construction, financial or contractual risks.

- For the 3.5% max grade option, the mean construction time required for the I-5 alignment is almost twice as much as that required for the AV alignment (2218 working days against 1125 working days, see Table 6.9). Similar results were obtained for the 2.5% max grade option. A slight increase in the mean construction time for the AV alignment due to increased total length of tunneling was observed (see also Table 3.1).

- In terms of the mean construction cost for the 3.5% max grade option, the Antelope Valley alignment is about 40% less costly than the I-5 alignment. This advantage is reduced for the 2.5% maximum grade option. The 2.5% grade option is 15% less costly, due to increased total length of the tunnel. Furthermore, the increased tunnel length for the AV alignment at 2.5% max grade will reduce the costs for the corresponding external works and environmental impact.

In summary, the ground conditions along the AV alignment involve lower risks regarding construction, financing, and contracts. For both max. grades (2.5% and 3.5%), the AV alignment is clearly less costly than the I-5 alignment. Note that the DAT analyses does not simulate the financial consequences of increased duration of construction. However, it is likely that a longer duration of construction will further increase the difference in the cost of the two alternatives.

Generally speaking, the findings of this study quantifies to some extent the relative risks involved in the two alternative alignments. This should allow the Authority to make a more informed decision regarding the final alignment choice.

It is recommended that geologic uncertainties be reduced by pursuing a planned site investigations, eventually using a service tunnel as a pilot bore for an investigation. Innovative technological solutions should be incorporated in the strategy for managing the high-risk aspects of the project.

Study Team

The study Team was a joint effort of Transmetrics Inc., a civil engineering firm based in Campbell, California, and Geodata S.p.A. of Turin, Italy. Both firms have previously teamed together for work on projects of similar nature. Geodata is a geo-engineering company with particular expertise in the design of underground structures in complex and difficult ground conditions. Since its beginning in 1984, Geodata's activities have involved one or more of the various technical phases (lab and in-situ characterization, feasibility study, preliminary design, final design, performance monitoring, design optimization during construction, resident engineering, independent design checks) for over 1500 km of tunnels (for transportation, water supply, and sewage disposal).

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1. INTRODUCTION

1.1 HSRA Project Description and Background

The California High-Speed Rail Authority (HSRA) has undertaken a process to develop a high speed rail ground transportation system (HSGT) to connect the cities of San Diego, Los Angeles, San Francisco, and Sacramento. The proposed HSR system would be similar to the HSR systems currently in place in Germany, France, Italy, Spain and Japan. However, the HSGT must cross the Tehachapi Mountain Range north of Los Angeles. There are several active faults in this mountain range and will require a choice of route alignment which is safe and minimizes construction related issues.

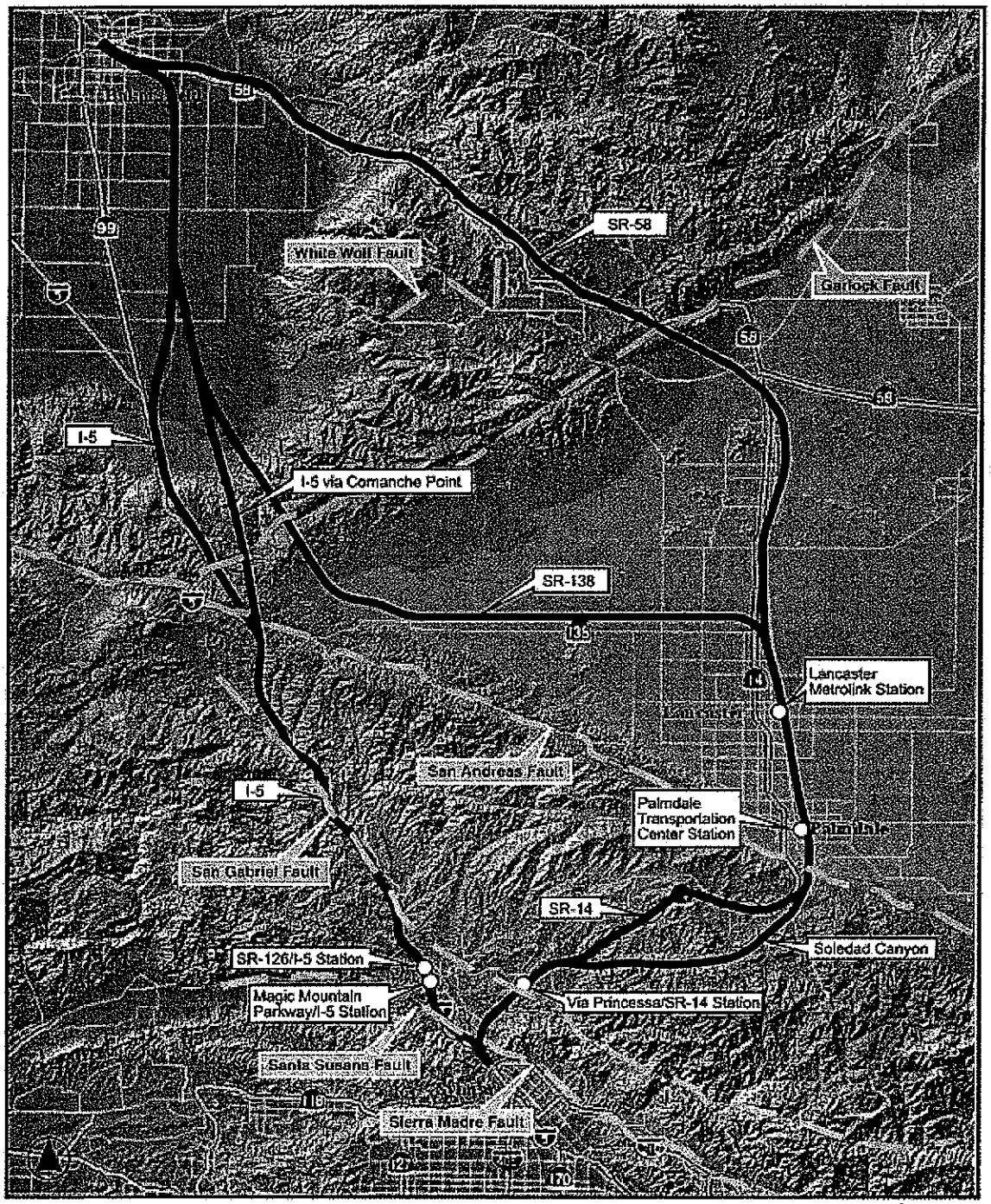
The two principal alignment options considered by the HSRA for crossing the Tehachapi Mountains between Los Angeles Union Station and Bakersfield are – the AV, or the Antelope Valley, alignment and the I-5, or the Grapevine, alignment. The two alignments differ principally in relation to length, accessibility, and construction complexity and risk (see Fig. 1.1).

For the tunnel study in this report, the tunnel portal positions have been established assuming that at least 20 meters of overburden are required above the tunnel base. This is due to the large dimension of the tunnels and the need to have a reasonable minimum cover thickness to start the excavation. This means that the position of the portals can be slightly different with respect to the position defined in the HSRA's documents (Orthophotos).

The I-5 alignment is some 65km shorter than the AV alignment and would, therefore, allow a 5 percent (6-9 minute) shorter non-stop travel time, depending on the final choice of the high speed rail technology and the train speed. In comparison, the AV alignment would offer high-speed rail service to at least 438,000 additional residents and 165,000 employees today, and to over 720,000 additional residents (and 270,000 employees) at the time of system startup in the 2015-20 period.

Finally, from a construction perspective, while the I-5 option would require the construction of a shorter track than the AV alignment, this advantage would come at the cost of more route miles of tunneling (the exact figure for the miles will depend on the choice of the grade) through a fault-ridden section of the Tehachapi Mountains, the costliest – and riskiest – type of civil construction that would be encountered in an attempt to cross the Tehachapi Mountain range.

Figure 1.1 Map of the Alternative Alignments



1.2 Review of Available Information

1.2.1 Extent of available information

The analyses presented in this report have been developed by the Consultant using the available information (under the categories discussed below) and, in the absence of available information, using the appropriate assumptions based on experience.

Geology

The main source of information regarding the geology and geotechnical characteristics of the ground along the two alternative alignments was contained in the document on "Preliminary Engineering Feasibility Study – Final Geotechnical Summary Report" dated April 11, 1994, submitted to the California Department of Transportation, prepared for Parsons Brinkerhoff Quade & Douglas by MAA Engineering Consultants, Inc. of Los Angeles. On request, this document, and the maps and sections annexed to it, were supplied to Geodata by PBQD. Additional information was downloaded from the Authority's website.

Geodata also acquired relevant reports and maps from the United States Geological Survey to study the geomorphological, geological, hydrogeological, and geotechnical conditions of the two alternative alignment-corridors, aiming at identifying the corresponding risks. This information from the USGS came from their offices in Menlo Park, San Francisco and Denver.

Drawings

The only drawings available for the study where those produced for the Preliminary Engineering Feasibility Study in the period of 1993-1994 by MAA Engineering.

Boreholes

No borehole information was available to Geodata. It is understood that some boreholes were drilled recently to check the ground conditions of alternative alignments.

Tunnel Design

The Tunneling Feasibility Study made in the period of 1993-1994 for Caltrans was the only background information available on the design for either of the two alternative alignments. A judgment on certain design and construction parameters required for the analysis had to be made by the Consultant to complete the model for this study.

Construction methodology

A clear statement of the construction methodology is not found in any official documents made available to the Consultant, except in the Tunneling Conference Summary where it was mentioned that "Tunnel Boring Machines should be assumed as the excavation method for all tunnels with the exception of specific areas identified during the conference that have difficult geology."

1.2.2 Review of Previous studies

The project planning and feasibility studies, the environmental impact assessment, and the selection of the system's route alignment have been conducted primarily by the Authority's consultant, and the project development is currently at the stage of final screening evaluation of alignment options. The following two events in the long process of initial project development study should be noted.

1. During the period of 2001 to March 2002, the Authority conducted an alignment optimization and refinement study to further clarify screening decisions using the QUANTM system. The QUANTM system is a new automated alignment optimization system developed and applied in Australia. It was the intent of the authority to improve on the previous analyses based on "best practices" for conceptual engineering. The results were presented in a final report titled, "Alignment Refinement/Optimization and Evaluation of the QUANTM System" published in April 2002.

   In the beginning of December 2001, the Authority organized a two-day (December 3 and 4) Tunneling Conference to discuss major tunneling problems involved in the California HSR project. However, the documentation of this Conference is limited to only a few pages of summary placed on the Authority's website, and the proceedings of the Conference have not yet been published.

2. Great importance has been given by both the Authority and its consultant to the above two events.

   - Previous corridor evaluation studies have focused on minimizing tunnel requirements and cost;
   - Current screening evaluations focused on minimizing potential environmental impacts;
   - Influenced by the results of the Tunneling Conference, the QUANTM study attempted to minimize tunneling and capital costs. In this regard, it is more comparable to the earlier corridor evaluation study results.

The two often conflicting aspects of minimizing tunnel requirements and cost, and minimizing potential environmental impacts are interrelated. They should be treated following a systematic engineering approach.

The risks and/or critical considerations listed below have been identified in previous studies. Attempts have also been made to deal with these issues.

- Alignment crossing fault and shear zones of considerable length. The solution adopted, wherever possible, was to avoid these zones by either deviating the route or increasing the vertical grade to move the alignment to the surface.
- Alignment crossing water-saturated zones and/or zones with high groundwater pressure. The attempted solution was to deviate the route wherever possible.
- One longer versus many shorter tunnels. In general, shifting the problem of fault crossing from underground to surface may not be a an optimum choice. For the HSR project this problem will be complicated by the fact that the alignments run across active earthquake faults. The I-5 alignment is of concern because it is parallel to at least two faults. While the region is vulnerable to earthquakes, tunnels are generally more resistant to seismic events than equivalent superstructures as experienced in Kobe, Japan and in the Loma Prieta, California events. The region's faults are expected to produce large, lateral shear displacements during an earthquake and might endure a tunnel section closure.
- During operation. The time and cost involved in rehabilitating an earthquake-damaged tunnel section (compared to that of an equivalent superstructure) needs to be investigated.
- The addition of high embankments and deep trenches may also be a factor associated with vertical-grade options, considering the associated costs of trench support, embankment-slope protection, and maintenance.

However, there are also other risks which were not addressed in the previous studies. For example, the potential, typical risks to be encountered in a mega tunneling project like the California HSR project may include:

1) The risk of encountering adverse conditions due to the inherent uncertainties of ground and groundwater conditions – leading to significant cost overruns and project delay;

2) The potential for accidents during tunneling and post construction;

3) Construction risks, such as selecting the wrong type of TBM, human error, rock squeezing behavior, face collapses and production of materials causing hazardous environmental conditions;

4) Financial risks to the owner, such as delay in completion of the contract, cost overruns, or lower than projected rates of capital return;

5) Contractual risks, such as additional work not covered, time delays, disputes, claims and litigation.

It should be noted that the underground construction industry seems particularly prone to disputes – this is most likely because of the risks and uncertainties associated with subsurface conditions and costly plant and equipment required for tunneling.

It is believed that the costing (and timing) of the project would be quite different if the geological and construction risks, as well as the entailed financial risks, were included in all cost calculations.

Therefore, it is necessary to perform an alignment-specific risk analysis for each potentially suitable alignment, to complement the QUANTM analysis, considering at a minimum the following:

- the variation of construction time and cost as a function of the expected geologic conditions and the associated variations and uncertainties;
- the impact of construction duration on economic and financial issues.

The final choice of the optimum alignment can be enhanced on the basis of a multi-criteria analysis, taking into account the following key factors:

1) Environmental impacts,

2) Total construction cost and risk of cost over-runs,

3) Construction duration and the risk of delays,

4) Performance of the chosen alignment alternative in dealing with risks during operation,

5) Capital investment and the related financial risks.

Determining an optimal alignment for the HSR system is quite complex and requires a multidisciplinary approach supported by effective and efficient tools.

1.3 Purpose and Scope of the Analysis

The study presented in this report was commissioned for two main reasons, (1.) Specific uncertainties in the tunneling process were not adequately integrated into earlier studies commissioned by the Authority, and (2.) to identify the optimum alignment with respect to minimizing capitol investment and risk of construction cost overruns, and costly delays.

The objective of the study is to conduct a geo-engineering risk analysis and an economic risk analysis associated with the design and construction of tunnels for the high-speed rail project between Sylmar and Bakersfield, along two alternative alignments (see Figure 1.1):

1. *I-5 Alignment - Sylmar to Bakersfield following Interstate 5*

   ("Grapevine")

2. *Antelope Valley Alignment –*

   Segment 1 - Sylmar to Palmdale via SR-14 and Soledad Canyon

   Segment 2 - Palmdale to Mojave (level terrain)

   Segment 3 - Mojave to Bakersfield via SR-58

The tunneling duration and cost as well as the corresponding risk assessment of the two alternative alignments will be made to address the following two questions:

1. Which alignment requires the least capital investment; and
2. Which alignment presents the lowest risk of construction cost overruns and schedule delays?

[*Note that a unified benefit-cost analysis previously prepared by the Consultant, HLB Decision Economics, Inc., will be updated to include the results of the present tunneling risk analysis.*]

The specific tasks of Transmetrics Inc. and Geodata S.p.A. (to be referred to as the "CONSULTANT" will include:

1. Define Risk Assessment Model and establish the primary output paramenters such as:
   - Number, length, size, alignment, and location of tunnels, surface structures and the related surface structures;
   - General rock mass type and quality;
   - Proximity to favorable or adverse geotechnical conditions
   - Faults and fault zones (vulnerability to earthquake damage),
   - Water-saturated zones,
   - Surface instabilities,
   - Location/impact of surface facilities and structure (e.g., portals, ventilation facilities).
2. Analyze data provided by PBQD and the USGS
3. Prepare Quantitative Cost and Risk Outputs.

   Prepare central, upper, and lower values for costs and schedule impacts for each alignment and grade option.
4. Prepare General Discussion of Tunneling Risks and Risk-minimization.

   This will include a discussion of key tunneling design and cost parameters, risk factors, and other issues associated with alignment and design of long, deep tunnels based on the Consultant's international experience.
5. Prepare a Technical Working Paper.

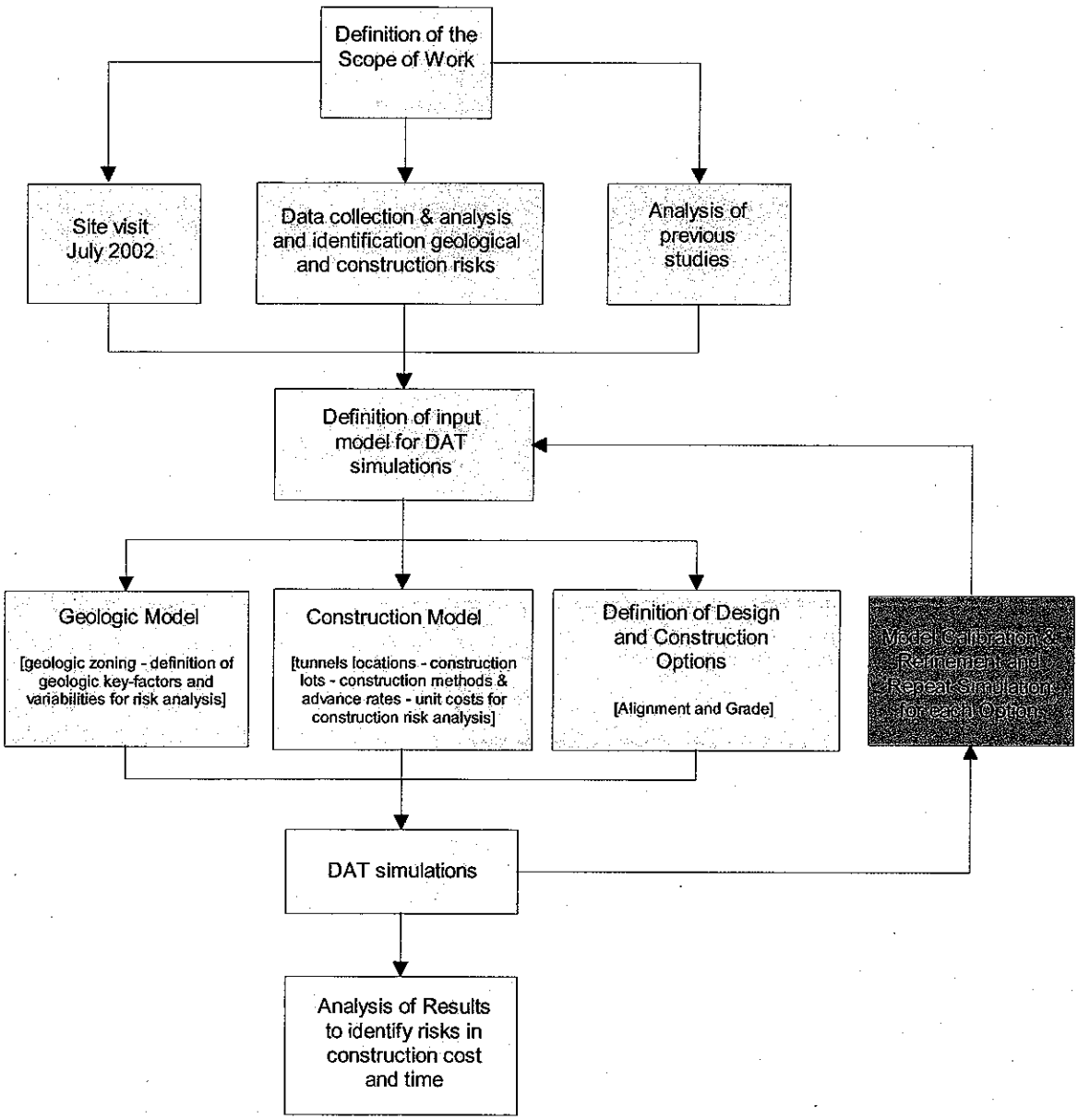
The process to fulfill the above tasks are illustrated in Figure 1.2.

1.4 List of Acronyms

CONSULTANT	Transmetrics Inc. and Geodata S.p.A.
CHSRA	California High-Speed Rail Authority
HSR	High-Speed Rail
DAT	Decision Aids in Tunneling
QUANTM	Automated Alignment Optimum System developed and applied in Australia
PBQD	Consultant to HSRA
AV	Antelope Valley (alignment)
I-5	Grapevine (alignment)
GSI	Geologic Strength Index
UCS	Unconfined Compressive Strength
TZ	Tunnel Zone
TBM	Tunnel Boring Machine

EPB	Earth Pressure Balance
CONV	Conventional Excavation (using drill-and-blast technique)

Figure 1.2 Flowchart illustrating the process for risk analysis conducted



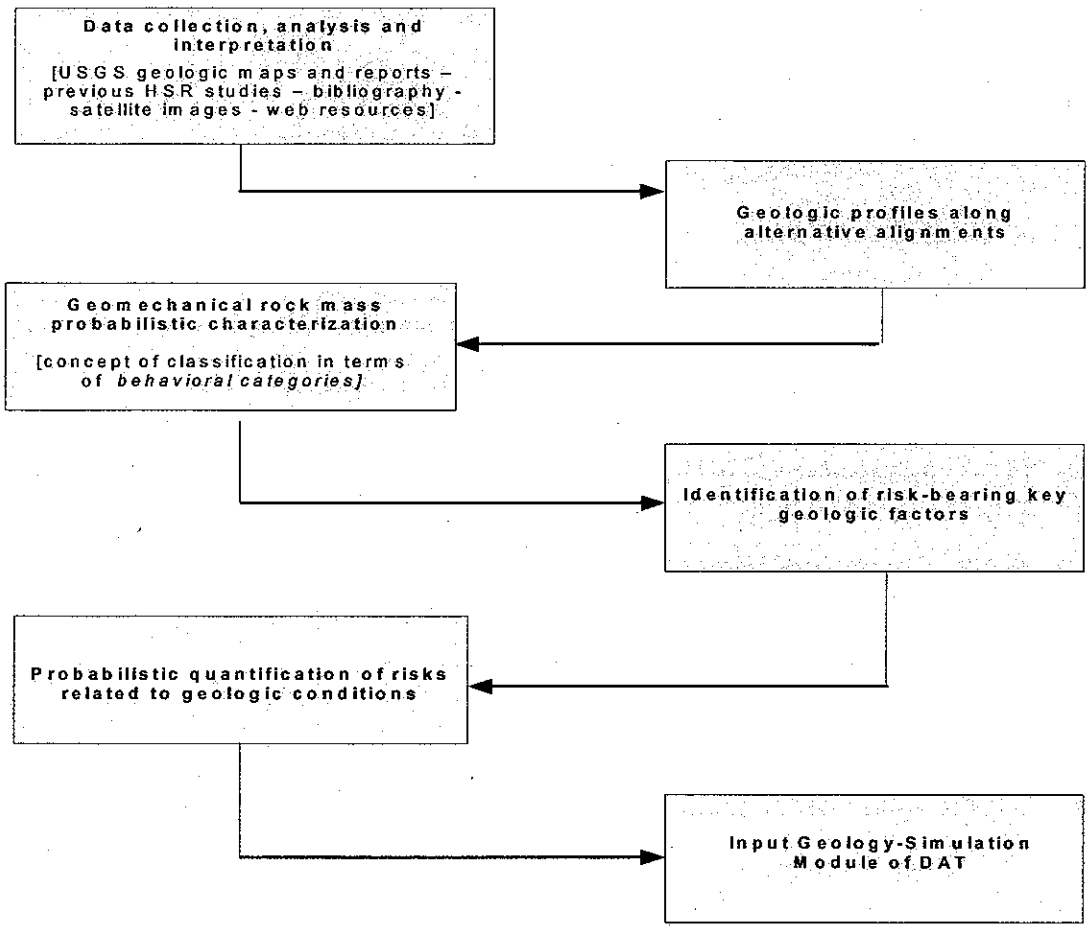
2. GEOLOGIC CONDITIONS ALONG ALTERNATIVE ALIGNMENTS

It is common experience in tunnelling that geologic conditions play an important, often critical role in determining the final success of a project in terms of meeting the planned schedule and budgeted costs. This is due to the inherent uncertainties about the prediction of the geologic key factors and their natural spatial variability, that can only be reduced but not eliminated through the execution of proper site investigations.

Bearing this in mind and considering the extent and complexity of the California HSR project, we have considered it necessary to establish an adequate geologic model aimed at defining the conditions to be encountered during tunnelling along the two alternative alignments. The model should be consistent with the current stage of development of the Project and with the available information.

The model-development process is illustrated in Figure 2.1.

Figure 2.1 Flowchart showing the geological-model development process



The following is a summary of the geologic conditions that are expected to be encountered along the I-5 and AV alignments. Details of the geologic conditions are provided in Appendix 2.

2.1 Geologic Units

The four broad geologic units expected to be crossed by the tunnel alignments are:

- (Pre-Tertiary) Metamorphic rocks, such as quartzite.
- (Pre-Tertiary) Intrusive rocks, such as granite.
- (Tertiary) Sedimentary rocks, such as sandstone, and volcanic rocks, such as basalt.
- Quaternary deposits, such as gravel.

2.2 Principal Faults

The characteristics of the principal faults that are considered to directly intersect the underground sections of the two tunnel alignments are summarized in Table 2.1. Two important aspects of the faults, which should be considered in the selection of a tunnel alignment are: the tectonically active character, and the slow, plastic slippage that may generate ground movements of several mm/year.

Table 2.1 Principal fault zones affecting the alternative alignments

Fault zone	Location (align., approx. chain.) (3)		Type	Attitude (dip/dip direction or strike direction)	Estimated width [m] (1)	Last seismic event year/magnitude] (2)	
S. Andreas	I-5	km 78+000	S, RH	Near vertical, NW-SE	800 - 1000	1857 (south branch)	8.0
Garlock	I-5 AV	km 70+250 km 79+350	S, LH	Near vertical, NE-SW	500 - 800	1992 (Mojave)	5.7
S. Gabriel	AV	km 177+950 km 178+200 km 178+850	S, RH	Near vertical, NW-SE	400 - 600	Quaternary	unknown
S. Susana	I-5 AV	? km 183+600 km 184+200	T	var., NW to NE	200 - 250	Late Quaternary 1971 (S. Fernando)	unknown. 6.5
Pleito	I-5	km 57+700	T	var., NNW	150 - 200	345-1465 years ago	unknown
Pastoria	I-5	km 67+000	R	var., SSE	300 - 400	unknown; probably non active	
Edison	AV	km 38+600 km 40+600	N	45-75°, NNW	100 - 200	unknown; probably non active	
Legend	S (strike-slip fault), T (thrust fault), N (normal fault), R (reverse fault); RH, LH (right-hand mov., left-hand mov.)						
Note	(1) The figures refer to the estimated width of the fault affected zone (2) From SCDEC (Southern California Earthquake Data Center http://www.scecdc.scec.org/faultmap.html) (3) Chainage onset is assumed in Bakersfield						

2.3 Groundwater Conditions

Groundwater in the study area is contained in three basin-fill aquifer systems: the Basin and Range aquifers, the Central Valley aquifers, and the Coastal Basins aquifers. Due to the lack of any detailed hydrogeological information, a qualitative hydrogeologic characterization was made to distinguish the potentially affected zones from the potentially unaffected zones with respect to the negative impacts of water inflow during tunneling.

2.4 Geomechanical Characterization of the Ground

The ground along the tunnel horizon was assigned "behavioral categories" **a** to **f** using the approach detailed in Appendix 2. The approach combines the Geologic Strength Index with the Deformation Index of the ground at the tunnel face and around the cavity, to define a behavioral category for the ground at a given section of the tunnel.

2.5 Anticipated Geologic Conditions Along Alternative Alignments

This section will outline the expected geologic conditions along the alternative alignments as recognized through the study of background literature (listed in Appendix 1) and visual inspection during the site visit of July 2002. Descriptions are presented for all the tunnel zones (TZ) of each alternative alignment option separately. For the sake of simplicity and completeness, reference will be made to deeper and longer, 2.5%-maximum-grade-alignment configuration. The descriptions are also valid for 3.5% max grade configuration.

I-5 (Grapevine) alignment

- TZ 1 (Grapevine to Castaic Lake)

Metamorphic to granitic rock types shall be encountered.

Tunneling shall intersect a very tectonically disturbed zone. Major regional faults are (i.e. Garlock and San Andreas systems) several hundred meterswide, while other important faults (e.g. Pleito thrust zone, Pastoria fault) and a certain number of minor shear zones will be crossed. Poor to very poor conditions can be anticipated through these zones, with a high potential for ground instability phenomena. Ground squeezing could occur in zones of low rock mass strength to lythostatic pressure ratio, while wedge-like instabilities could occur as a consequence of the blocky nature of the rock mass.

Zones bounded by successive fault zones are, on average, expected to be quite disturbed due to significant, though variable, fracture intensity. Also, the occurrence of associated potential water inflow phenomena seems to be quite probable in these zones.

The northern portal area (Grapevine) is a well recognized area subject to landsliding.

A particularly difficult geologic zone is represented by the section that extends between Garlock and San Andreas fault zones where, besides the expected very poor geomechanical conditions, groundwater can play a critical role in tunnel stability. The

presence of a water body at the surface (tunneling shall be very close to Castaic lake) of this relatively low overburden zone, will constitute a very special environmental and geotechnical hazard.

- TZ 2 (Castaic Lake to Marple Canyon-Violin Canyon)

Here, sedimentary units of flysch-like character (interlayered sequence of sandstone, siltstone, claystone) are anticipated; rock properties are quite variable primarily as a consequence of the variability in rock types (reference can be made to the concept of *geotechnical complexity* or *complex rocks* as developed by the Italian Geotechnical Association since 1979).

In the northern area, intensely folded rock masses are anticipated. According to data from the USGS, the relative stiffness of the prevailing rock type (sandstone) folding could be associated with severe fracturing and blockyness of the rock mass, particularly in the fold hinge zones.

In the southern part of the tunnel zone not well lithified claystones may be encountered over a stretch of several hundred meters. Here instability phenomena is likely to occur during the excavation.

Similar to TZ1, the alignment will pass near a water body at surface (ZZZ artificial reservoir), this will be a matter of particular concern from the environmental and construction points of view.

From morphologic analysis (on both topographic maps and satellite image) the zone seems to be intersected by several minor faults that could be associated with their proximity to major fault zones (San Gabriel, San Andreas).

- TZ 3 (Santa Clara River to Lyon Canyon)

This narrow tunnel zone will intersect sedimentary units from Quaternary, unconsolidated coarse-grained grounds to Pliocene rocks. Tunneling shall be mainly in shallow conditions, except for a zone towards the center of the TZ where it will pass through a relief that appears quite densely urbanized.

While the potential for significant water inflows should not be important, the nature of the rocks could indicate the presence of gas.

- TZ 4 (Weldon Canyon to San Fernando-Sylmar)

Through this tunnel zone the alignment finally arrives at the San Fernando-Sylmar node. Again, clastic sedimentary rocks, of both marine and continental origins, will be encountered.

The entire zone, and particularly the second half towards Sylmar, is directly affected by important fault structures linked to the Santa Susana thrust system. Severe tectonization due to compressive shearing and, consequently, poor geomechanical conditions can be anticipated. Both water and gas could be present.

The tunnel will underpass a very low overburden near the I-5 freeway as well as the L.A. aqueduct.

Antelope Valley (Soledad Canyon) alignment

- TZ 1 (El Tejon to SR58-SR223-Bena Road junction)

This is the first tunnel zone that is between Bakersfield and the Tehachapi mountains.

Separated by the Edison fault, this tunnel zone encounters coarse sedimentary rocks in the first section of the tunnel, and granitic rocks until the eastern limit. With regard to the former, some uncertainty is represented by the very nature of the unit, i.e. whether it behaves more like a soil or a rock. For purposes of this study, it has been assumed that the unit is characterized by having a cohesive strength due to the presence of inter-particle bondage.

Due to its spatially variable altitude, the Edison fault could be actually intersected in different locations and possibly also in very unfavorable conditions (subparallel to the tunnel axis).

- TZ 2 (Clear Creek to Rowen)

This quite narrow tunnel zone is expected to be entirely excavated through good granitic rocks. Only minor tectonic structures have been hypothesized based on morphologic analysis.

A mainly elastic response to excavation can be anticipated.

- TZ 3 (West of Keene to West of Summit - Tehachapi)

This long tunnel zone will intersect a staggered series of dioritic and quartz-monzonitic and metamorphic rocks of probable sedimentary origin.

Through morphologic analysis and interpretation, some narrow fault zones have been introduced in the geologic model.

From the geomechanical perspective, potential instability phenomena are more likely to be associated with metamorphic rocks under high overburden and/or where rocks have been subjected to shearing.

- TZ 4 (from Proctor Lake zone to Mojave Desert)

Tehachapi mountains crossing will be carried out through this tunnel zone. The most evident feature is represented by the Garlock fault zone, which combines quartz-monzonitic rocks and Paleozoic gneiss. The latter represents a sort of tectonic slice bounded at both limits by a fault structure, and is expected to be mostly tectonically disturbed and weathered.

At the southern boundary (Mojave), quartz-monzonitic rocks disappear giving place to Quaternary coarse continental sedimentary units that progressively thicken towards the Mojave plain. For older deposits a certain cohesive strength can be hypothesized, but for more recent deposits a prevailing frictional behavior is anticipated.

Challenging geotechnical conditions shall be encountered when boring through the wide Garlock fault zone and the neighboring gneissic rocks, and particularly where the rocks are loose as a consequence of tectonic events.

- TZ 5 (from Soledad to Apple Canyon)

This long tunnel zone is south of the San Andreas Fault relief, through the Soledad Canyon region, and will intersect a variety of geologic units.

Hard and massive granitic rocks are present in the eastern border. The central portion is occupied mostly by heterogeneous rocks of the Vasquez volcano-sedimentary complex, and a tectonically bounded volume of Precambrian deeply weathered anorthosites. Finally, in the western zone, clastic sedimentary rocks appear.

On average, fair geotechnical conditions can be anticipated, with the exception of the area where anorthosites are present. Also across fault zones, most of which have also been recognized on geologic maps (e.g. the Pole Canyon fault), worse conditions are expected. Unfavorable groundwater conditions should characterize the section where the Soledad Canyon valley will be crossed with a reduced overburden.

- TZ 6 (South of SR 14 to Placerita Canyon)

This tunnel zone crosses, under relatively low overburden, sedimentary clastic rocks of various type: sandstones, siltstones, mudstones and, to a lesser extent, conglomerates (in the form of quite isolated levels or lenses). In addition, some tuff layers will be encountered in the eastern portion.

This zone also crosses in different locations some branches of the San Gabriel fault zone, which will provide a series of sub-zones with very poor geotechnical conditions. Groundwater is not expected to be a problematic issue because of the prevailing shallow conditions in which the TZ exists.

- TZ 7 (from Elsemere Canyon to San Fernando-Sylmar)

Through this tunnel zone the corridor enters the San Fernando Valley. It follows at a short distance TZ6 and shall encounter similar geologic units of sedimentary origin.

Non-marine facies, encountered at the northern margin, are described as quite loosely consolidated to poorly cemented, while marine facies in the central portion, appear as rock masses.

At the southern margin, the corridor is repeatedly crossed by different branches of the Santa Barbara thrust system, giving rise to a significant length of rock masses of very poor geotechnical condition.

Oil fields are present in the area and the potential of encountering some gas volumes particularly in the deepest sections of the TZ has to be considered.

2.6 Evaluation of Risk Arising from Adverse Geologic Conditions (Events)

For the purpose of the present study, only potentially adverse geologic conditions are considered. Other event categories, which might negatively affect the construction process, such as mechanical failures, socio-economic events, natural extreme phenomena (e.g. earthquakes, inundations, etc.) are not taken into account.

It should also be mentioned, that other factors not considered in the present study shall play an important role when a comprehensive risk analysis is implemented to help decision makers in selecting the more reliable project solution.

For example, when dealing with an alignment that passes through an area subject to landslides, one has to consider that more lengthy and costly tunneling could be a more reliable solution than increasing the grade or aerial sections. This reasoning holds true

when considering the same alignment with respect to potential earthquake induced structural or functional failures.

Another important issue is represented by environmental factors. Temporary as well as permanent works or facilities above ground have different impacts on the perceived environmental value of certain areas. In this respect, a more general public consensus could be reached regarding the feasibility of some solutions instead of others. For instance, the increased costs of a longer tunnel in a territory of environmental value could represent an acceptable trade-off.

Adverse geologic conditions that can be experienced in tunnel construction have the potential of causing time delays and costs overruns. This is of particular relevance when such adverse conditions have not been sufficiently investigated before starting the construction phase.

Although the principal types of potentially adverse geologic features can be reasonably anticipated through detailed studies, uncertainties about the location still remain as an inherent risky aspect of underground construction.

The best way to effectively manage such uncertainties is to treat them in a probabilistic manner, describing the possible occurrence of each category of accident with specific probabilistic parameters as will be depicted in the description of DAT (Section 4).

For the purpose of this study, starting from the referenced geologic model, four categories of potentially adverse conditions (geo-events) have been recognized, namely:

- Tunnel instability phenomena (from local collapse to severe ground squeezing)
- Water inflows
- Presence of hazardous gas (explosive or toxic hydrocarbons)
- Anomalous abrasivity

Conceptually, the risk for each event can be defined as a function of uncertainty and damage; that is,

$$\text{Risk} = f\,(\textit{event uncertainty, event damage})$$

Through DAT simulations, a zoning of the geologic adverse conditions has been performed emphasizing for each *geo-event* two or three levels of significance. This is done combining the estimated likelihood of occurrence and the potential impact on the construction phase.

3. SCHEMES FOR CONSTRUCTION OF THE TWO ALIGNMENTS

In order to perform the proposed alignment specific risk analysis, the Consultant had to make a conceptual construction of each design construction option, making relevant assumptions for those aspects not yet defined in previous studies. This conceptual design is summarized in the following subsections.

3.1 Definition of the Alignment Alternatives

As anticipated in Section 1 - Introduction, the two alternative alignments considered by the HSRA for crossing the Tehachapi Mountains between Los Angeles Union Station and Bakersfield are:

- The AV, or the Antelope Valley Alignment, and
- The I-5, or the Grapevine Alignment.

These two alignments differ principally in relation to (1) length, (2) accessibility, and (3) construction complexity and risk.

The position of the so called "Tunnel Zones" is defined based on the position indicated in the Authority's documents (Orthophotos).

The position of each single tunnel is fixed using the following procedure:

1) Get the approximate position from the Orthophotos.
2) On the basis of Step 1, evaluate if the maximum vertical grade of the tunnel in question is consistent with the specified maximum grade option (be it 2,5% or 3,5%). If not, move the position of one or both portals, changing as a consequence slightly the length of the tunnel in order to be consistent with the maximum-grade option to be analyzed.
3) In order to have 20M of overburden above a tunnel base, portals can be adjusted to insure a reasonable cover thickness before the start of construction.
4) For those long tunnels whose lengths are greater than 6 miles (see forward to Section 3.3) a third service tunnel is required for ventilation, evacuation and construction access. In this case the portal positions are fixed in accordance with those of the corresponding main tunnels.

Applying the above procedure, the positions of the portals and the lengths of the tunnels analyzed can be slightly different with respect to those defined in the Authority's documents.

The construction scheme for each tunnel is defined according to the Consultant's experience and knowledge. The schemes adopted are detailed in the subsection 3.5 (Tables 3.3 to 3.6). Each alignment grade option has been studied independently with the intent of reducing construction risks in terms of time and cost, without neglecting the technical feasibility.

The main tunnels are configured with twin bores, each bore housing a single rail track. The distance between the two bores and therefore the length of the cross-

passages, should be determined properly in a successive design phase to ensure the stability of the pillar between the twin bores.

3.2 Choice of an Excavation Technique

As technical literature and excavation experiences all over the world have shown in the last decade, long tunnel excavation by TBM is nowadays a must, not only to ensure financial return of the investment, but also to manage labor conditions and environmental impacts. When rock mass conditions exist in a wider range, TBM excavation minimizes the construction time due to the high advance rates of this technology. This technological benefit is complemented often with an almost immediate installation of the final lining in the tunnel without incurring delays.

A particular family of TBM machines, i.e., the Double Shield TBM, is known for its wide application range and high performance. This is made possible by the feature that allows the machine to advance both as an open TBM when rock conditions are good to medium and as a single shield TBM when rock conditions are poor to extremely poor. In both excavation modes, the working site is kept in a safe condition by the protection of the telescopic shield and the consequent pre-cast concrete segmental lining which is installed simultaneously with the advance of the excavation. The result is a high performance rate in both good and poor rock conditions. The main disadvantages are the high initial investment and a long period of procurement and assembly.

For the both the I-5 and the AV alignment alternative, Double Shield TBMs have been selected for the tunnel excavation.

TBM excavation is applied for all long tunnels in order to make each machine excavate as long as technically feasible, thus amortizing the initial high cost of the machine.

For short tunnels, the first option is to use a TBM previously employed to excavate a similar small section in another tunnel, taking into account the related costs of disassembling and reassembling as well as transportation from one site to the other. If the transfer of a TBM from another excavation site impacts too negatively on overall construction time, a dedicated TBM should be adopted.

Conventional excavation may be selected for all those situations where its application will significantly reduce overall construction duration.

3.3 Service Tunnel

As discussed in the Tunneling Conference (December 3-4, 2001), a service tunnel is required for tunnel lengths over 6 miles, with the aim of providing a safety access way. It is assumed that the excavation of the service tunnels will start as early as possible before to the excavation of main tunnels.

The horizontal position of the service tunnel is assumed to be central to the main twin bore tunnels, in order to provide the best geological information for the excavation of the main tunnels and thus optimize its safety role. The service tunnel also provides drainage for groundwater to avoid inflow into the main tunnels.

It should also be pointed out that the service tunnel requires a thicker pillar between the main tunnels. Therefore, the length of each cross passage must take into account this increase in the separation distance between the twin bores of the main tunnel.

3.4 Seismic Chamber

As mentioned previously in Section 1.2.2, in case the tunnel crosses a major potential earthquake inducing fault zone (the San Andreas Fault and the Garlock Fault), the construction of a 1000m long large cross-section chamber, will allow for the realignment of the rail tracks in case of a major seismic event. The basis of this conceptual design choice is that these faults are expected to produce sufficiently large, lateral shear displacements during an earthquake capable of cutting and closing the tunnel section. It should be noted that so far the enlargement of a normal tunnel section to form the required seismic chamber has been considered only in the direction of the assumed potential lateral movement, which is predicted based on the past movement records of the fault concerned. However, a very recent science discovery has revealed that "faults go backwards". This discovery was reported first in the September 2002 issue of "Science" and then in the November 2002 issue of "Geoscientist" the magazine of the Geological Society of London. The following paragraphs are extracted from the article published in "Geoscientist",

> *"The earthquake known as the Hector Mine Event (1999) has enabled seismologists to identify new forms of earthquake-related deformation.*
>
> *On October 16 1999, approximately 37 miles from Palm Springs, California, a magnitude 7.1 earthquake ripped through 28 miles of faults in the Mojave Desert. Because of the area's sparse population and development, the massive quake caused virtually no major measurable injuries or destruction.*
>
> *Yet the Hector Mine event, named after a long-abandoned mine in the area, has indeed created a mine of information about earthquakes, faults, and ruptures for scientists at Scripps Institution of Oceanography at the University of California, San Diego.*
>
> *Writing in Science (September 13), the scientists, along with a colleague at the California Institute of Technology (Caltech), reveal how they used satellite and radar technologies to uncover characteristics of faults previously unknown to science. These include the first evidence that faults move backwards, contrary to conventional observations, and indications that the material within faults is significantly different from that in its surroundings."*

This new discovery suggests there is a risk that the seismic chamber solution may not serve its intended purpose. Clearly, this is not just a design risk. On the other hand, an alternative design of the seismic chamber is out the scope of work of the Consultant.

For the proposed analysis, the seismic chamber conceived by the HSRA is analyzed, also in terms of its potential for optimization of the construction of the tunnel crossing through a fault zone. Possible scenarios have been defined and analyzed to check if construction of a seismic chamber beforehand may help to reduce the overall time of constructing the main tunnel, and to minimize at the same time, the risk exposure of the main tunnel construction.

In any case, as a design choice an at grade fault crossing is preferred for each alignment option wherever the allowable maximum grade permits in order to limit construction costs and reduce risks.

In the case of the I-5 Alignment, the excavation of the seismic chambers through the Garlock Fault, is assumed to start from the service tunnel for both the 2.5% and the 3.5% maximum grade options. Consequently, when the 9.5m diameter TBMs reach the fault zone, they can simply be pulled or pushed through the already constructed seismic chamber, and thus avoid the risks of instability and blocking of the TBM. Only for the 2.5% maximum grade option, the seismic chamber required for crossing the San Andreas Fault Zone is assumed to be realized before the arrival of the 9.5m diameter TBM excavating the main tunnel. In this case it is also assumed that the seismic chamber will be constructed during the long period of procurement and assembly of the large TBM.

In the same manner, the 2.5% maximum grade option of the AV Alignment requires the construction of a couple of seismic chambers in the Tunnel Zone no. 4 to cross the Garlock Fault. To reduce general scheduling risks and to avoid ground instabilities when constructing the main tunnels, it is assumed that these seismic chambers will be constructed *a priori* from an access shaft.

3.5 Construction Scheme of Alignment Grade Option

Given the choice of two alternative alignments (I-5 or AV) and two maximum grade (2.5% or 3.5%) options, there are in total four combined options. The construction schemes adopted for these 4 alignment maximum grade options are defined on the basis of the criteria presented in Sections 3.1 to 3.4 and are illustrated in Figures 3.1 to 3.6. In these figures the realization scheme for each portal is not represented in order to keep the figure readable.

Table 3.1 gives a legend to the graphic symbols used in Figures 3.1 to 3.6, while Table 3.2 contains a summary of the construction features of various options, detailed also separately in Tables 3.3 to 3.6.

Table 3.1 Legend to Figures 3.1 to 3.6

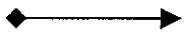
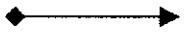
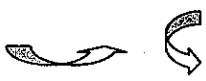
Tunnel Zone n° 1	Name of the Tunnel Zone considered
	Profile of the area
	Approximate position of tunnels
SHAFT	Excavation of shafts, with conventional method, is represented with black vertical arrows
Seismic Chamber	Excavation of the seismic chambers for major fault crossings (San Andreas Fault and Garlock Fault), by conventional methods, is represented with green straight arrows
TBM 9.5m  EPB 9.5m	Excavation of the main tunnels is represented by black straight arrows to show the direction of advance, and with a "9.5m TBM" label if the excavation is realized by means of a 9.5m diameter TBM, or a "EPB 9.5m" label if it is realized by means of an Earth Pressure Balance Shield
TBM 5.0m 	Excavation of the service tunnels (by means of a 5.0m-diameter TBM) is represented with red straight arrows
CONV	Excavation of the main tunnels using conventional methods (such as Drill & Blast or NATM) is represented with blue straight arrows
	A curved arrow represents the transportation of the same TBM in a different tunnel or in the second tube of the same twin bore tunnel
50000 60000	Chainage (i.e. Station) is given in the bottom of every figure. The chainage distance increases from Bakersfield to Los Angeles.

Fig. 3.1 I-5 Alignment with 3.5% maximum grade – Tunnel profile and construction scheme

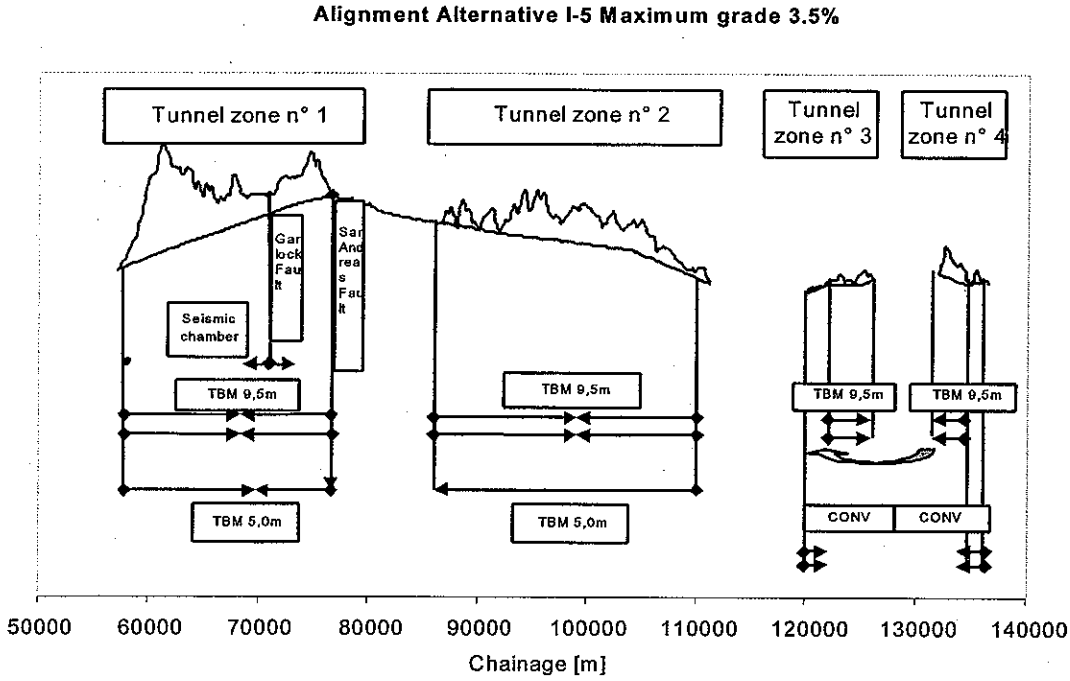


Fig. 3.2 I-5 Alignment with 2.5% maximum grade – Tunnel profile and construction scheme

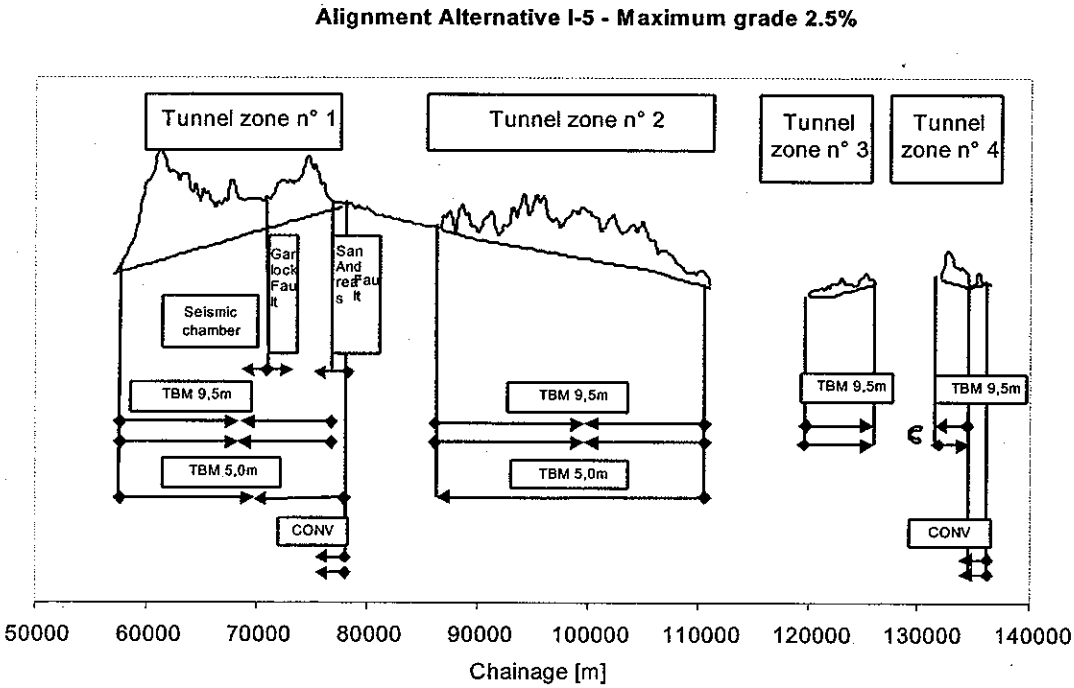


Fig. 3.3 AV Alignment with 3.5% maximum grade – Tunnel profile and construction scheme

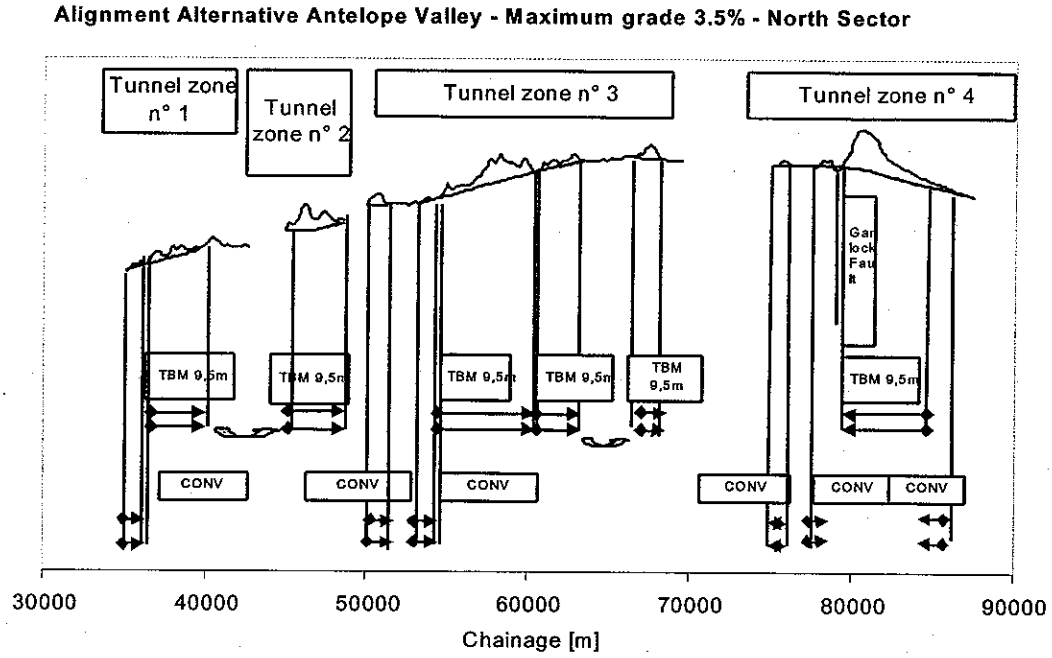


Fig. 3.4 AV Alignment with 3.5% maximum grade – Tunnel profile and construction scheme.

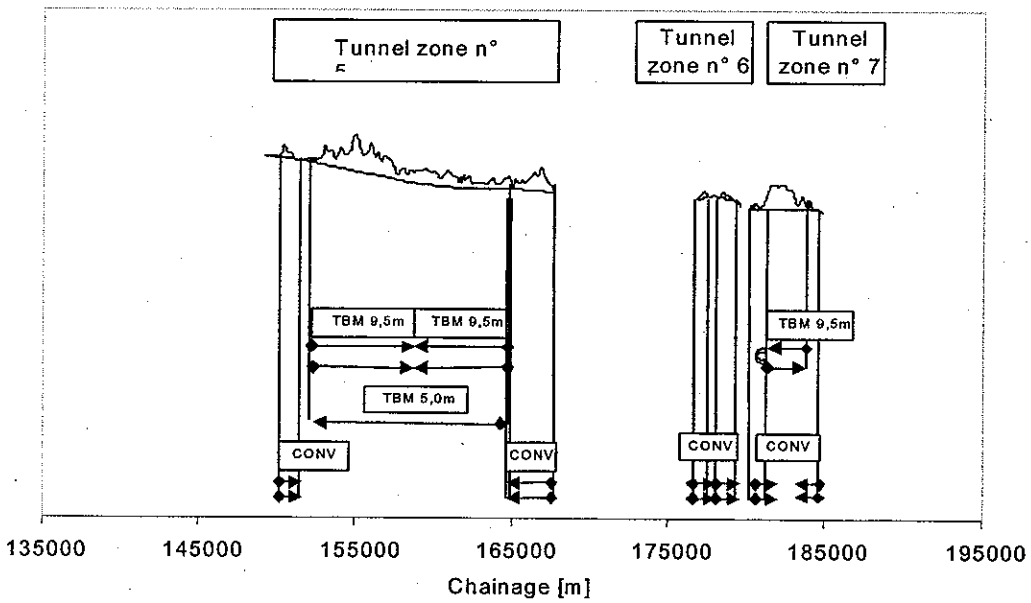


Fig. 3.5 AV Alignment with 2.5% maximum grade – Tunnel profile and construction scheme

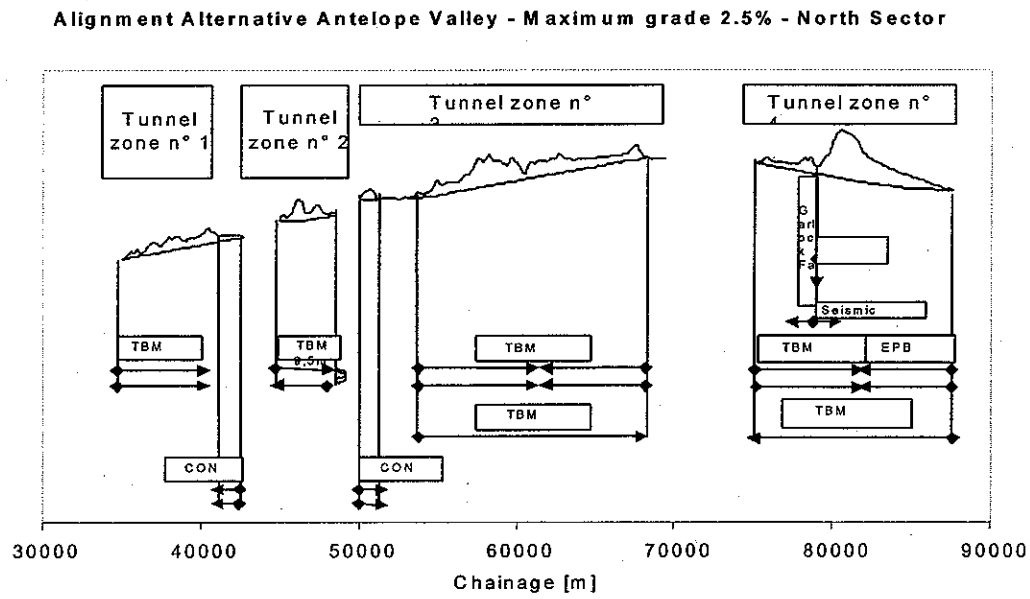


Fig. 3.6 AV Alignment with 2.5% maximum grade – Tunnel profile and construction scheme

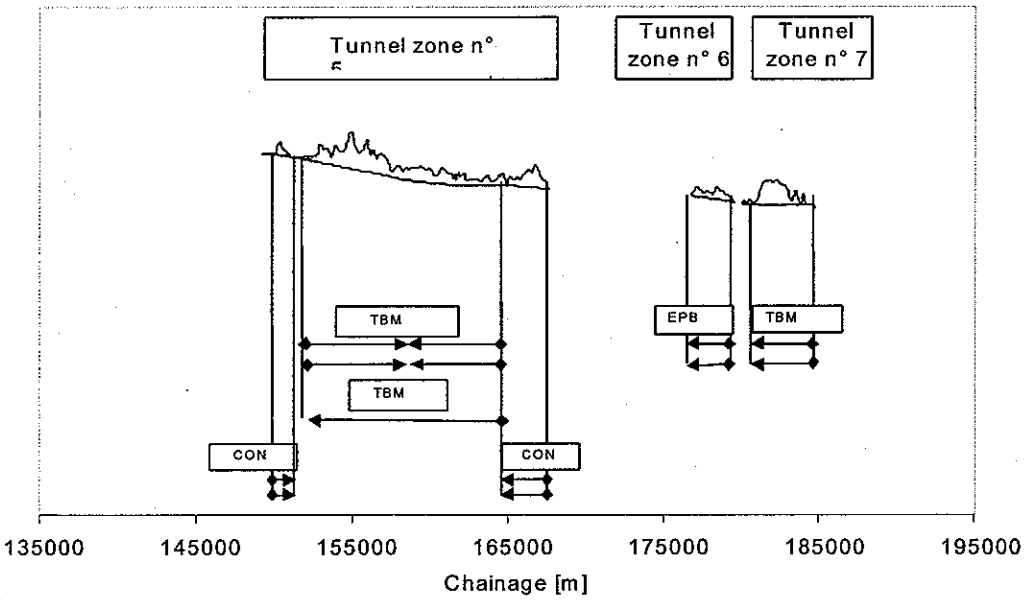


Table 3.2 Summary of construction phases

Summary of construction phases		Alignment Alternative I-5		Alignment Alternative AV	
		Max grade 3.5%	Max grade 2.5%	Max grade 3.5%	Max grade 2.5%
1) Main tunnels					
Number of Main Tunnels	[-]	8	8	36	14
Number of 9.5 m TBMs	[-]	*	*	*	*
Number of 9.5 m EPBSs	[-]	*	*	*	*
Cumulative Tunnel Length (Twin-Tunnel)	[km]	52.5	54.0	50.0	64.2
	[miles]	32.6	33.5	31.1	39.9
Total Tunneling length (counting both tubes)	[km]	104.9	107.9	99.9	128.3
	[miles]	65.2	67.0	62.1	79.7
Breakdown of Total Tunneling length according to Tunneling methods					
by TBM	[km]	100.8	103.8	78.9	114.0
	[miles]	62.6	64.5	49.0	70.8
by Cut & Cover	[km]	2.1	2.1	10.0	4.5
	[miles]	1.3	1.3	6.2	2.8
by Conventional method	[km]	2.0	2.0	11.0	9.8
	[miles]	1.2	1.2	6.8	6.1
2) Service Tunnels					
Number of Service Tunnels	[-]	2	2	1	3
Number of 5.0 m TBMs	[-]	*	*	*	*
Total length of Service Tunnels	[km]	43.5	43.5	13.0	24.9
	[miles]	27.0	27.0	8.1	15.5
3) Trenches					
Total length of Trenches due to adjustment of the Tunnels profiles	[km]	2.7	0.0	4.0	1.4
	[miles]	1.7	0.0	2.5	0.9
4) Other works					
Excavation sites/Portals	[-]	23	23	50	41
Number of shafts	[-]	1	1	0	1
Number of Major Fault Crossing Seismic Chambers	[-]	2	4	0	2
* To be defined					

Table 3.3 Construction scheme for the I-5 Alternative Alignment, 3.5% max. grade

	Alignment Alternative	I-5				
	Maximum grade	3.5%				
Tunnel zone number	Construction features	From chainage [m]	To chainage [m]	9.5m TBM	5.0m TBM	Traditional Excavation Sites
		[m]	[m]	[-]	[-]	[-]
1	Twin main tunnels	57300	76600	4		
	Service tunnel	57300	76600		2	
	Seismic chambers (from Service tunnel)	71325	70825			2
	Seismic chambers (from Service tunnel)	71325	71825			2
2	Twin main tunnels	86600	111200	4		
	Service tunnel	86600	111200		1	
3	Conventional excav.	120000	121500			2
	Twin main tunnels	121550	126000	2*		
4	Twin main tunnels	131950	134600	2*		
	Shaft (h=50m)	134600				1
	Conventional excav.	134600	135000			2
	Conventional excav.	135000	136200			2

Table 3.4 Construction scheme for the I-5 Alternative Alignment, max. 2.5% grade

	Alignment Alternative	I-5				
	Maximum grade	2.5%				
Tunnel zone number	Construction features	From chainage [m]	To chainage [m]	9.5m TBM	5.0m TBM	Traditional Excavation Sites
		[m]	[m]	[-]	[-]	[-]
1	Twin main tunnels	57300	76600	4		
	Service tunnel	57300	76600		2	
	Seismic chambers in Garlock Fault crossing (from Service tunnel)	71325	70825			2
	Seismic chambers in Garlock Fault crossing (from Service tunnel)	71325	71825			2
	Shaft (h=60m)	76200				1
	Seismic chambers in San Andrea Fault crossing (from Shaft)	75800	76200			2
	Seismic chambers in San Andrea Fault crossing (from Shaft)	76200	76800			2
2	Twin main tunnels	86600	111200	4		
	Service tunnel	86600	111200		1	
3	Twin main tunnels	120000	126000	2		
4	Twin main tunnels	131950	134600	1		
	Shaft (h=50m)	134600				1
	Conventional excavation	134600	135000			2
	Conventional excavation	135000	136400			2

Table 3.5 Construction scheme for the AV Alternative Alignment, max. 3.5% grade

	Alignment Alternative	AV				
	Maximum grade	3.5%				
Tunnel zone number	Construction features	From chainage [m]	To chainage [m]	9.5m TBM	5.0m TBM	Traditional Excavation Sites
		[m]	[m]	[-]	[-]	[-]
1	Conventional excav.	35000	36200			2
	Twin main tunnels	36250	39300	2*		
2	Twin main tunnels	44900	47850	2*		
3	Conventional excav.	50000	51350			2
	Conventional excav.	53000	54300			2
	Twin main tunnels	54300	60400	2		
	Twin main tunnels	60450	63150	2*		
	Twin main tunnels	66550	68250	2*		
4	Conventional excav.	75350	76250			2
	Conventional excav.	77750	78850			2
	Twin main tunnels	79150	85200	2		
	Conventional excav.	85200	85700			2
5	Conventional excav.	150150	151150			2
	Twin main tunnels	151950	165050	4		
	Service tunnel	151950	165050		1	
	Conventional excav.	165050	167750			2
6	Conventional excav.	176800	177600			2
	Conventional excav.	178500	179350			2
7	Conventional excav.	180600	180850			2
	Conventional excav.	181050	181650			2
	Twin main tunnels	181650	184000	1		
	Conventional excav.	184000	184700			2

Table 3.6 Construction scheme for the AV Alternative Alignment, max. 2.5% grade

	Alignment Alternative	AV				
	Maximum grade	2.5%				
Tunnel zone number	Construction features	From chainage [m]	To chainage [m]	9.5m TBM	5.0m TBM	Traditional Excavation Sites
		[m]	[m]	[-]	[-]	[-]
1	Twin main tunnels	35000	41500	2		
	Conventional excav.	41500	42950			2
2	Twin main tunnels	44900	48600	1		
3	Conventional excav.	50000	51350			2
	Twin main tunnels	53000	68200	4		
	Service tunnel	53000	68200		1	
4	Twin main tunnels	75000	87100	2+2**		
	Service tunnel	75000	87100		1	
	Shaft (h=50m)	78500				1
	Seismic chambers in Garlock Fault crossing (from Shaft)	78200	78500			2
	Seismic chambers in Garlock Fault crossing (from Shaft)	78500	79200			2
	*** EPB machine					
5	Conventional excav.	150150	151150			2
	Twin main tunnels	151950	165050	4		
	Service tunnel	151950	165050		1	
	Conventional excav.	165050	167750			2
6	Twin main tunnels	176800	179600	2**		
	** EPB machine					
7	Twin main tunnels	180000	184800	2		

4 DESCRIPTION OF DAT (DECISION AIDS IN TUNNELING)

In view of the number of alternatives under analysis and the potential for considerable risks associated with the selection of one alignment over the other, the use of the software /system DAT (Decision Aids in Tunneling) was used by the project study team. DAT is a tool for making probabilistic estimates of the time and cost of constructing a tunnel, or network of tunnels, taking into account the uncertainties in the geologic and construction variables. DAT also functions as a value adding tool for making an assessment of the risk of exceeding the thresholds of cost and time for projects.

A DAT run is essentially a computer simulation of several random processes. The idea of using computer simulations comes with the fact it is not possible to find analytically resulting random functions when processes are too complicated like the construction of tunnels. So simulating a construction process is the only solution to obtain statistical information about the total time and cost. This information gives a good idea on the average, minimum and maximum expected values. By definition, the simulation of a random process uses a random number generator.

DAT and the associated computer code SIMSUPER have been developed over a period of 20 years by MIT (Massachusetts Institute of Technology) and EPFL (École Polytéchnique Fédérale de Lausanne), with the participation of the US National Science Foundation, the Swiss Federal Office for Transportation, the Swiss Science Foundation, and Geodata SpA.

A unique feature of DAT is its capability for a comparative evaluation of the performance of project alternatives with respect to the potential of these alternatives in managing geotechnical and construction uncertainties within prescribed or acceptable values of time and cost.

DAT consists of two interrelated simulation modules: Geology and Construction.

In the Geology module the geotechnical conditions are organized in the various input matrices following an approach similar to that of defining a geotechnical profile, i.e., defining, chainage by chainage, all the geological and geomechanical conditions that have an impact on the tunnel construction practice. The user's task is to identify and define which are those parameters and what are their possible states. Uncertainty in this definition is either entered by indicating the variability in the assigned value of the parameter, and/or in its state probability (e.g., see Table 5.3). In addition, variability of conditions along a segment is modeled using a Markov process. In a manner similar to defining the geomechanics classification, different parameter states are combined to define homogeneous ground classes that are subsequently associated with the construction methods. For example, if problematic water inflows and squeezing conditions are identified as impacting parameters, their possible states have to be defined, as well as the influence of their possible state combinations on every excavation phase modeled in the subsequent construction module.

The Construction module consists of two principal components:

- The first refers to the construction methods where the construction cycle can be simulated activity by activity. In this case variability is introduced into the model by statistical distributions of basic construction indices, e.g., advance rate and unit cost, usually derived practical case histories and price analysis.
- The second module, which is referred to as *tunnel network,* permits the definition of the sequence of realization of a tunnel and a project, e.g., two opposite fronts for a tunnel, or excavation of a pilot bore by a TBM, followed by the enlargement by traditional (or conventional) methods.

In both the geology and the construction modules, variability of the parameters is described through a user-defined distribution function that can be chosen from among Uniform, Triangular, and Bounded Triangular distributions. In the Uniform distribution, the variable always has the same probability of taking on any value. In the Triangular distribution, a minimum value, a most likely value (the mode), and a maximum value have to be provided, recognizing that the total area under the triangle must equal one (as the total probability of occurrence of the parameter must be 100%). In the Bounded Triangular distribution, the probabilities on the minimum and maximum boundaries of the triangle are greater than zero. Where this last distribution has been used in this study, the minimum and maximum probabilities are indicated in the input tables.

5 DAT SIMULATIONS INPUT

5.1 Determination of the Geomechanical Parameters

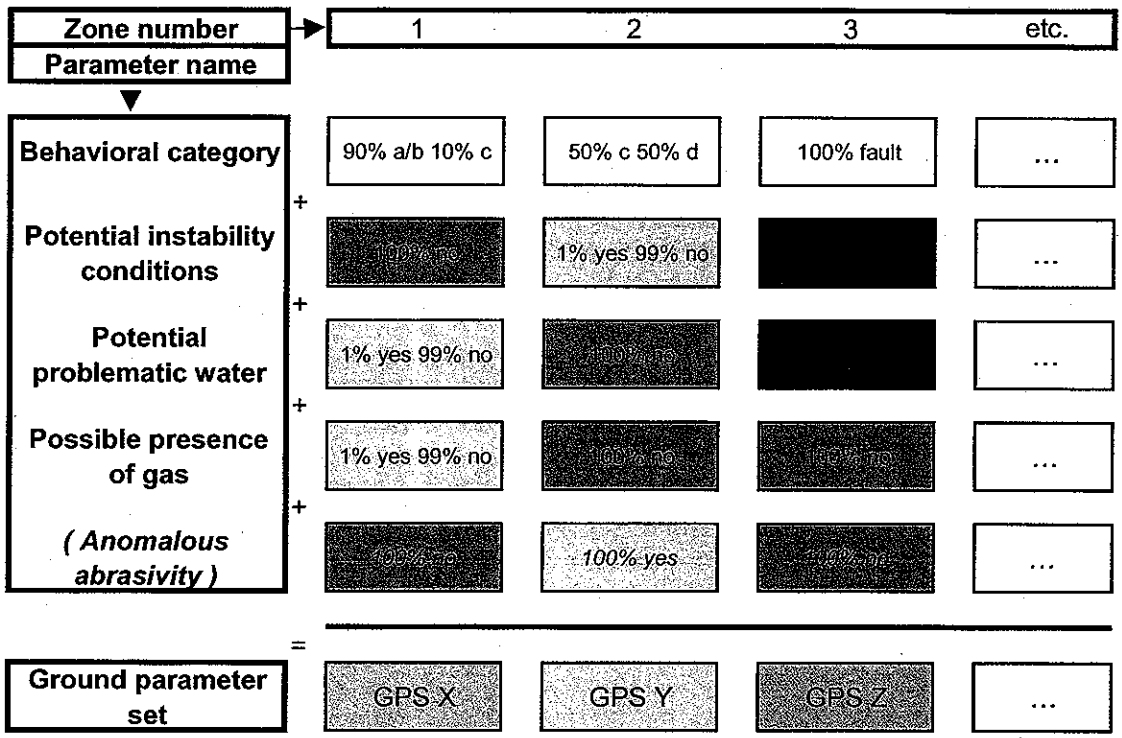
As part of the input to the DAT analysis, geological and geomechanical longitudinal profiles were defined based on maps of the USGS. Also, based on USGS reports, the essential geomechanical parameters were defined for each homogeneous geological zone.

In addition to the behavioral categories, the range of "geo-events" (see Sec. 2.6) that could cause delays and extra costs were considered, particularly when a tunnel was to be excavated by a TBM. A TBM is a relatively rigid method of excavation that cannot easily be adapted to changing ground conditions. The events that have been considered are:

- Potential instability conditions (excavation face, cavity, or both);
- Potential problematic water inflows (large quantities in short time);
- Possible presence of gas
- Anomalous abrasivity of the rocks to be excavated.

The combination of the behavioral categories and the first three of the above mentioned geo-events determines in an unambiguous way the so-called "Ground Parameter Set". A Ground Parameter Set includes the probability of occurrence of each parameter state and is not yet associated with a segment of tunnel. In other words, a few combinations of the parameters can be applied to a zone characterized by a unique Ground Parameter Set, as each parameter state is still expressed as a probability of occurrence. The univocal association of the unit segment to a homogeneous set of parameters brings it to the following stages: (a) combination of the Ground Parameter Set and the Anomalous Abrasivity parameter to define a Combined Ground Class, and (b) the Geological simulation that is repeated at every global simulation. The combination of the parameters that determine the values of cost and average advance rates, and/or the cost and duration of interventions in case of "accidents" associated with each meter of tunnel or each unit segment is the output of the Geological simulation. This output in turn becomes an input to the Construction simulation. This feature, which can be considered as the simulation of the geological uncertainty, makes one simulation different from another with respect to the geological aspect. It is not possible to show the detailed zoning of each parameter as it is different for each of the 1000 simulations. Instead, the following sections will define the meaning and the determination process of each Ground Parameter Set, as well as its zoning and the formation of the Anomalous Abrasivity zones that constitute the highest detail information that can be given without entering into each simulation run. Further details are given in Section 5.2.

Table 5.1 Schematic generation of the Ground Parameter Set corresponding to each homogeneous zone in DAT's Geo Module, results from the combination of behavioral categories and "geo-events". Colors refer to different states and/or combination of the parameter and express the importance of this combination. Values and combinations are given as an example of the method of determination of any Ground Parameter Set. For a detailed screening of possible parameter states, see Sections 5.1.1 to 5.1.5. The significance of brackets around the parameter "Anomalous abrasivity" is explained in paragraph 5.1.5.



The following sections show the details of each parameter, and the resulting Ground Parameter Set for each homogeneous zone.

5.1.1 Behavioral categories

For a description of the assumed classification, reference may be made to Section 2.4 Geomechanical characterization of the ground. In the present analysis, behavioral classes have been grouped in a slightly different way to fit the specific conditions of the specific project area characterized by an important number of major fault zones. In order to associate the most suitable construction parameters to those very special zones, a behavioral category named "fault" has been created because its characteristics actually duplicate those of the "f" category discussed in Section 2.4. The possible states of the "Behavioral category" parameter are shown in Table 5.2.

Table 5.2 The possible states of the "Behavioral category" parameter

Parameter	Possible states
Behavioral category	a/b
	c
	d
	e/f
	fault

In the definition of the Ground Parameter Sets, assignment of the parameter state is obtained with probabilistic assumptions, for example, a particular zone may be defined with a 50% probability of state "c" and a 50% probability of state "d". Several combinations have been assumed, presenting ratios of 10/90, 50/50 and 90/10 between two contiguous classes. The result is a probabilistic distribution of the behavioral classes, modeled in every simulation-run.

5.1.2 Potential instability conditions

Instability conditions have been grouped into three main categories: No Instability Zones, Minor Instability Zones and Major Instability Zones.

The three possible states of the parameter are associated with a probability of occurrence that allows the program to create the parameter zoning in a probabilistic way. The possible states of the "Potential Instability Condition" parameter, with their associated probabilities, are shown in Table 5.3.

Table 5.3 "Potential Instability Condition" parameter possible states and assumed probabilities of occurrence

Parameter	Possible states	Probability of occurrence	Probability of occurrence
		Instability	No Instability
Potential Instability Condition	No instability zones	0%	100%
	Minor instability zones	1%	99%
	Major instability zones	10%	90%

5.1.3 Potential problematic water inflow

Two principal scenarios have been hypothesized. In the first, no significant water inflows or minor water inflows (that do not impact on the construction process) can be anticipated. In the second, the water inflow phenomenon is severe enough to cause a construction delay (the excavation must be stopped in order to adopt the necessary countermeasures).
The two possible states of the parameter, are associated with a probability of occurrence that allows the program to create the parameter zoning in a probabilistic way. The possible states of the "Potential Problematic Water Inflow" parameter, with their associated probabilities, are shown in Table 5.4.

Table 5.4 "Potential Problematic Water Inflow" parameter possible states and assumed probabilities of occurrence in fault-free zones

Parameter	Possible states	Probability of occurrence	Probability of occurrence
		Water Inflow	No Water Inflow
Problematic Water Inflow	No/Minor Water Inflow	0%	100%
	Severe Water Inflow	1%	99%

When associated to Fault Zones, the probabilities of occurrence have been modified in order to consider the particular conditions and the higher risks of encountering problematic water inflows. In those particular zones, the two states of the parameter are shown in Table 5.5.

Table 5.5 The possible states of the "Potential Problematic Water Inflow" parameter and assumed probabilities of occurrence in Fault zones

Parameter	Possible states	Probability of occurrence	Probability of occurrence
		Water Inflow	No Water Inflow
Problematic Water Inflow	Minor Water Inflow	10%	90%
	Severe Water Inflow	20%	80%

5.1.4 Possible presence of gas

Two principal scenarios have been hypothesized. In the first case, no gas (mainly potentially explosive hydrocarbon-type) shall be encountered during construction, while in the second case it will be encountered without prior warning and thus force the excavation to be stopped in order to allow the gas to dissipate.

The two possible states of the parameter are associated with a probability of occurrence that allows the program to create the parameter zoning in a probabilistic way. The possible states of the "Possible presence of gas" parameter, with their associated probabilities, are shown in Table 5.6.

Table 5.6 The possible states of the "Possible presence of gas" parameter and assumed probabilities of occurrence.

Parameter	Possible states	Probability of occurrence	Probability of occurrence
		Gas detected	No Gas detected
Possible presence of gas	No Gas zone	0%	100%
	Probable Gas zone	1%	99%

As for the "Potential Problematic Water Inflow" parameter, in Fault zones characterized by a high risk of gas presence, the probability of occurrence has been raised as showed in Table 5.7.

Table 5.7 The possible states of the "Possible presence of gas" parameter and assumed probabilities of occurrence in Fault zones

Parameter	Possible states	Probability of occurrence	Probability of occurrence
		Gas detected	No Gas detected
Possible presence of gas	Minor Gas zone	10%	90%
	Probable Gas zone	20%	80%

5.1.5 Anomalous abrasivity

Two conditions are anticipated. In the first, normal abrasion conditions can be anticipated, while in the second, the presence of quartz-feldspar-rich massive rocks can cause delays during the TBM construction phase due to abrasivity. This condition will lead to additional costs because excavation tools are changed more often. Like the other parameters, the "Anomalous abrasivity" parameter has also two states with different assumed probabilities of occurrence that permit the creation of the parameter state distribution profile along a tunnel alignment in a probabilistic way. Unlike the other parameters, the abrasivity doesn't really take part in the definition of the Ground Parameter Set (that is why its name has been enclosed in brackets in Table 5.1), but acts at the same level as the Ground Parameter Set. This increases the cost and reduces the advance rate in the successive construction phase. This option, especially included in the DAT program, allows for the number of Ground Parameter Sets to be kept relatively low otherwise it would be doubled by the presence of this double state additional parameter, thus increasing the data-input time and the possibility of errors. The combination of Ground Parameter Set and Abrasivity class leads to the definition of the so-called "Combined Ground Class" that is finally used to define the most appropriate method of construction for each of the Combined Ground Classes. By the way, the effect of this device over the simulation results is minimal as it works as a mere user facility.

For this reason abrasivity will henceforth be considered as a "normal" parameter in order to maintain a higher readability of the report.

Table 5.8 The possible states of the "Anomalous abrasivity" parameter and assumed probabilities of occurrence

Parameter	Possible states	Probability of occurrence	Probability of occurrence
		Anomalous abrasivity	Normal abrasivity
Anomalous abrasivity	Non abrasive	0%	100%
	Abrasive	100%	0%

5.1.6 Ground parameter set

The result of the combination of considered parameters is the subdivision of both the Alignment Alternative corridors in homogeneous zones, defined either position wise or length wise and characterized by an assigned Ground Parameter Set. In Table 5.9a an example of a particular tunnel zone is given (Tunnel zone n°2 of the I-5 Alternative Alignment), with reference to the univocal determination of the Ground Parameter Set in each homogeneous zone. In Table 5.9b a detailed example is given for a typical Ground Parameter Set in order to show how the concepts shown previously are realized in the geomechanical input phase.

Note that a zone can be considered as homogeneous only when the key geologic factors, characteristic of that particular zone, can be reasonably assumed to be constant or variable in accordance with a certain "probabilistic rule" (the concept of Markov process).

Furthermore, the zoning of an alignment according to the established geologic conditions is modeled in DAT allowing the boundaries between adjacent homogeneous zones to vary in each simulation run with a predefined range. For example, the position of a fault zone at the tunnel level cannot be defined precisely until construction approaches the approximate position and the variability can be considered in the geological model and modeled statistically by DAT. This method of simulating geological parameter variations or uncertainties represents actually a sensitivity analysis.

Finally, it should be noted that the negative effects of tunnel instability on construction time and cost are generally greater with increasingly worse ground conditions or when the ground falls in unfavorable behavioral categories (e, f and fault zones).

Table 5.9a Example of the zoning of Tunnel zone n°2 in the I-5 Alternative with reference to the determination of the Ground Parameter Set (GPS)

			BEHAVIORAL CATEGORIES					POTENTIAL INSTABILITY CONDITIONS		POTENTIAL PROBLEMATIC WATER INFLOW		POSSIBLE PRESENCE OF GAS		GPS
Zone number	Mode start position	Mode end position	a/b	c	d	e/f	Fault	Instability	No instability	Water inflow	No water inflow	Gas detected	No gas detected	
T2_1	86600	86700			50%	50%		1%	99%		100%	0%	100%	41
T2_2	86700	87900	10%	90%					100%		100%	10%	90%	21
T2_3 f	87900	87950					100%	1%	99%	10%	90%	10%	90%	4
T2_4	87950	90100	10%	90%					100%		100%	10%	90%	21
T2_5 f	90100	90150					100%	1%	99%	10%	90%	10%	90%	4
T2_6	90150	91900		90%	10%			1%	99%		100%	10%	90%	27
T2_7 f	91900	91950					100%	1%	99%	10%	90%	10%	90%	4
T2_8	91950	93600		50%	50%			1%	99%	1%	99%	10%	90%	34
T2_9 f	93600	93650					100%	1%	99%	10%	90%	10%	90%	4
T2_10	93650	94600		50%	50%			1%	99%	1%	99%	10%	90%	34
T2_11 f	94600	94650					100%	1%	99%	10%	90%	10%	90%	4
T2_12	94650	97400		50%	50%			1%	99%	1%	99%	10%	90%	34
T2_13 f	97400	97450					100%	1%	99%	10%	90%	10%	90%	4
T2_14	97450	101300		90%	10%			1%	99%	1%	99%	10%	90%	26
T2_15 f	101300	101350					100%	1%	99%	10%	90%	10%	90%	4
T2_16	101350	103200		90%	10%			1%	99%	1%	99%	10%	90%	26
T2_17 f	103200	103250					100%	1%	99%	10%	90%	10%	90%	4
T2_18	103250	104550		50%	50%			1%	99%	1%	99%	10%	90%	34
T2_19	104550	106350			50%	50%		1%	99%		100%	10%	90%	43
T2_20 f	106350	106400					100%	1%	99%	10%	90%	10%	90%	4
T2_21	106400	109850			50%	50%		1%	99%		100%	10%	90%	43
T2_22 f	109850	109900					100%	1%	99%	10%	90%	10%	90%	4
T2_23	109900	120000			50%	50%		1%	99%		100%	10%	90%	43

As can be seen in Table 5.9a, each homogeneous zone of Tunnel n°2 is defined by a particular set of parameters and its code is given in the last column. That particular value is the result of the combination of behavioral category and the range of "geo-events". For example, the Ground Parameter Set n°26 can be found in Table 4.9a at Chainage 97450-101300 and 101350-103200, with the corresponding parameter probabilities. As it is shown in that table, those two zones contain a Fault zone (Chainage 101300–101350, characterized by an "f" suffix in the zone name, Ground Parameter Set 4), that is characterized by a 100% probability of "fault" behavioral category, a 1% probability of instability conditions, 10% probability of problematic water inflow and 10% of gas presence. Other fault zones can be found in the same tunnel zone, as well as in poor condition zones.

Table 5.9b Example of characterization of a Ground Parameter Set for a given zone

Ground Parameter Set number					26	Zones in which the GPS is present in Alignment Alternative AV				T5_16, T5_20	
						Zones in which the GPS is present in Alignment Alternative I-5				T2_14, T2_16, T4_6	
BEHAVIORAL CATEGORIES						POTENTIAL INSTABILITY CONDITIONS		POTENTIAL PROBLEMATIC WATER INFLOW		POSSIBLE PRESENCE OF GAS	
a/b	c	d	e/f	Fault		Instability	No instability	Water inflow	No water inflow	Gas detected	No gas detected
	90%	10%				1%	99%	1%	99%	10%	90%
Notes						Notes		Notes		Notes	
In the zones characterized by the GPS 26, DAT assigns to each unit length a behavioral category that is determined with the Monte Carlo method assuming a probabilistic distribution of 90% of "c" group and a 10% of "d" group.						In the same zones, the presence of instability conditions has a probabilistic distribution of 1% of occurrence, and 99% of no occurrence		The presence of problematic water inflows has a probabilistic distribution of 1% of occurrence, and 99% of no occurrence		In the same manner, the presence of gas has a probabilistic distribution of 10% of occurrence, and 90% of no occurrence	

The Ground Parameter Set n°26 is shown with its characteristics in Table 5.9b; the meaning of the given probabilities is expressed in the last-row notes. For each unit length (whose value gives the distance between two successive parameters typically 10 m), the Monte Carlo method is applied to determine the state of each parameter following the distribution of probabilities defined in the corresponding Ground Parameter Set. With reference to the same Ground Parameter Set n°26, shown as an example, it can be pointed out that each unit segment can be assigned a "c" or a "d" behavioral category following respective probabilities of 90% and 10%. In the same way, instability or no instability can be assigned with a 1%/99% ratio, as well as water inflow or no water inflow and gas detected and no gas detected with their relative probabilities. This leads to the fact that each unit segment characterized with a Ground Parameter Set n°26 may be assigned to a combination of parameters that is different in every simulation run. (See Table 5.9c):

Table 5.9c Example of the combinations of Behavioral category, Instability conditions, Problematic water inflow and Presence of Gas that can be assigned to a unit segment characterized by a defined Ground Parameter Set (in this example, set n° 26).

GROUND PARAMETER SET N° 26			
BEHAVIORAL CATEGORIES	**POTENTIAL INSTABILITY CONDITIONS**	**POTENTIAL PROBLEMATIC WATER INFLOW**	**POSSIBLE PRESENCE OF GAS**
c (90%)	Instability (1%)	Water inflow (1%)	Gas detected (10%)
			No gas detected (90%)
		No water inflow (99%)	Gas detected (10%)
			No gas detected (90%)
	No instability (99%)	Water inflow (1%)	Gas detected (10%)
			No gas detected (90%)
		No water inflow (99%)	Gas detected (10%)
			No gas detected (90%)
d (10%)	Instability (1%)	Water inflow (1%)	Gas detected (10%)
			No gas detected (90%)
		No water inflow (99%)	Gas detected (10%)
			No gas detected (90%)
	No instability (99%)	Water inflow (1%)	Gas detected (10%)
			No gas detected (90%)
		No water inflow (99%)	Gas detected (10%)
			No gas detected (90%)

As explained in Section 5.1, it is not possible to show the detailed zoning of each segment, as it varies in each simulation run and its single run report would not bring any further useful information. The zoning of both the Alignment Alternatives is thus given in Tables 5.10 to 5.17, showing both the probabilistic positioning of zones and the probabilistic assignment of the parameters by means of the Ground Parameter Set zoning. In Tables 5.18 and 5.19 the zoning of the parameter "Anomalous abrasivity" is shown. The zonings with little error are valid for both max grade options 2.5% and 3.5%.

Finally, it should be pointed out that the estimation of the probability of occurrence of adverse geologic conditions is partly based on engineering judgement and past experiences gained from tunneling in similar geologic environments, in addition to maximizing the usage of the available information. This approach is appropriate considering the limited quality and the extent of the available geologic knowledge about the specific area of interest, as mentioned earlier in Section 1.2.1. In the future when additional new information (from direct investigations and from records of past tunneling experiences in the project region) becomes available one can use the new information to check the adequacy of currently assumed figures and to re-calibrate the occurrence assumptions of adverse conditions, thus arriving at a more objective model.

Table 5.10 Alignment Alternative I-5 - Subdivision in homogeneous zones and Ground Parameter Set of each zone (1 of 4).

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16
Name	T1_0	T1_1	T1_2	T1_3 Pleito	T1_4	T1_5	T1_6	T1_7	T1_8 f	T1_9	T1_10 f	T1_11	T1_12 f	T1_13	T1_14 f	T1_15
Generation mode	1	1	2	1	1	1	1	2	1	2	1	2	1	2	1	2
Min length	57000	150	--	100	50	700	400	--	50	--	50	--	50	--	50	--
Mode length	57000	200	--	200	100	800	500	--	100	--	100	--	100	--	100	--
Max length	57000	250	--	300	150	900	600	--	150	--	150	--	150	--	150	--
Prob. Min length	0	0.1	--	0.1	0.1	0.1	0	--	0	--	0	--	0	--	0	--
Prob. Max length	0	0.1	--	0.1	0.1	0.1	0	--	0	--	0	--	0	--	0	--
Min end position	--	--	57550	--	--	--	--	62300	--	62900	--	63800	--	64500	--	66700
Mode end position	57000	--	57600	--	--	--	--	62400	--	63000	--	63900	--	64600	--	66850
Max end position	--	--	57650	--	--	--	--	62500	--	63100	--	64000	--	64700	--	67000
Prob. Min position	--	--	0	--	--	--	--	0	--	0	--	0	--	0	--	0
Prob. Max pos	--	--	0	--	--	--	--	0	--	0	--	0	--	0	--	0
Ground parameter set	41	41	24	5	24	17	19	24	3	24	3	24	3	20	3	41

	Zone 17	Zone 18	Zone 19	Zone 20	Zone 21	Zone 22	Zone 23	Zone 24	Zone 25	Zone 26	Zone 27	Zone 28	Zone 29	Zone 30	Zone 31	Zone 32
Name	T1_16 Pastoria	T1_17	T1_18	T1_19 Garlock	T1_20	T1_21	T1_22	T1_23 S Andreas	T2_1	T2_2	T2_3 f	T2_4	T2_5 f	T2_6	T2_7 f	T2_8
Generation mode	1	2	1	1	1	2	2	2	1	2	1	2	1	2	1	2
Min length	200	--	150	600	150	--	--	--	50	--	25	--	25	--	25	--
Mode length	500	--	200	800	200	--	--	--	100	--	50	--	50	--	50	--
Max length	800	--	250	1000	250	--	--	--	150	--	75	--	75	--	75	--
Prob. Min length	0	--	0	0	0	--	--	--	0	--	0.5	--	0.5	--	0.5	--
Prob. Max length	0	--	0	0	0	--	--	--	0	--	0	--	0	--	0	--
Min end position	--	69500	--	--	--	75600	76700	86600	--	87800	--	90000	--	91800	--	93500
Mode end position	--	69650	--	--	--	75800	76800	86600	--	87900	--	90100	--	91900	--	93600
Max end position	--	69800	--	--	--	76000	76700	86600	--	88000	--	90200	--	92000	--	93700
Prob. Min position	--	0	--	--	--	0	0	0	--	0	--	0	--	0	--	0
Prob. Max pos	--	0	--	--	--	0	0	0	--	0	--	0	--	0	--	0
Ground parameter set	5	22	24	5	24	22	36	5	41	21	4	21	4	27	4	34

Table 5.11 Alignment Alternative I-5 - Subdivision in homogeneous zones and Ground Parameter Set of each zone (2 of 4)

	Zone 33	Zone 34	Zone 35	Zone 36	Zone 37	Zone 38	Zone 39	Zone 40	Zone 41	Zone 42	Zone 43	Zone 44	Zone 45	Zone 46	Zone 47	Zone 48
Name	T2_9 f	T2_10	T2_11 f	T2_12	T2_13 f	T2_14	T2_15 f	T2_16	T2_17 f	T2_18	T2_19	T2_20 f	T2_21	T2_22 f	T2_23	T3_1
Generation mode	1	2	1	2	1	2	1	2	1	2	2	1	2	1	2	1
Min length	25	--	25	--	25	--	25	--	25	--	--	25	--	25	--	1900
Mode length	50	--	50	--	50	--	50	--	50	--	--	50	--	50	--	2100
Max length	75	--	100	--	75	--	75	--	75	--	--	75	--	75	--	2300
Prob. Min length	0.5	--	0	--	0.5	--	0.5	--	0.5	--	--	0.5	--	0.5	--	0
Prob. Max length	0	--	0	--	0	--	0	--	0	--	--	0	--	0	--	0
Min end position	--	94500	--	97300	--	101200	--	103100	--	104350	106250	--	109750	--	120000	--
Mode end position	--	94600	--	97400	--	101300	--	103200	--	104550	106350	--	109850	--	120000	--
Max end position	--	94700	--	97500	--	101400	--	103300	--	104750	106450	--	109950	--	120000	--
Prob. Min position	--	0	--	0	--	0	--	0	--	0	0	--	0	--	0	--
Prob. Max pos	--	0	--	0	--	0	--	0	--	0	0	--	0	--	0	--
Ground parameter set	4	34	4	34	4	26	4	26	4	34	43	4	43	4	43	36

	Zone 49	Zone 50	Zone 51	Zone 52	Zone 53	Zone 54	Zone 55	Zone 56	Zone 57	Zone 58	Zone 59	Zone 60	Zone 61	Zone 62	Zone 63	
Name	T3_2	T3_3 f	T3_4	T3_5 f	T3_6	T3_7 f	T3_8	T4_1	T4_2	T4_3 f	T4_4	T4_5 f	T4_6	T4_7 f	T4_8	
Generation mode	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
Min length	--	25	--	100	--	25	--	50	--	25	--	25	--	25	--	
Mode length	--	50	--	150	--	50	--	100	--	50	--	50	--	50	--	
Max length	--	75	--	250	--	75	--	150	--	75	--	75	--	75	--	
Prob. Min length	--	0.5	--	0	--	0.5	--	0	--	0.5	--	0.5	--	0.5	--	
Prob. Max length	--	0	--	0	--	0	--	0	--	0	--	0	--	0	--	
Min end position	123200	--	124100	--	125500	--	132000	--	134200	--	134600	--	135200	--	200000	
Mode end position	123300	--	124200	--	125600	--	132000	--	134300	--	134700	--	135300	--	200000	
Max end position	123400	--	124300	--	125700	--	132000	--	134400	--	134800	--	135400	--	200000	
Prob. Min position	0	--	0	--	0	--	0	--	0	--	0	--	0	--	0	
Prob. Max pos	0	--	0	--	0	--	0	--	0	--	0	--	0	--	0	
Ground parameter set	36	4	36	6	36	4	36	41	27	4	27	4	26	4	41	

Table 5.12 Alignment Alternative I-5 - Subdivision in homogeneous zones and Ground Parameter Set of each zone (3 of 4)

				BEHAVIORAL CATEGORIES					POTENTIAL INSTABILITY CONDITIONS		POTENTIAL PROBLEMATIC WATER INFLOW		POSSIBLE PRESENCE OF GAS		Ground Parameter Set
Zone number	Zone name	Mode start position	Mode end position	a/b	c	d	e/f	Fault	Instability	No instability	Water inflow	No water inflow	Gas detected	No gas detected	
Zone 1	T1_0	57000	57000	0%	0%	50%	50%	0%	1%	99%	0%	100%	0%	100%	41
Zone 2	T1_1	57000	57200	0%	0%	50%	50%	0%	1%	99%	0%	100%	0%	100%	41
Zone 3	T1_2	57200	57600	0%	90%	10%	0%	0%	1%	99%	1%	99%	0%	100%	24
Zone 4	T1_3 Pleito	57600	57800	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
Zone 5	T1_4	57800	57900	0%	90%	10%	0%	0%	1%	99%	1%	99%	0%	100%	24
Zone 6	T1_5	57900	58700	90%	10%	0%	0%	0%	0%	100%	0%	100%	0%	100%	17
Zone 7	T1_6	58700	59200	90%	10%	0%	0%	0%	0%	100%	0%	100%	10%	90%	19
Zone 8	T1_7	59200	62400	0%	90%	10%	0%	0%	1%	99%	1%	99%	0%	100%	24
Zone 9	T1_8 f	62400	62500	0%	0%	0%	0%	100%	1%	99%	10%	90%	0%	100%	3
Zone 10	T1_9	62500	63000	0%	90%	10%	0%	0%	1%	99%	1%	99%	0%	100%	24
Zone 11	T1_10 f	63000	63100	0%	0%	0%	0%	100%	1%	99%	10%	90%	0%	100%	3
Zone 12	T1_11	63100	63900	0%	90%	10%	0%	0%	1%	99%	1%	99%	0%	100%	24
Zone 13	T1_12 f	63900	64000	0%	0%	0%	0%	100%	1%	99%	10%	90%	0%	100%	3
Zone 14	T1_13	64000	64600	10%	90%	0%	0%	0%	0%	100%	0%	100%	0%	100%	20
Zone 15	T1_14 f	64600	64700	0%	0%	0%	0%	100%	1%	99%	10%	90%	0%	100%	3
Zone 16	T1_15	64700	66850	0%	0%	50%	50%	0%	1%	99%	0%	100%	0%	100%	41
Zone 17	T1_16 Pastoria	66850	67350	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
Zone 18	T1_17	67350	69650	50%	50%	0%	0%	0%	0%	100%	0%	100%	0%	100%	22
Zone 19	T1_18	69650	69850	0%	90%	10%	0%	0%	1%	99%	1%	99%	0%	100%	24
Zone 20	T1_19 Garlock	69850	70650	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
Zone 21	T1_20	70650	70850	0%	90%	10%	0%	0%	1%	99%	1%	99%	0%	100%	24
Zone 22	T1_21	70850	75800	50%	50%	0%	0%	0%	0%	100%	0%	100%	0%	100%	22
Zone 23	T1_22	75800	76800	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
Zone 24	T1_23 S Andreas	76800	86600	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
Zone 25	T2_1	86600	86700	0%	0%	50%	50%	0%	1%	99%	0%	100%	0%	100%	41
Zone 26	T2_2	86700	87900	10%	90%	0%	0%	0%	0%	100%	0%	100%	10%	90%	21
Zone 27	T2_3 f	87900	87950	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 28	T2_4	87950	90100	10%	90%	0%	0%	0%	0%	100%	0%	100%	10%	90%	21
Zone 29	T2_5 f	90100	90150	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 30	T2_6	90150	91900	0%	90%	10%	0%	0%	1%	99%	0%	100%	10%	90%	27
Zone 31	T2_7 f	91900	91950	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 32	T2_8	91950	93600	0%	50%	50%	0%	0%	1%	99%	1%	99%	10%	90%	34
Zone 33	T2_9 f	93600	93650	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 34	T2_10	93650	94600	0%	50%	50%	0%	0%	1%	99%	1%	99%	10%	90%	34
Zone 35	T2_11 f	94600	94650	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 36	T2_12	94650	97400	0%	50%	50%	0%	0%	1%	99%	1%	99%	10%	90%	34
Zone 37	T2_13 f	97400	97450	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 38	T2_14	97450	101300	0%	90%	10%	0%	0%	1%	99%	1%	99%	10%	90%	26
Zone 39	T2_15 f	101300	101350	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 40	T2_16	101350	103200	0%	90%	10%	0%	0%	1%	99%	1%	99%	10%	90%	26
Zone 41	T2_17 f	103200	103250	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 42	T2_18	103250	104550	0%	50%	50%	0%	0%	1%	99%	1%	99%	10%	90%	34

Table 5.13 Alignment Alternative I-5 - Subdivision in homogeneous zones and Ground Parameter Set of each zone (4 of 4)

				BEHAVIORAL CATEGORIES					POTENTIAL INSTABILITY CONDITIONS		POTENTIAL PROBLEMATIC WATER INFLOW		POSSIBLE PRESENCE OF GAS		Ground Parameter Set
Zone number	Zone name	Mode start position	Mode end position	a/b	c	d	e/f	Fault	Instability	No instability	Water inflow	No water inflow	Gas detected	No gas detected	
Zone 43	T2_19	104550	106350	0%	0%	50%	50%	0%	1%	99%	0%	100%	10%	90%	43
Zone 44	T2_20 f	106350	106400	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 45	T2_21	106400	109850	0%	0%	50%	50%	0%	1%	99%	0%	100%	10%	90%	43
Zone 46	T2_22 f	109850	109900	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 47	T2_23	109900	120000	0%	0%	50%	50%	0%	1%	99%	0%	100%	10%	90%	43
Zone 48	T3_1	120000	122100	0%	0%	10%	90%	0%	1%	99%	1%	99%	0%	100%	36
Zone 49	T3_2	122100	123300	0%	0%	10%	90%	0%	1%	99%	1%	99%	0%	100%	36
Zone 50	T3_3 f	123300	123350	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 51	T3_4	123350	124200	0%	0%	10%	90%	0%	1%	99%	1%	99%	0%	100%	36
Zone 52	T3_5 f	124200	124350	0%	0%	0%	0%	100%	10%	90%	20%	80%	20%	80%	6
Zone 53	T3_6	124350	125600	0%	0%	10%	90%	0%	1%	99%	1%	99%	0%	100%	36
Zone 54	T3_7 f	125600	125650	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 55	T3_8	125650	132000	0%	0%	10%	90%	0%	1%	99%	1%	99%	0%	100%	36
Zone 56	T4_1	132000	132100	0%	0%	50%	50%	0%	1%	99%	0%	100%	0%	100%	41
Zone 57	T4_2	132100	134300	0%	90%	10%	0%	0%	1%	99%	0%	100%	10%	90%	27
Zone 58	T4_3 f	134300	134350	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 59	T4_4	134350	134700	0%	90%	10%	0%	0%	1%	99%	0%	100%	10%	90%	27
Zone 60	T4_5 f	134700	134750	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 61	T4_6	134750	135300	0%	90%	10%	0%	0%	1%	99%	1%	99%	10%	90%	26
Zone 62	T4_7 f	135300	135350	0%	0%	0%	0%	100%	1%	99%	10%	90%	10%	90%	4
Zone 63	T4_8	135350	200000	0%	0%	50%	50%	0%	1%	99%	0%	100%	0%	100%	41

Table 5.14 Alignment Alternative AV - Subdivision in homogeneous zones and Ground Parameter Set of each zone (1 of 4)

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16	Zone 17
Name	T1_0	T1_1	T1_2	T1_3 f	T1_4	T1_5	T1_6	T1_7	T1_8 Edison	T1_9	T1_10 Edison	T1_11	T2_1	T2_2 f	T2_3	T2_4 f	T2_5
Generation mode	1	2	2	1	2	2	1	2	1	2	2	2	1	1	2	1	2
Min length	35000	--	--	25	--	--	450	--	150	--	--	--	50	50	--	25	--
Mode length	35000	--	--	50	--	--	550	--	200	--	--	--	100	100	--	50	--
Max length	35000	--	--	75	--	--	650	--	250	--	--	--	150	150	--	75	--
Prob. Min length	0	--	--	0	--	--	0	--	0	--	--	--	0	0	--	0	--
Prob. Max length	0	--	--	0	--	--	0	--	0	--	--	--	0	0	--	0	--
Min end position	--	35050	35900	--	36500	37100	--	38300	--	39600	40400	45000	--	--	47950	--	50000
Mode end position	--	35100	36000	--	36600	37200	--	38400	--	39800	40600	45000	--	--	48050	--	50000
Max end position	--	35150	36100	--	36700	37300	--	38500	--	40000	40800	45000	--	--	48150	--	50000
Prob. Min position	--	0	0	--	0	0	--	0	--	0	0	0	--	--	0	--	0
Prob. Max pos	--	0	0	--	0	0	--	0	--	0	0	0	--	--	0	--	0
Ground parameter set	29	29	33	4	33	29	33	29	5	32	36	40	33	5	22	3	33

	Zone 18	Zone 19	Zone 20	Zone 21	Zone 22	Zone 23	Zone 24	Zone 25	Zone 26	Zone 27	Zone 28	Zone 29	Zone 30	Zone 31	Zone 32	Zone 33	Zone 34
Name	T3_1	T3_2	T3_3	T3_4	T3_5 f	T3_6	T3_7	T3_8	T3_9	T3_10 f	T3_11	T3_12 f	T3_13	T3_14	T3_15	T3_16 f	T3_17
Generation mode	1	2	1	1	1	1	2	1	2	1	2	1	2	2	2	1	2
Min length	50	--	25	4600	25	150	--	600	--	100	--	25	--	--	--	25	--
Mode length	75	--	50	4800	50	200	--	650	--	150	--	50	--	--	--	50	--
Max length	100	--	75	5000	75	250	--	700	--	200	--	75	--	--	--	75	--
Prob. Min length	0	--	0	0	0	0	--	0	--	0	--	0	--	--	--	0	--
Prob. Max length	0	--	0	0	0	0	--	0	--	0	--	0	--	--	--	0	--
Min end position	--	50800	--	--	--	--	58800	--	59900	--	61450	--	64500	66900	67700	--	69200
Mode end position	--	51000	--	--	--	--	59000	--	60100	--	61550	--	64600	67000	67800	--	69300
Max end position	--	51200	--	--	--	--	59200	--	60250	--	61650	--	64700	67100	67900	--	69400
Prob. Min position	--	0	--	--	--	--	0	--	0	--	0	--	0	0	0	--	0
Prob. Max pos	--	0	--	--	--	--	0	--	0	--	0	--	0	0	0	--	0
Ground parameter set	40	28	5	44	5	32	25	32	37	5	32	5	37	40	44	5	44

	Zone 35	Zone 36	Zone 37	Zone 38	Zone 39	Zone 40	Zone 41	Zone 42	Zone 43	Zone 44	Zone 45	Zone 46	Zone 47	Zone 48	Zone 49	Zone 50	Zone 51
Name	T3_18	T4_1	T4_2 f	T4_3	T4_4 Garlock	T4_5	T4_6 f	T4_7	T4_8 f	T4_9	T4_10	T4_11	T5_1	T5_2 f	T5_3	T5_4	T5_5 f
Generation mode	2	2	1	2	1	2	1	2	1	1	2	2	2	1	2	2	1
Min length	--	--	100	--	400	--	25	--	25	500	--	--	--	25	--	--	25
Mode length	--	--	150	--	500	--	50	--	50	600	--	--	--	50	--	--	50
Max length	--	--	200	--	600	--	75	--	75	700	--	--	--	75	--	--	75
Prob. Min length	--	--	0	--	0	--	0.5	--	0.5	0	--	--	--	0.5	--	--	0.5
Prob. Max length	--	--	0	--	0	--	0	--	0	0	--	--	--	0	--	--	0
Min end position	75000	77400	--	78750	--	82150	--	83400	--	--	84300	149400	150900	--	151650	152550	--
Mode end position	75000	77500	--	78850	--	82250	--	83500	--	--	84400	149400	151000	--	151750	152650	--
Max end position	75000	77600	--	78950	--	82350	--	83600	--	--	84500	149400	151100	--	151850	152750	--
Prob. Min position	0	0	--	0	--	0	--	0	--	--	0	0	0	--	0	0	--
Prob. Max pos	0	0	--	0	--	0	--	0	--	--	0	0	0	--	0	0	--
Ground parameter set	40	44	5	36	5	40	3	17	3	17	22	48	17	3	22	17	3

Table 5.15 Alignment Alternative AV - Subdivision in homogeneous zones and Ground Parameter Set of each zone (2 of 4)

	Zone 52	Zone 53	Zone 54	Zone 55	Zone 56	Zone 57	Zone 58	Zone 59	Zone 60	Zone 61	Zone 62	Zone 63	Zone 64	Zone 65	Zone 66	Zone 67	Zone 68
Name	T5_6	T5_7	T5_8	T5_9 f	T5_10	T5_11	T5_12	T5_13 f	T5_14	T5_15 f	T5_16	T5_17 f	T5_18	T5_19 f	T5_20	T6_1	T6_2 S. Gabriel
Generation mode	1	2	2	1	2	1	2	1	2	1	2	1	2	1	2	2	1
Min length	1100	--	--	25	--	600	--	100	--	100	--	25	--	25	--	--	100
Mode length	1200	--	--	50	--	700	--	150	--	150	--	50	--	50	--	--	150
Max length	1300	--	--	75	--	800	--	200	--	200	--	75	--	75	--	--	200
Prob. Min length	0	--	--	0.5	--	0	--	0	--	0	--	0.5	--	0.5	--	--	0
Prob. Max length	0	--	--	0	--	0	--	0	--	0	--	0	--	0	--	--	0
Min end position	--	155400	156150	--	156650	--	159050	--	161350	--	163900	--	164900	--	176800	177700	--
Mode end position	--	155500	156250	--	156750	--	159150	--	161450	--	164000	--	165000	--	176800	177800	--
Max end position	--	155600	156350	--	156850	--	159250	--	161550	--	164100	--	165100	--	176800	177900	--
Prob. Min position	--	0	0	--	0	--	0	--	0	--	0	--	0	--	0	0	--
Prob. Max pos	--	0	0	--	0	--	0	--	0	--	0	--	0	--	0	0	--
Ground parameter set	17	23	28	4	28	23	21	6	40	6	26	4	34	4	26	48	6

	Zone 69	Zone 70	Zone 71	Zone 72	Zone 73	Zone 74	Zone 75	Zone 76	Zone 77	Zone 78	Zone 79	Zone 80	Zone 81	Zone 82	Zone 83	Zone 84	
Name	T6_3	T6_4 S. Gabriel	T6_5	T6_6 S. Gabriel	T6_7	T6_8	T7_1	T7_2	T7_3 f	T7_4	T7_5	T7_6	T7_7 S. Susana	T7_8	T7_9 S. Susana	T7_10	
Generation mode	2	1	2	1	2	2	2	2	1	2	1	2	1	2	2	2	
Min length	--	100	--	100	--	--	--	--	25	--	200	--	50	--	--	--	
Mode length	--	150	--	150	--	--	--	--	50	--	300	--	100	--	--	--	
Max length	--	200	--	200	--	--	--	--	75	--	400	--	150	--	--	--	
Prob. Min length	--	0	--	0	--	--	--	--	0.5	--	0	--	0	--	--	--	
Prob. Max length	--	0	--	0	--	--	--	--	0	--	0	--	0	--	--	--	
Min end position	178000	--	178650	--	178900	180000	180250	180900	--	182000	--	183400	--	183900	184100	200000	
Mode end position	178050	--	178700	--	179200	180000	180350	181000	--	182600	--	183500	--	184050	184200	200000	
Max end position	178100	--	178750	--	179300	180000	180450	181100	--	183200	--	183800	--	184150	184400	200000	
Prob. Min position	0	--	0	--	0	0	0	0	--	0	--	0	--	0	0	0	
Prob. Max pos	0	--	0	--	0	0	0	0	--	0	--	0	--	0	0	0	
Ground parameter set	48	6	48	6	48	48	43	21	4	21	43	43	6	38	6	42	

Table 5.16 Alignment Alternative AV- Subdivision in homogeneous zones and Ground Parameter Set of each zone (3 of 4)

				BEHAVIORAL CATEGORIES					POTENTIAL INSTABILITY CONDITIONS		POTENTIAL PROBLEMATIC WATER INFLOW		POSSIBLE PRESENCE OF GAS		Ground Parameter Set
Zone number	Zone name	Mode start position	Mode end position	a/b	c	d	e/f	Fault	Instability	No instability	Water inflow	No water inflow	Gas detected	No gas detected	
T1_0	Zone 1	35000	35000	0%	10%	90%	0%	0%	1%	99%	0%	100%	0%	100%	29
T1_1	Zone 2	35000	35100	0%	10%	90%	0%	0%	1%	99%	0%	100%	0%	100%	29
T1_2	Zone 3	35100	36000	0%	50%	50%	0%	0%	1%	99%	0%	100%	0%	100%	33
T1_3 f	Zone 4	36000	36050	0%	0%	0%	0%	100%	5%	95%	10%	90%	10%	90%	4
T1_4	Zone 5	36050	36600	0%	50%	50%	0%	0%	1%	99%	0%	100%	0%	100%	33
T1_5	Zone 6	36600	37200	0%	10%	90%	0%	0%	1%	99%	0%	100%	0%	100%	29
T1_6	Zone 7	37200	37750	0%	50%	50%	0%	0%	1%	99%	0%	100%	0%	100%	33
T1_7	Zone 8	37750	38400	0%	10%	90%	0%	0%	1%	99%	0%	100%	0%	100%	29
T1_8 Edison	Zone 9	38400	38600	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
T1_9	Zone 10	38600	39800	0%	50%	50%	0%	0%	1%	99%	1%	99%	0%	100%	32
T1_10 Edison	Zone 11	39800	40600	0%	0%	10%	90%	0%	1%	99%	1%	99%	0%	100%	36
T1_11	Zone 12	40600	45000	0%	0%	50%	50%	0%	1%	99%	1%	99%	0%	100%	40
T2_1	Zone 13	45000	45100	0%	50%	50%	0%	0%	1%	99%	0%	100%	0%	100%	33
T2_2 f	Zone 14	45100	45200	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
T2_3	Zone 15	45200	48050	50%	50%	0%	0%	0%	0%	100%	0%	100%	0%	100%	22
T2_4 f	Zone 16	48050	48100	0%	0%	0%	0%	100%	5%	95%	10%	90%	0%	100%	3
T2_5	Zone 17	48100	50000	0%	50%	50%	0%	0%	1%	99%	0%	100%	0%	100%	33
T3_1	Zone 18	50000	50075	0%	0%	50%	50%	0%	1%	99%	1%	99%	0%	100%	40
T3_2	Zone 19	50075	51000	0%	10%	90%	0%	0%	1%	99%	1%	99%	0%	100%	28
T3_3	Zone 20	51000	51050	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
T3_4	Zone 21	51050	55850	0%	0%	90%	10%	0%	1%	99%	1%	99%	0%	100%	44
T3_5 f	Zone 22	55850	55900	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
T3_6	Zone 23	55900	56100	0%	50%	50%	0%	0%	1%	99%	1%	99%	0%	100%	32
T3_7	Zone 24	56100	59000	0%	90%	10%	0%	0%	1%	99%	0%	100%	0%	100%	25
T3_8	Zone 25	59000	59650	0%	50%	50%	0%	0%	1%	99%	1%	99%	0%	100%	32
T3_9	Zone 26	59650	60100	0%	0%	10%	90%	0%	1%	99%	0%	100%	0%	100%	37
T3_10 f	Zone 27	60100	60250	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
T3_11	Zone 28	60250	61550	0%	50%	50%	0%	0%	1%	99%	1%	99%	0%	100%	32
T3_12 f	Zone 29	61550	61600	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
T3_13	Zone 30	61600	64600	0%	0%	10%	90%	0%	1%	99%	0%	100%	0%	100%	37
T3_14	Zone 31	64600	67000	0%	0%	50%	50%	0%	1%	99%	1%	99%	0%	100%	40
T3_15	Zone 32	67000	67800	0%	0%	90%	10%	0%	1%	99%	1%	99%	0%	100%	44
T3_16 f	Zone 33	67800	67850	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
T3_17	Zone 34	67850	69300	0%	0%	90%	10%	0%	1%	99%	1%	99%	0%	100%	44
T3_18	Zone 35	69300	75000	0%	0%	50%	50%	0%	1%	99%	1%	99%	0%	100%	40
T4_1	Zone 36	75000	77500	0%	0%	90%	10%	0%	1%	99%	1%	99%	0%	100%	44
T4_2 f	Zone 37	77500	77650	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
T4_3	Zone 38	77650	78850	0%	0%	10%	90%	0%	1%	99%	1%	99%	0%	100%	36
T4_4 Garlock	Zone 39	78850	79350	0%	0%	0%	0%	100%	10%	90%	20%	80%	0%	100%	5
T4_5	Zone 40	79350	82250	0%	0%	50%	50%	0%	1%	99%	1%	99%	0%	100%	40
T4_6 f	Zone 41	82250	82300	0%	0%	0%	0%	100%	5%	95%	10%	90%	0%	100%	3
T4_7	Zone 42	82300	83500	90%	10%	0%	0%	0%	0%	100%	0%	100%	0%	100%	17

Table 5.17 Alignment Alternative AV- Subdivision in homogeneous zones and Ground Parameter Set of each zone (4 of 4)

				BEHAVIORAL CATEGORIES					POTENTIAL INSTABILITY CONDITIONS		POTENTIAL PROBLEMATIC WATER INFLOW		POSSIBLE PRESENCE OF GAS		Ground Parameter Set
Zone number	Zone name	Mode start position	Mode end position	a/b	c	d	e/f	Fault	Instability	No instability	Water inflow	No water inflow	Gas detected	No gas detected	
T4_8 f	Zone 43	83500	83550	0%	0%	0%	0%	100%	5%	95%	10%	90%	0%	100%	3
T4_9	Zone 44	83550	84150	90%	10%	0%	0%	0%	0%	100%	0%	100%	0%	100%	17
T4_10	Zone 45	84150	84400	50%	50%	0%	0%	0%	0%	100%	0%	100%	0%	100%	22
T4_11	Zone 46	84400	149400	0%	0%	50%	50%	0%	1%	99%	1%	99%	10%	90%	48
T5_1	Zone 47	149400	151000	90%	10%	0%	0%	0%	0%	100%	0%	100%	0%	100%	17
T5_2 f	Zone 48	151000	151050	0%	0%	0%	0%	100%	5%	95%	10%	90%	0%	100%	3
T5_3	Zone 49	151050	151750	50%	50%	0%	0%	0%	0%	100%	0%	100%	0%	100%	22
T5_4	Zone 50	151750	152650	90%	10%	0%	0%	0%	0%	100%	0%	100%	0%	100%	17
T5_5 f	Zone 51	152650	152700	0%	0%	0%	0%	100%	5%	95%	10%	90%	0%	100%	3
T5_6	Zone 52	152700	153900	90%	10%	0%	0%	0%	0%	100%	0%	100%	0%	100%	17
T5_7	Zone 53	153900	155500	50%	50%	0%	0%	0%	0%	100%	0%	100%	10%	90%	23
T5_8	Zone 54	155500	156250	0%	10%	90%	0%	0%	1%	99%	1%	99%	0%	100%	28
T5_9 f	Zone 55	156250	156300	0%	0%	0%	0%	100%	5%	95%	10%	90%	10%	90%	4
T5_10	Zone 56	156300	156750	0%	10%	90%	0%	0%	1%	99%	1%	99%	0%	100%	28
T5_11	Zone 57	156750	157450	50%	50%	0%	0%	0%	0%	100%	0%	100%	10%	90%	23
T5_12	Zone 58	157450	159150	10%	90%	0%	0%	0%	0%	100%	0%	100%	10%	90%	21
T5_13 f	Zone 59	159150	159300	0%	0%	0%	0%	100%	10%	90%	20%	80%	20%	80%	6
T5_14	Zone 60	159300	161450	0%	0%	50%	50%	0%	1%	99%	1%	99%	0%	100%	40
T5_15 f	Zone 61	161450	161600	0%	0%	0%	0%	100%	10%	90%	20%	80%	20%	80%	6
T5_16	Zone 62	161600	164000	0%	90%	10%	0%	0%	1%	99%	1%	99%	10%	90%	26
T5_17 f	Zone 63	164000	164050	0%	0%	0%	0%	100%	5%	95%	10%	90%	10%	90%	4
T5_18	Zone 64	164050	165000	0%	50%	50%	0%	0%	1%	99%	1%	99%	10%	90%	34
T5_19 f	Zone 65	165000	165050	0%	0%	0%	0%	100%	5%	95%	10%	90%	10%	90%	4
T5_20	Zone 66	165050	176800	0%	90%	10%	0%	0%	1%	99%	1%	99%	10%	90%	26
T6_1	Zone 67	176800	177800	0%	0%	50%	50%	0%	1%	99%	1%	99%	10%	90%	48
T6_2 S. Gabrie	Zone 68	177800	177950	0%	0%	0%	0%	100%	10%	90%	20%	80%	20%	80%	6
T6_3	Zone 69	177950	178050	0%	0%	50%	50%	0%	1%	99%	1%	99%	10%	90%	48
T6_4 S. Gabrie	Zone 70	178050	178200	0%	0%	0%	0%	100%	10%	90%	20%	80%	20%	80%	6
T6_5	Zone 71	178200	178700	0%	0%	50%	50%	0%	1%	99%	1%	99%	10%	90%	48
T6_6 S. Gabrie	Zone 72	178700	178850	0%	0%	0%	0%	100%	10%	90%	20%	80%	20%	80%	6
T6_7	Zone 73	178850	179200	0%	0%	50%	50%	0%	1%	99%	1%	99%	10%	90%	48
T6_8	Zone 74	179200	180000	0%	0%	50%	50%	0%	1%	99%	1%	99%	10%	90%	48
T7_1	Zone 75	180000	180350	0%	0%	50%	50%	0%	1%	99%	0%	100%	10%	90%	43
T7_2	Zone 76	180350	181000	10%	90%	0%	0%	0%	0%	100%	0%	100%	10%	90%	21
T7_3 f	Zone 77	181000	181050	0%	0%	0%	0%	100%	5%	95%	10%	90%	10%	90%	4
T7_4	Zone 78	181050	182600	10%	90%	0%	0%	0%	0%	100%	0%	100%	10%	90%	21
T7_5	Zone 79	182600	182900	0%	0%	50%	50%	0%	1%	99%	0%	100%	10%	90%	43
T7_6	Zone 80	182900	183500	0%	0%	50%	50%	0%	1%	99%	0%	100%	10%	90%	43
T7_7 S. Susan	Zone 81	183500	183600	0%	0%	0%	0%	100%	10%	90%	20%	80%	20%	80%	6
T7_8	Zone 82	183600	184050	0%	0%	10%	90%	0%	1%	99%	1%	99%	10%	90%	38
T7_9 S. Susan	Zone 83	184050	184200	0%	0%	0%	0%	100%	10%	90%	20%	80%	20%	80%	6
T7_10	Zone 84	184200	200000	0%	0%	50%	50%	0%	1%	99%	1%	99%	10%	90%	42

Table 5.18 Alignment Alternative I-5 - Zoning of the parameter "Anomalous abrasivity"

Abrasive zone n°	Parameter State	Generation Mode	Min. End Position	Mode End Position	Max. End Position	Prob Min.	Prob Max.	Mean End Position
1	Non abrasive zone	Position	57000	57000	57000	0	0	57000
2	Non abrasive zone	Position	57000	57100	57200	0.1	0.1	57000
3	Abrasive zone	Position	62100	62100	62300	0.1	0.1	62100
4	Non abrasive zone	Position	64800	64900	65000	0.1	0.1	64900
5	Abrasive zone	Position	66700	66800	66900	0.1	0.1	66800
6	Non abrasive zone	Position	67100	67200	67300	0.1	0.1	67200
7	Abrasive zone	Position	68900	69000	69100	0.1	0.1	69000
8	Non abrasive zone	Position	70600	70700	70800	0.1	0.1	70700
9	Abrasive zone	Position	86400	86500	86600	0.1	0.1	86500
10	Non abrasive zone	Position	96200	96300	96400	0.1	0.1	96300
11	Abrasive zone	Position	100200	100300	100400	0.1	0.1	100300
12	Non abrasive zone	Position	101200	101300	101400	0.1	0.1	101300
13	Abrasive zone	Position	104500	104600	104700	0.1	0.1	104600
14	Non abrasive zone	Position	136200	136200	136200	0.1	0.1	136200

Table 5.19 Alignment Alternative AV - Zoning of the parameter "Anomalous abrasivity"

Abrasive zone n°	Parameter State	Generation Mode	Min. End Position	Mode End Position	Max. End Position	Prob Min.	Prob Max.	Mean End Position
1	Non abrasive zone	Position	35000	35000	35000	0	0	35000
2	Non abrasive zone	Position	38400	38500	38600	0.1	0.1	38500
3	Abrasive zone	Position	56300	56400	56500	0.1	0.1	56400
4	Non abrasive zone	Position	56500	56600	56700	0.1	0.1	56600
5	Abrasive zone	Position	57900	58000	58100	0.1	0.1	58000
6	Non abrasive zone	Position	58600	58700	58800	0.1	0.1	58700
7	Abrasive zone	Position	59200	59300	59400	0.1	0.1	59300
8	Non abrasive zone	Position	60500	60600	60700	0.1	0.1	60600
9	Abrasive zone	Position	63600	63700	63800	0.1	0.1	63700
10	Non abrasive zone	Position	65300	65400	65500	0.1	0.1	65400
11	Abrasive zone	Position	79100	79200	79300	0.1	0.1	79200
12	Non abrasive zone	Position	84300	84400	84500	0.1	0.1	84400
13	Abrasive zone	Position	155200	155300	155400	0.1	0.1	155300
14	Non abrasive zone	Position	184800	184800	184800	0.1	0.1	184800

5.2 Construction Related Input

The construction related input has been modeled using the following scheme:

a) The basic average advance rates and costs per linear meter of tunnel have been defined for each construction method as follows:
   - Tunnel excavated by 9.5m diameter TBM;
   - Service tunnel excavated by 5.0m diameter TBM;
   - Tunnel excavated by Earth Pressure Balanced Shield;
   - Tunnel excavated by conventional method such as Drill and Blast or NATM;
   - Shaft excavated by conventional methods;
   - Seismic chamber excavated by conventional methods;
   - Portal zone realization.

   For each Behavioral Category (a/b, c, d, e/f and Fault), the definition is with a probabilistic min-mode-max range.
   The advance rates for excavation by TBMs have been defined based on the Colorado School of Mines Model (Clark, 1987 and Howart, 1987). The Model represents a well-known boring-speed prediction method that calculates the penetration rate per revolution of the TBM cutterhead on the basis of the rock mass characteristics (like the uniaxial compression strength and the tensile strength of the rocks), the characteristics of the cutters and the layout of the cutters of the cutterhead, as well as the machine-specific data (like maximum thrust on each cutter and rotation speed of the cutterhead). The Model gave a range of penetration rates for each rock formation. These predicated values together with the practical experiences gained from boring in similar geomechanical conditions, allowed for the definition of a realistic range of basic, average, advance rates for each Behavioral Category. The values of costs per meter for excavation by TBMs have been determined taking into account the various aspects involved such as the depreciation of the machine, assembly and disassembly as well as any transfer of the machine, the labor costs, the consumables including cutters, energy consumption, the segmental lining and/or grouting, etc. For the other excavation methods, costs and advance rates have been assumed mainly on the basis of relevant experiences gained from similar European projects, especially when no such data about U.S. projects are available.

b) In the DAT analysis, "Geo-event" related formulas have been defined in order to consider the influence of the occurrence of the unfavorable conditions on construction time and cost. Consequently, for each unit zone analyzed, if none of the unfavorable geo-events (like water inflow, anomalous abrasivity, etc.) is forecasted (or simulated by the geology module of DAT), the formulas defined for the corresponding, normal condition (in terms of the behavioral class and the associated construction method) will be used to calculate the time and cost for constructing the tunnel in this zone. If a problematic water inflow has been forecasted in a unit zone, the formulas defined for the specific type of geo-event will be used to determine the construction time and cost of this unit zone. The net influences of each unfavorable geo-event is the increase in the construction cost and the lowering of the advance

rate, reflecting the impact of the specific interventions and/or downtime periods required to overcome the event.

c) If as a result of forecasting minor and major instability conditions there is an occurrence of an instability phenomena, an increasing law that considers the effect of successive and reiterated events has been adopted. In this manner, it is possible to take into account the effect of the socio-political-economic conditions that arise as a consequence of a repetitious accident. The cost of overcoming the problem is no longer stated in terms of time and cost but would depend on other aspects such as contracts, safety, social impact, etc.

5.2.1 Modeled activities and construction techniques

The construction of the various structures has been modeled in the DAT simulation as follows:

a) Main tunnels (diameter 9.5 m, single track twin tunnels) are mostly realized by means of fully mechanized excavation. Due to the anticipated geologic conditions and the related hazards, double shielded TBMs have been chosen in order to allow excavation and lining activities in medium to fair conditions. In poor conditions, excavation is slowed by the necessity of alternating lining installation and face advancing, while insufficient gripping conditions force the machine to act as a single shield TBM. While advance rates are significantly reduced, costs per meter are not affected to the same degree, which implies that the construction time of a tunnel in poor ground conditions may vary in a wider range than its final cost. As expressed previously, financial costs are not considered in this analysis.

b) In particular conditions, it is assumed the capability of the TBMs can be modified in order to exert a counter pressure to support the face during excavation. For those excavation methods, for which the construction schemes are referred to as EPB-Shields, the advance rates have a smaller range due to the very special features of the excavation technique itself and the particular field of application.

c) A service/safety tunnel (in this case, a single bore of 5.0 m in diameter) is required for those main, twin-bore tunnels longer than 6 miles (9.6 km) and this service/safety tunnel is assumed to be in a central position between the twin bores. Usually, the relatively small, service/safety tunnel will be constructed ahead of the main tunnel as the so-called pilot tunnel to probe the ground conditions and, hence, to reduce the geological uncertainties for the subsequent construction of the main tunnel. The excavation method assumed for the service/safety tunnels is the same as that assumed for the corresponding main tunnel, but with considerably higher advance rates when tunnelling in medium to fair conditions. However, the presence of very poor ground conditions will reduce the advance rates significantly since it has been assumed that the encounter of a critical zone will require the TBM excavating the service/safety tunnel to adopt wide inspection measures to exclude the possibility of having the machine blocked, while the TBMs for excavation of the main tunnel will subsequently use the information acquired.

d) Conventional techniques (NATM and others) have been applied to the construction of structures such as seismic chambers, shafts, portals and specific sectors of the main tunnels, where conditions and/or reduced lengths make the fully mechanized

d) Conventional techniques (NATM and others) have been applied to the construction of structures such as seismic chambers, shafts, portals and specific sectors of the main tunnels, where conditions and/or reduced lengths make the fully mechanized method uneconomic and/or unfeasible. In this last case, both advance rates and cost per meters may vary within a wider range than for the TBM methods. In very poor conditions it could be necessary to partialize the excavation section and/or realize wide consolidation interventions.

e) The by-pass to connect the parallel, twin bores of a main tunnel have not been considered in calculating the total construction time and cost of the main tunnel. However, it is important to define time and cost for constructing the bypasses in the global analysis. Besides their intended purpose, service/safety tunnels can help to keep the twin bores of a long, main tunnel at a distance which is approximately twice the separation distance between the twin bores of a relatively short main tunnel (i.e., less than 6 miles long), thus helping to avoid the stress-strain interferences between the twin bores of the main tunnel upon excavation. The only negative effect is that the number of bypasses under the triple-bore configuration will be twice that of the simple, twin-bore configuration.

5.2.2 Advance rates and costs per meter in "normal" conditions

The advance rates and costs per meter for the various technical classes and the various excavation techniques modeled are shown in Tables 5.20 to 5.29. Unit costs of some European tunnel projects are given in Appendix 3 for reference purpose. As mentioned previously, those values are applied directly in case no unfavorable events such as

water inflows, instabilities, anomalous abrasivity and presence of gas are detected, while they are employed in specific formulas if those "accidents" or "geo events" are encountered. The details of those aspects are shown in the following paragraphs.

Table 5.20 Distributions of advance rates for 9.5 m diameter TBMs

9.5 diameter TBMs: advance rates							
Parameter	Parameter states	Min [m/d]	Mode [m/d]	Max [m/d]	Prob. min	Prob. max	Mean [m/d]
Behavioral category	a/b	8.5	11.5	15	0.1	0.1	11.7
	c	11.5	14.6	18.7	0.1	0.1	15.0
	d	12	14.9	21.8	0.1	0.1	16.4
	e/f	8.2	9.5	11.9	0.1	0.1	9.9
	fault	8.2	9.5	11.9	0.1	0.1	9.9

Table 5.21 Distributions of excavation costs for 9.5 m diameter TBMs

9.5 diameter TBMs: costs per meter							
Parameter	Parameter states	Min [US$/m]	Mode [US$/m]	Max [US$/m]	Prob. min	Prob. max	Mean [US$/m]
	a/b	7850	8440	9180	0.1	0.1	8495

Behavioral category	a/b	7850	8440	9180	0.1	0.1	8495
	d	7260	8000	8470	0.1	0.1	7908
	e/f	8800	9500	10200	0.1	0.1	9500
	fault	8800	9500	10200	0.1	0.1	9500

Table 5.22 Distributions of advance rates for 5.0 m diameter TBMs

5.0 diameter TBMs: advance rates							
Parameter	Parameter states	Min [m/d]	Mode [m/d]	Max [m/d]	Prob. min	Prob. max	Mean [m/d]
Behavioral category	a/b	17	23	30	0.1	0.1	23.4
	c	23	29.2	37.4	0.1	0.1	29.9
	d	24	29.8	43.6	0.1	0.1	32.7
	e/f	12.5	13.9	16.3	0.1	0.1	14.3
	fault	12.5	13.9	16.3	0.1	0.1	14.3

Table 5.23 Distributions of excavation costs for 5.0 m diameter TBMs

5.0 diameter TBMs: costs per meter							
Parameter	Parameter states	Min [US$/m]	Mode [US$/m]	Max [US$/m]	Prob. min	Prob. max	Mean [US$/m]
	a/b	4690	4960	5350	0.1	0.1	5004
	c	4670	4850	5070	0.1	0.1	4864
	d	4430	4710	4940	0.1	0.1	4691
	e/f	5800	6100	6450	0.1	0.1	6118
	fault	5800	6100	6450	0.1	0.1	6118

Table 5.24 Distributions of advance rates for EPB machines

9.5 diameter EPBs: advance rates							
Parameter	Parameter states	Min [m/d]	Mode [m/d]	Max [m/d]	Prob. min	Prob. max	Mean [m/d]
Behavioral category	used mainly in e/f and fault	6	7.5	8	0.1	0.1	7.1

Table 5.25 Distributions of excavation costs for EPB machines

9.5 diameter EPBs: costs per meter							
Parameter	Parameter states	Min [US$/m]	Mode [US$/m]	Max [US$/m]	Prob. min	Prob. max	Mean [US$/m]
Behavioral category	used mainly in e/f and fault	10000	10500	11000	0.1	0.1	10500

Table 5.26 Distributions of advance rates for conventional methods excavation

Conventional methods excavation: advance rates							
Parameter	Parameter states	Min [m/d]	Mode [m/d]	Max [m/d]	Prob. min	Prob. max	Mean [m/d]
Behavioral category	a/b	5	5.5	6	0.1	0.1	5.5
	c	5	5.5	6	0.1	0.1	5.5
	d	2.5	2.75	3	0.1	0.1	2.8
	e/f	1.5	1.75	2	0.1	0.1	1.8
	fault	1.5	1.75	2	0.1	0.1	1.8

Table 5.27 Distributions of excavation costs for conventional methods excavation

Conventional methods excavation: costs per meter							
Parameter	Parameter states	Min [US$/m]	Mode [US$/m]	Max [US$/m]	Prob. min	Prob. max	Mean [US$/m]
Behavioral category	a/b	9000	9500	10000	0.1	0.1	9500
	c	9000	9500	10000	0.1	0.1	9500
	d	14000	14500	15000	0.1	0.1	14500
	e/f	20000	21000	22000	0.1	0.1	21000
	fault	20000	21000	22000	0.1	0.1	21000

Table 5.28 Distributions of advance rates for other conventional methods excavation

Other conventional methods excavation: advance rates						
Excavation activity	Min [m/d]	Mode [m/d]	Max [m/d]	Prob. min	Prob. max	Mean [m/d]
Shaft	2	3	4	0.1	0.1	3.0
Seismic chamber	1.75	2	2.5	0.1	0.1	2.1
Portals	4.5	6	7.5	0.1	0.1	6.0

Table 5.29 Distributions of excavation costs for other conventional methods excavation

Other conventional methods excavation: costs per meter						
Excavation activity	Min [US$/m]	Mode [US$/m]	Max [US$/m]	Prob. min	Prob. max	Mean [US$/m]
Shaft	13200	13400	13900	0.1	0.1	13510
Seismic chamber	45000	50000	55000	0.1	0.1	50000
Portals	12500	15000	17500	0.1	0.1	15000

5.2.3 Advance rates and costs per meter in instability zones

When unstable conditions are associated to a unit zone, two instability phenomena (parameter states) are simulated: Minor Instability Phenomenon and Major Instability Phenomenon.

In the first case, the simulation considers a minor event such as the temporary blockage of the cutterhead due to either detachments of rock wedges/blocks from the face or minor squeezing conditions. In the latter case, severe squeezing around the shield or face collapse is considered, resulting in important delays and a major intervention cost. In this latter case, the phenomenon has been considered as the result of coupled hydro-mechanical effects, and includes in itself the influence of the presence of water in terms of costs and delays.

In both cases, the costs and delays are not independent from previous instability phenomena, but follow an incremental law that amplifies the effect of successive and reiterated events.

- Time

Time necessary to overcome the unfavorable event unit zone is expressed with the following formula:

$$t_{instability} = (delay_time + \frac{unit_length}{advance_rate}) \cdot F$$

where advance_rate = is the corresponding advance rate of the behavioral class, as seen in Tables 5.20 and 5.22.

delay_time = is the estimated duration of the intervention required to overcome the "accident", with different distributions in Minor and Major Instability Phenomena, as shown in the following table:

Table 5.30 Distribution of the delay time parameter

Instability Phenomena: delay times						
Instability Phenomenon	Min [w-days]	Mode [w-days]	Max [w-days]	Prob. min	Prob. max	Mean [w-days]
Minor (9.5 m TBM)	2.5	3.5	5	0.1	0.1	3.7
Major (9.5 m TBM)	7	15	30	0.1	0.1	17.6
Minor (5.0 m TBM)	1	1.5	2	0.1	0.1	1.5
Major (5.0 m TBM)	7	15	30	0.1	0.1	17.6

$F = F(A) = (1 + n \cdot A)$

n = number of repetition of the same "accident" in the same simulation

A = is an empirical factor characterizing the degree of impact of repeating accidents, whose value depends on the type of the Instability Phenomenon, as shown in the following table.

Table 5.31 Distribution of the values of the empirical factor A

Instability Phenomena: value of empirical factor A						
Instability Phenomenon	**Min**	**Mode**	**Max**	**Prob. min**	**Prob. max**	**Mean**
Minor	0.1	0.2	0.3	0.1	0.1	0.2
Major	0.25	0.5	0.8	0.1	0.1	0.5

As shown, the effect of reiterative events has been simulated with a relatively small amplitude in case of Minor Instability Phenomenon, while it may induce important and greater delays when Major Instability Phenomena occur.

- Cost

The total cost required to overcome the instability zone results from the association of two subcosts:

- a time dependent cost, consequence of the forced downtime and labor costs, based on an average cost per site stopped day whose average value is assumed to be $30,000 per day.
- direct additional cost of the remedial measures, which is a function of the particular type of intervention required to overcome the accident zone such as the protection of the crown level with forepoling, grouting with special materials as polyurethanes, or other ground treatments. These interventions have a higher cost in Major Instability Phenomena than in Minor ones, also the service tunnels require a lower intervention due to the minor diameter of the TBMs.

Both subcosts are subject to the factor that increases the amplitude of the event in case of reiterated events. The formula used to determine the cost of overcoming the unfavorable event zone is given:

$$cost_{instability} = (\$30{,}000 \cdot delay_time + delay_cost) \cdot F + unit_length \cdot cost_per_meter$$

where cost_per_meter = is the corresponding cost per meter of the behavioral class, as shown in Tables 5.21 and 5.23.

delay_time = is the same parameter shown previously in the time equation.

delay_cost = is the estimated cost of the intervention, assumed on similar experiences, with different values in Minor and Major Instability Phenomena, as shown in the following table:

Table 5.32 Distribution of the delay cost parameter

Instability Phenomena: intervention costs	
Instability Phenomena	**Delay_cost [US$]**
Minor (9.5 m TBM)	100,000
Major (9.5 m TBM)	300,000
Minor (5.0 m TBM)	70,000
Major (5.0 m TBM)	200,000

F = F(A) = (1 + n · A) is the same parameter used previously in the time equation.

5.2.4 Advance rates and costs per meter in problematic water inflow zones

- Time

When severe water inflow zones are to be encountered, a "delay time" parameter is defined to account for the delay imposed by pumping out the water from the excavation face. The equation that expresses the time necessary to overcome a unit zone characterized by the water inflow event is given:

$$t_{water\ inflow} = delay_time + \frac{unit_length}{advance_rate}$$

where the parameters are the same as those used to represent the instability case, except for the "delay_time" whose values are the following:

Table 5.33 Distribution of the values of the "delay_time" parameter characterizing severe water inflows.

Problematic water inflows: delay_time						
Water Inflow Phenomena	**Min [w-days]**	**Mode [w-days]**	**Max [w-days]**	**Prob. min**	**Prob. max**	**Mean [w-days]**
Severe water inflow	1	1.5	2	0.1	0.1	1.5

- Cost

The cost of overcoming the event has been modeled as time dependent, since it depends on the downtime period and on the energy consumption of the pumping system. The average cost per day is slightly higher than that of the production stop cost, because it includes the energy cost, i.e. $31,000 per day.

$$\text{cost}_{\text{water inflow}} = (\$31{,}000 \cdot \text{delay_time}) + \text{unit_length} \cdot \text{cost_per_meter}$$

5.2.5 Advance rates and costs per meter in gas-bearing zones

It is assumed gas detection devices will be employed during the excavation, thus avoiding unexpected gas ignitions. It is common to do this where there is risk of encountering gas pockets.

- Time

When gas bearing zones are to be encountered, a "delay time" parameter is used to account for the delay imposed by the necessity to de-gas the tunneling environment. The equation that expresses the time necessary to overcome a unit zone characterized by this event is given:

$$t_{\text{gas bearing}} = \text{delay_time} + \frac{\text{unit_length}}{\text{advance_rate}}$$

where the parameters are the same as those used in the instability case, except for the "delay_time" whose values are the following:

Table 5.34 Distribution of the delay time parameter in presence of gas

Gas bearing zones: delay times						
Gas Phenomena	**Min [w-days]**	**Mode [w-days]**	**Max [w-days]**	**Prob. min**	**Prob. max**	**Mean [w-days]**
Present	1	1.5	2	0.1	0.1	1.5

- Cost

The cost of overcoming the gas bearing zone has been modeled as time dependent, as it depends both on the downtime period and on the energy consumption of the airing system. The average cost per day is slightly higher than the production stop cost to include the energy cost, i.e. $31,000 per day.

$$\text{cost}_{\text{gas detected}} = (\$31{,}000 \cdot \text{delay_time}) + \text{unit_length} \cdot \text{cost_per_meter}$$

5.2.6 Advance rates and costs per meter in anomalous-abrasivity zones

- *Time*

When anomalous-abrasivity zones are assigned, the equation that expresses the time necessary to overcome a unit zone characterized by this event considers a 10% increase of advance time due to more frequent change of the excavation tools, as given in the formula below:

$$t_{anom.abrasivity} = 1.10 \cdot \frac{unit_length}{advance_rate}$$

- *Cost*

In the same way, the cost necessary to overcome the same unit zone is also assumed to be 10% higher:

$$cost_{anom.abrasivity} = 1.10 \cdot unit_length \cdot cost_per_meter$$

5.2.7 Other assumptions

All time related values are given in working days. Holidays, vacations and possible downtimes generated outside the construction process have not been taken into account.

Cost related values are given in US dollars and are inclusive of overhead and profit (10%) rates. All the conditions that could negatively affect the tunnel construction such as poor geomechanical conditions, "geo-events", etc. have been quantified in terms of their economic impact. Financial costs are not included in the DAT analysis.

A maximum number of simultaneous working sites has not been fixed. No limitations about the TBM's market have been considered, assuming generally a delivery time of approximately 12 months (range between 300 and 325 working days, with 6 working days per week and 26 working days per month) for the 9.5 m TBMs, and 8 months (range between 205 and 230 working days) for the 5.0 m TBMs. The on site assembly of each TBM will take approximately another two months (modal value 52, range between 45 and 60 working days). During the long period of TBM procurement and assembly, other working activities can be started or even completed, but each activity like excavation of shaft or advance a short tunnel by conventional method will also need to have a lead time of two months to prepare the site.

6. DAT SIMULATION RESULTS

6.1 Summary Description of the Pre-DAT-Simulation Analysis

With reference to the flowchart illustrating the process of risk analysis (see figure 1.2), the following preparatory tasks for the DAT simulations were accomplished:

- Definition of the design and construction-options in Section 3;
- Definition of input data to the Geological Model for each design and construction option in Section 5.1;
- Definition of input data to the Construction Model for each design and construction option in Section 5.2; and
- A summary of the principles of the DAT simulation process in Section 4.

However, to make sure that the DAT system ran correctly and yielded meaningful results, we also conducted the following pre-analyses:

1) Used minimum values defined for all geological and construction parameters to make a deterministic estimate of the minimum and total construction cost and duration for each alignment and maximum grade option. The minimum construction cost and time values obtained served as a guide for checking the output of the DAT simulations;
2) Conducted a limited number of DAT simulation runs for each alignment and maximum grade option and compared the output with the deterministic estimates, thus calibrating the DAT process;
3) Tested the sensitivity of the DAT simulation results to the number of simulation runs considering the huge number of geological and construction variables involved. For this purpose, the number of test simulation runs for each option was progressively increased from 100, to 300, to 500, to 750, and finally to 1000. The results obtained from each step were compared with those from the previous one. It was noted that for all the options studied, there was practically no further benefit to increase the number of simulation-runs to more than 1000. Therefore, for the final, production analysis, the number of simulation runs was fixed at 1000.

6.2 Post-Processing of the DAT-Simulation Results

The post processing of the simulation results for each combined alignment maximum grade option mainly involves the application of standard statistical procedures including:

- simple statistical summary of the construction time and cost to yield the minimum, maximum, and the mean at 95% probability, and standard deviation values for the total construction cost and time of each option.
- frequency counting and histogram representation of the variation in the total time and cost.
- fitting of a normal distribution curve to the frequency of total time and cost.
- production of cost versus time scatter plots for comparison.

6.3 The Results of the DAT Analysis

With reference to the procedures given in Section 6.2, the presentation of the post-processed results of the DAT analysis is done using consistently standardized formats.

Step 1 – Separate presentation of the results for each combined alignment maximum grade option (see forward to Sections 6.3.1 to 6.3.4 for the 4 options analyzed, respectively), in the order given below.

1. A scatter plot showing the direct output from DAT in terms of the total construction time and cost of the 1000 simulation-runs for each option;
2. A time-frequency histogram, fitted with a cumulative normal distribution curve;
3. A table presenting the summary statistics of the construction time including its minimum, maximum, mean, at-95%-probability, and standard deviation values for the total construction cost and time of each option
4. The cost-frequency histogram, fitted with a cumulative normal distribution curve;
5. A table presenting the summary statistics of the construction cost including its minimum, maximum, and the mean at 95% probability and standard deviation values for the total construction cost and time of each option.

Specifically,

Section 6.3.1 presents the results of the I-5 Alignment with 3.5% maximum grade option (Figure 6.1, Figure 6.2, Table 6.1, Figure 6.3, and Table 6.2).

Section 6.3.2 presents the results of the I-5 Alignment with 2.5% maximum grade option (Figure 6.4, Figure 6.5, Table 6.3, Figure 6.6, and Table 6.4).

Section 6.3.3 presents the results of the AV Alignment with 3.5% maximum grade option (Figure 6.7, Figure 6.8, Table 6.5, Figure 6.9, and Table 6.6).

Section 6.3.2 presents the results of the AV Alignment with 2.5% maximum grade option (Figure 6.10, Figure 6.11, Table 6.7, Figure 6.12, and Table 6.8).

Step 2 – Comparative presentation of all the results for the four combined alignment maximum grade options (see forward to **Sections 6.3.5**), in the order given below.

1. A superimposed, scatter plot (Figure 6.13) showing the direct output from DAT in terms of the total construction time and cost of the 1000 simulation-runs;
2. A summary table presenting the global statistics of the construction time and cost including the minimum, the maximum, and the mean, at 95% probability and standard deviation values for the total construction cost and time of all options (Table 6.9).

6.3.1 The results of the I-5 Alignment with 3.5% maximum grade option

Figure 6.1 Total Construction Time vs. Cost scatter plot of the option of I-5 Alignment with 3.5% maximum grade

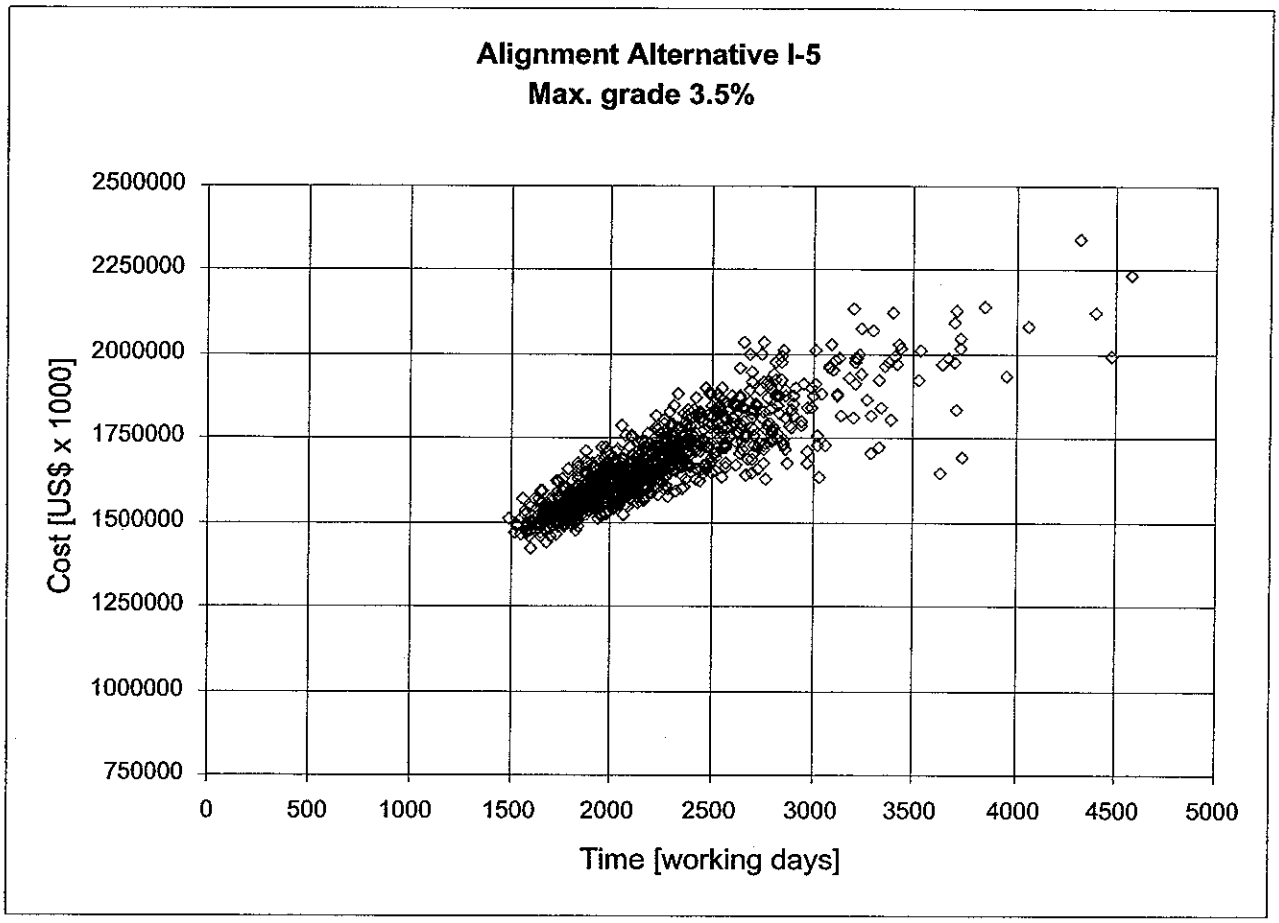


Figure 6.2 Total Construction Time histogram of the option of I-5 Alignment with 3.5% maximum grade

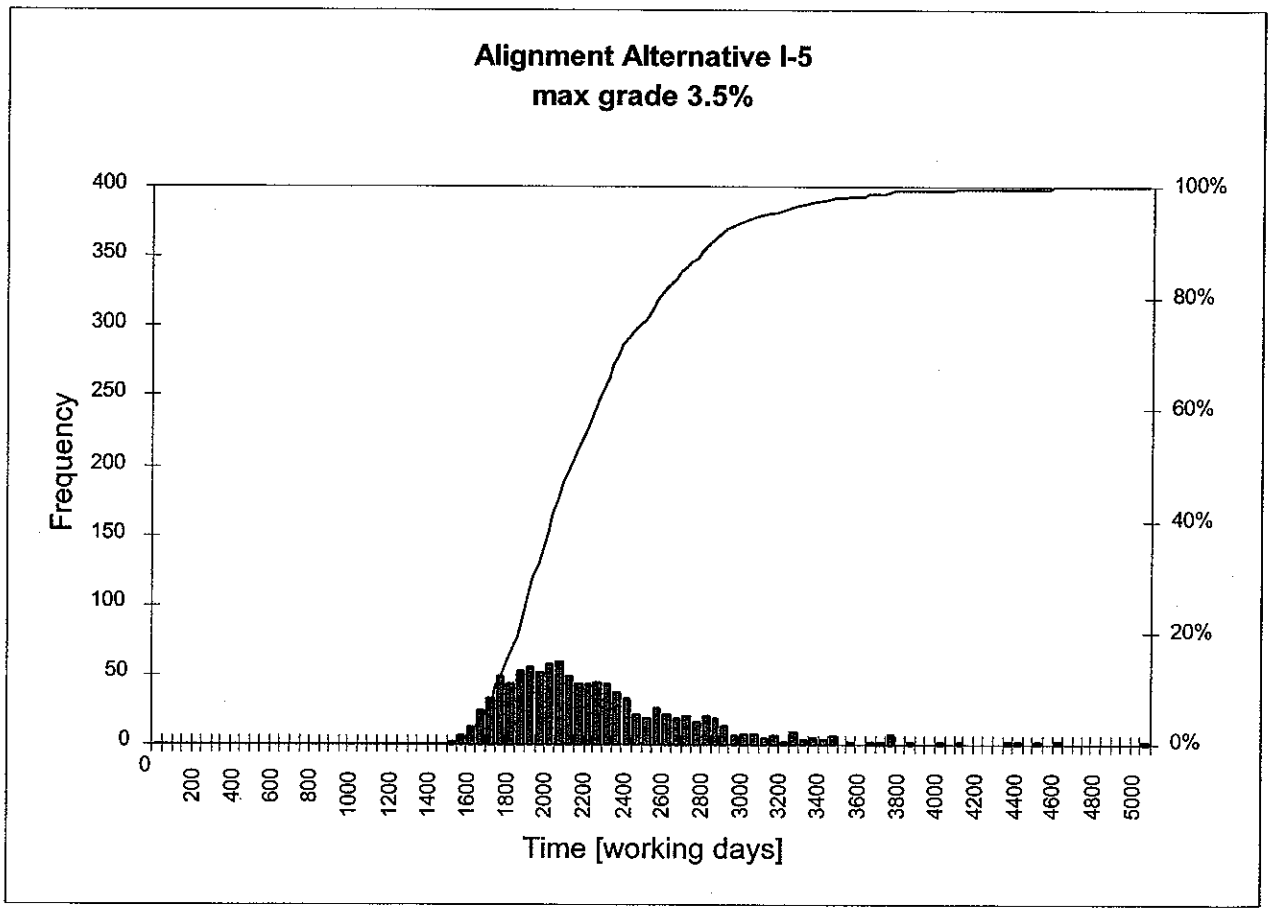


Table 6.1 Statistical data about the Total Construction Time of the option of I-5 Alignment with 3.5% maximum grade

Alignment Alternative I-5 Max grade 3.5%	Construction time	
	Unit	Value
Number of simulations	[-]	1000
Mean value	[working days]	2218
Median value	[working days]	2111
St. Deviation	[working days]	471
Minimum value	[working days]	1492
Value at 95%	[working days]	3100
Difference between 95% value and mean value	[working days]	882
Difference between 95% value and min value	[working days]	1608

Figure 6.3 Total Construction Cost histogram of the option of I-5 Alignment with 3.5% maximum grade

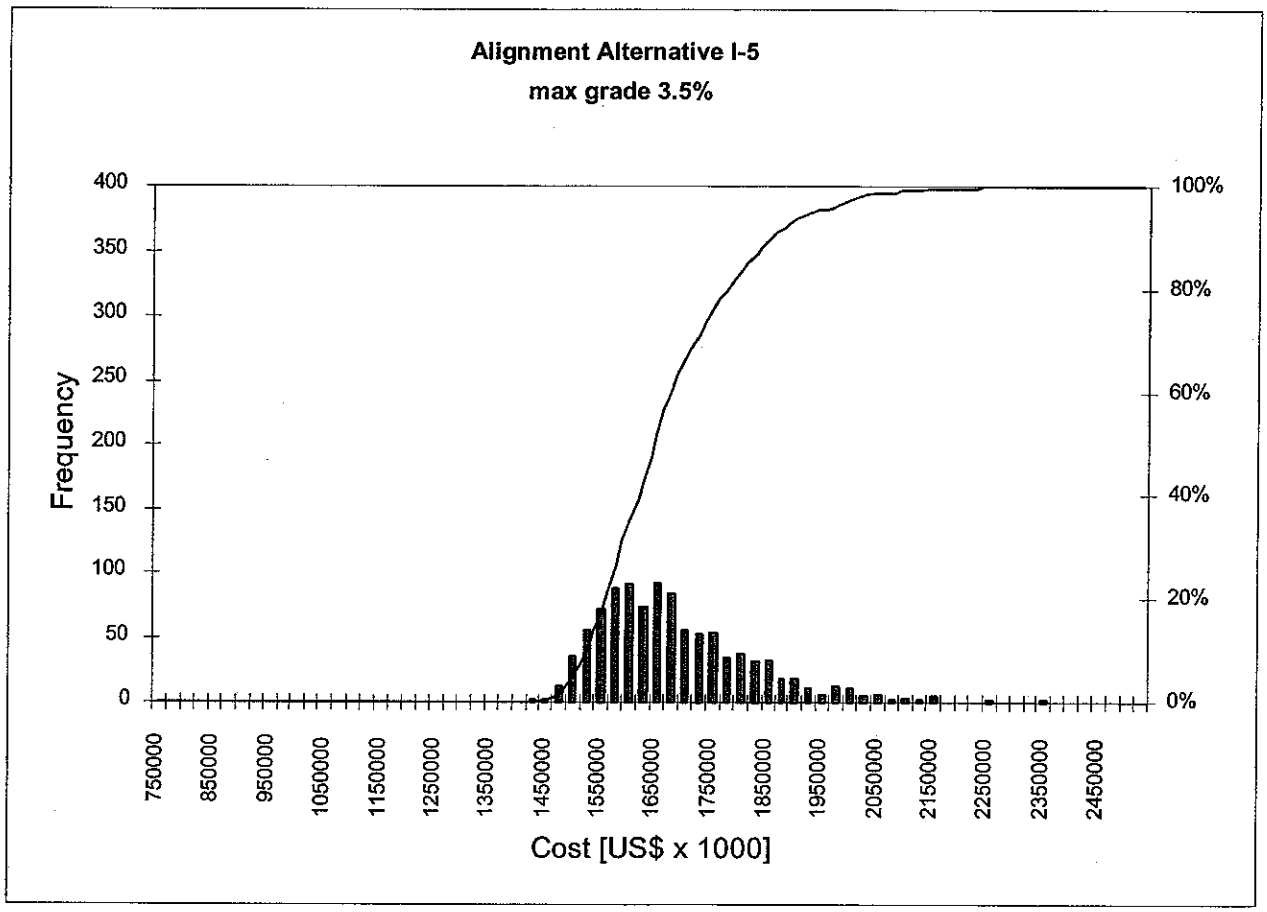


Table 6.2 Statistical data about the Total Construction Cost of the option of I-5 Alignment with 3.5% maximum grade

Alignment Alternative I-5 Max grade 3.5%	Construction cost	
	Unit	Value
Number of simulations	[-]	1000
Mean value	[US$ x 1000]	1670080
Median value	[US$ x 1000]	1643417
St. Deviation	[US$ x 1000]	133507
Minimum value	[US$ x 1000]	1420421
Value at 95%	[US$ x 1000]	1925000
Difference between 95% value and mean value	[US$ x 1000]	254920
Difference between 95% value and min value	[US$ x 1000]	504579

6.3.2 The results of the I-5 Alignment with 2.5% maximum grade option

Figure 6.4 Total Construction Time vs. Cost scatter plot of the option of I-5 Alignment with 2.5% maximum grade

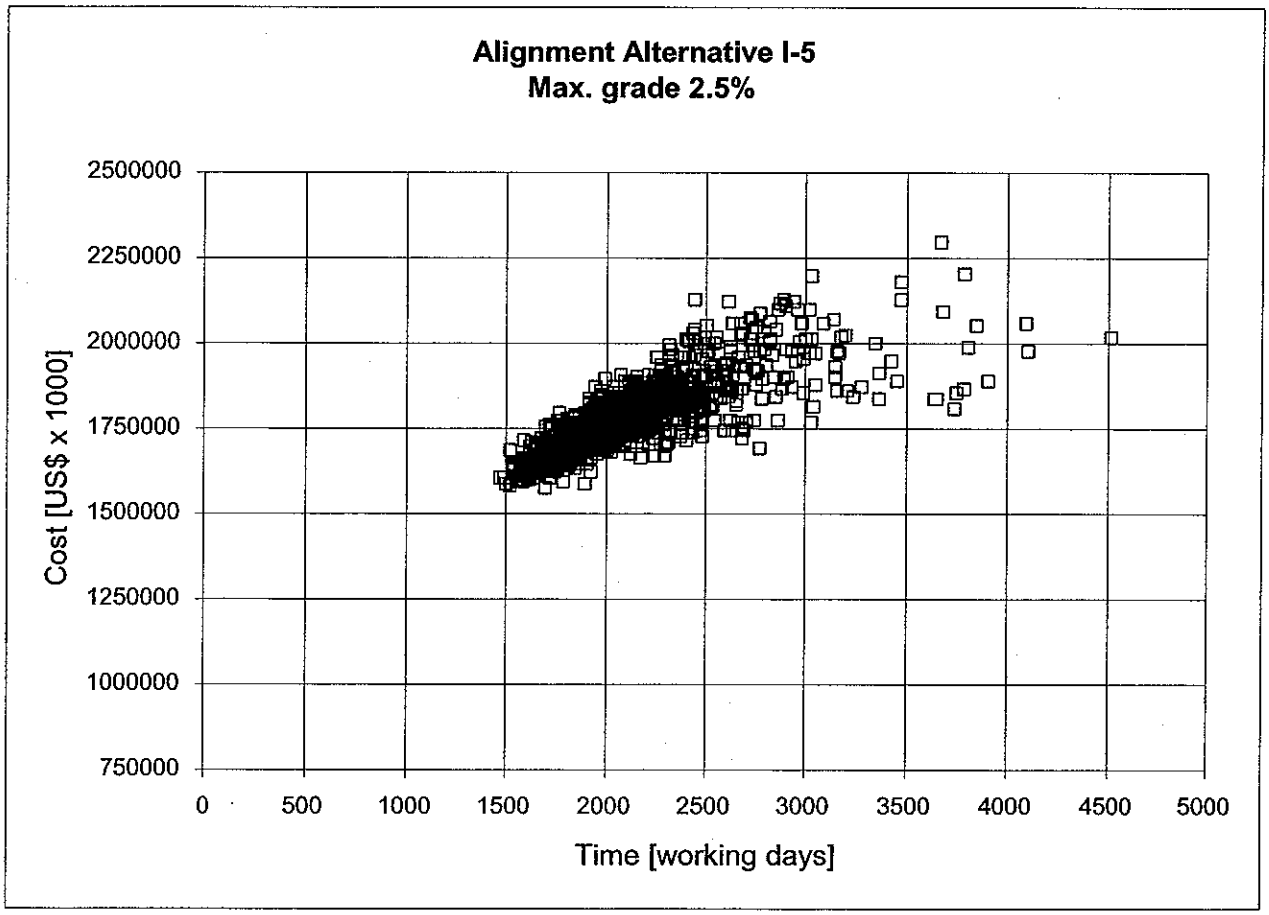


Figure 6.5 Total Construction Time histogram of the option of I-5 Alignment with 2.5% maximum grade

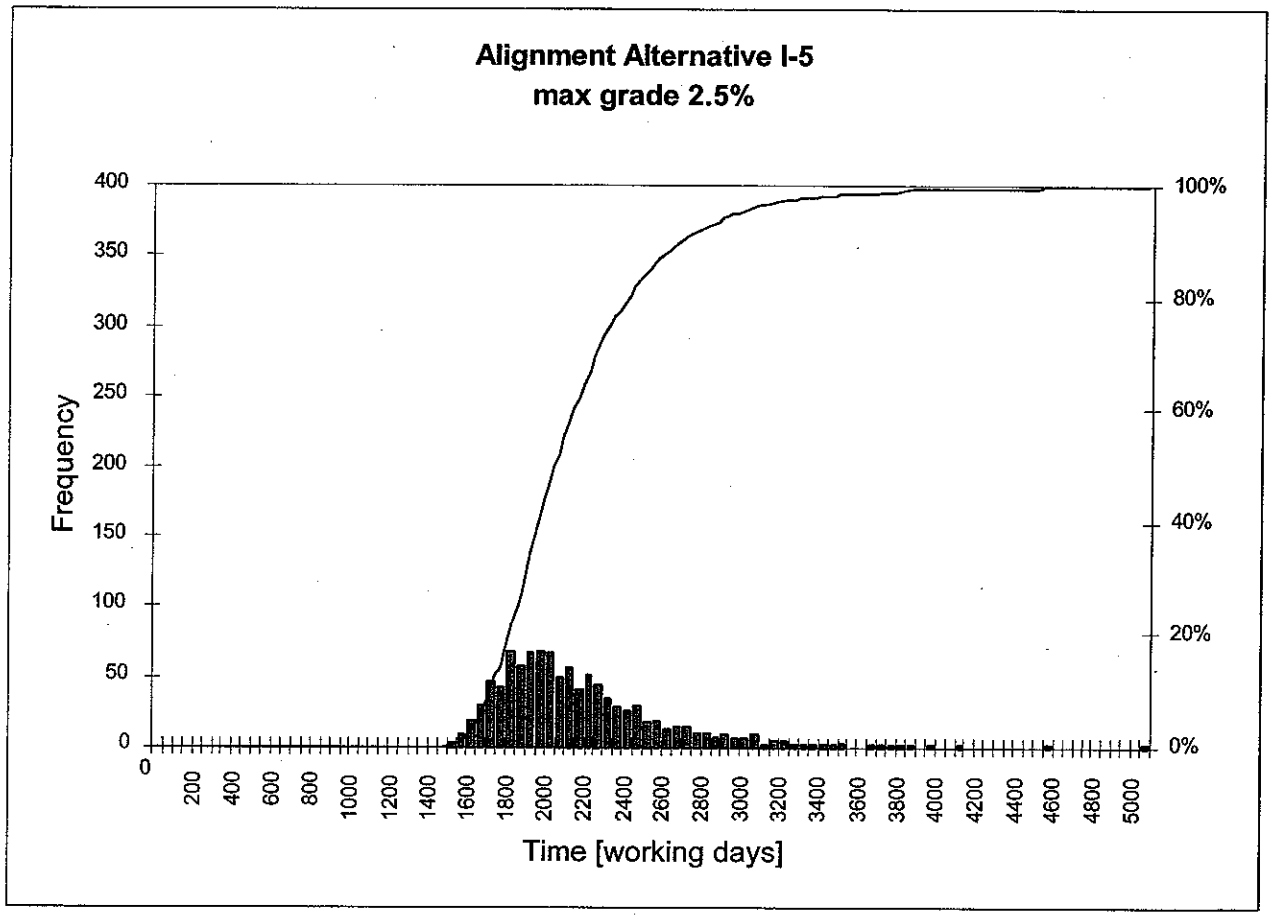


Table 6.3 Statistical data about the Total Construction Time of the option of I-5 Alignment with 2.5% maximum grade

Alignment Alternative I-5 Max grade 2.5%	Construction time	
	Unit	Value
Number of simulations	[-]	1000
Mean value	[working days]	2124
Median value	[working days]	2027
St. Deviation	[working days]	431
Minimum value	[working days]	1470
Value at 95%	[working days]	2900
Difference between 95% value and mean value	[working days]	776
Difference between 95% value and min value	[working days]	1430

Figure 6.6 Total Construction Cost histogram of the option of I-5 Alignment with 2.5% maximum grade

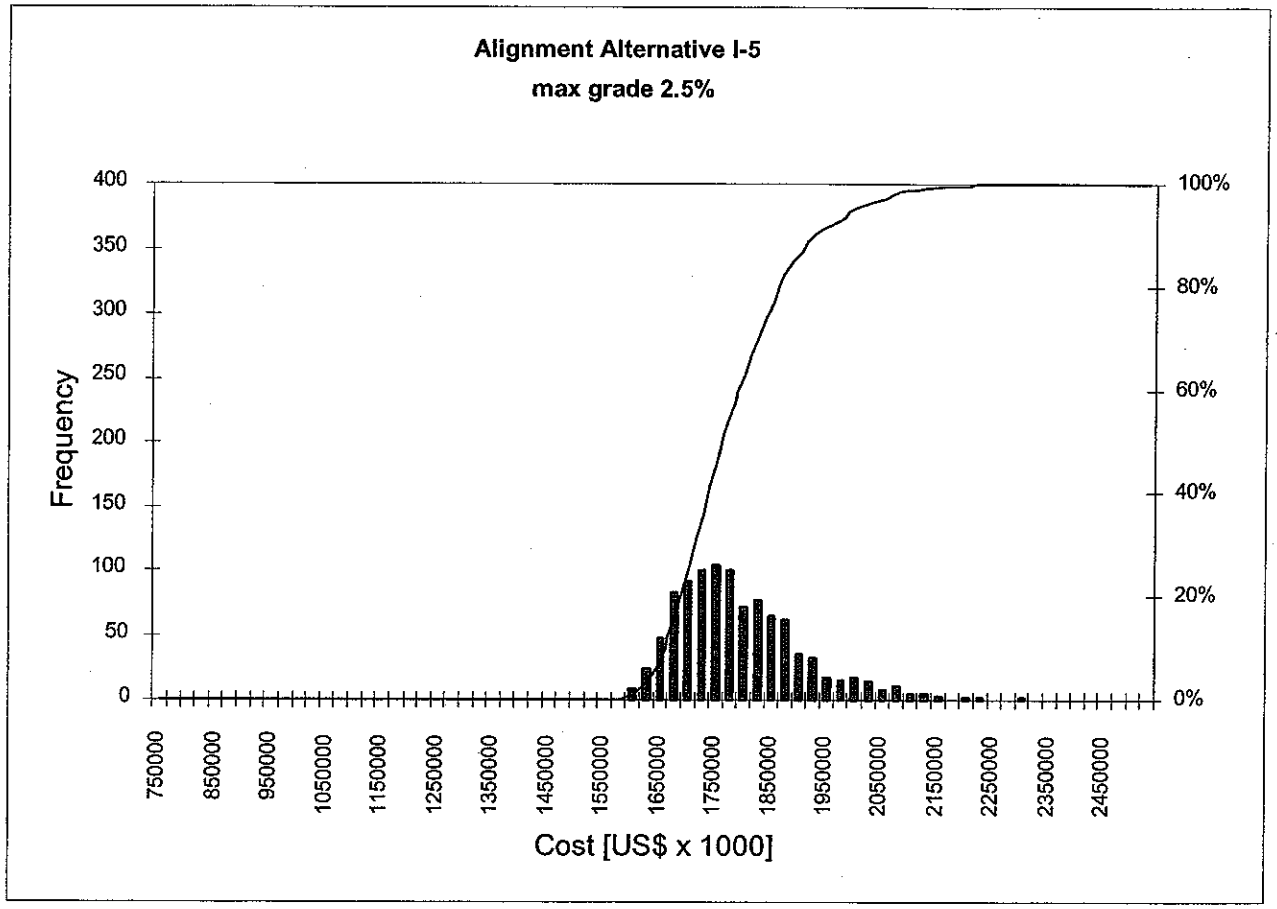


Table 6.4 Statistical data about the Total Construction Cost of the option of I-5 Alignment with 2.5% maximum grade

Alignment Alternative I-5 Max grade 2.5%	Construction cost	
	Unit	Value
Number of simulations	[-]	1000
Mean value	[US$ x 1000]	1779101
Median value	[US$ x 1000]	1758361
St. Deviation	[US$ x 1000]	110232
Minimum value	[US$ x 1000]	1576264
Value at 95%	[US$ x 1000]	1975000
Difference between 95% value and mean value	[US$ x 1000]	195899
Difference between 95% value and min value	[US$ x 1000]	398736

6.3.3 The results of the AV Alignment with 3.5% maximum grade option

Figure 6.7 Total Construction Time vs. Cost scatter plot of the option of AV Alignment with 3.5% maximum grade

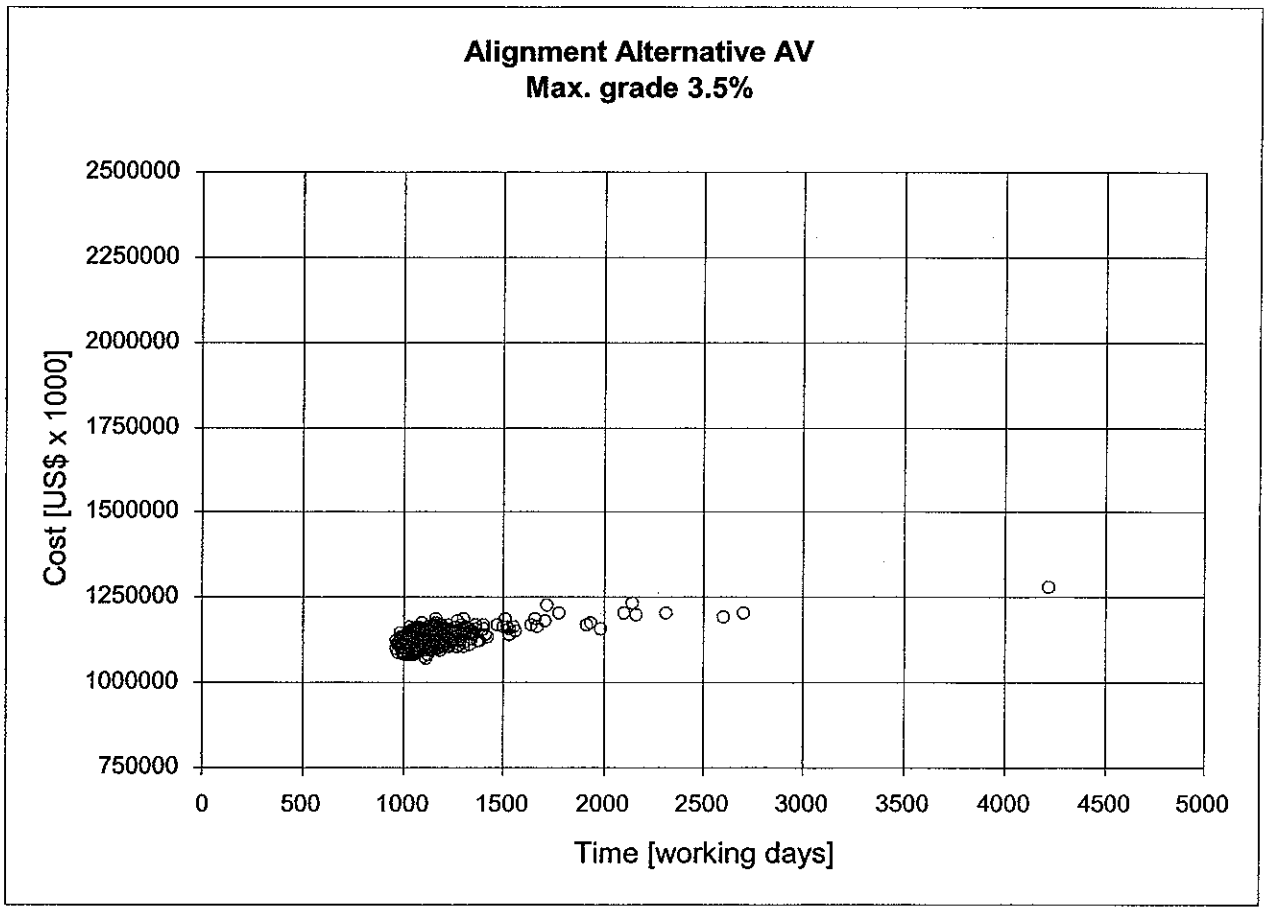


Figure 6.8 Total Construction Time histogram of the option of AV Alignment with 3.5% maximum grade

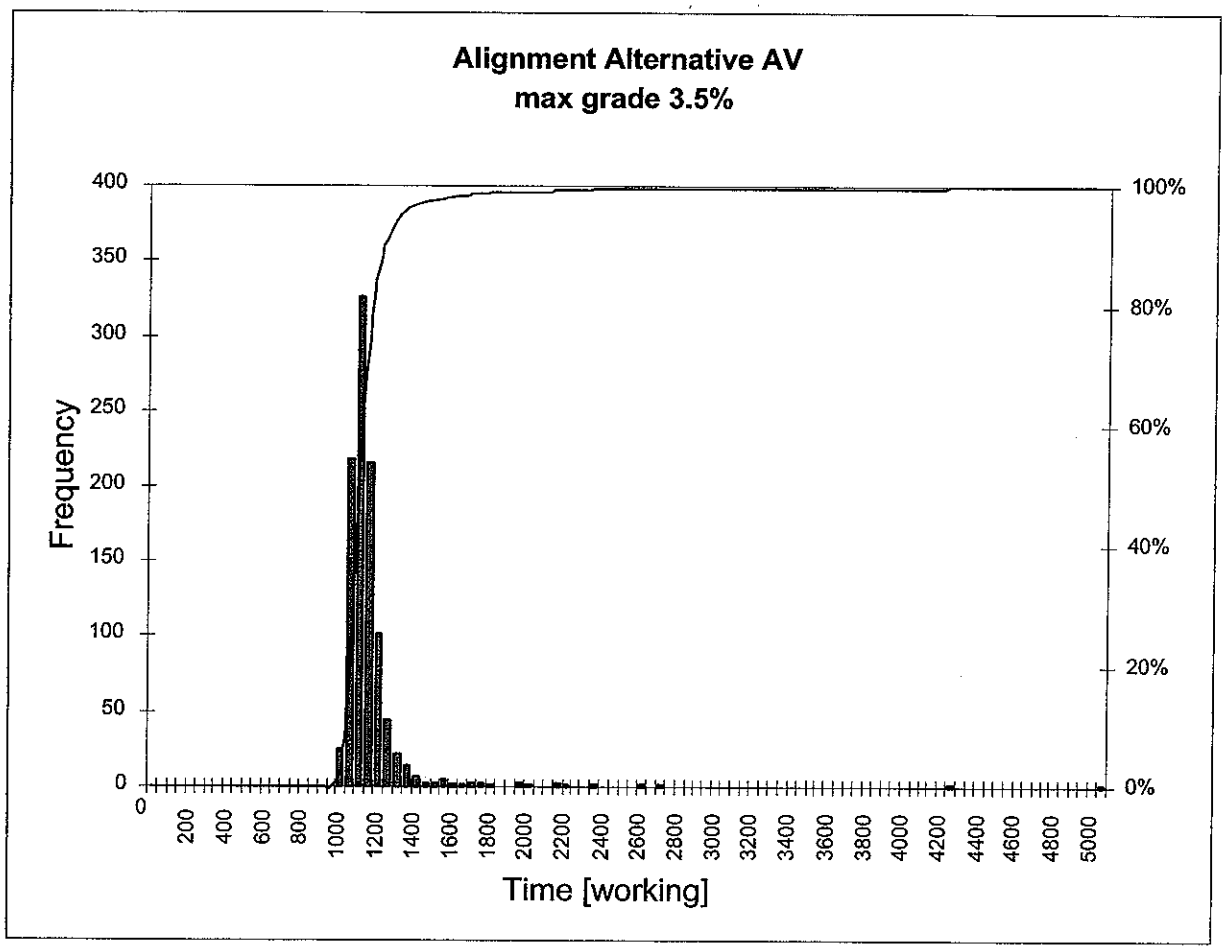


Table 6.5 Statistical data about the Total Construction Time of the option of AV Alignment with 3.5% maximum grade

Alignment Alternative AV Max grade 3.5%	Construction time	
	Unit	Value
Number of simulations	[-]	1000
Mean value	[working days]	1125
Median value	[working days]	1089
St. Deviation	[working days]	217
Minimum value	[working days]	962
Value at 95%	[working days]	1250
Difference between 95% value and mean value	[working days]	125
Difference between 95% value and min value	[working days]	288

Figure 6.9 Total Construction Cost histogram of the option of AV Alignment with 3.5% maximum grade

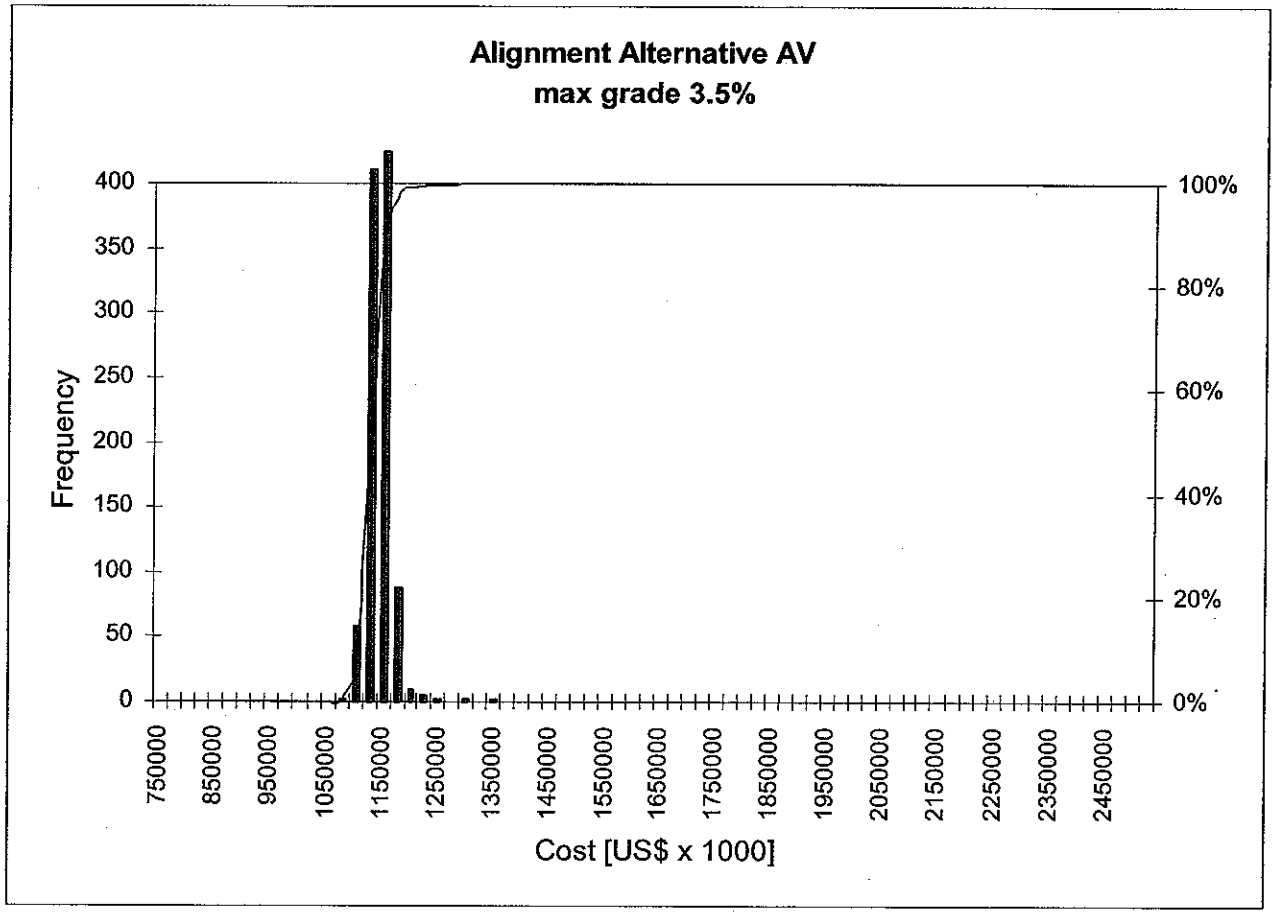


Table 6.6 Statistical data about the Total Construction Cost of the option of AV Alignment with 3.5% maximum grade

Alignment Alternative AV Max grade 3.5%	Construction cost	
	Unit	Value
Number of simulations	[-]	1000
Mean value	[US$ x 1000]	1127511
Median value	[US$ x 1000]	1125936
St. Deviation	[US$ x 1000]	21023
Minimum value	[US$ x 1000]	1073210
Value at 95%	[US$ x 1000]	1150000
Difference between 95% value and mean value	[US$ x 1000]	22489
Difference between 95% value and min value	[US$ x 1000]	76790

6.3.4 The results of the AV Alignment with 2.5% maximum grade option

Figure 6.10 Total Construction Time vs. Cost scatter plot of the option of AV Alignment with 2.5% maximum grade

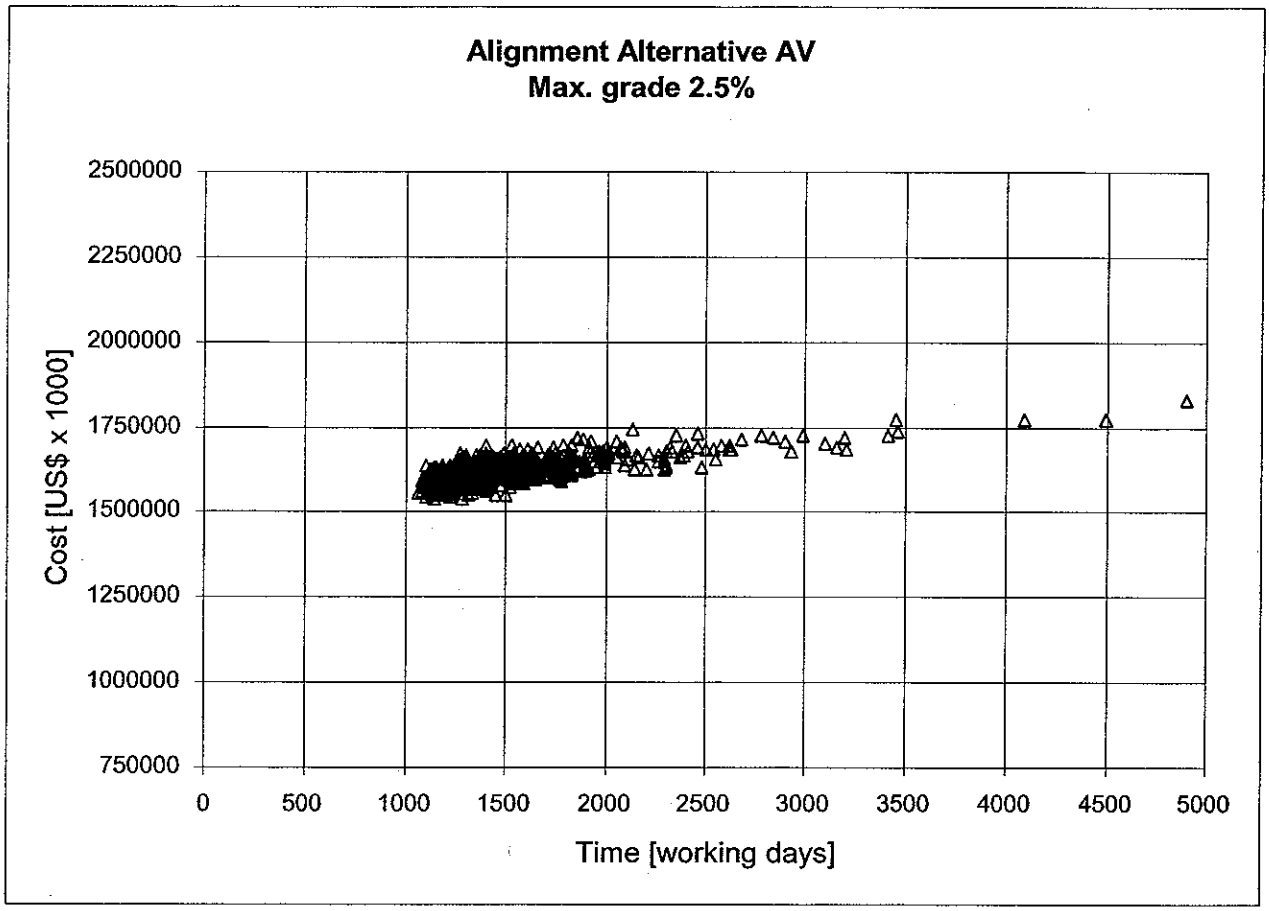


Figure 6.11 Total Construction Time histogram of the option of AV Alignment with 2.5% maximum grade

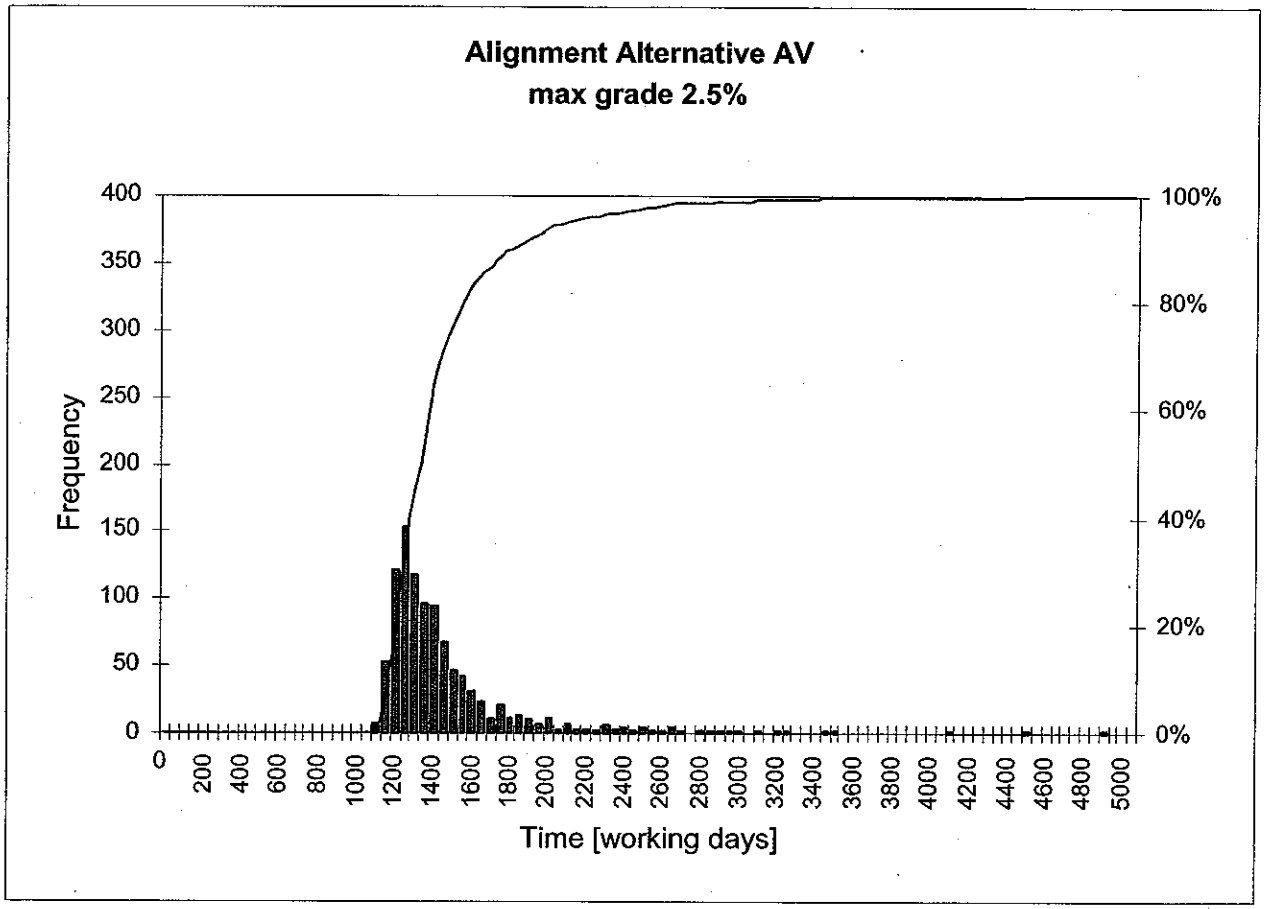


Table 6.7 Statistical data about the Total Construction Time of the option of AV Alignment with 2.5% maximum grade

Alignment Alternative I-5AV Max grade 2.5%	Construction time	
	Unit	Value
Number of simulations	[-]	1000
Mean value	[working days]	1430
Median value	[working days]	1321
St. Deviation	[working days]	370
Minimum value	[working days]	1060
Value at 95%	[working days]	2050
Difference between 95% value and mean value	[working days]	620
Difference between 95% value and min value	[working days]	990

Figure 6.12 Total Construction Cost histogram of the option of AV Alignment with 2.5% maximum grade

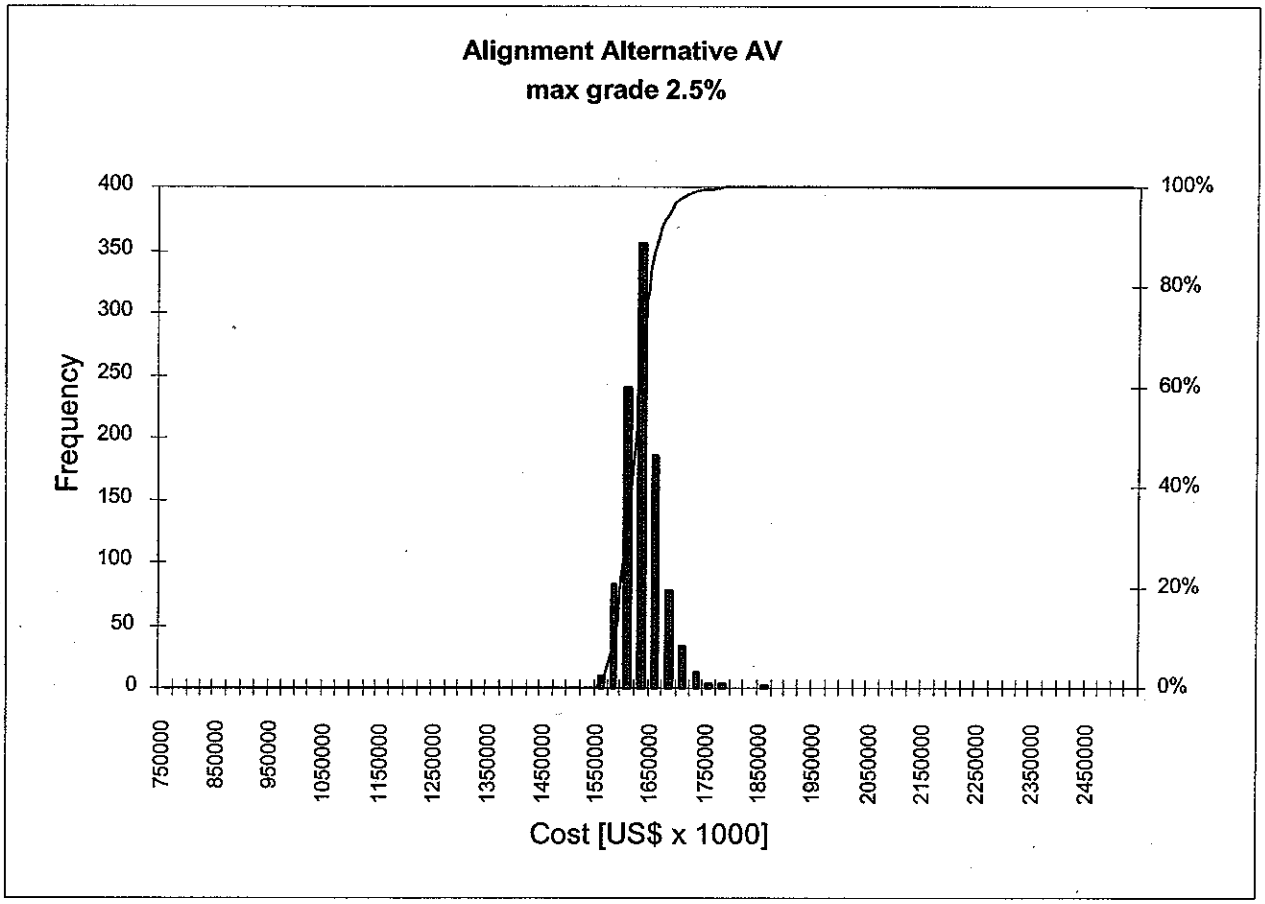


Table 6.8 Statistical data about the Total Construction Cost of the option of AV Alignment with 2.5% maximum grade

Alignment Alternative AV Max grade 2.5%	Construction cost	
	Unit	Value
Number of simulations	[-]	1000
Mean value	[US$ x 1000]	1614790
Median value	[US$ x 1000]	1610143
St. Deviation	[US$ x 1000]	34021
Minimum value	[US$ x 1000]	1537212
Value at 95%	[US$ x 1000]	1675000
Difference between 95% value and mean value	[US$ x 1000]	60210
Difference between 95% value and min value	[US$ x 1000]	137788

6.3.5 Comparative presentation of all the results

Figure 6.13 Scatter plot showing the results of all 4 options for comparison

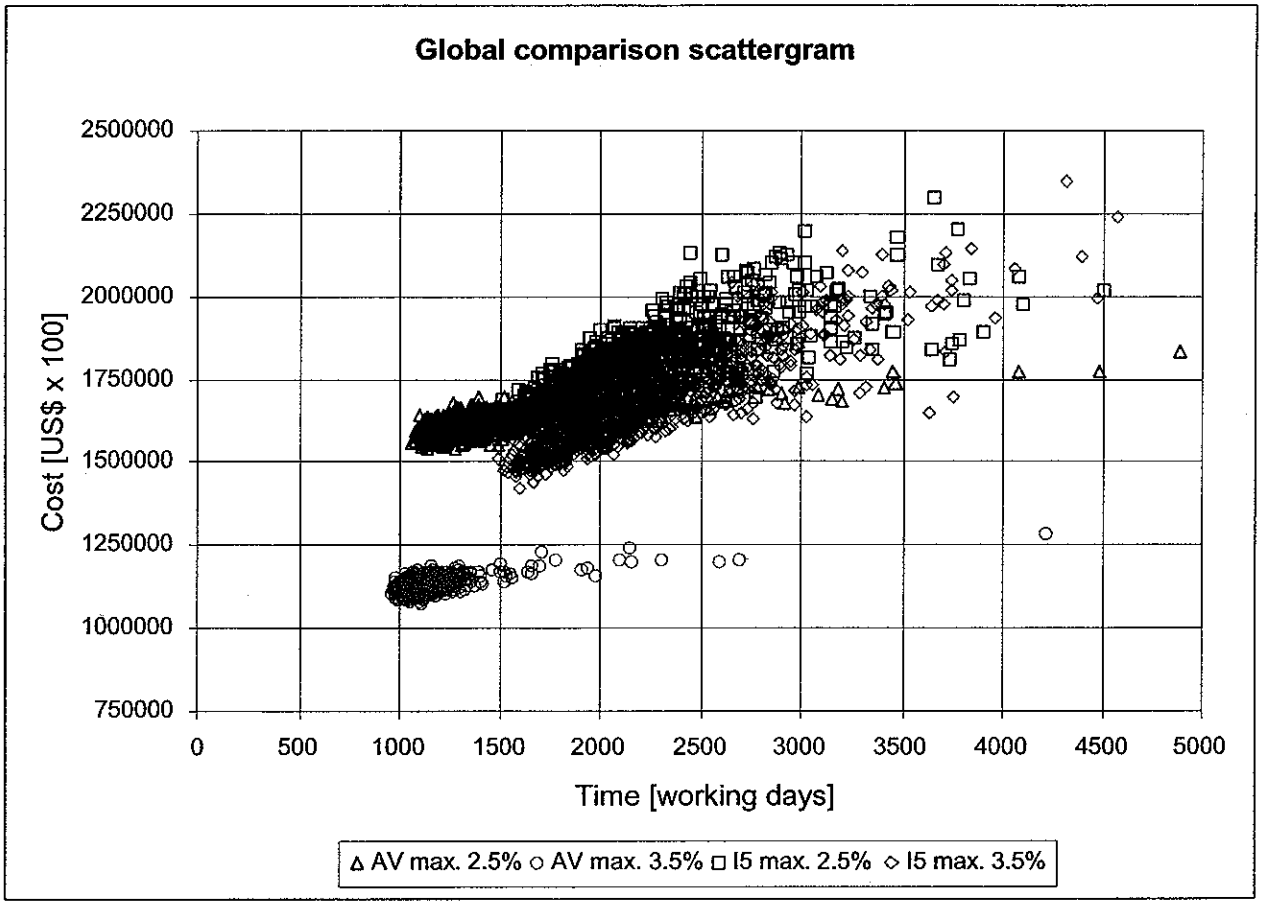


Table 6.9 Global statistics of all 4 options for comparison

		Alignment Alternative I-5		Alignment Alternative AV	
		Max. grade 3.5%	Max. grade 2.5%	Max. grade 3.5%	Max. grade 2.5%
Construction time analysis	**Unit**	**Value**	**Value**	**Value**	**Value**
Number of simulations	[-]	1000	1000	1000	1000
Mean value	[working days]	2218	2124	1125	1430
Median value	[working days]	2111	2027	1089	1321
St. Deviation	[working days]	471	431	217	370
Minimum value	[working days]	1492	1470	962	1060
Value at 95%	[working days]	3100	2900	1250	2050
Difference between 95% value and mean value	[working days]	882	776	125	620
Difference between 95% value and min value	[working days]	1608	1430	288	990
Coefficient of Variation	[%]	21.2	20.3	19.3	25.9
Construction cost analysis	**Unit**	**Value**	**Value**	**Value**	**Value**
Number of simulations	[-]	1000	1000	1000	1000
Mean value	[US$ x 1000]	1670080	1779101	1127511	1614790
Median value	[US$ x 1000]	1643417	1758361	1125936	1610143
St. Deviation	[US$ x 1000]	133507	110232	21023	34021
Minimum value	[US$ x 1000]	1420421	1576264	1073210	1537212
Value at 95%	[US$ x 1000]	1925000	1975000	1150000	1675000
Difference between 95% value and mean value	[US$ x 1000]	254920	195899	22489	60210
Difference between 95% value and min value	[US$ x 1000]	504579	398736	76790	137788
Coefficient of Variation	[%]	8.0	6.2	1.9	2.1

6.4 Discussion of the Results

The results obtained from the DAT simulations must be correctly interpreted in the light of the underlining assumptions.

Considering the variation in the total construction costs (see Figure 6.13 and Table 6.9), it can be observed that, for both Alignment alternatives there is a clear positive relationship between the increase in the average cost and the total length of tunneling (when changing from the 3.5%-max-grade to the 2.5%-maximum grade), as one would normally expect.

Considering the uncertainty about costs which can be measured by the Coefficients of Variation, see Table 6.9), both maximum grade options of the I-5 alignment show higher dispersion than those of the corresponding AV alignment which can be attributed to the more adverse, geologic conditions found along the I-5 alignment.

Additionally, the augmented tunneling length for the AV alignment implies an increase in the spread of results (COV from 1.9% to 2.1%), which is consistent with the increased uncertainties associated with more tunnel stretches running through geologically difficult zones. [Considering the actual tunnel configurations which do not differ from the 2.5% to the 3.5% maximum grade option, the opposite trend of COV, from 8.0% to 6.2%, is evident for the I-5 alignment.]

Similar considerations can be made about the total construction times, especially for the I-5 alignment. The reduced average total construction time for the 2.5% maximum grade configuration, which has approximately 1.5 miles of more tunneling than the 3.5% configuration, derives from the different construction schemes adopted, where one more TBM had to be introduced to optimize the whole construction scheme.

In addition to the above general comments, the following specific observations can be made:

1) The shape of the clouds for the AV alignment (both 3.5% and 2.5% grade options), as shown in the comparative scatter plot of Figure 6.13, is quite different from those of the I-5 alignment (both grade options).

   In the case of the AV Alignment, the cloud tends to close down towards the high ends (of time and cost) with increasingly fewer number of points, while that of the I-5 Alignment is not only wider but also open, with a lower concentration of results in the desired lower range of total construction cost and duration.

   Without entering into the statistical data and the absolute values, the discrepancy above means that the uncertainty of the result in the I-5 alignment is much higher than in the AV alignment.

2) For all four options studied, the dispersion of results is always wider in the time direction than in the cost direction. This is because a linear correspondence between an increase of time and an increase of costs is not foreseen. For tunnel excavation by TBM, supported by pre-cast concrete lining, there is a wide variation in the advance rate due to variations in ground conditions. However, there is no significant variation in the construction cost per linear meter of tunnel. For the HSR Project, the combination of TBM excavation with pre-cast concrete lining is the construction method adopted for almost all tunnels involved in each option.

3) The scattering aspect revealed in Item 1) above is shown clearly by the histograms, especially in the area of costs. Both grade options of the AV Alignment have an extremely "slim" distribution (see Figures 6.9 and 6.12) of cost, with quite small differences between the 95% value and the minimum value (being 76 millions of USD for the 3.5% maximum grade option and 137 millions of USD for the 2.5% maximum grade option, respectively, see Table 6.6 and Table 6.8). The same results are much more uncertain for the I-5 Alignment, with very large differences between the 95% value and the minimum value (being 500 millions of USD and 400 millions of USD for the 3.5%, see Table 6.2, and the 2.5% maximum grade option, see Table 6.4, respectively.)

4) In terms of the mean construction cost, the 3.5% maximum grade option of the AV alignment is about 40% cheaper than that of the corresponding I-5 alignment, while this advantage is reduced for the 2.5% maximum grade option, being about 15% cheaper, due to the increased total length of tunnelling works involved. Furthermore, it should be noted that the increased tunnel length for the AV alignment at the 2.5% maximum grade means savings in costs for construction of the external works and for the mitigation of the environmental impact in the stretches replaced by tunnels.

5) The time histograms of both maximum grade options of the I-5 alignment have similar distributions (see Figure 6.2 and Figure 6.5), due to the fact that the differences in the construction schemes do not affect the final construction time. The main difference consists in the existence of a second set of seismic chambers to cross the San Andrea Fault Zone. This feature introduces additional, costs, but not time because the construction of the second couple of seismic chambers was foreseen to be done mainly during the long period of procurement and assembly of the TBMs. The TBMS will start their tunnel excavation from the chambers and, thus will not affect the final construction time.

6) The 2.5% maximum grade option of the AV alignment has a consistently lower range of variation in the total construction time (with a difference of 990 working days between the 95% value and the minimum value, see Table 6.7), and the 3.5% maximum grade option has an even lower range (being only 288 working days, see Table 6.5). However, the corresponding differences for the I-5 alignment are 1608 and 1430 working days respectively for the 3.5% (see Table 6.1) and the 2.5% maximum grade option (see Table 6.3). These differences between the AV and the I-5 alignment derive mainly from the differences in the geological conditions involved: the relatively shorter and shallower tunnels on the AV alignment are associated with less geological difficulties and thus a lower degree of uncertainty, compared with the long and deep tunnels on the I-5 Alignment.

7) For the 3.5% maximum grade option, the mean construction time required for the I-5 alignment is almost twice as much as that required for the AV alignment (2218 working days against 1125 working days, see Table 6.9). The same trend is basically true also for the 2.5% maximum grade option, with a slight increase in the mean construction time for the AV alignment, due to increased total length of tunneling (see also Table 3.1).

8) It should be pointed out that our DAT analysis does not simulate the financial consequences associated with increased construction duration which could change significantly the forecast of the total investment cost. This financial impact of

construction duration will definitely further magnify the current differences in the construction costs between the I-5 options and the AV options.

Finally, with reference to all the histograms fitted with a cumulative normal distribution curve, the risk of exceeding certain cost or time limits can be easily evaluated if such limits or targets are known.

The conclusions derived from the DAT-simulation results are presented in Section 7.

7. CONCLUSIONS AND RECOMMENDATIONS

Given the large amount of tunneling works involved (see Table 3.1), the Bakersfield to Los Angeles Corridor itself, be it the I-5 alignment or the Antelope Valley alignment, is a mega project.

The potential, typical risks that may be encountered in a mega tunneling project are:

1) Risk of encountering adverse conditions due to the inherent uncertainties of ground and groundwater conditions – leading to significant cost overruns and project delay;

2) The potential for accidents during tunneling work and, later on, during operation;

3) Risk to the health and safety of workers and third party individuals, including personal injury and, in extreme cases, loss of life;

4) Construction risks, such as choice of a wrong type of TBM, ground-squeezing behavior, face collapses; and production of materials causing hazardous environmental conditions;

5) Financial risks to the owner, such as delay in completion of the contract or cost overruns;

6) Contractual risks, such as additional work not covered, time delays, disputes, claims and litigation.

The underground construction industry seems particularly prone to disputes. This is most likely because of the risks and uncertainties associated with subsurface conditions and the costly plant and equipment required (for example, the TBM and its associated back up gear).

Traditionally, the potential risks listed above have been managed indirectly through the engineering decisions taken during project development. This approach is often found to be inadequate during construction. Many recent case histories have demonstrated that risk management can be significantly improved by using systematic risk management techniques throughout the tunneling project development. The use of these techniques can ensure that most potential problems are identified and addressed in a timely fashion so that appropriate and cost effective risk reducing measures can be implemented. The use of risk management in the early stages of a tunnel project is essential, particularly at the beginning of the planning process where major decisions, such as choice of alignment and selection of construction methods, can be influenced.

The study presented in this report was commissioned for two main reasons, (1.) Specific uncertainties in the tunneling process were not adequately integrated in earlier studies commissioned by the Authority, and (2.) to identify the optimum alignment with respect to minimizing capitol investment and risk of construction cost overruns and costly delays.

As pointed out in Section 1.2.2, the earlier studies of the Authority have focused on minimizing tunnel requirements and cost (Corridor Evaluation study and QUANTM study) and minimizing potential environmental impacts (the Screening Evaluation) by

avoiding sensitive zones in identifying the potentially suitable routes. However, there is a limit to these reductions due to the constraints imposed by the specific topography and tectonic setting of the region as well as the high speed train technology. Furthermore, for the limited number of potentially suitable routes identified by the previous screening studies, and subsequently confirmed by the QUANTM analysis, the various categories of risks, especially the geological and construction risks, were not considered. In the opinion of Transmetrics/Geodata, these other risks are as important as those already considered by the Authority. They are also critical in the final choice of the optimum alignment/route for the mega tunneling project.

Consequently, the study commissioned by the City of Palmdale and undertaken by Transmetrics/Geodata represents a complementary, step forward in the development process of the Project.

It is understood from the beginning of this report that, to perform an alignment specific risk analysis, focusing on the geological and constructional aspects, requires specific information about the ground conditions of each potentially suitable alignment. However, most of the required information is not directly available because no preliminary site-specific investigations have been made.

To overcome this problem, we adopted the common practice of utilizing our tunneling experience and judgment as well as USGS data and reports in lieu of precise, in situ explorations and measurements. In addition, full use was made of the information contained in the Preliminary Engineering Feasibility Study of PBQD. We acquired relevant reports and maps from the USGS to study the geomorphological, geological, hydrogeological, and geotechnical conditions of the two alternative alignment corridors, establishing foreseeable ground models. We also made a preliminary design of both alignments, defining the corresponding construction schemes based on our European experience for similar projects.

To facilitate the comparison of the geological and construction risks involved in the two alternative alignments and also to further overcome the problem of limited data, we adopted a probabilistic model that incorporates the impact of different geological factors on the risks and productivity. The specific model adopted was developed at the Massachusetts Institute of Technology and is called Decision Aids in Tunneling (DAT). The model allows for the comparison, in terms of construction time and cost, of various, feasible, design and construction solutions for a tunneling project, and for quantification of risks related to each solution.

<u>The various analyses presented in this report have demonstrated the following:</u>

- Although the amount of tunneling work involved in the I-5 and the AV alignment are almost the same, be it the 2.5% grade or the 3.5% grade option, the ground conditions along the AV are relatively more favorable and hence involve less construction risks, financial risks, and contractual risks.
- For the 3.5% max grade option, the mean construction time required for the I-5 alignment is almost twice as much as that required for the AV alignment (2218 working days against 1125 working days, see Table 6.9). The same trend is basically true for the 2.5% max grade option, with a slight increase in the mean construction time for the AV alignment due to increased total length of tunneling (see also Table 3.1).

- In terms of the mean construction cost, for the 3.5% max grade option, the Antelope Valley alignment is about 40% cheaper than the I-5 alignment, while this advantage is reduced for the 2.5% max grade option. The 2.5% grade option is 15% cheaper, again due to increased total length of the tunnel. Furthermore, the increased tunnel length for the AV alignment at 2.5% max grade will reduce the costs for the corresponding external works and environmental impact.
- It should be pointed out that the DAT analyses presented in this report do not simulate the financial consequences associated with increased construction duration. If the financial impact due to longer construction duration is taken into consideration, the final results will not only change significantly the forecast of the total investment required for each alignment option, but will also magnify the construction cost differences between the I-5 and the Antelope Valley alignment.

Generally speaking, the findings of this study have confirmed the concerns of the City of Palmdale over the relative risks involved in the two alternative alignments. These findings should also permit the Authority to make more informed decisions regarding the final choice of the best alignment, including the process to be followed before making the final choice.

On the basis of the analysis conducted, we offer the following three specific recommendations:

In general, the construction experience gained by Geodata from similar, International, mega projects is directly useful as information to assist consideration of new alternatives – management, contracting and new technologies – for the current mega project.

1) Reducing uncertainties

Reducing uncertainties through site investigations, especially the preliminary investigation, for mechanized tunneling, is a key investment strategy for project owners because it will directly reduce risks with short, medium and long term benefits.

To facilitate the final choice of the optimum alignment, site investigations should be designed to reduce the geological uncertainties, thus either confirming or negating the geological and construction risks identified in the analyses presented in this report. For this purpose, a proper balance of effort should be maintained between investigating the I-5 alignment and exploring the Antelope Valley alignment.

Once the optimum alignment is selected, it is strongly recommended that critical sections (if not all sections) of the service tunnels should be constructed first, since they can be used as pilot tunnels to investigate the ground conditions and to experiment with the construction techniques to be employed for the construction of the main tunnels later.

2) Development of Innovation – New Technologies

The greatest payoff can be realized by the use of innovation in complex underground projects, especially long and deep tunnels, with difficult or unexplored geology, as in the California High Speed Rail project. In addition to the risks listed previously, there are still potential technological risks. For example, the technical feasibility of realizing the huge, seismic chambers in very wide fault zones, and the technical capacity of the tunneling market to supply the great number of large-diameter TBM's required for realizing this mega tunneling project will be a challenging task.

Innovation means that the new concepts are competently developed, consistent with the limits of current knowledge and experience, and carefully matched to the specific conditions of the project. For this purpose, it is suggested that the Authority work closely with engineers, contractors and manufacturers, as early as possible, to develop innovative solutions to the high risk aspects of the project, bearing in mind that innovation takes time.

3) Contracting Practices

It is now almost universally accepted that "the ground belongs to the Owner" – including the sometimes unknown difficult geologic conditions which will be encountered. Wise Owners recognize this and seek ways to equitably mitigate the risks, sharing and allocating risk to the best entity that can foresee or control that particular risk. Passing risk along without a strategic and equitable approach will often lead to disputes which will eventually have a great impact on the project and the Owner.

It is now accepted by many Owners that the contracting practice of accepting a fixed-cost low bidder from a group of "qualified" contractors, should not be adopted when the jobs are large, the geology uncertain, and potential for extremely high cost overruns escalate. It has been the experience of some Owners that the low-bid contracting system can result in delays, cost overruns, problems with project completion and a long process of claims and litigation. Negotiated contracts with fair allocation of risks among the parties involved could be more cost effective and equitable.

Appendix 1 List of reference geological documents

Type	Title	Year of publ.	Other
Map	Geologic map of the Warm Springs Mountain Quadrangle	1997	scale 1:24,000
Map	Geologic map of the Whitaker Peak Quadrangle	1997	scale 1:24,000
Map	Geologic map of California. Los Angeles sheet	1969	scale 1:250,000
Map	Geologic map of California. Bakersfield sheet	1965	scale 1:250,000
Map	Geologic map of California	1977	scale 1:750,000
Map	Geologic map and cross sections of the southeastern margin of the San Joaquin Valley, California	1984	scale 1:125,000 (contains Bakersfield area)
Map+Paper	Geologic map of the Tehachapi Quadrangle, Kern County, California	1970	scale 1:65,000 (with accompaining explanatory paper)
Map	Geologic map of the San Andreas Fault Zone, Leona Valley, California	1976 (repr. 1984)	scale 1:10,000
Paper+Maps	Geology of the Willow Springs and Rosamond Quadrangles, California	1963	scale 1:62,500
Map+Paper	Geologic map of the Cummings Mountain Quadrangle, Kern County, California	1970	scale 1:65,000 (with accompaining explanatory paper)
Map	Geologic map of the Pearland Quadrangle, California	1953	scale 1:24,000 relevant descriptive notes on the map
Map	Geologic map of the Black Mountain Quadrangle, California	2002	scale 1:24,000
Map	Geologic map of the Liebre Mountain Quadrangle, California	2002	scale 1:24,000
Map	Geologic map of the Pacifico Mountain and Palmdale (south half) Quadrangle, California	2001	scale 1:24,000
Map	Geologic map of the Sleepy Valley and Ritter Ridge Quadrangles, California	1997	scale 1:24,000
Paper+Map	Postcrystalline Deformation of the Pelona Schist Bordering Leona Valley, Southern California	1978	Geological Survey Professional Paper 1039 with annexed geologic map at 1:10,000
Paper+Map	Basement-Rock Correlations Across the White Wolf-Breckenridge-Southern Kern Canyon Falut Zone, Southern Sierra Nevada, California	1986	U.S. Geological Survey Bull. 1651, with annexed geologic map at 1:25,000
Paper+Map	Stratigraphy and Sedimentology of the Eocene Tejon Formation, Western Tehachapi and San Emigdio Mountains, California	1987	U.S. Geological Survey Bull. 1268, with annexed geologic non colour map at 1:62,500
Paper+Map	The Metamorphic and Plutonic Rocks of the Southermost Sierra Nevada, California, and their Tectonic Framework	1989	U.S. Geological Survey Professional Paper 1381, with annexed geologic map at 1:125,000
Map	Geologic map of the Grapevine Quadrangle, California	1973	U.S. Geological Survey open file map, preliminary non colour. Scale 1:24,000
Map	Geologic map of the Pastoria Creek Quadrangle, California	1973	U.S. Geological Survey open file map, preliminary non colour. Scale 1:24,000
Map	Geologic map of the Eagle Rest Peak Quadrangle, California	1973	U.S. Geological Survey open file map, preliminary non colour. Scale 1:24,000
Map	Geologic map of the Santiago Creek Quadrangle, California	1973	U.S. Geological Survey open file map, preliminary non colour. Scale 1:24,000
Map	Geologic map of the Pleito Hills Quadrangle, California	1973	U.S. Geological Survey open file map, preliminary non colour. Scale 1:24,000
Maps (4)+Table	Geologic maps of the Knob Hill, Pine Mountain, Oil Center and Bena Quadrangles, California	1986	U.S. Geological Survey open-file report 86-188, preliminary non colour. Scale 1:24,000
Map+Notes	Preliminary Geologic map of the Val Verde 7.5' Quadrangle, Southern California	1995	U.S. Geological Survey open-file report 95-504, preliminary non colour. Scale 1:24,000
Map+Notes	Preliminary Geologic map of the Oat Mountain 7.5' Quadrangle, Southern California	1995	U.S. Geological Survey open-file report 95-89, preliminary colour. Scale 1:24,000
Map+Notes	Preliminary Geologic map of the Mint Canyon 7.5' Quadrangle, Southern California	1996	U.S. Geological Survey open-file report 96-89, preliminary colour. Scale 1:24,000
Map+Notes	Preliminary Geologic map of the Newhall 7.5' Quadrangle, Southern California	1995	U.S. Geological Survey open-file report 95-503, preliminary non colour. Scale 1:24,000
Notes	Geologic map and Digital Database of the Apache Canyon 7.5' Quadrangle, Ventura and Kern Counties, California	2000	U.S. Geological Survey open-file report 00-359. Stratigraphy, structure and units description. NO MAP
Notes	Preliminary Geologic map of the San Fernando 7.5' Quadrangle, Southern California: a Digital Database	1997	U.S. Geological Survey open-file report 97-163. Just a description of the adopted GIS system
Map	Preliminary Geologic map of the Mojave Quadrangle, California	1959	scale 1:62,500
Map	Geologic map of the Lancaster Quadrangle, Los Angeles County, California	1960	scale 1:62,500
Map	State of California - Special Studies Zones. Palmdale Quadrangle	1979	scale 1:24,000 topographic map with tectonic lineaments (potentially active faults)
Map	State of California - Special Studies Zones. Ritter Ridge Quadrangle	1979	scale 1:24,000 topographic map with tectonic lineaments (potentially active faults)
Maps (13)	Topographic maps along I-5 route	-	scale 1:24,000
Maps (24)	Topographic maps along SR-14 (via Palmdale) route	-	scale 1:24,000

APPENDIX 2 GEOLOGIC SETTING

2.1 Physiography of the region

The physiography of the region is a product of the geologic history of the area. Several coastal mountain ranges underlain by severely folded, faulted, mostly metamorphosed marine and continental sediments, forming the Pacific Border and the Lower Californian Physiographic Provinces.

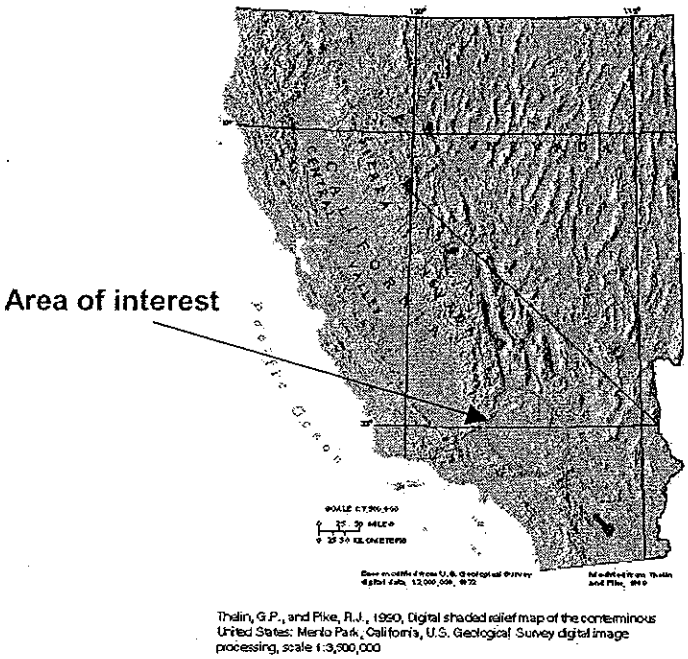


Figure A2.1 Digital, shaded relief map showing the high rugged California mountain ranges surrounding the low lying Central Valley (modified after USGS Groundwater Atlas of United States; California, Nevada)

In the interior, the granitic rocks that underlie the fault blocks of the Sierra Nevada and the volcanic rocks of the southern Cascade Mountains join to form the eastern border of the low lying California Trough, which contains the Central Valley.
East of the Sierra Nevada, the landscape is characterized by a series of low, north-south trending mountain ranges and intervening valleys; the ranges and valleys were created by faulting that resulted in the horst and graben structures which in turn formed the Basin and Range Physiographic Province.

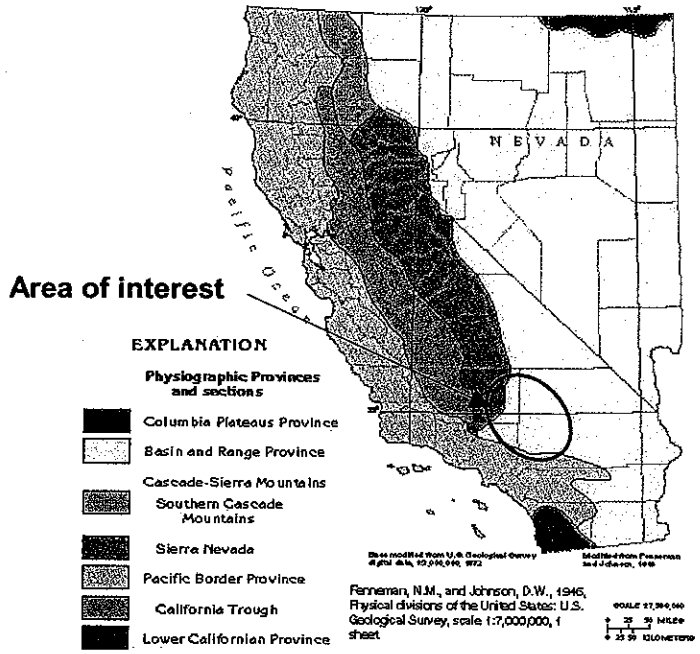


Figure A2.2 California Physiographic provinces (modified after USGS Groundwater Atlas of United States; California, Nevada).

The alternative alignment options intersect three physiographic provinces, namely: Central Valley (California Trough), Basin and Range (Mojave desert), and Pacific Border (Transverse Ranges; south of San Andreas fault alignment).

2.2 Regional structural outline

The California geographic region is situated along the active geodynamic margin between North America and North Pacific tectonic plates. The main boundary between the two plates coincides with the NNW-SSE San Andreas active fault system which separates the southern California from the rest of the north America continent.

Many other important regional active faults are present in California which determine and control the geologic development of distinct zones. The principal faults include: the NE-SW trending Garlock fault and the associated Tehachapi mountains separate the Sierra Nevada batholithic region from the Mojave desert, the complex system of San Gabriel-Santa Susana Sierra Madre faults which bound the Transverse Ranges north of Los Angeles, the San Gabriel NW-SE trending fault system which limits westward the San Gabriel mountains region, the White Wolf fault zone which intersects the southern part of the Sierra Nevada batholite.

The main faults are associated with a lateral strike slip character (San Andreas, Garlock, San Gabriel), while the minor faults are considered as compressive thrust faults (e.g., Santa Susana Sierra Madre, Pleito, and Pastoria systems) or normal type (e.g., Raymond Fault).

Practically all the above-mentioned main faults, and a significant number of minor associated faults will be crossed by the alternative alignment options. Depending on the geometric characteristics of the alignment such faults will be crossed either underground or at grade.

For the choice of the final alignment, one crucial aspect is represented by the active character of the faults. In fact, most of these faults are considered tectonically active or potentially active and seismogenetic in historic or recent (< 10,000 years B.P.) times. In this respect, California is well recognized as one of the most seismically active areas in the world. Besides, the anticipated lateral offset that could occur along major faults during earthquakes of exceptional magnitude, the design of underground structures will also have to take into consideration another important phenomenon associated with active fault zones, namely, the slow plastic slippage by which tectonic stresses are accommodated. Such movements can amount to several mm/year.

For the present study, the identification of fault zones is based on evidence from available maps (see reference documents list, Appendix 1) and on interpretation of satellite images coupled with morphologic analysis carried out on topographic maps (1:24,000 scale).

Because of their complex and long geologic history that presumably caused several lateral migrations of the principal fault plane, as well as the possible existence of multiple associated shear zones that might have been activated in different times, no attempt has been made to distinguish between the true fault planes and the associated fault affected zones, in terms of their geomechanical properties. It seems that this task might only be accomplished with the support of detailed studies and proper investigations.

Table A2.1 summarizes some characteristics of the principal faults that are considered to directly interfere with the underground sections of the studied alignments.

Table A2.1 Principal fault zones affecting the tunnels on the alternative alignments

Fault zone	Location (align., approx. chain.) (3)		Type	Attitude (dip/dip direction or strike direction)	Estimated width [m] (1)	Last seismic event year/magnitude] (2)	
S. Andreas	I-5	km 78+000	S, RH	Near vertical, NW-SE	800 - 1000	1857 (south branch)	8.0
Garlock	I-5	km 70+250	S, LH	Near vertical, NE-SW	500 - 800	1992 (Mojave)	5.7
	AV	km 79+350					
S. Gabriel	AV	km 177+950	S, RH	Near vertical, NW-SE	400 - 600	Quaternary	unknown
		km 178+200					
		km 178+850					
S. Susana	I-5	?	T	var., NW to NE	200 - 250	Late Quaternary	unknown.
	AV	km 183+600				1971 (S. Fernando)	6.5
		km 184+200					
Pleito	I-5	km 57+700	T	var., NNW	150 - 200	345-1465 years ago	unknown
Pastoria	I-5	km 67+000	R	var., SSE	300 - 400	unknown; probably non active	
Edison	AV	km 38+600	N	45-75°, NNW	100 - 200	unknown; probably non active	
		km 40+600					
Legend	S (strike-slip fault), T (thrust fault), N (normal fault), R (reverse fault); RH, LH (right-hand mov., left-hand mov.)						
Note	(1) The figures refer to the estimated width of the fault affected zone						
	(2) From SCDEC (Southern California Earthquake Data Center http://www.scecdc.scec.org/faultmap.html)						
	(3) Chainage onset is assumed in Bakersfield						

2.3 Lithologic and lithostratigraphic outline

The alternative, analyzed alignments traverse a variety of geologic units which can be broadly divided in three principal groups separated by unconformities: pre-Tertiary crystalline rocks; Tertiary volcanic, volcano clastic and sedimentary rocks; Quaternary sedimentary deposits.

Pre-Tertiary crystalline rocks are composed of plutonic igneous Mesozoic rocks (ranging in composition from hornblende diorite to quartz monzonite to granite) and metamorphic Paleozoic to Precambrian rocks which generally occur as isolated bodies or as interbedded layers within plutonic rocks. The two rock groups together constitute the crystalline basement upon which all later units were deposited.

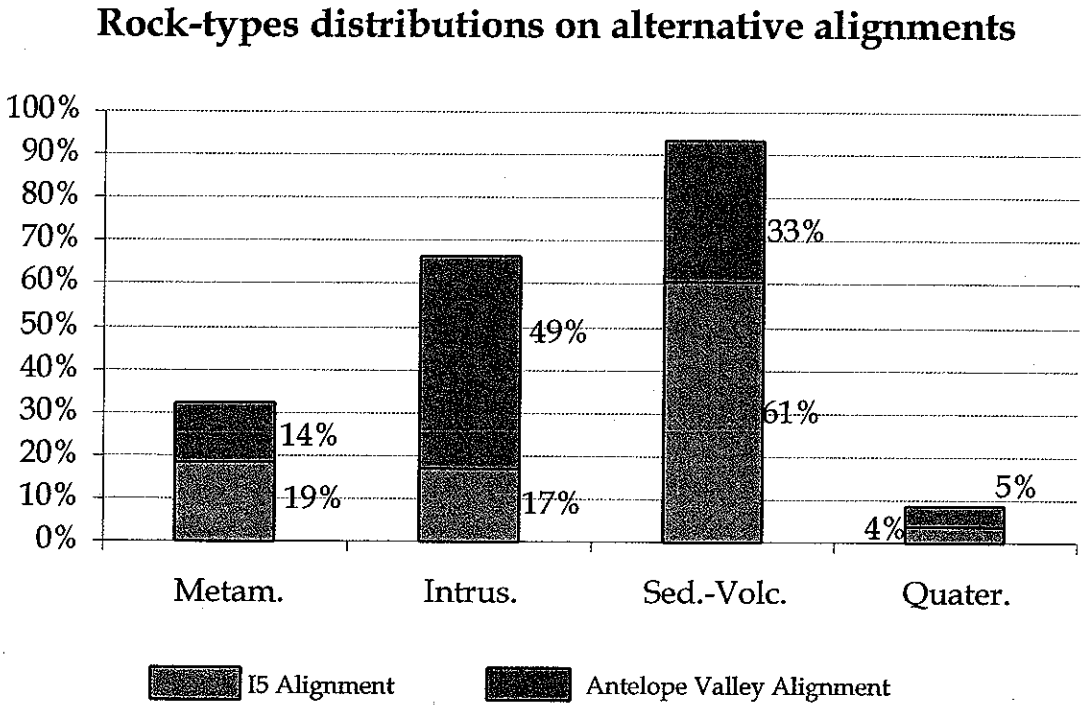
The Tertiary complex is composed of volcanic to sub-volcanic Eocene to Miocene units (rhyolite, andesite, basalt, pyroclastic rocks) and clastic flysch-like and non-marine sedimentary units (variably interbedded sandstones, siltstones, claystones and to a minor extent conglomerates).

The Quaternary deposits range from Pleistocene marine and non marine clastic deposits to fanglomeratic (i.e. sedimentary rock composed of heterogeneous unrelated materials that were originally deposited in an alluvial fan) and unlithified coarse piedmont deposits (gravel to boulder sized).

A more detailed description of the different rock-type occurrence along the alternative alignments is presented in Section 6 (Anticipated geologic conditions along alternative routes).

Figure A2.3 shows the relative distributions of different rock-types (pre-Tertiary metamorphic and intrusive rocks, Tertiary sedimentary-volcanic rocks, Quaternary deposits).

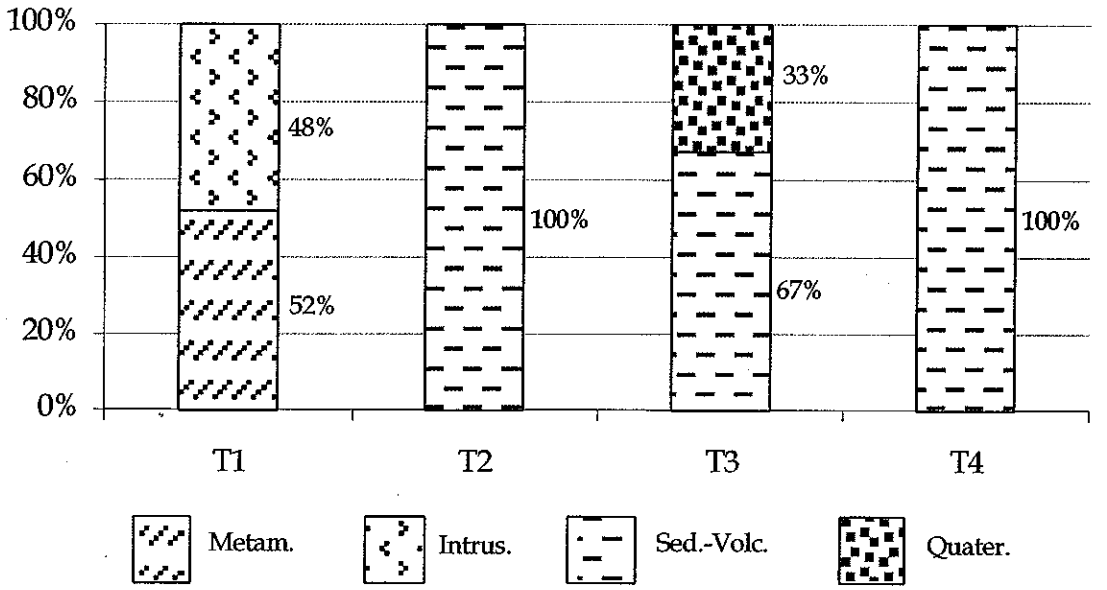
Figure A2.3 Distribution of the various rock types for the alignment options with reference to 2.5% max. grade (Metam. = metamorphic rocks, Intrus.= intrusive rocks, Sed.-Volc.= sedimentary-volcanic rocks, and Quarter.= Quaternary deposits)



Figures A2.4 gives the distribution the various rock types, in terms of both their percentage and accumulative length, on each tunnel along the I-5 alignment.

Figures A2.5 gives the distribution the various rock types, in terms of both their percentage and accumulative length, on each tunnel along the Antelope Valley alignment.

Figure A2.4 Rock type distribution in percentge and by length for each tunnel on the I-5 alternative alignment (with reference to the 2.5% max grade)



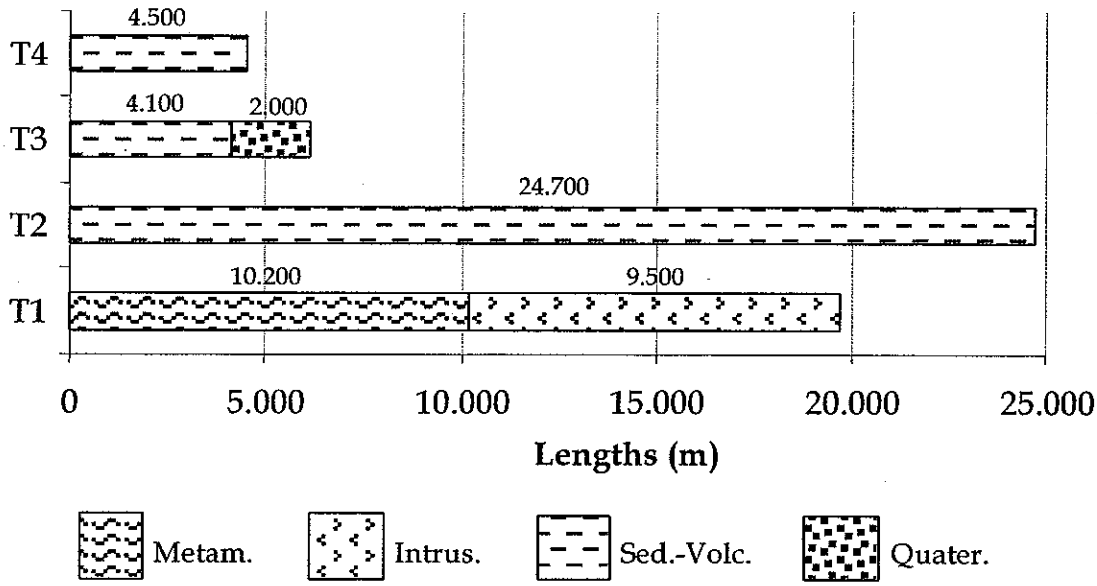
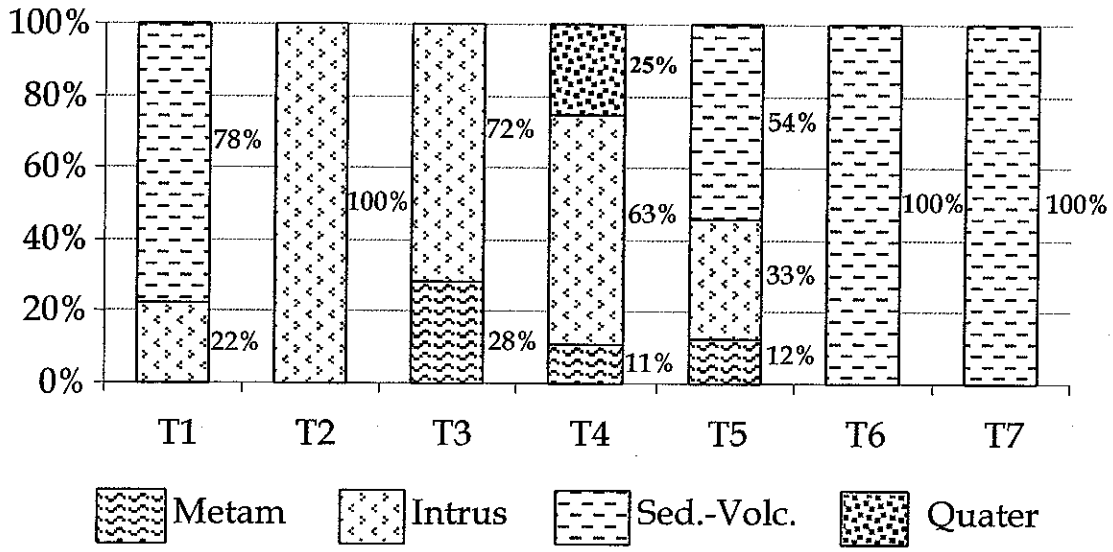
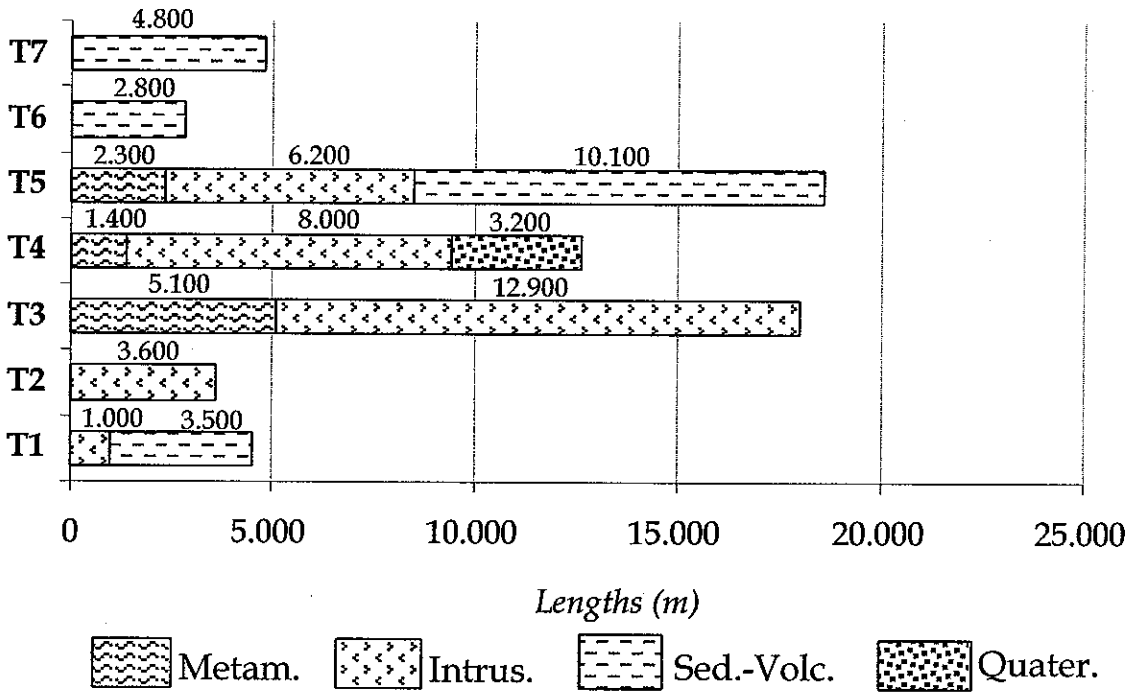


Figure A2.4 Rock type distribution in percentge and by length for each tunnel on the Antelope Valley alternative alignment (with reference to the 2.5% max grade)





The characteristics of the principal geological formations that are expected to be encountered in tunneling, for both alignment options, are described in the following sections.

Pre-Cenozoic crystalline rocks

- Precambrian anorthosites

Medium to very coarse-grained hornblende plagioclase rock; it outcrops in the San Gabriel Mountains area. It could be deeply weathered, broken and shattered with local, hard, slightly weathered to unweathered remnants. In the Soledad Canyon zone it appears to be in tectonic contact with more recent sedimentary units (Vasquez Fm).
Antelope Valley(AV) alignment (Soledad Canyon section)

- Paleozoic to Cretaceous metamorphic rocks

Moderately-foliated, fine-grained phyllites (Paleozoic) with interbedded marble and quartzite layers; this metamorphic complex is abundant towards North of Tehachapi Mountains where it is associated with younger intrusive rocks.
AV alignment

Probably of Paleozoic age highly foliated, sheared and faulted biotitic schists rich in quartz feldspar lenses are found along the Tehachapi Mountain chain where they are strictly associated with and bounded by main regional tectonic structures (Garlock fault zone).
AV alignment (Tehachapi Mountains section)
Cretaceous gneiss, amphibolite and granulite metamorphic complex is present in the northern side of the San Emigdio mountains; the complex is expected to be intensely fractured and weathered also at considerable depths. A Mesozoic to Paleozoic interlayered pile of calcareous, siliceous and pelitic rocks (Keene unit) is present along the tectonic contact between the previous metamorphic complex and the granitic rocks to the South.
I-5 alignment (Grapevine peak)

- Cretaceous intrusive rocks

In terms of relative abundance, they represent the second lithologic group as shown in Figure A2.5; they range in composition from granites, granodiorites, tonalites to quartz diorites and quartz monzonites and are known in the literature under various names. Their geomechanical properties are expected to cover the entire range (from good to very poor) of conditions in relation to specific topographic and tectonic settings.
Both I-5 and AV alignments

Tertiary sedimentary and volcanic rocks

- Vasquez Formation

It consists of coarse clastics, deposited upon volcanic rocks released as the North American tectonic plate initially collided with the Pacific Plate.

Figure A2.6 gives a typical appearance of Vasquez rock formation. The sediments at Vasquez formation were deposited above and with numerous basalt flows that constitute a major portion of the lower sequence; repeated episodes of uplift to quiescence produced several distinctive sequences called megacycles. These megacycles are characterized by coarse clastic sand and gravel deposits at the base of the sequence (as uplift became strong) with an upward fining progression (as tectonic activity slowed

down) into the siltstones and shales of a distal alluvial fan playa depositional environment.

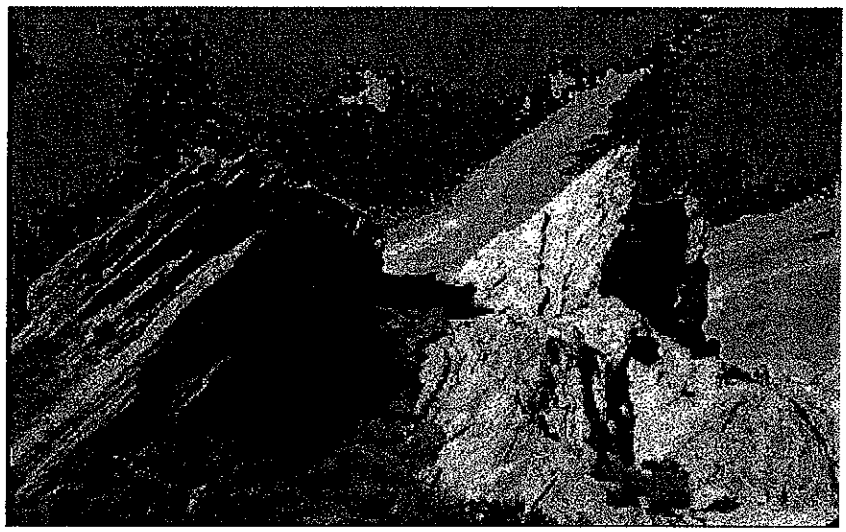


Figure A2.6 Typical appearance of Vasquez rocks

AV alignment (Soledad Canyon section)

- Saugus Formation (Pliocene to lower Pleistocene)

Clastic sedimentary unit composed of two principal facies.
A marine Pliocene facies, composed of sandstones, mudstones, red conglomerates beds and thin limestone beds. A fluvial Pliocene Pleistocene facies, consisting of sandstones, conglomerates and siltstones, described as loosely consolidated to poorly cemented.
In the San Gabriel Mountains region, it underwent intense folding by north south directed compressional forces that were associated with the mid-Pleistocene major orogenetic event of San Gabriel Mountains building.
Both *I-5 and AV alignments*

- Ridge Basin Group (Miocene to Pliocene)

Clastic sedimentary units composed of interlayered and interfingered sandstones, siltstones and claystones; each singular lithotype can locally constitute the prevailing rock unit. The sandstone unit is highly folded, fractured and jointed in the vicinity of the major tectonic structures.
I-5 alignment

- Castaic Formation (Miocene)

Shallow marine clastic, moderately lithified unit. Prevailing facies is composed of a thin bedded claystone (crumbly where weathered) with minor, thin sandstone layers. A secondary interlayered facies is composed of fine to medium grained arkosic cohesive sandstones interbedded claystone levels.
I-5 alignment

- Towsley Formation (upper Miocene to lower Pliocene)

Fairly well indurated with lightly, well cemented interbeds of siltstones to sandstones, with local well cemented pebble conglomerate and beds of breccia. They outcrop in the Santa Susana Mountains range where they are expected to be tectonically quite disturbed. Squeezing behavior of claystone layers was reported during the 60's when the 8m-diameter Newhall tunnel was constructed.
Both *I-5 and AV alignments*

- Pico Formation (Pliocene to Pleistocene)

Marine siltstones, sandstones and red conglomerate beds, fairly well indurated with lightly well-cemented interbeds
I-5 alignment

Quaternary deposits
Mainly alluvial type sedimentary deposits ranging form more recent, unconsolidated, undisected valley fill (gravels to silt grained) to older slightly-consolidated deposits. The deposits can reach considerable thickness also along the piedmont areas (300 to 350 ft. exposed thickness in the Mojave zone).
Both *I-5 and AV alignments*

2.4 Groundwater conditions

Groundwater in the considered area is contained in three major aquifer systems which consist primarily of basin fill deposits that occupy structural depressions caused by crustal deformations. The basin-fill aquifer systems are the Basin and Range aquifers, the Central Valley aquifer system, and the Coastal Basins aquifers.

The principal water yielding units are unconsolidated, continental, clastic deposits of Tertiary age that partly fill structural basins created by faulting. Volcanic rocks, which are principally lava and pyroclastic flows of Tertiary age, are important aquifers in some sparse, non contiguous areas.

The recharge of aquifers, which occurs mainly through runoff from precipitation in the surrounding mountains, infiltrates the permeable sediments of the valley floor either at the basin margins or through streambeds.

Confined or semi-confined aquifers are also known to exist in some places, particularly where interlayering and overlapping of fine and coarse sediments do occur (e.g. in the sediment-filled tectonic depression of Antelope Valley where a deeper artesian aquifer is separated from the upper freatic aquifer through fine lacustrine clays).

For the present study no detailed hydrogeologic information was available concerning hydrogeologic regional setting in the mountainous zones: i.e., no data on the hydraulic heads, permeability distributions, flow nets, hydraulic tests. Consequently, a very qualitative hydrogeological characterization has been carried out that allowed the distinguishing of the zones in which tunneling operations could be negatively affected by

potential water inflows from the zones where hydrogeologic occurrences, if any, should not cause significant impacts.

Basement rocks (granite-like and metamorphic units) which build up the lower and lateral bound of the basin fill deposits can be normally considered as relatively impervious.

Groundwater flow through rock-like materials is basically controlled by discontinuities in rock masses; intact rocks can be considered practically impervious to water flow (due to very low primary porosity and low degree of pore interconnectivity), whereas water circulation in open fissures, joints, solution cavities is strongly facilitated.

Localized water bearing geologic structures, connected to and recharged from basin fill aquifers and from lakes and streams, are represented by areas of intense rock deformation and rupture such as folds and faults. Where the permeability of the rock material has been strongly enhanced due to tectonization, crushed basement rocks are also important water bearing features with enough effective storage and sufficient permeability to act as a local groundwater reservoir.

Anomalous hydraulic differential heads (in both vertical and horizontal directions) can develop through shear zones due to the presence of impermeable barriers made up of finegrained and weathered fault gouges. Such a condition is of particular relevance for all the numerous underground fault crossings.

2.5 Geomechanical characterization methodology

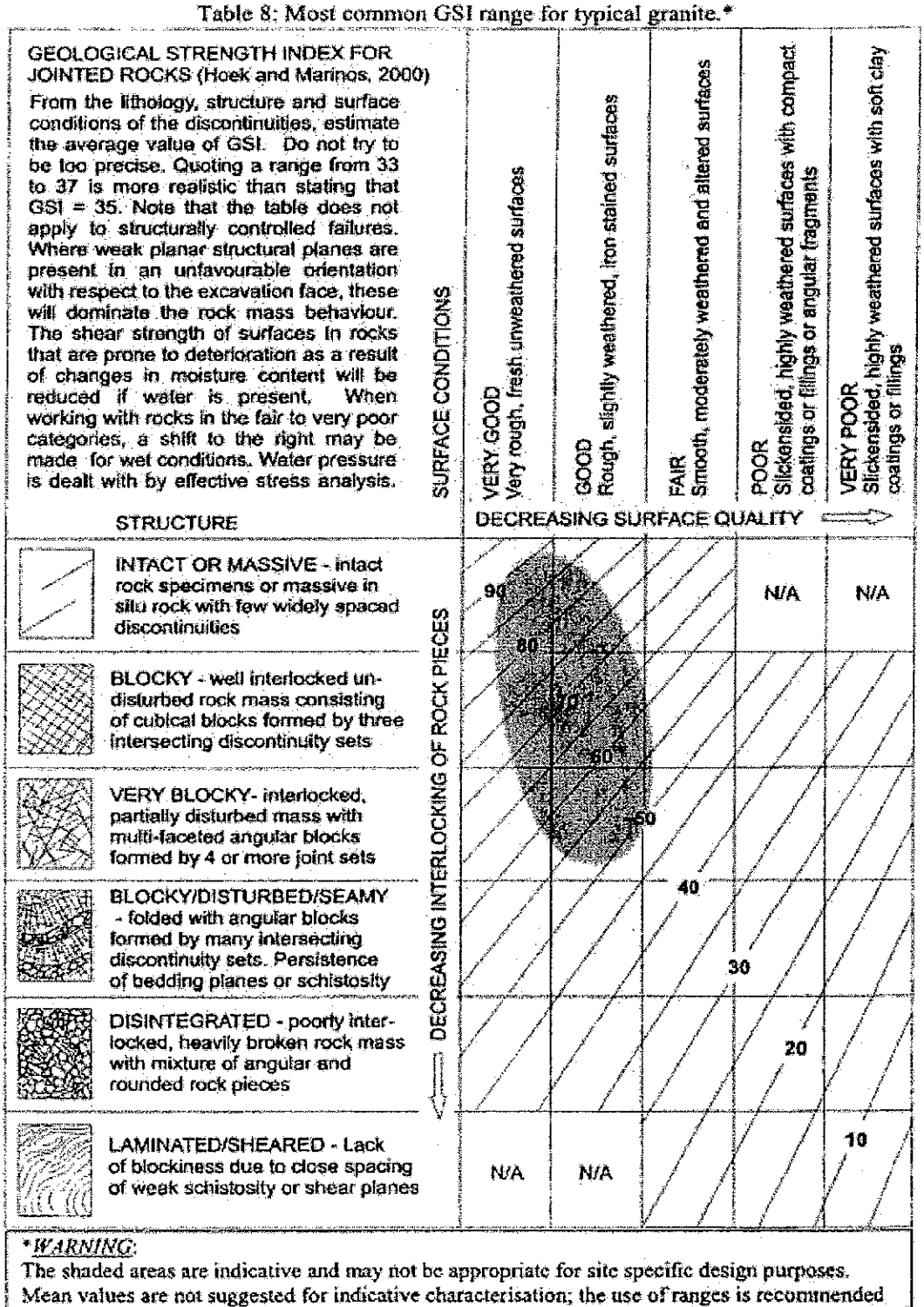
At the present stage of the study, geotechnical and geomechanical data about the geologic units that will be encountered in tunneling are not available.
In order to establish a reference geomechanical frame that permits the describing and classifying of the excavation conditions for tunneling, a simplified approach has been adopted which involves a two-step process:

- First, classify all the geologic units involved in each tunnel alignment into Geomechanical Groups according to the GSI (Geological Strength Index) system proposed by Hoek et al. (1995-2002), that is, assigning characteristic GSI-values to each unit present at the tunnel elevation and subsequently to the right Geomechanical Group;
- Then, determine the behavior class of each geologic unit according to the system proposed by Russo et al. (1998), considering not only the possible geomechanical characteristics of the unit (represented GSI) but also the corresponding in-situ stress conditions (generally, assumed to be geostatic, i.e. only proportional to the thickness of the overburden).

Practically, for Step 1 a characteristic range of GSI is attributed to each geological unit through visual comparison of its "imagined" characteristics with those shown on the special, standard charts by an experienced engineering geologist. As a result, the average, best and worst conditions are obtained. Figures A2.7 and A2.8 present two examples of such GSI charts, comparing two rock types with the standard chart (granite on Figure A2.7, and siltstones and claystones on Figure A2.8, respectively).

Figure A2.7 GSI chart for granites (after Marinos and Hoek, 2000)

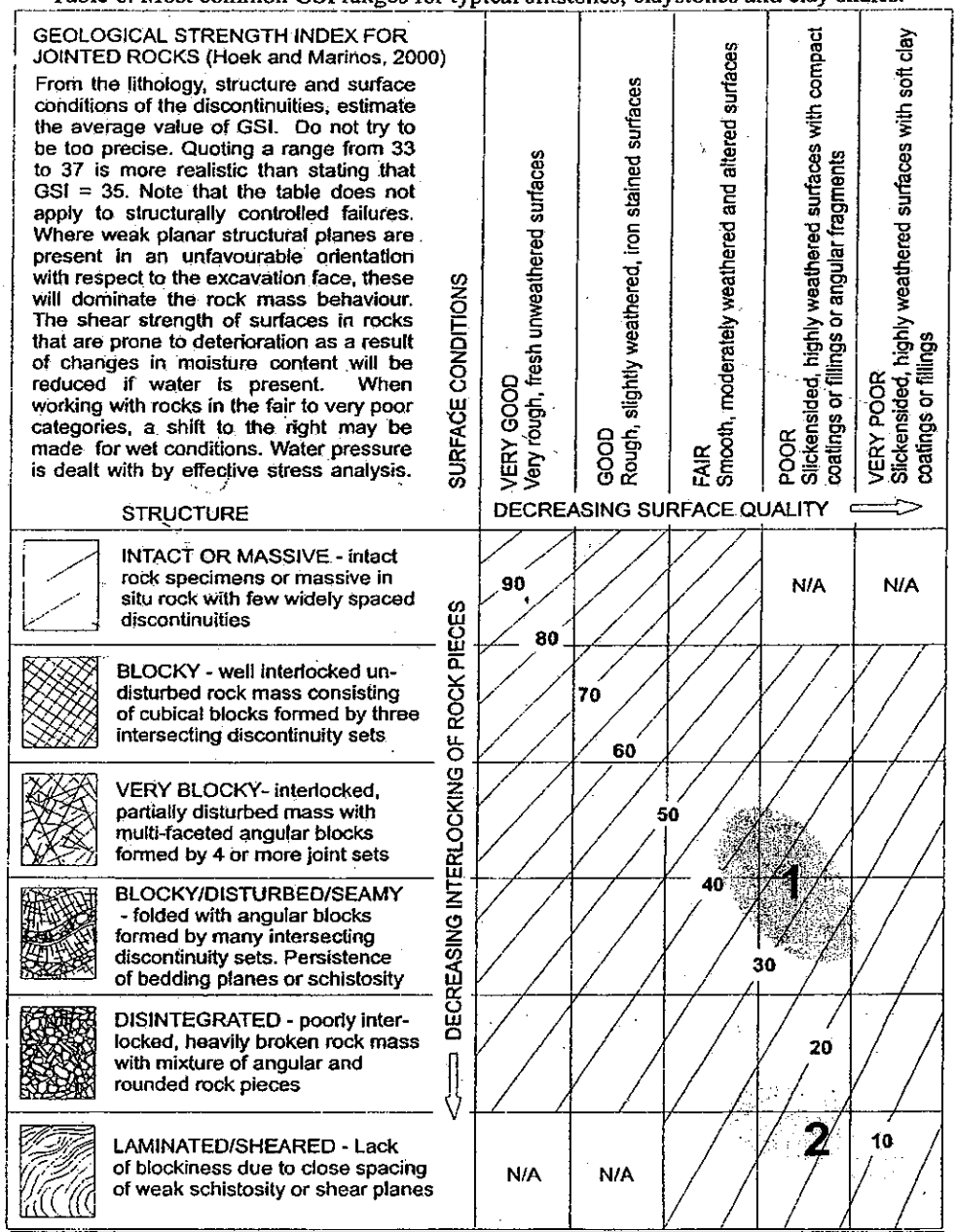
Table 8: Most common GSI range for typical granite.*



Only fresh rock masses are shown. Weathered granite may be irregularly illustrated on the GSI chart, since it can be assigned greatly varying GSI values or even behave as an engineering soil.

Figure A2.8 GSI chart for siltstones and claystones (after Marinos & Hoek, 2000)

Table 6: Most common GSI ranges for typical siltstones, claystones and clay shales.*



*WARNING:
The shaded areas are indicative and may not be appropriate for site specific design purposes. Mean values are not suggested for indicative characterisation; the use of ranges is recommended

1. Bedded, foliated, fractured
2. Sheared, brecciated

These soft rocks are classified by GSI as associated with tectonic processes. Otherwise, GSI is not recommended. The same is true for typical marls.

After the definition of geomechanical groups, the analysis of the excavation behaviour of rock masses around the excavation has been carried out, taking into account the existing stress conditions at the assumed tunnel levels.

Analysis are performed by combining the "Convergence-confinement" method (solution of Brown et al., 1983) and the probabilistic approach, through a spreadsheet model developed by Geodata (SIGRES); typical ranges for intact rock parameters, which are the necessary input to carry out such analysis (i.e., UCS, unit weight, etc.) were attributed to each rock type based on data derived from available literature. The latter is considered particularly adequate for the examined cases, in order to incorporate the actual uncertainties and the inherent variability of the geomechanical parameters.

The results of the simulations are classified on the basis of deformation indexes of the face and of the cavity (Russo et al., 1998), distinguishing six possible categories of behavior: from the best (Category "a") to the worst condition (Category "f"). A short description of the categories follows (see also Figure A2.9).

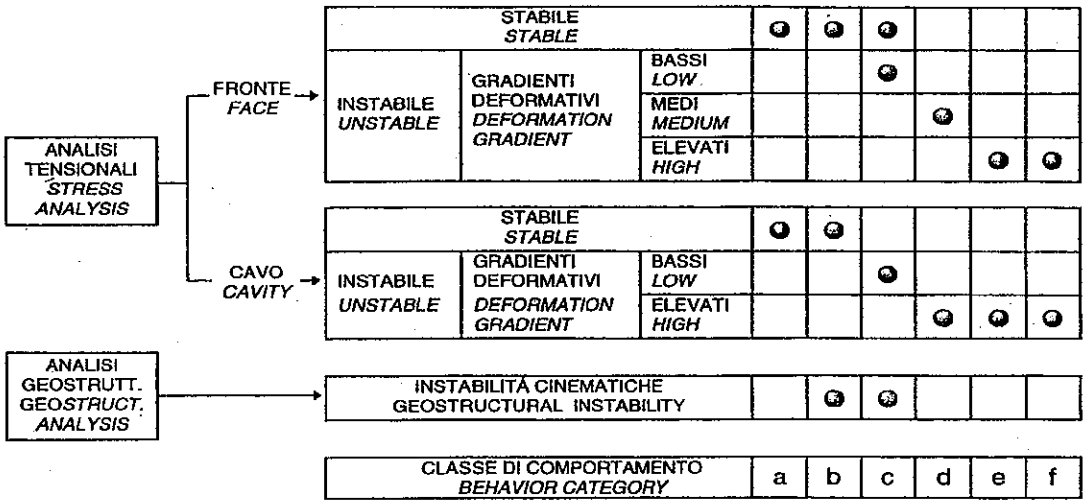
Categories "a-b"
In the behaviour categories "a-b", the strength of the rock mass exceeds the stress level at the face and around the cavity. The ground behaves elastically and in general deformations are of negligible magnitude. Instability phenomena are associated with wedge failure and seldom occur in category "a", where the rock mass is considered as a continuum, but joints are relatively abundant in category "b", where the rock mass is usually considered as discontinuous.

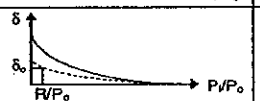
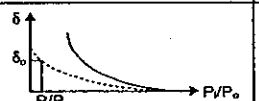
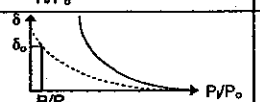
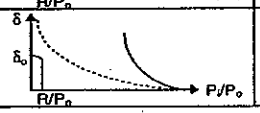
Category "c"
The magnitude of stress concentrations at the face approaches the strength of the rock mass (strength-to-stress ratio, S, is approximately one). The behaviour is elastic-plastic, resulting in minor instabilities. Nevertheless, the deformability gradient at the face is low, and the radial deformation (δ_o), defined as the percentage ratio of radial displacement at the face (u_o) to the equivalent cavity radius, R_o, is less than 0.5%. On the periphery of the cavity the stresses exceed the strength of the rock mass, S<1, resulting in the formation of a plastic zone around the excavation, having a width less than R_o. The formation of the plastic zone results in significant convergence until a new condition of equilibrium is reached.

Category "d"
The magnitude of stress concentrations at the face exceeds the strength of the rock mass. The face is in a plastic state. The deformation gradient is low for typical excavation advance rates; therefore, immediate collapse of the face (δ_o<1.0%) is prevented. The plastic state at the face in conjunction with the development of the plastic zone around the cavity results in a worse overall stability condition than that of category "c".

Category "e"
Category "e" differs from category "d" with respect to the magnitude of deformation at the face and away from the face. At the face the stress-to-strength state results in high deformation gradient and critical conditions of face stability (δ_o>1.0%). The width of the plastic zone is greater than R_o. Therefore, in practical terms, this category includes the highly "squeezing" condition.

Figure A2.9 Definition of the behavioural categories (after Russo et al., 1998)



Classe Category	Fronte *Face*	Cavo *Cavity*	Curve caratteristiche *Characteristic curve* al fronte - at the *face* (·····) e o distanza - *at a dist.* (——)	Interventi di stabilizzazione *Stabilization measures* Funzione prev. *Primary function*	Tipologia *Type*
a	stabile *stable* S>1 (lievi instabilità di blocchi) (limited block instability)	Stabile *Stable* S>1 $R_p/R_o = 1$			
b	globalmente stabile *globally stable* S>1 (cinematismi di blocchi) (wedge instability)	globalmente stabile *globally stable* S>1 (cinematismi di blocchi) *(wedge instability)* $R_p/R_o = 1$		Confinamento *Confinement*	Radiale *Radial*
c	da stabile a leggermente instabile - *limit condition* S≅1 (bassi gradienti deformativi) *(low deformation gradient)* ($\delta_o \leq 0.5\%$)	instabile *unstable* S<1 (poco spingente) *(light squeezing)* $R_p/R_o \cong 1\text{-}2$		>Confinamento *>Confinement*	Radiale *Radial*
d	instabile: fronte plasticizzato ma stabilità non critica *not critical face instability* (S<1) (medi gradienti deformativi) *(medium deformation gradient)* ($0.5\% < \delta_o < 1.0\%$)	instabile *unstable* S<1 (spingente) *(squeezing)* $R_p/R_o \sim 2\text{-}4$		Confinamento e/o miglioramento *Confinement and/or improvement*	Radiale ed eventualmente in avanzamento *Radial and eventually in advance*
e	instabile: condizioni critiche *critical instability* S<1 (elevati gradienti deformativi) *(high deformation gradient)* ($\delta_o \geq 1.0\%$)	instabile *unstable* S<1 (spingente) *(squeezing)* $R_p/R_o > 4$		Miglioramento e confinamento *Improvement and confinement*	In avanzamento e radiale *In advance and radial*
f	instabile a breve termine *short term stability* S<1 (immediate condizioni di collasso) *(immediate collapse)*	instabile *unstable* S<1		Miglioramento e/o confinamento *Improvement and/or confinement*	In avanzamento e radiale *In advance and radial*

Note:
S=Rapporto di mobilitazione (resistenza/sollecitazioni) *strength-to-stress ratio*
R=Resistenza mezzo nucleo - *strength of half nucleus*
δ=deformazione radiale (rapporto spostamento radiale $/R_o$) *radial deformation defined as the percent ratio of radial displacement (u_r) to R_o*
δ_o=deformazione radiale scontata al fronte - *radial deformation at the face*
R_p=Raggio plastico - *plastic zone radius*
R_o=Raggio equivalente galleria - *equivalent tunnel radius*

Confinamento: Intervento teso ad evitare la decompressione della roccia e quindi il suo decadimento
Confinement: Measures to avoid relaxation and preserve the inherent rock mass strength
Miglioramento: Intervento teso a migliorare le caratteristiche geomeccaniche della roccia all'estradosso
Improvement: Measures to enhance rock mass characteristics around the cavity

Definizione delle classi di comportamento - *Definition of behavior categories*
(Russo et al., 1998)

Category "f"
Category "f" is characterised by immediate collapse of the face during excavation (impossible to install support). This behaviour is associated with non cohesive soils and cataclastic rock masses such as those found in fault zones, especially under conditions of high, hydrostatic pressure and/or high in-situ stresses.

With specific reference to mechanized tunneling using TBMs, as in the present case, it can be observed that "a" to "d" categories are generally not associated with significant problems for the advancement of the boring machine, while the opposite situation is related to the category "e" (highly "squeezing" condition) and category "f" (immediate collapse of the cavity).

APPENDIX 3 UNIT COSTS OF SOME EUROPEAN TUNNEL PROJECTS

The range of cost values used in the DAT analysis derives from the Consultant's experience gained from similar international projects. Table A3.1 gives a summary of the unit costs (cost per linear meter of tunnel) for different excavation methods of some European high-speed rail projects. The unit costs include the cost of excavation, temporary support and permanent support.

Specifically, the tunnels listed in the table refer to the Gotthard and Lötschberg tunnels in Switzerland, the base tunnel (also known as the Alpetunnel) of the High-Capacity Railway between Turin and Lyon, the High-Speed Railway tunnel between Bologna and Florence, the Monginevro railway tunnel at the border of Italy and France, the Somport tunnel crossing the border of France/Spain, and the Guadarrama tunnel on the High-Speed Railway in Spain.

Table A3.1 Summary of unit costs of some European tunnel projects

Tunnel (Length)	Type of Work	Excavation Method	Rock Quality	Diameter /Section	Cost (US$/m)
Lötschberg (36km)	Railway Tunnel	TBM	Good	9.5m	7500
			Poor		19000
Gotthard (57km)	Railway Tunnel	TBM	Good	9.5m	7400
			Poor		24950
	Shaft (840m)	CONV	-	8.4m	43000
Lugano	Shaft (375m)	CONV	-	7.0m	30300
Alpetunnel (54km)	Railway Tunnel	TBM	Good	9.0m	12600
			Medium		15240
			Poor		30120
		CONV	Good	9.0m	13950
			Medium		18150
			Poor		40000
	Access Tunnel	CONV	-	$70m^2$	24800
Monginevro (23km)	Railway Tunnel	TBM	Good	9.0m	8000
			Medium		9850
			Poor		18100
		CONV	Good	9.0m	11200
			Medium		14000
			Poor		19800
	Access Tunnel	CONV	-	-	14200
Bologna-Firenze	Access Tunnel	CONV	Good	$60m^2$	8200
			Poor	$90m^2$	13000
Guadarrama	Railway Tunnel	TBM	Good	9.5m	10200
	Access Tunnel	CONV	Medium	$75\ m^2$	12000
Somport	Motorway Tunnel	CONV	-	10.0m	10700

APPENDIX 4 REFERENCES

- C.A. Indermitte, H.H. Einstein. "Decision Aids for Tunnelling – SIMSUPER" User's Manual, 1998 and subsequent revisions. Department of Civil and Environmental Engineering of Massachusetts Institute of Technology.
- Clark G.B., 1987. "Principles of Rock fragmentation". Wiley & Sons, N.Y.
- G. Russo, G.S. Kalamaras, P. Grasso. "A discussion on the concepts of: geomechanical classes, behavioral categories, and technical classes for an underground project". Gallerie e grandi opere Sotterranee, March, 1998, No. 54, pp. 40-51, in both English and Italian.
- P. Marinos, E. Hoek. "GSI: A geologically friendly tool for rock mass strength estimation". GEOBEN 2000, Italy.
- E. Hoek, P.K. Kaiser, W.F. Bawden. "Support of Underground Excavations in Hard Rock". Balkema, 1995.
- E. Hoek, C. Carranza-Torres, B. Corkum. "Hoek-Brown failure criterion – 2002 edition".
- Howart K.D., 1987. "Mechanical rock excavation assessment of cuttability and boreability". Proc. RETC, New Orleans.

PRIVILEGED AND CONFIDENTIAL FINAL DRAFT REPORT

SPRAWL OR SMART GROWTH

Analysis of High Speed Rail Alignments and Smart Growth

Prepared For The California High Speed Rail Authority and the

City of Palmdale, California

August 26, 2004

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Source of Graphic: City of Palmdale Department of Public Works, Capital Improvements Plan

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I. Introduction and Summary Findings

This Report has been prepared at the request of the City of Palmdale to provide an independent assessment of the two proposed High Speed Rail alignments for Southern California from Bakersfield to Los Angeles.

The California High Speed Rail Authority is considering two alternative rail alignments for Southern California. One segment passes directly from Bakersfield to Los Angeles (the "Grapevine" alignment), and the other stops in the City of Palmdale before continuing to Los Angeles (the "Antelope Valley" alignment). While both alignments include a Bakersfield station, only one services the growing demand for commuter rail and other alternative transportation systems in the north Los Angeles region. The Antelope Valley route should be selected by the Authority because it is consistent with state and regional "smart growth" and other land use environmental and economic development policies.

Smart Growth is at the forefront of land use policy for the new millennium for all of California and major coastal urban regions throughout the nation. A significant issue before the High Speed Rail Authority therefore is which of the proposed alignments creates urban sprawl or promotes smart growth. This requires consideration by the Environment Impact Report (EIR) of local and regional plan policies and the impacts of the alignments on agricultural lands, urban growth, and regional growth patterns.[1]

In 1969 I developed the "Ramapo Plan" establishing timing and sequencing of growth and argued the resulting litigation through the U.S. Supreme Court. The Ramapo plan was approved by the New York Court of Appeals (highest N.Y. Court) and the United States Supreme Court in 1972. *Golden v. Planning Board of the Town of* Ramapo 30 N.E. 2d 359, 285 N.E. 2d 138 (New York 1972), app. dismissed, 409 U.S. 1003 (1972) and was cited and approved in *Association of Homebuilders of the Greater East Bay, Inc. v. City of Livermore*, 18 Cal. 3d 582, 557 P2d473 (1976). It established the constitutionality of growth management in the United States. The Ramapo principles of requiring adequate public facilities linked to the priorities established in an 18 year capital improvement program has been the cornerstone of every major growth management system and Smart Growth in California and the U.S. (City and County of Los Angeles; San Diego; Ventura County; City of Riverside; Monterey County; Seattle-Puget Sound Council; Minneapolis-St. Paul; Miami-Dade County; Baltimore and Montgomery Counties (Wash. D.C.) (among over 200 city, county and regional land use-transportation growth management plans that Freilich, Leitner & Carlisle has designed, implemented and defended in the courts).[2]

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[1] California Code of Regulations Title 14, Chapter 3 (Guidelines for Implementation of the California Environmental Quality Act) (hereinafter "CEQA Guidelines"), § 15125 ("EIR shall discuss any inconsistencies between the proposed project and applicable general plans and regional plans."

[2] See Freilich, "FROM SPRAWL TO SMART GROWTH: SUCCESSFUL LEGAL PLANNING AND ENVIRONMENTAL SYSTEMS (Dec. 1999, American Bar Association)".

Twenty years ago Freilich, Leitner & Carlisle was requested by the Coalition for Los Angeles County Planning in the Public Interest, to assess whether Los Angeles County was properly implementing its General Plan goals, objectives, policies and strategies for retaining open space and containing urban sprawl through its development approval process.[3] The Report was incorporated into the Special Master's and Court's findings requiring implementation of the General Plan's Growth Management strategy. The Report called for enforcement of the adequate public facilities requirement of the General Plan designed in accord with the Ramapo principles of timing, phasing and sequencing of growth to avoid sprawl, leapfrog development, and prevent excessive loss of open space lands.

In 1991 Freilich, Leitner & Carlisle developed the transportation corridor overlay system for building permit allocations, which has formed the spine for transit in the City of Los Angeles. The project resulted from the building permit moratoria that was imposed upon Los Angeles by the EPA due to inadequate sewerage treatment. The allocation of building permits systems created a priority for construction along transportation corridors and centers and forms the backbone of the growth management strategy of the city to date.[4]

In analyzing the High Speed Rail Alignments, this Report endeavors to assess whether the alignments meet the criteria for Smart Growth set out in state plans and policies, local general plans, and the regional COMPASS plan under consideration by the Southern California Association of Governments (SCAG).

The Report carefully analyzes both the Grapevine and Antelope Valley alignments and strongly recommends that the Antelope Valley alignment is superior for the following reasons:

1. The Antelope Valley Alignment Furthers Smart Growth Policies Embodied In State, Regional And Local Land Use Plans. In California and nationally "sprawl" refers to unplanned, single use, auto dependent development built without regard to availability of infrastructure the need for which is generated by new growth. "Smart Growth" is the antithesis of sprawl. It channels growth either into (1) compact and sustainable development patterns within regional growth boundaries already served with infrastructure; or (2) within outlying new towns or communities with appropriate densities, mixed uses, affordable housing, sustainable walkable environments and adequate public facilities. The Antelope Valley alignment will encourage Smart Growth. The Grapevine alignment accomplishes the opposite - eliminating a station in the Antelope Valley, it will disperse development beyond existing infrastructure on large lots converting critical agricultural land in the Central Valley. Despite its separation from the City of Los Angeles by the Angeles National Forest, the Antelope Valley is the antithesis of leap-frog development. It is connected to Los Angeles by high-

[3] *Coalition of Los Angeles County Planning v. County of Los Angeles*, 76 Cal.App. 3d 241, 142 Cal. Rptr. 766 (1977).

[4] See New York Times, March 10, 2002 "Sprawl Weary Los Angeles Buildings Up and In".

capacity road and now rail infrastructure, and is an important mixed- use regional center with complete infrastructure systems. It will accommodate the large increases in population anticipated in 2040 (See Part VI below).

2. The Antelope Valley Alignment Is Consistent With State, Regional And Local Agricultural Preservation Policies. Agricultural preservation is not only a key element of Smart Growth, it is particularly important to Southern California and the Central Valley because of the vast economic importance of farming to the state's economy. Protection of the sensitive and valuable agricultural resources of the Central Valley through reduction of the conversion of prime agricultural lands to urban development, and preservation of open space and environmentally sensitive lands is a key part of state, regional and local policy (See Part IV, below).

3. The Antelope Valley Alignment Addresses The Population Impacts Of High Speed Rail Infrastructure In A Way That Supports Regional Smart Growth Policies. Without the Antelope Valley alignment, excessive growth occurs in the Central Valley. The Grapevine Alignment passes over the areas of north Los Angeles that are needed and capable of accommodating future growth and development and substitutes excessive growth in the Central Valley. (See Part III, below).

4. The Antelope Valley Alignment Places Transportation Facilities And Related Growth In Palmdale Where Infrastructure Is Already In Place. Reducing urban sprawl is accomplished by promoting redevelopment and infill of Palmdale's existing incorporated built up areas is discussed in (See Part V of this Report).

5. The Antelope Valley Alignment Positions The Palmdale Transportation Center As A True Mixed Use Transportation Corridor Center. The Antelope Valley has developed the range of uses needed to support transportation and land use policies embodied in state laws such as the Transit Village Planning Act. The Palmdale transportation center can generate substantial long-term leasehold revenue and concession income through joint public-private development that will directly mitigate high speed rail alignment costs. The Antelope Valley alignment provides integration with transportation and infrastructure policies for Lancaster and Palmdale by (a) rerouting a percentage of commuter traffic off Rte 14; (b) establishing a transit hub to increase transit ridership reducing projected traffic volume increases along Interstate 5, particularly on the highly congested segments south of Rte 14; and (c) creating major public capital and service cost savings for infrastructure, operation, maintenance and public service costs, through having adequate public facilities at time of development, eliminating the major concerns related to discontinuous development (see Part VII, below).

6. Local Land Use Policies Support High Speed Rail Infrastructure. Palmdale's general plan and zoning regulations accommodate transit supportive land uses and densities, as well as a wide range of uses within the station influence area. These

uses are uniquely supportive of the intercity rail system that the high speed rail network will provide. (See Part VIII below)

It is the Report's conclusion that the Palmdale alignment is superior to the Grapevine alignment because it meets and enhances state, regional and local growth management goals, objectives, policies and strategies.

II. The Sprawl - Smart Growth Dichotomy

A. Smart Growth Principles[5]

An appropriate high speed rail alignment encourages balanced communities providing housing, employment, shopping and recreational opportunities for a diverse population. Key principles[6] of Smart Growth are summarized below:

- Develop a range of housing opportunities and choices through density and compactness
- Establish walkable neighborhoods to reduce the number and length of trips
- Foster distinctive, attractive places with a strong sense of community
- Utilize General and Specific Plans, goals, objectives, policies and strategies
- Mix land uses to create jobs-housing balance reducing transportation congestion and improving air quality
- Preserve open space, farmland, natural resources and critical environmentally sensitive lands
- Provide a variety of transportation demand management choices and techniques
- Strengthen and direct development towards existing communities
- Utilize existing infrastructure capacity before extending new capacity

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[5] Douglas R. Porter, et al, Making Smart Growth Work (June 2002); F. Kaid Benfield, et al, Solving Sprawl: Models of Smart Growth in Communities Across America (October 2001); John R. Nolon, Well Grounded: Using Local Land Use Authority to Achieve Smart Growth by (July 2001); Terry S. Szold & Armando Carbonell, Smart Growth: Form and Consequences (Lincoln Institute of Land Policy, June 2002); Jane S. Shaw & Ronald D. Utt. Ed., A Guide to Smart Growth: Shattering Myths, Providing Solutions (Property and Environment Research Center [PERC] 2000); David O'Neill, Smart Growth Took Kit: Community Profiles and Case Studies to Advance Smart Growth Practices (Urban Land Institute 2000); Urban Land Institute, ULI on the Future: Smart Growth-Economy, Community (October 1998); Robert H. Freilich, From Sprawl To Smart Growth: Successful Legal, Planning and Environmental Systems (ABA, 1999); Irving Schiffman, Alternative Techniques for Managing Smart Growth (2nd Edition 1999); Institute of Transportation Engineers, Smart Growth: Transportation Guidelines (2003); Leora Waldner & Jerry Weitz, Smart Growth Audits (American Planning Association, Planning Advisory Service Report No. 512, 2003); International City Management Association, Getting to Smart Growth: 100 Policies for Implementation (2002); International City Management Association, Getting to Smart Growth II: 100 More Policies for Implementation (2003).

[6] About Smart Growth, Smart Growth Network, http/www.smartgrowth.org/about/default.asp 11/3/03.

The balance of the Report demonstrates that the Palmdale Alignment fulfills each of these principles.[7]

Smart growth is the antithesis of sprawl.[8] A recent state Supreme Court decision aptly defines sprawl as: "The term 'sprawl' is typically used to describe development that embodies inefficient use of land (i.e. low density); constructed in a "leap frog" manner in areas without existing infrastructure, often on prime farmland automobile dependent and consisting of isolated single use neighborhoods requiring excessive transportation."[9] Since 1968 the control of urban sprawl has been national policy,[10] particularly control of low density development.[11]

Many environmental impacts are brought about by a sprawling growth pattern:

- Loss of prime agricultural and environmentally sensitive lands;
- Degradation of critical habitat;
- Erosion of steep slopes;
- Increased water pollution;
- Alteration of natural hydrologic features; and
  A reduction in air quality.[12]

After World War II, the enormous demand for housing coupled with mortgage subsidies and an explosion of subsidized infrastructure projects (particularly the Interstate Highway system) accelerated per capita consumption of farmland, ranchland, forests and open-spaces. This acceleration was abetted by local government development regulations that mandated large minimum lot sizes as a method to control sprawl.[13]

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[7] Douglas R. Porter, et al, Making Smart Growth Work (June 2002); F. Kaid Benfield, et al, Solving Sprawl: Models of Smart Growth in Communities Across America (October 2001); John R. Nolon, Well Grounded: Using Local Land Use Authority to Achieve Smart Growth by (July 2001); Terry S. Szold & Armando Carbonell, Smart Growth: Form and Consequences (Lincoln Institute of Land Policy, June 2002); Jane S. Shaw & Ronald D. Utt. Ed., A Guide to Smart Growth: Shattering Myths, Providing Solutions (Property and Environment Research Center [PERC[2000); David O'Neill, Smart Growth Took Kit: Community Profiles and Case Studies to Advance Smart Growth Practices (Urban Land Institute 2000); Urban Land Institute, ULI on the Future: Smart Growth-Economy, Community (October 1998); Irving Schiffman, Alternative Techniques for Managing Smart Growth (2nd Edition 1999); Institute of Transportation Engineers, Smart Growth: Transportation Guidelines (2003); Leora Waldner & Jerry Weitz, Smart Growth Audits (American Planning Association, Planning Advisory Service Report No. 512, 2003); International City Management Association, Getting to Smart Growth: 100 Policies for Implementation (2002); International City Management Association, Getting to Smart Growth II: 100 More Policies for Implementation (2003).

[8] About Smart Growth, Smart Growth Network, http/www.smartgrowth.org/about/default.asp, 11/3/03.

[9] In Re Dolington Land Group 839 A.2d 1021 (Pa. 2003).

[10] The National Commission On Urban Problems, Building The American City 245 (1968) "The prevention of urban sprawl should therefore qualify as a valid public purpose justifying the use of valid zoning and timing regulations in order to postpone urban development in areas inappropriate for development."

[11] Density is one of the major quantifiers of The Sierra Club 1999 Sprawl Index Report.

[12] Bruce Katz, The Permanent Campaign Against Sprawl, Urban Land (2003).

[13] Richard Cutler, Legal and Illegal Means of Controlling Community Growth on the Urban Fringe 1961 Wis. L. Rev. 371.

B. *Palmdale and Smart Growth*

The City of Palmdale lies 60 miles north of Los Angeles in the high desert region of Los Angeles County. It is one of two incorporated cities and several unincorporated communities within the Antelope Valley. The city is bordered by the city of Lancaster to the north and unincorporated areas on all other sides of its corporate boundaries.[14]

The City is strategically located with respect to the Antelope Valley, San Joaquin Valley, Owens Valley and the San Fernando Valley/Los Angeles basin. It has direct access to State Route 14 (Antelope Valley Freeway) and Highway 138, rail access via the Southern Pacific Transportation Company, and airport and public transportation facilities. It is the most southerly community in Antelope Valley. The City has approximately 95 square miles and has an adopted sphere of influence containing approximately 174 square miles. (Plan at 1-5). 79% of the planning area is vacant, but served with adequate public facilities, meeting smart growth infill objectives. (Plan at 1-11).

Palmdale and Lancaster's position in the region is analogous to the "New Town" concept, which directs jobs and housing to self-contained communities outside of the traditional regional urban core.[15] Rather than continuing the sprawl dispersal of low-density development, the "New Town" concept establishes new communities that are sized appropriately to insure that population is accommodated on far less land than under sprawl development. As per capita land consumption decreases, more land resources (e.g., open space, habitat and agricultural lands) are retained and traffic congestion reduced through trip length reduction and air quality is vastly improved.

Master planned "New Towns" include meaningful open spaces designed to protect the natural environment, provide paths for pedestrian and light vehicle traffic while improving the marketability of the development by providing natural amenities. The Woodlands in Montgomery County, Texas, was designed in the early 1970's under the Federal New Communities Act 42U U.S.C. §§3901-14 (1968) to protect natural drainage patterns, water quality and provide pathways for non-motorized movement. As of January 2002, The Woodlands had 120 miles of trails and over 1,800 acres of open space, primarily forested land and riparian corridors. The large preserves of open space often featured in master planned "New Towns" protect the physical environment (e.g., reduced stormwater runoff and erosion), and provide habitat for flora and fauna.

New Towns facilitate environmental sustainability because the developer is required to concentrate development in areas with the least environmental impact. In contrast, suburban fringe development reduces opportunities to retain or create linkages between open space areas because land costs are higher and land supplies are constrained. Given these constraints, there is greater pressure to develop in environmentally hazardous zones (e.g., steep slopes, fire hazard zones, liquefactions zones, and floodplains). The

[14] City of Palmdale General Plan (adopted January 25, 1993), at 1-13.
[15] Avin, "Should We Copy Columbia?", Planning (Feb. 2004), at 27.

inevitable cost of conventional development in hazardous areas in California is the loss of life and property to mudslides, fires, earthquakes and floods.

C. Economic Development

New town development has distinct economic development advantages over contiguous fringe development of existing metropolitan areas. Conventional development in fringe areas typically consists of segregated residential, commercial and employment areas. This pattern generates distinct problems for commercial and employment uses in addition to increasing traffic congestion.

Development of conventional, free-standing regional commercial facilities draws sales from existing built up area centers, which results in business failures, blight and reduced sales tax revenues. As regional fringe facilities lure customers from existing built up areas, existing commercial development becomes less profitable and space is under-used or vacated. Vacated or partially used commercial properties (grayfields) fail to produce revenues needed for proper maintenance of the property or public services. Reduced demand on existing streets, schools and utilities result in unused and unfunded public infrastructure. Where multiple jurisdictions are involved, sales tax revenue is siphoned from the existing built up jurisdictions. All of these factors contribute to urban blight (from public and private disinvestment).

The impact of development of office and industrial sites in outlying areas is less clear. If existing built up area employment remains strong, the dispersal of employment to outlying areas may reduce traffic congestion and air quality problems by stimulating reverse commutes. The development of new towns avoids the negative impacts on existing neighborhood stability caused by sprawl. To succeed, new towns must be built on the neighborhood unit basis and balance commercial development with its supporting residential roof-tops ("jobs-housing balance"). The "neighborhood unit" concept is reflected in Palmdale's careful balance of residential, commercial and civic uses. The location of commercial development in a non-contiguous new town community does not siphon significant sales from existing core communities. Consequently, commercial development is phased to primarily reflect internal demands.

The failure of businesses related to the dispersal and relocation of population has a direct impact on capital investment. Loan defaults reduce financial institution investment in property because of depreciating property values and customer base loss. Disrepair and disinvestment follow. As noted by the Bank of America:

> "Sprawl has created enormous costs that California can no longer afford. Ironically sprawl has shifted from an engine of growth to a force that now threatens to inhibit growth and degrade the quality of life." Bank of America Report "Beyond Sprawl" (1995)

The experiences of Columbia, Maryland, Reston, Virginia and the Woodlands, Texas suggest that new towns have a net positive benefit on regional employment and industrial

development. New towns have been very successful in attracting businesses from outside the region. New towns produce a ripple of new jobs throughout the region. In the case of Palmdale, the creation of additional employment center brings significant benefits by attracting commuter trips to Palmdale that otherwise would be contributing to the high existing levels of congestion along Rte 14 and I-5 south of the Rte 14 interchange.

D. Fiscal Impacts

Palmdale does not have the negative fiscal impacts that recent studies attribute to contiguous fringe sprawl development.[16] Fringe development relies on infrastructure of the core community to supplement its physical and social infrastructure needs without contributing its fair share to its funding. By contrast, Palmdale already has a full complement of urban services including multi-modal transportation facilities, water, sewer, police, fire, emergency service, parks and stormwater management.

The costs of constructing and servicing utility infrastructure in low-density sprawl development patterns exceed those of concentrated new town development. A dispersed land use pattern requires longer lengths of water, sewer, stormwater, electric power, telephone, natural gas and other service lines to serve the same population. Large minimum lot sizes separate uses and require greater infrastructure investments per customer. Consequently the installation, maintenance and replacement costs are greater in low-density subdivisions. These costs are typically 3 to 9 times higher in sprawled development versus planned moderate density development. The difference in water and sewer line length in sprawl (uncontrolled) growth versus smart growth (controlled) development is very evident in the western region of the United States.[17]

These higher maintenance costs of infrastructure per development unit are paid for by utility ratepayers and taxpayers.[18] Even assuming that development fully funds the initial capital costs, maintenance and replacement costs are assigned to local governments' general utility rate payers or general fund tax payers once the new infrastructure is dedicated to the public. Property owners who have paid user fees and property taxes for many years are expected to continue to do so to support long-term maintenance of inefficient sprawl development and to fund the resolution of infrastructure deficiencies. These are direct subsidies that existing taxpayers provide for inefficient sprawl development that depletes the ability of existing built up areas to regenerate themselves.[19]

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[16] Robert W. Burchell, Fiscal Impacts of Alternative Land Development Patterns in Michigan: The Cost of Sprawl Development Versus Compact Growth, South-East Michigan Regional Council of Governments (1977).

[17] Robert W. Burchell, George Lowenstein, William R. Dolphin and Catherine C. Galley, Costs of Sprawl – 2000, Transportation Research Board – National Research Council, National Academy Press, New York, 2002, pg. 222.

[18] Few local governments actually establish fees to fully fund the on and off-site impacts of new development for all infrastructure costs. Franklin J. James, Evaluation of Local Impact Fees as a Source of Infrastructure Finance, 11 Mun. Finance J. 408 (1990).

[19] Eric D. Kelly, Managing Community Growth: Politics, Techniques and Impacts (1993); John DeGrove, Balanced Growth, A Planning Guide for Local Government (1991).

Not only does Palmdale fund all of its initial capital costs, but through efficient community design, its on-going maintenance and operations costs are much lower than for conventional fringe area development. The mix of uses and the high degree of connectivity between uses produce the following cost savings:

- Reduced road maintenance costs due to reduced per unit trip generation, reduced average trip length and reduced lot frontage per unit resulting from the compact development pattern;
- Reduced school, police, fire and emergency service transportation costs;
- Fully funded operations for water and wastewater services;
- More efficient transit service due to higher densities along transit routes;
- Reduced off-site transportation costs due to greater internal capture of trips than conventional development.

E. Social Costs of Sprawl

One frequently cited characteristic of sprawl is the homogeneous land use pattern, which segregates residential from non-residential uses and isolates socio-economic and demographic groups within the housing market. Conventional suburban development converts large tracts of land into single-use developments and residential subdivisions that serve a narrow segment of the public. This uniformity of housing type plays to the human instinct to congregate with those similar to oneself ("monoculture").[20] The targeted housing market segregate people by age, income, race, ethnic and national origin.

New town development recognizes the benefits of diversity in housing options by providing a variety of housing sizes, densities and a mixture of land uses. Built around the neighborhood commercial center, the mixture of housing for various market segments typically includes:

- Loft apartments above retail and service businesses;
- Townhouses and other forms of attached housing;
- Apartment buildings and complexes;
- Accessory dwellings attached to single-family structures; and
- Assisted living and other alternatives that serve the variety of household ages and incomes anticipated within a community.

Jobs-housing balance coupled with affordable and workforce housing present distinct advantages for new towns over conventional development. Sustainable new town development with a balance of housing, employment, shopping, education and recreation opportunities, limits the need for frequent highway trips. The reduction of highway trips equates to a reduction in traffic fatalities and increased walkability promotes better

[20] Andres Duany, Elizabeth Plater-Zyberk, Jeff Speck, Suburban Nation – The Rise of Sprawl and the Decline of the American Dream, North Point Press, New York, 2000, pg. 43.

health.[21] Within the town, connectivity, streetscaping and traffic calming measures combine to reduce the likelihood and severity of traffic accidents. Pedestrian facilities, light vehicle paths and well-designed intersections can reduce the number of pedestrian, light vehicle and automobile conflicts. By providing its regional fair share of affordable and attainable housing, Palmdale will create a balanced opportunity for all residents.

F. Capital Facility And Service Planning

The inefficient provision of infrastructure and services is the most significant fiscal cost of sprawl. Failure to establish efficient development patterns has increased the cost of providing adequate public facilities and funding ongoing maintenance and operations of public services. These costs typically are shifted back to existing residents and businesses, thereby reducing funding for core areas and/or causing the need for significant increases in user fees and/or tax rates.[22]

The costs of providing services for sprawl development is at least double, compared to development located close to existing facilities.[23] New development in "leapfrogged" areas exhibit scattered, inefficient development patterns of low density, with a concomitant loss of scale economies and increased housing costs.[24] "Sustainability,"[25] "growth management" and "fiscal conservatism" concepts form the basis for Smart Growth by encouraging and requiring responsible development, as communities try to balance jobs, the environment and social well-being across a constantly evolving and changing landscape.[26]

Financial responsibility for community facilities and services shifted to rate payers, assessment districts and user fees, and was borne only partially by the developer or new home owner.[27] As expectations for local government service rose, the general fund, comprised of property and other taxes and fees, became an alternate source to subsidize facility and services demanded by new development. Communities failed to make new growth pay for needed infrastructure and services creating trillions of dollars in infrastructure deficiencies alone.[28] In the wake of unprecedented public obligations for providing facilities and services, communities now must recognize that new growth must

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[21] Martha T. Moore, Suburban Designs Could Be Bad For Your Health, U.S.A. Today, April 22, 2003; Frumkin, Urban Sprawl and Public Health, 117 Public Health Reports 201 (2002).

[22] City of Palmdale General Plan (adopted January 25, 1993), at 1-13.

[23] James E. Frank, *The Costs of Alternative Development Patterns* (1989) at 39.

[24] See James Heilburn, Urban Economics and Public Policy (1981) 117-152.

[25] *See Earth Summit in Rio, Sustainable Development* (1992), *BioDiversity: The United Kingdom Action Plan* (1994).

[26] *See* Robert H. Freilich & Michael M. Shultz, *Model Subdivision Regulations* (1995); *see also* Virginia W. Maclaren, *Urban Sustainability Reporting*, 62 Journal of the American Planning Association 184, 185 (1996).

[27] Franklin J. James, *Evaluation of Local Impact Fees As A Source of Infrastructure Finance,* 11 Mun. Fin. J., 408, 414 (1990).

[28] See Hard Choices, Summary Report of the National Infrastructure Study, Joint Economic Committee, U.S. Congress (February 1984); Nancy S. Rutledge, Public Infrastructure As A National Concern; Report of the National Council on Public Works Improvement, 17-18 (1987); The American Society of Civil Engineers reports current deficiencies in transportation infrastructure alone to be $1.3 trillion dollars. ASCE, Report Card for America's Infrastructure (2003).

pay for its own one-time cost of capital infrastructure so that the general fund can be utilized to cover infrastructure deficiencies, operation and maintenance.[29]

III. Population Impacts

A. *High Speed Rail Land Use Patterns and Population Redistribution*

The statewide[30] and regional[31] high speed rail Environmental Impact Reports document that the high speed rail system will have a significant impact on future land use patterns. Population will increase by 15.2 million in Southern California and the Central Valley by 2040. The State EIR (§ 5.3) establishes extraordinary forecasts:

- A shift in residential population between Los Angeles and Kern counties due to change in accessibility between the Modal and HST Alternatives (long distance commutes)
- changes in densification/development patterns
- reallocation of population between developed and undeveloped areas including consumption of undeveloped land will be prominent
- the HST alternative will accelerate South Central Valley growth by 95.1% versus 47.1% for Southern California (Table 5-3-3).
- growth in the South Central Valley of 273,000 will out balance Los Angeles County of 118,000 (Table 5.3.4).

Without a Palmdale stop, the travel time from Bakersfield to Los Angeles declines from 2-4 hours by car to 47 minutes on high speed rail, distributing an excessive proportion of population increase to Bakersfield, as travel times become shorter and less expensive than automobile trips on I-5 in severe congestion.[32] The State EIR (§ 5.3.6) states that: "An HST system would improve accessibility to labor and customer markets. With this second effect businesses that locate close to an HST station could operate more efficiently than elsewhere – creating a competitive advantage for high-wage employment sectors." Bypassing Palmdale will severely accelerate the rate of growth in Bakersfield

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[29] *See* Freilich and Morgan, Municipal Strategies For Imposing Valid Development Exactions, 10 Zoning and Planning L. Rep. 169 (1987); *See also* U.S. Supreme Court cases upholding development exactions if based upon proper municipal studies proportioning the cost. *Nollan v. California Coastal Commission*, 483 U.S. 825 (1987), *Dolan v. City of Tigard*, 114 S.Ct. 2309 (1994), all discussed in Freilich and Bushek, Exactions, Dedication and Impact Fees, APA Press (1995).

[30] California High Speed Rail Authority and United States Department of Transportation, Federal Rail Administration, *Draft Program Environmental Impact Report/Environmental Impact State (EIR/EIS) for the Proposed California High-Speed Train System* (January 2004) (hereinafter "State EIR").

[31] The regional EIR/EIS is a series of reports including: P&D Consultants, Inc., Bakersfield to Los Angeles Sections 4(f) and 6(f) Technical Evaluation (January 2004); P&D Consultants, Inc., *Bakersfield to Los Angeles Region Land Use And Planning, Communities And Neighborhoods, Property, & Environmental Justice Technical Evaluation* (January 2004); and P&D Consultants, Inc., *Bakersfield-To-Los Angeles Traffic, Transit, Circulation & Parking Technical Evaluation* (January 2004).

[32] Kaveh V. Vessali, Land Use Impacts of Rapid Transit, 11 BERKELEY PLAN. J. 71, 72-73 (1996)(decreasing commute costs provide incentives for workers to move, both farther out and along lower-cost corridors).

and Kern County by shifting growth from the Antelope Valley (Palmdale, Lancaster and unincorporated northern Los Angeles and southern Kern Counties), to the Central Valley.

B. Transit Impacts on Growth

Empirical evidence demonstrates that the high speed rail alignment will have a significant impact on growth in north Los Angeles and the Central Valley.[33] This was demonstrated by the experience of "streetcar suburbs" at the turn of the century in all major metropolitan areas of the country including Los Angeles.[34] The availability of streetcars minimized the correlation between travel times and distance, thereby causing metropolitan areas to spread in a linear pattern along transportation corridors.[35]

As congestion along I-5 increases, the price of trips by automobile will increase relative to other modes of transportation such as high speed rail.[36] Rail transit has the greatest impact on station areas where it confers a distinct accessibility advantage because of the size or characteristics of the transit system operating in the region.[37]

IV. Agricultural Preservation

A. Need for Agricultural Preservation

California's farmland is rapidly disappearing. The State EIR (§ 3.8) reports that California lost approximately 497,000 acres of farmland to urbanization in the decade between 1988 and 1998, a loss rate of approximately 49,700 acres per year, and will lose 850,000 acres by 2020.[38] According to the Department of Conservation, statewide urbanization of farmland from 1998-2000 exceeded 90,000 acres for the first time since 1990-1992, with prime farmland accounting for 19% of the 91,258 new urban acres.[39] Land use policies adopted by the State of California, the City of Bakersfield, Kern County, and Central Valley regional planning efforts place heavy emphasis on the preservation of agricultural land in the Central Valley. AB 857 provides that the protection of environmental and agricultural resources such as farms and other "working landscapes" is a state planning priority. Excessive growth in the Bakersfield region

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[33] Vessali, supra, at 88-92. The impacts on land use and property value are greater in suburban locations, where there is a greater improvement in accessibility and travel cost by the creation of the railway. Id. at 92.

[34] Moore & Thorsnes, The Transportation/Land Use Connection (American Planning Association, Planning Advisory Service Report No. 448/449, 1994), at 17 (citing M.S. Foster, From Streetcar to Superhighway: American City Planners and Urban Transportation (1981), Wachs, "Autos, Transit, and the Sprawl of Los Angeles: the 1920's," 50 J. Am. Planning Assn. No. 3, at 297-310 (1984), and S.B. Warner, Streetcar Suburbs: The Process of Growth in Boston (1870-1900) (1978)).

[35] Moore & Thorsnes, at 17.

[36] Moore & Thorsnes, at 22.

[37] Parsons Brinkerhoff Quade & Douglas, Inc., Transit and Urban Form, Vol. 1, Report 16 (National Research Council, Transportation Research Board, Transit Cooperative Research Program, 1996), at 29.

[38] State EIS, Summary, at S-12.

[39] California Department of Conservation, Division of Land Resource Protection, Farmland Mapping and Monitoring Program, California Farmland Conversion Report 1998 – 2000 (Dec. 2002), at 10.

created by the Grapevine alignment will inevitably spill over into other parts of the Central Valley, which is the nation's most agriculturally productive region. By contrast, the Antelope Valley alignment stop in Palmdale will eliminate unnecessary conversion of agricultural land. Excessive conversion of agricultural land to urban uses under the Grapevine alignment would be inconsistent with state, regional, and local policies to balance future growth with the protection of agricultural lands.

Agricultural preservation plays a critical role in state and national land use policy. Agricultural preservation is important for a number of reasons, including:

- ***Economic development.*** California has the nation's most productive agricultural economy. The American Farmland Trust reports that: "California is by far the number one agricultural producer and exporter in the United States. With 1999 production values reaching $26.7 billion, California produced more than Texas and Iowa combined—the nation's second and third agricultural states."[40]
- ***Environmental protection.*** The Williamson Act states that "agriculture constitutes an important physical, social, esthetic and economic asset to existing or pending urban or metropolitan developments." (Government Code § 51220(d)).
- ***Establishing efficient regional growth patterns.*** The Williamson Act, Government Code § 51220(c), states: "discouragement of premature and unnecessary conversion of agricultural land to urban uses is a matter of public interest and will be of benefit to urban dwellers themselves in that it will discourage discontiguous urban development patterns which unnecessarily increase the costs of community services to community residents."

The importance of the high speed rail alignment is illustrated by the confluence of the Antelope Valley (the northern reach of SCAG's planning area) and Kern County (the southern reach of the Central Valley). As is illustrated in Figure 1, below, the Antelope Valley is not within a Farmland Security Zone (FSZ) County, while Kern county is within a contiguous eleven (11) county region of FSZ counties. These areas should be protected by the careful siting of high speed rail facilities, emphasizing areas outside of these important agricultural resources.

[40] American Farmland Trust, *AFT Around The Country: California Region* at http://www.farmland.org/california/index.htm.

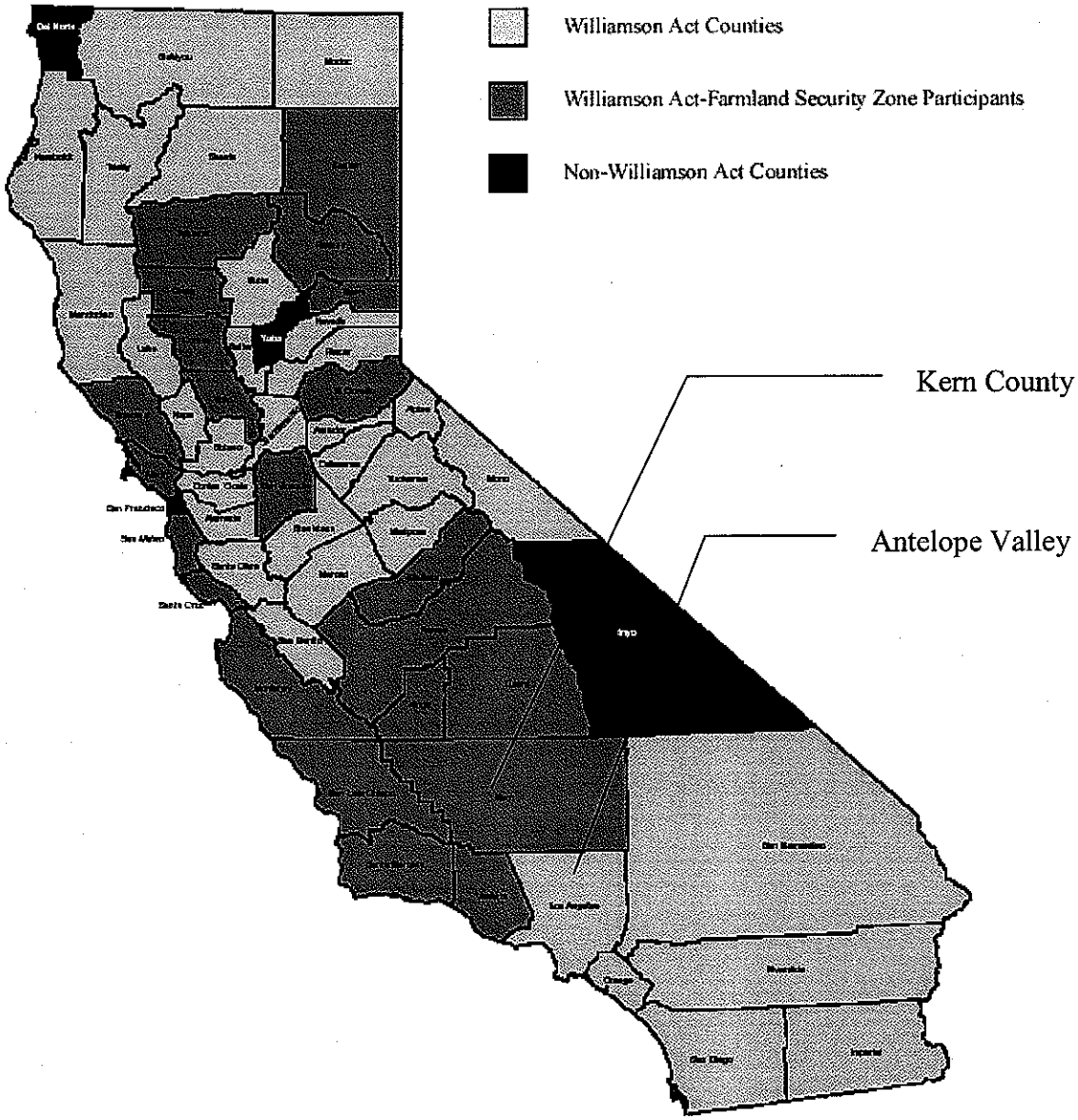

Figure 1 Williamson Act Counties (Source: California Department of Conservation, The California Land Conservation (Williamson) Act Status Report 2002, at http://www.consrv.ca.gov/DLRP/lca/stats_reports/)

B. *The Central Valley*

California's great Central Valley stretches from Shasta County to Kern County. It includes over five million people on 42,000 square miles. Bakersfield and Kern County lie in the San Joaquin Valley, which encompasses eight counties at the southern end of the Central Valley.[41] The Central Valley, anchored on the south by Bakersfield, is the

[41] Umbach, Ph.D, Kenneth W. A Statistical Tour of California's Great Central Valley (California Research Bureau CRB-97-009, August 1997)(online at http://www.library.ca.gov/CRB/97/09/index.html). The San Joaquin counties include San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and

most productive agricultural region in the world. Kern, Tulare and Fresno Counties are consistently ranked among the top three counties in the nation in agricultural production.[42] Providing over 30% of employment, it is the region's leading industry.[43]

Rapid growth in the Central Valley is threatening California's agricultural land resources. The American Farmland Trust (AFT) rates the Central Valley as the nation's most threatened farming region.[44] The Central Valley's rapid growth has caused the loss of considerable amounts of farmland to urban development.[45] A seminal 1995 study by AFT forecasts that the Central Valley will lose 1 million acres of agricultural land by 2040 if current growth trends continue.[46]

This impact is especially pronounced in Kern County. The State Department of Conservation's Farmland Mapping and Monitoring Program (FMMP) has documented that urban land in the county has increased by 29,202 acres and irrigated farmland has decreased by 76,318 acres since 1990, with forty percent of the irrigated land decreases containing prime soils.[47] The California Department of Conservation reports that nearly 50,000 acres of important farmland were converted to urban or built up uses in the 8-year period from 1992-2000, the latest figures available (see Table 2, below).

Table 1 Farmland Converted to Urban and Built-Up Land (acres)

	1998-2000	***1996-1998***	***1994-1996***	***1992-1994***
Prime Farmland	1,300	1,491	987	2,030
Farmland of Statewide Importance	138	19	0	199
Unique Farmland	0	0	0	12
Farmland of Local Importance	0	0	0	0
IMPORTANT FARMLAND SUBTOTAL	1340	1,510	987	2,241
Grazing Land	487	183	90	149
AGRICULTURAL LAND SUBTOTAL	1,925	1,693	1,077	2,390
Urban and Built-Up Land	--	--	--	--
Other Land(1)	3,115	2,333	830	811
Water Area	0	0	0	0
TOTAL ACREAGE CONVERTED	5,040	4,026	1,907	3,201
Total Important Farmland (end of period)	691,903	703,387	708,739	726,291
Developed 1994-2000 (2)	49,923			

Kern. Fresno, Kern, Kings, and Tulare County are included in the "Southern Central Valley" for purposes of the EIR/EIS analysis of economic impacts. See EIR/EIS Document, § 5.2.2.

[42] American Farmland Trust. *California Region: Southern San Joaquin Valley*, at http://www.farmland.org/california/south_san_joaquin.htm.

[43] *California region: Southern San Joaquin Valley ,supra.*

[44] *AFT Around the country: California region, supra.*

[45] *AFT Around the country: California region, supra* (citing University of California study indicating that the state lost approximately 500,000 acres of farmland to urban development between 1988-1998).

[46] American Farmland Trust. *Alternatives for Future Urban Growth in California's Central Valley: The Bottom Line for Agriculture and Taxpayers* (1995).

[47] *AFT Around the country: California region, supra.*

Source: California Department Of Conservation, Division of Land Resource Protection, Farmland Mapping and Monitoring Program, Land Use Conversion Reports, Table A-46.

(1) Includes conversion to Prime Farmland and Farmland of Statewide Importance primarily due to newly irrigated agriculture in the Antelope Valley area and agricultural boundary adjustments.
(2) The Important Farmland subtotal for 1992 was 741,826.

In addition, with much of the eastern portion of Kern county undevelopable due to government ownership or mountainous terrain, much of the growth pressure will occur in the agriculturally productive areas of the western county. These areas are contiguous to the incorporated areas of the City of Bakersfield (see Figure 2, below).

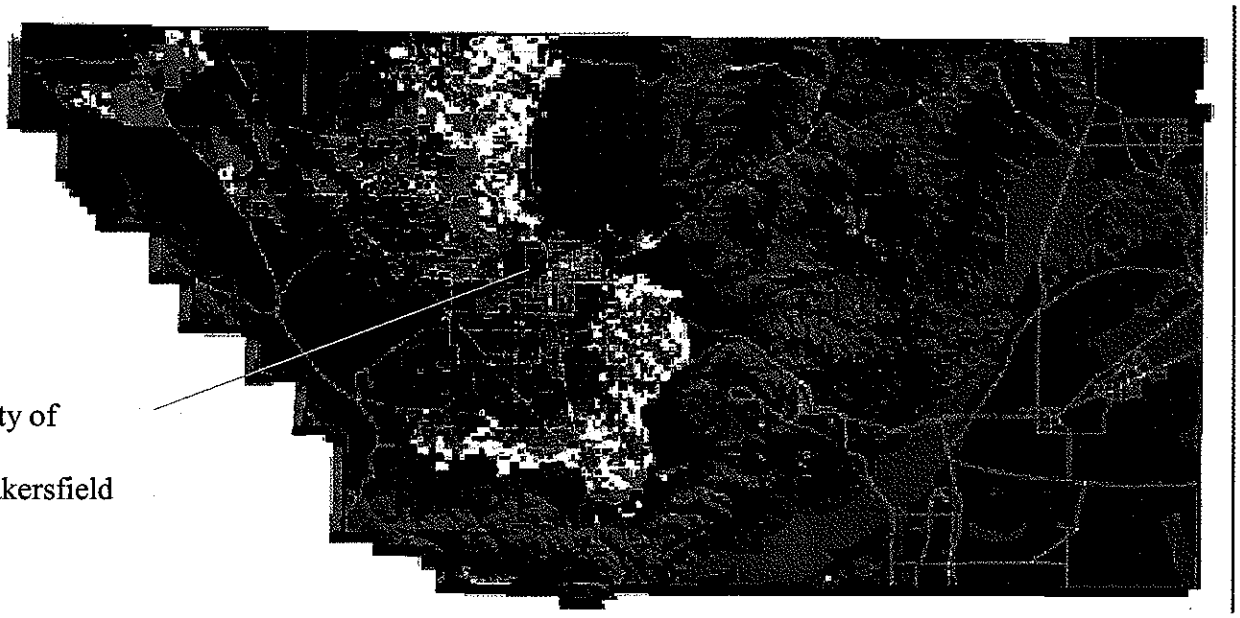

Figure 2 Kern County Permitted Cropland

Key: red - field crops, yellow - fruits, blue - nuts, and green – vegetables. Source: Kern County Department of Agriculture/Measurement Standards Geographic Information System, April 2000 (at http://www.co.kern.ca.us/kernag/our_gis.htm).

C. *Impact of Alignments on Agricultural Preservation*

If not carefully integrated with local land use policies and design, transit station locations can accelerate rather than deter urban sprawl.[48] The State EIR, § 5.4.7, states that the HST Alignment Options result in less farmland conversion than the base HST scenario

[48] Webber, Melvin, "The BART Experience -- What Have We Learned?" The Public Interest Vol. 12, No. 3, pp.79-110 (Fall 1976), at 90 (by heavily subsidizing and charging fares under its actual costs, BART reduced commuting expenses for outlying suburbanites and therefore encourage, rather than discouraged sprawl).

with the Palmdale scenario showing the largest reduction (2,800 acres). Total farmland conversion for alignment right-of-way – especially prime farmland - will experience the largest absolute loss of all four categories. While the right of way needs of either HST alternative will impact up to 1562 acres of farmland,[49] the secondary impacts will be catastrophic unless the Antelope Valley alignment diverts Central Valley growth. The Antelope Valley alignment is consistent with long established state growth policies. The Strategic Growth Report (discussed below) states, at ES-9: "The goal of State Policy in this regard should be to prevent conversion patterns - which means keeping development out of agricultural areas by either contiguous development to existing urban areas or by building new areas of development with a careful eye to the efficient delivery of services."

V. Impact on Sprawl

State and regional policy calls for the prevention of urban sprawl and "leapfrog" development into areas not served by infrastructure. In fact, the high-speed rail statute itself expressly provides that "the high-speed train system shall be planned and constructed in a manner that *minimizes urban sprawl* and impacts on the natural environment" (California Streets And Highways Code §§ 2704.09). The elimination of sprawl is statutorily required to be among the highest priorities of the system. To combat sprawl, there is sufficient capacity in the Antelope Valley to handle a significant portion of the rapid growth in Southern California and the Central Valley. According to the Brookings Institution Center On Urban And Metropolitan Policy, metropolitan Los Angeles is running out of land to accommodate an expected 6 million new residents over the next 20 years.[50] This makes the Antelope Valley a key part of the region's strategy to accommodate growth. The Antelope Valley has an abundant supply of vacant undeveloped land already served by transportation infrastructure (including arterials, transit, and airports), water, sewer, and other public utilities. By placing high capacity transportation infrastructure in the Antelope Valley, the region can absorb additional growth without extending new infrastructure beyond presently served areas. The Antelope Valley will accommodate this growth without further loss of agricultural lands, environmental resources, significant increases in trip lengths, air quality degradation, and declines in infrastructure capacity. If excess population is transferred to the Central Valley, extensive sprawl into agricultural areas not served by existing infrastructure will occur.

Local governments can ill afford to waste taxpayer dollars to expand infrastructure into areas not served by existing infrastructure. According to the American Society of Civil Engineers, a $1.3 trillion investment is needed to bring transportation infrastructure conditions to acceptable levels throughout the nation.[51] In California, total capital requirements for 1999-2009 are $82.2 billion, with total infrastructure spending

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[49] State EIS, Summary, at S-12.

[50] Southern California Studies Center and Brookings Institution Center on Urban and Metropolitan Policy, Sprawl Hits the Wall: Confronting the Realities of Metropolitan Los Angeles (2001), at 2.

[51] ASCE, Report Card for America's Infrastructure, (2003).

requirements of $150 billion when deferred maintenance is taken into consideration.[52] The California Infrastructure Plan identifies $54.2 billion in needs over five years for transportation, K-12 schools, higher education, water, administrative space, natural resources, environmental protection, public safety, and courts.[53] The California Transportation Commission reports found a ten-year total for unmet transportation needs of $117 billion for transportation infrastructure alone.[54]

Expanding infrastructure into areas not presently served also diverts scarce resources from operation and maintenance. This expense is minimized by placing new growth inducing infrastructure in existing areas such as the Antelope Valley. The State EIR shows that the HST successfully reduces sprawl only if associated with related policies, including the following:[55]

- Exploring opportunities for joint and mixed-use development at stations
- Controlling growth around stations
- Promoting urban infill
- Implementing transit supportive land use policies

This theme is echoed by other regional policy studies: "State investments in public transportation equipment and operations cannot be cost-effective without supportive land use planning and design. Transit supportive land use is a process whereby communities plan and zone for intensive, mixed use development in close proximity to transit stations or along transit corridors where physical infrastructure is typically already in place."[56] Transit stations should be located in "destinations that support high transit ridership As well as in existing urban centers where high intensities exist or will be fostered. Where intensities that support transit ridership do not already exist, it is important that future stations abut lands that can be developed or redeveloped."[57] As is described in the discussion below, station location should conform to state, regional and local land use policies to promote this objective.

VI. State, Regional and Local Land Use Policies

The Antelope Valley alignment is consistent with state, regional and local growth management strategies. The Southern California Association of Governments (SCAG) has embarked on a regional growth management strategy that directs future growth to northern and eastern cities including Palmdale, Lancaster and San Bernardino in order to address the region's deficient air quality through reduction of transportation trips and

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[52] David E. Dowall & Jan Whittington, *Making Room for the Future: Rebuilding California's Infrastructure* (Public Policy Institute of California, 2003), at 153.

[53] California Office of Governor, *California Five Year Infrastructure Plan 2003* (March 2003).

[54] California Business Roundtable, *Infrastructure*, at http://www.cbrt.org/infrastructure.html.

[55] State EIS, Summary, at S-11.

[56] Office of Policy and Management, Conservation and Development: Policies Plan for Connecticut 2004-2009, at 44.

[57] Dane County Commuter Rail Feasibility Study, ch.3, at 2 (2004).

congestion. This policy acknowledges current residential growth trends. It also provides for economic development opportunities in these areas to foster balanced growth in jobs and housing (minimizing the length and number of trips), minimize existing congestion of regional facilities (such as Los Angeles International Airport), and encouraging multimodal transportation facilities that provide a wider range of travel options for the region's outlying cities. Failing to provide a wide range of transportation infrastructure that includes high speed rail only serves to encourage and reinforce the air quality problems arising from existing automobile centric commuting patterns. By placing a high speed rail station in Palmdale, the state will reinforce the city's multimodal infrastructure support and regional land use and growth management strategies that call for balanced development in a regional two tier structure.

A. State Policy

Palmdale plays an important role in curbing regional sprawl. Los Angeles County is part of a larger regional core that extends from Interstate 10 in downtown Los Angeles to San Bernardino and Riverside Counties.[58] Containing growth inside existing urban boundaries is no longer a viable growth management alternative.

1. State Strategic Growth Plan

In 1992, I assisted Governor Pete Wilson in the development of the State's Strategic Growth Plan commissioned pursuant to Executive Order W-2-91. The Strategic Growth Plan expressly recognizes, as part of its agricultural conservation recommendations, the appropriateness of separated urban areas such as "new towns" that provide for the efficient delivery of public services and prevent unreasonable congestion.[59] The report expressly "reject[s] the idea of arbitrary urban limit lines or urban growth boundaries," focusing instead on "local comprehensive plan guidelines that encourage growth and development through fill utilization of infrastructure." These suggested measures do not prohibit non-contiguous development or "new towns" if carefully planned to ensure efficient delivery of services and prevent unreasonable congestion. The Governor's original Executive Order notes the positive role that growth management can play in contributing to a sound economy, indicating that other studies have suggested that better planning, far from discouraging economic development may support it by encouraging businesses attracted by the quality of life.[60]

The Strategic Growth Plan, which provided a foundation for the State's current planning priorities (discussed in paragraph 2, below), established a number of planning policies to address California's rapid growth demands. These include:[61]

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[58] Southern California Studies Center and Brookings Institution Center on Urban and Metropolitan Policy, Sprawl Hits the Wall: Confronting the Realities of Metropolitan Los Angeles (2001), at 10.

[59] Strategic Growth Plan, at 38.

[60] Id. at 9.

[61] Governor's Office of Planning and Research, Strategic Growth: Taking Charge of the Future, Report of the Growth Management Council to Governor Wilson (January 1993).

- Establishing regional congestion management planning (ES-8). The efforts of SCAG to coordinate regional transportation and land use patterns, discussed below, is representative of these efforts.
- Establishing efficient growth patterns that that link jobs growth and housing within regions or sub regions (ES-8, 11). This includes voluntary Statewide growth guidelines that encourage more sensible land-use patterns including orderly growth, provision of housing, protecting the environment and natural resources, cost effective provision and use of necessary infrastructure, and closely integrating transportation, housing, air quality, and energy. The growth guidelines suggest resource identification and conservation, removing barriers to housing, local permit streamlining, consultation with neighbors, infill/densification, efficient infrastructure (funding and capacity), jobs/housing balance, and transit/housing integration (19). This expressly includes encouraging development contiguous to existing urban areas by fully utilizing infrastructure (20). The plan also acknowledges the importance of establishing higher densities with compact development, as well as a balance between jobs and housing. (32).
- Preventing urban development patterns that unnecessarily compromise the agricultural industry by keeping development contiguous to existing urban areas, while building new areas of development that promote the efficient delivery of public services (ES-9).
- Requiring state infrastructure investments to support cost efficient growth and development patterns that direct and encourage growth in areas where it is environmentally and economically desirable. The plan suggests that preferred development areas could be designed in areas that are served by new state funded infrastructure (17). This includes the coordination of state transportation investments with other infrastructure such as housing, water, sewer and similar facilities. The plan treats transportation investments as an integrated system, with linkages between different travel modes and transfers and congestion management plans that include bridges, ports, airports, and transit systems as well as roads, bus and rail services (30-31).

Designating preferred development areas in locations that are served by new state funded infrastructure implements the same principle as Maryland's pioneering "Smart Growth" program that channels state transportation investment to Priority Funding Areas designated in regional and local plans.[62] This includes the coordination of state transportation investments with other infrastructure such as housing, water, sewer and similar facilities. The Maryland plan treats transportation investments as an integrated system, with linkages between different travel modes and congestion management plans that include airports and transit systems as well as roads, bus and rail services.

The Strategic Growth Plan expressly recognizes, as part of its agricultural conservation recommendations, the appropriateness of distinct new concentrated urban areas such as

[62] Md. Code Ann. Title 5, Subtitle 7B (Priority Funding Areas).

Antelope Valley that provide for the efficient delivery of public services and prevent unreasonable congestion.

2. State Planning Priorities

The Strategic Growth Plan's policies are echoed in the AB 857 legislation adopted in 2002 and the high speed rail statute. AB 857's polices promote infill development and equity, improving existing infrastructure that supports infill development, steering development to areas that are presently served by transit, streets, water, sewer, and other essential services, protecting environmental and agricultural resources, and encouraging efficient development patterns by ensuring that any infrastructure associated with development, other than infill development, supports new development. The high-speed rail statute expressly provides that "the high-speed train system shall be planned and constructed in a manner that minimizes urban sprawl and impacts on the natural environment."

AB 857, adopted on September 28, 2002, establishes state planning priorities for growth and development.[63] These policies are used to select infrastructure and to guide state expenditures as set forth in the comprehensive State Environmental Goals and Policy Report.[64] There is no comprehensive state land use plan for private development decisions or local comprehensive plans. AB 857 establishes statewide policies for sound infrastructure planning (priorities and funding), promoting development with existing infrastructure, encouraging existing development areas with services that minimizes costs to taxpayers, and protects agricultural land. The State Planning Priorities of AB 857 (Gov't Code § 65041.1) are as follows:

- Promote equity in urban, suburban, and rural communities (purpose)
- Strengthen the economy in urban, suburban, and rural communities (purpose)
- Protect the environment in urban, suburban, and rural communities (purpose)
- Promote public health and in urban, suburban, and rural communities (purpose)
- Promote infill development and equity by rehabilitating, maintaining, and improving existing infrastructure that supports infill development and appropriate reuse and redevelopment of previously developed, underutilized land that is presently served by transit, streets, water, sewer, and other essential services, particularly in underserved areas, and to preserving cultural and historic resources.
- Protect environmental and agricultural resources by protecting, preserving, and enhancing the state's most valuable natural resources, including working landscapes such as farm, range, and forest lands, natural lands such as wetlands, watersheds, wildlife habitats, and other wildlands, recreation lands such as parks, trails, greenbelts, and other open space, and landscapes with locally unique features and areas identified by the state as deserving special protection.

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[63] Cal. Gov't Code § 65041.1.

[64] Cal. Gov't Code § 65049.

- Encourage efficient development patterns by ensuring that any infrastructure associated with development, other than infill development, supports new development.
- Use land efficiently
- Build adjacent to existing developed areas to the extent consistent with the priorities specified pursuant to the environmental policies, above
- Locate development in areas appropriately planned for growth.
- Provide adequate transportation and other essential utilities and services.
- Minimize ongoing costs to taxpayers.

A central theme of these policies is the concept of regional infill, which utilizes designated urban centers such as the Antelope Valley cities of Palmdale and Lancaster to provide for the region's enormous anticipated growth in jobs and housing. This growth cannot be accommodated solely or even primarily in existing urban areas such as the city of Los Angeles. While the larger urban areas are important for infill or compact development, it is concentrated "new town" outlying centers that are the key to successfully implementing regional growth management policies. Smart Growth requires that they be supported by state and regional infrastructure improvements, including the high speed rail system.

B. Regional Policy

1. COMPASS

The Southern California Association of Governments (SCAG) has prepared a regional growth management "fifth tier" strategy that directs future growth to the Antelope Valley in order to address the region's deficient air quality through reduction of transportation trips and congestion. The *COMPASS Growth Vision Report*[65] is the comprehensive Growth Vision for the six-county SCAG region. It is the product of an extensive regional and multi jurisdictional public participation process, supported by a $2 million study over an 18-month period.[66] Compass replacing a 1989 plan, is based on 2001 computer models that demonstrate the dramatic effect of land use decisions on vehicle miles and congestion.[67]

Compass acknowledges that future demands for jobs and housing in the region cannot be accommodated exclusively in traditional urban areas. Directing growth to the Antelope Valley balances the growth in jobs and housing, minimizes existing congestion at other regional facilities (such as Los Angeles International Airport), and encourages multimodal transportation facilities. In addition, SCAG's *Regional Transportation Plan*

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[65] Southern California Association of Governments, Southern California Compass Growth Vision Report (June 2004)(hereinafter "Compass Report").

[66] Southland counties seek unity on growth, Los Angeles Daily News (January 28, 2003).

[67] Steuteville, "To live and drive in LA," 9 NEW URBAN NEWS, no. 2 (March 2004), at 1. VMT per capita will fall from 21.9 to 20.8 (Compass Report, at 91). This article cites similar regional efforts by the Association of Bay Area Governments (ABAG) and the Atlanta Regional Commission's Livable Centers Initiative to link land use and transportation.

establishes the Planning for Integrated Land Use and Transportation (PILUT) "Fifth Ring" strategy that allocates growth to newly developed areas in the Antelope Valley. By placing a high speed rail station in the Antelope Valley, the state will reinforce the city's multimodal infrastructure and regional land use and growth management strategies that call for balanced development in the regional tier structure. In short, the Antelope Valley is the designated regional center that provides regional growth opportunities.

The Compass Report projects that the region will grow by an additional 6.3 million people by 2030 – a 38% increase over its current population of 16.5 million and the equivalent of two Chicagos. The report identifies some benefits from this high population growth rate based on the preferred regional growth alternative. The preferred growth vision involves the following growth scenarios:

- Intensive infill in the region's traditional centers.
- Satellite cities for new urban density growth in the High Desert and Palmdale, Lancaster and San Bernardino County.
- Corridors and Centers that provide transit supportive density, walkable streets, and jobs-housing balance.

This growth alternative has the following benefits over policies that rely on infill alone to accommodate future growth:

- Better trip reduction and a more efficient use of transportation infrastructure.
- Larger reductions in vehicle miles traveled (VMT)
- Economic development opportunities, including the ability to balance the location of jobs and housing.
- Less sprawling growth on the region's periphery.
- Accommodation of Smart Growth alternatives, such a transit-supportive land use patterns.

The Compass alternative can reduce VMT by 18 million daily from its current level.[68] Two-thirds of this reduction will occur because of changes in land use patterns, with high density centers replacing sprawl. This is an important component of the region's transportation program, which will be supported by $211 billion in road and transit spending through 2030.

[68] Steuteville, supra, at 2.

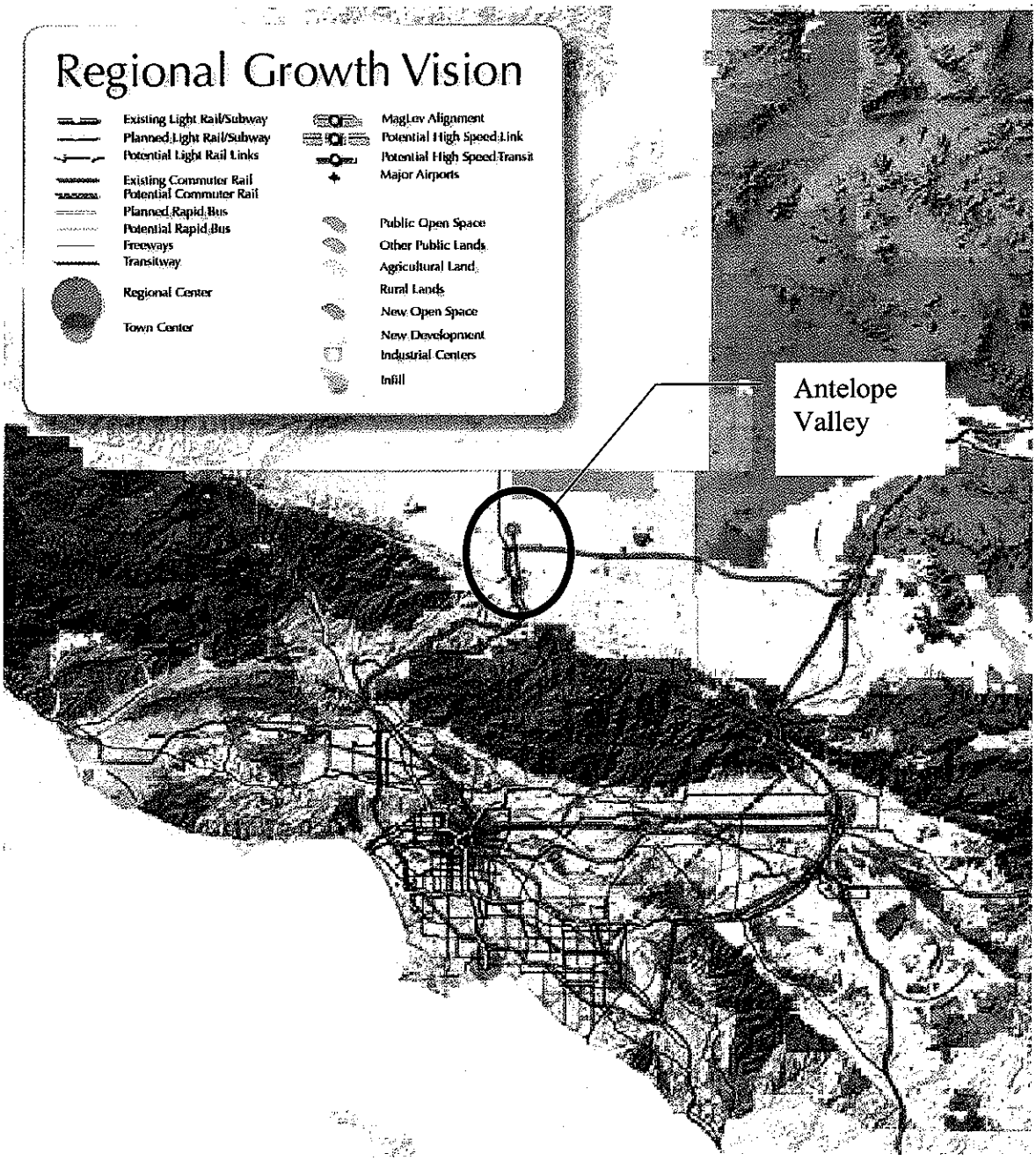

Figure 3 Compass Regional Growth Vision (Source: Compass Report, at 42)

2. Growth Visioning

The Compass strategy is based upon an extraordinary regional transportation visioning process. This process encouraged local governments in the region to consider the regional implications of land use decisions. The process was established by the 2001 Regional Transportation Plan to expand on the 1998 RTP's Livable Communities

Program.[69] A Growth Visioning Subcommittee was established to develop a process to assist local, sub regional and regional officials in developing additional strategies to accommodate growth. The visioning process produced "smart growth" policies which guided the COMPASS strategy. These policies are discussed below.

Visioning Process Policy	Description
Principle 1: Improve the Link between Land Use & Transportation	Address future population and employment growth and their effect on traffic congestion, transportation investment choices and air quality by using alternatives to provide highways expansion. The public expects more efficient transportation investments that support desired development patterns, achieve and maintain economic growth and a sustainable environment, and promote global competitiveness.
Principle 2: Focus Development in Urban Centers	Continue the renaissance of urban centers to promote public and private investments and decisions that will enable existing urban centers to become centers of housing, jobs, shopping, culture and entertainment.
Principle 3: Support the Preservation of Stable, Single-Family Neighborhoods	Maintain existing neighborhoods. Appropriate in-fill opportunities are identified by community planning efforts. Consider neighborhood preservation within the framework of development in urban centers policy to promote increased density in certain corridors where services are available, as well as the development of residentially-oriented transportation and other public services.
Principle 4: Locate New Housing Near Existing Jobs and New Jobs Near Existing Housing	Increase the supply of housing in current jobs-rich areas and to encourage the development and growth of jobs in housing-rich communities to reduce congestion, commute times and personal transportation costs, improve air quality, and reduce the cost to local governments of providing new facilities and services to new developments outside of existing service areas.
Principle 5: Encourage Transit-Oriented Development	Locate a mixture of uses within an average of ¼-mile walking distance of a transit station or bus transfer center. Design, configure and mix of uses to emphasize a pedestrian-oriented environment. These centers reinforce the development of office, open space, public and residential uses and personal commercial services within comfortable walking distance, making it convenient for residents and employees to travel by transit, bicycle, or foot, as well as by car. Mixed-use areas containing restaurants, a museum, a theater and retail stores have a greater potential to generate bus and rail ridership than an area with retail stores alone.
Principle 6: Create Walkable Communities	Foster walkable communities and urban centers where different kinds of homes, shops and workplaces are integrated with one another; ensure that housing of different costs is integrated throughout each community. Walkable communities put urban environments back on a scale for sustainability of resources (both natural and economic) and lead to more social interaction, physical fitness and diminished crime.
Principle 7: Promote Travel Choices	Provide people with additional travel choices including rail, bus, bicycles and pedestrian access through infrastructure investment, development choices and urban design. Expand transit service and promote alternatives to driving alone. ISTEA has assisted in this effort by preserving a strong federal transit program, expanding access to flexible funds for transit, and encouraging innovative projects that promote alternatives to driving.
Principle 8: Promote Affordable Housing	Provide, in each community, a variety of housing types to meet the housing needs of all income levels.

[69] Southern California Association of Governments, 2001 Regional Transportation Plan/Community link 21, Executive Summary (approved April 12, 2001), at 19.

Principle 9: Conserve Rural, Agricultural,	Recreational and Environmentally Sensitive Areas Identify important rural, agricultural, recreational and environmentally sensitive lands that should be protected, and develop policies and strategies to protect them. Preserve the natural landscape that is key to the allure of southern California. Land is a finite resource that requires thoughtful management to build homes, induce new jobs and preserve open space.
Principle 10: Ensure that Educational Opportunities are not a Barrier to Achieving Balanced Growth	Ensure that K-12, colleges, universities and job-training facilities are adequately preparing the future workforce, and that schools are not a barrier toward the revitalization of urban areas and existing communities. Safe, good quality schools, integrated within the community, are essential to promote the revitalization of these areas.
Principle 11: Increase Quality of Life for All Residents in the SCAG Region	The ultimate goal of the Growth Visioning effort is to make the SCAG region a better place to live, work and play for all residents regardless of race, ethnicity or income class. Decisions regarding growth, transportation, land use, and economic development are intended to promote and sustain for future generations the region's livability and prosperity.

SCAG has also published a set of "Growth Principles for Sustaining a Livable Region," dated October 1, 2001. These principles are discussed below:

Principle	Description
Principle 1 - Improve Mobility for All Resident	• Encourage Transportation Investments and Land Use Decisions that Are Mutually Supportive • Locate New Housing Near Existing Jobs and New Jobs Near Existing Housing • Encourage Transit-Oriented Development • Promote a Variety of Travel Choices
Principle 2 - Foster Livability in All Communities	• Promote In-Fill Development and Redevelopment to Revitalize Existing Communities • Promote Developments which Provide a Mix of Uses • Promote "People-Scaled," Walkable Communities • Support the Preservation of Stable, Single-Family Neighborhoods
Principle 3 - Enable Prosperity for All People	• Provide, in Each Community, a Variety of Housing Types to Meet the Housing Needs of All Income Levels • Support Educational Opportunities that Promote Balanced Growth • Ensure Environmental Justice Regardless of Race, Ethnicity or Income Class • Support Local and State Fiscal Policies that Encourage Balanced Growth • Encourage Civic Engagement
Principle 4 - Promote Sustainability for Future Generations	• Preserve Rural, Agricultural, Recreational and Environmentally Sensitive Areas • Focus Development in Urban Centers and Existing Cities • Develop Strategies to Accommodate Growth that Use Resources Efficiently, Eliminate Pollution and • Significantly Reduce Waste Utilize "Green" Development Techniques

The importance of satellite locations in capturing future housing and employment growth is underscored by other local planning studies. A 2001 summit of regional leaders

brought together by the USC Lusk Center for Real Estate and the Urban Land Institute stated the following:

> ... several new "satellite cities" will be needed to accommodate the population growth while maintaining a jobs-housing balance. While tables, on average, located 60-80% of the projected new population in the core area of the region, significant new concentrations of people and jobs were also located at more peripheral locations. *The average allocation of new growth in the Palmdale-Lancaster area was about 340,000 new people and 235,000 new jobs*, while Victorville and Apple Valley would gain about 250,000 new residents and 145,000 new jobs. Several other larger new cities were envisaged for the south I-15 corridor between Corona and the San Diego County border. (emphasis added)[70]

The preferred approach for most participants was the "New Towns With Infill" model establishing large sized hubs distributed around the outer edges of the region, coupled with infill development in areas that are already densely populated. Under this approach approximately one million new residents are to be located in peripheral cities including Palmdale/Lancaster. A related alternative – termed the "New Cities" model – shifts 55% of future growth to large cities toward the edges of the region. This approach shifts 706,000 new residents to Santa Clarita/Palmdale/Lancaster.

C. *Air Quality*

Sprawl is a significant contributor to decreases in air quality.[71] Conversely, urban form can significantly contribute to reductions in emissions and VMT.[72] Studies in California and Oregon have estimated NOx and CO emissions reductions of 3-7% by the use of smart growth techniques including but not limited to mixed use and clustering.[73] While transit-supportive land use is the optimal development form for reducing air quality, it is unrealistic to expect all development to occur in transit influenced areas due to financial

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[70] USC Lusk Center for Real Estate and Urban Land Institute, Reality Check on Growth (2002).

[71] R. Ewing, R. Pendall, & D Chen, *Measuring Sprawl and its Impact* (Smart Growth America, 2002), at 5.

[72] U.S. Environmental Protection Agency. EPA Guidance: Improving Air Quality Through Land Use Activities (EPA420-R-01-001, January 2001), at 15.

[73] U.S. Environmental Protection Agency, at 18 (citing Cambridge Systematics, Inc. and Parsons, Brinckerhoff, Quade & Douglas. 1996a. Making the Land Use Transportation Air Quality Connection: Analysis of Alternatives. Vol. 5. Prepared for Thousand Friends of Oregon; Johnston, R.A., Rodier, C. J., Choy, M., and Abraham, J.E. 2000. Air Quality Impacts of Regional Land Use Policies. Prepared for U.S. Environmental Protection Agency, Urban and Economic Development Division, Washington, DC.; Cambridge Systematics. 1994. The Effects of Land Use and Travel Demand Strategies on Commuting Behavior. Prepared for the U.S. Department of Transportation, Federal Highway Administration, Washington, DC.; DeCorla-Souza, P. 1992. "The Impacts of Alternative Urban Development Patterns of Highway System Performance." Presented at ITE conference on Transportation Engineering in a New Era.)

and market constraints.[74] Accordingly, California communities use a combination of techniques to address the relationship between land use and air quality.

State and federal agencies recognize land use control strategies as a mechanism to reduce emissions and to secure planning and funding approval. Land use mechanisms including parking management programs, area-wide ride-share incentives, improved public transit, bicycle and pedestrian measures, and park-and-ride programs are expressly recognized as transportation control measures in the Clean Air Act.[75]

The SCAG Regional Transportation Plan includes a number of measures that rely on increased New Town development and transportation _____ Management (TDM).

TCMs Programmed and Implemented through the 2001 Regional Transportation Plan (RTP) and the 2002 Regional Transportation Improvement Program (RTIP)

Measures	Description
TCM-1A High Occupancy Vehicle (HOV) Interventions	HOV Projects
TCM-1B Transit and Systems Management Interventions	Bus, Rail and Shuttle Transit Improvements (includes all fixed-route local, express and rapid bus services, light rail service, and commuter rail Metrolink service) Bicycle and Pedestrian Facilities Park and Ride Lots and Intermodal Transfer Facilities Goods Movement Facilities (includes all Baseline projects and the SR-60 truck lane)
TCM-1C Information-based Interventions	Rideshare and Transit Marketing Intelligent Transportation Systems (ITS) (includes Urban Freeway System Management Improvements, Smart Corridors System Management Programs and Congestion Management Plan-based demand management strategies) Telecommuting Facilities TDM Demonstration Programs[1]

Figure 4 (Source: South Coast Air Quality Management District, Draft 2003 Air Quality Management Plan)

The High Speed Rail Antelope Valley alignment will not only provide significant air quality benefits over other potential growth alternatives, but it will also improve the position of SCAG and the County in securing state and federal air quality approvals. EPA looks more favorably to Smart Growth alternatives that are approved, under construction, or built rather than speculative estimates, in approving State Implementation Plans.[76] The EPA has awarded from $8 to $335 million under its

[74] The Planning Center, Land Use, Transportation and Air Quality: A Manual for Planning Practitioners, San Bernardino Air Quality Plan (1993).
[75] U.S. Environmental Protection Agency, at 52.
[76] U.S. Environmental Protection Agency, at 41-42.

Economic Incentive Programs (EIP) policy, under which it considers land use control strategies.[77]

D. Transportation

The regional transportation plan emphasizes land-use and transportation policies that accommodate future growth while addressing transportation demand and air quality concerns.[78] Some of the "Smart Growth choices" embraced by the plan include mixed-use centers, non-motorized transportation facilities, and transit improvements. A summary of Regional Transportation Plan policies is as follows:

- creating a mix of homes, shops, work places, parks, schools and civic institutions
- locating a significant share of new housing and jobs within walking distance (1/4 mile) of transit or major bus stations
- Link communities and neighborhoods with viable pedestrian and bicycle facilities
- Jobs/Housing Balance
- Develop needed affordable housing in high growth urban and suburban job centers
- Attract viable job centers to housing-rich communities

E. Housing

California's affordable housing crisis, which is particularly acute in the Los Angeles region, is well-documented. While the State Department of Finance predicts that there will be 8 million new households in the state by 2020, housing production has fallen short of needs for at least 11 consecutive years.[79] While 220,000 housing units are needed annually to meet projected demand, housing production from 1990-1997 averaged only 91,000 units.[80] The Little Hoover Commission points to local land use decisions as a major constraint on housing production. While the state has three times the land supply needed to accommodate growth by 2020, much of the land is not available for production due to local land use constraints and complicated regulatory approval processes.[81]

Palmdale provides needed housing in the northern area of the region. Los Angeles County is expected to add 33,400 households over the 1997-2005 housing element planning period. The most rapid growth is expected to occur in the north county area, which will add 17,600 households or 53% of the unincorporated county's total household growth. Population in the unincorporated county increased by 7% over the last decennial census period. This increase added 66,083 persons to the unincorporated county alone, a

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[77] U.S. Environmental Protection Agency, at 47-48.

[78] Southern California Association of Governments, 2001 Regional Transportation Plan/Community link 21, Executive Summary (approved April 12, 2001), at 25; Southern California Association of Governments, 2001 Regional Transportation Plan/Community link 21 (approved April 12, 2001), at 107.

[79] Little Hoover Commission, Rebuilding The Dream: Solving California's Affordable Housing Crisis (May 2002), at 3.

[80] Little Hoover Commission, at 3-4.

[81] Little Hoover Commission, at 8-9.

population equivalent of Redondo Beach or Walnut Creek.[82] Countywide population has increased by 460,270 since the 2000 Census.[83] This increase occurred despite the incorporation of Malibu and Calabasas, which removed an equivalent amount of population from the unincorporated area.[84]

The County's unique demographics create the need for a variety of housing types. While average household size has declined for the United States,[85] California and Los Angeles County have experienced an increase in household sizes. Average household size rose from 2.91 in 1990 to 2.98 in 2000,[86] while the County's average family size of 3.61 exceeds the national figure by 15%.[87] The Housing Element attributes this phenomenon to a countywide housing shortage that has caused households to combine.[88] It also notes that there is a need to provide larger dwelling units.[89] While some planners expect higher density housing to accommodate the overwhelming share of housing needs, the County's demographic profile suggests a need for a variety of low, medium and high density housing types.

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[82] State of California, Department of Finance, E-1 City/County Population Estimates, with Annual Percent Change, January 1, 2002 and 2003. Sacramento, California, May 2003.

[83] State of California, Department of Finance, E-4 Population Estimates for Cities, Counties and the State, 2001-2003, with 2000 DRU Benchmark. Sacramento, California, May 2003. This source reports an increase from 9,519,330 in April 2001 to 9,979,600 in January 2003.

[84] County of Los Angeles, Los Angeles County General Plan, Housing Element 1998-2005 (adopted by Los Angeles County Board of Supervisors, October 23, 2001), at ch. 3, pg. 6.

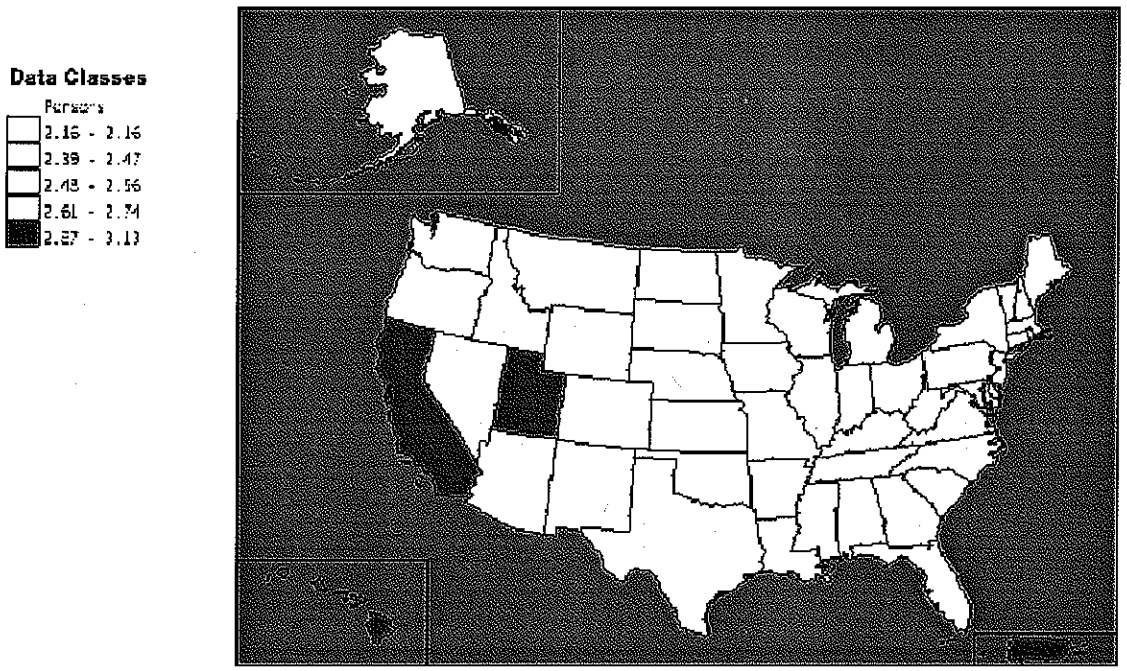
[85] Average household size decreased from 2.63 in 1990 to 2.59 in 2000. See United States Bureau of Census, Table DP-1. Profile of General Demographic Characteristics for the United States: 2000 and Table DP-1. Profile of General Demographic Characteristics for the United States: 1990, at http://www.census.gov/census2000/states/us.html.

[86] U.S. Department of Commerce, Bureau of Census, Profiles of General Demographic Characteristics, 2000 Census of Population and Housing, California 2000 (May 2001), at 20.

[87] U.S. Department of Commerce, Bureau of Census, Profiles of General Demographic Characteristics, 2000 Census of Population and Housing, United States 2000 (May 2001), at 1; U.S. Department of Commerce, Bureau of Census, Table DP-1: Profile of General Demographic Characteristics: 2000 Data Set: Census 2000 Summary File 1 (SF 1) 100-Percent Data for Los Angeles County, at factfinder.census.gov.

[88] Housing Element, Ch. 3, pg. 9.

[89] Housing Element, Ch. 3, pg. 7 ("An area with an increasing average household size indicates an increasing proportion of large family households and a need for larger dwelling units.").



Source. U.S. Census Bureau. Census 2000 Summary File 1 Matrix P17.

Figure 5; Household Size Comparison, from factfinder.census.gov

While households are projected to increase significantly, housing production has lagged. The recent drop in housing production has been particularly steep for multifamily housing, declining from over 150,000 in the mid-1980's to just over 50,000 in the late 1990's.[90] The Southern California Studies Center reports that Los Angeles and Orange County have consumed all the natural locations for growth that are not constrained by government policy.[91] For the first time in its history, the county is running out of developable land.[92] The Housing Element indicates that population growth is accelerating faster than the supply of housing, with 40,000 households residing illegally in garages.[93] The number of housing units is decreasing in the face of increasing household size and the number of households.[94]

The shortage of housing has led to increases in rents and sales prices that are not met by corresponding increases in income. While the state Employment Development Department reports a mean hourly wage of $18.13 for the Los Angeles-Long Beach MSA in 2002,[95] a 1999 survey concluded that $21.90 per hour was needed simply to afford the

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[90] Sprawl Hits the Wall, at 22-23.

[91] Southern California Studies Center and Brookings Institution Center on Urban and Metropolitan Policy, Sprawl Hits the Wall: Confronting the Realities of Metropolitan Los Angeles (2001), at 2.

[92] Sprawl Hits the Wall, at 30.

[93] Housing Element, Ch. 3, pg. 24.

[94] Housing Element, Ch. 3, pg. 24.

[95] California Employment Development Department, Occupational Employment (2001) & Wage (2002) Data, Occupational Employment Statistics (OES) Survey Results , (Revised January 2003), at http://www.calmis.ca.gov/file/occup$/oes$.htm.

average fair market rent for a two-bedroom apartment.[96] The median priced single family home is too expensive for 59% of all households in the County.[97]

Table 2 Housing Data

	1990	1997	2000	2005	2020
Population (Countywide)	8,863,052		9,884,255 (12%)		11,584,800 (17.2%)
Population (unincorporated)	970,194	993,900	1,036,277 (7%)	1,145,800 (11.5%)	
Households (countywide)	2,989,552		3,133,774 (4.8%)		
Households (unincorporated)		274,100		307,500 (12.2%)	
Households (North County)		35,600		53,200 (49.4%)	

Sources: County of Los Angeles, Housing Element (2001); U.S. Bureau of Census; State of California, Department of Finance, Interim County Population Projections — Estimated July 1, 2000 and Projections for 2005, 2010, 2015 and 2020.

Palmdale accommodates regional housing needs by providing a healthy balance of housing types and costs. The City's lower density General Plan land use classifications accommodate the need for larger dwelling units to accommodate the County's increasing household size.[98] The higher density housing in the General Plan add needed diversity to a housing stock dominated by single-family construction.[99] National surveys indicate that "baby boomers" (age 55-64) and "echo boomers" (age 25-35) prefer higher density housing in walkable neighborhoods.[100] These demographic categories account for 2,277,942 persons or 24% of the County's population.[101]

F. *Economic Development*

While the Los Angeles region contains one of the nation's largest economies,[102] it lost 440,000 jobs or 7% of its job base between 1990-1994.[103] While 550,000 jobs were added from 1994-98, Los Angeles County did not return to its 1990 level.[104] North Los Angeles, in particular, suffers from an imbalance of jobs to housing that is expected to

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96 Housing Element, Ch. 3, pg. 23.

97 Housing Element, Ch. 3, pg. 29.

98 Housing Element, Ch. 3, pg. 7 ("An area with an increasing average household size indicates an increasing proportion of large family households and a need for larger dwelling units.").

99 Housing Element, Ch. 3, pg. 25. While only 24% of dwelling units in the unincorporated county are multi-family, the countywide estimate is 45%.

100 Congress for the New Urbanism, The Coming Demand (2001)(based on research by D. Myers, E. Gearin, T. Banerjee, & A. Garde of the University of Southern California School of Policy, Planning, and Development for Funder's Network for Smart Growth and Livable Communities).

101 Census 2000, Summary File 1 for Los Angeles County.

102 State of California, Department of Finance, Interim County Population Projections – Estimated July 1, 2000 and Projections for 2005, 2010, 2015 and 2020.

103 Sprawl Hits the Wall, at 15.

104 Sprawl Hits the Wall, at 15.

worsen by year 2025.[105] The Antelope Valley alignment will attract new businesses to Palmdale, helping to remedy this imbalance.

G. Land Use forms

Traditionally, planners have equated "leapfrog" or non-contiguous development with sprawl. Development at the fringe or outside of urbanized areas was often characterized as sprawl, with little analysis of the actual built form of development. As regions have struggled with the issue of sprawl over the past 40 years, definitions of sprawl have become more complex. Planners now realize that, depending on its built form, development in satellite communities can have the same benefits as those in "infill" locations or existing urbanized areas.[106]

A recent study by several well-known researchers uses a variety of factors to assess the degree to which a community or region is sprawling.[107] This report measured indicators of sprawl for 83 metropolitan areas. The indicators include four factors:

- Residential density. Higher densities achieve higher (less sprawling) rankings. Los Angeles-Long Beach received a higher than average score on this factor, with an overall density of 1.26 dwelling units per acre.[108]

- Neighborhood mix of homes, jobs, and services. Palmdale brings jobs and shopping opportunities to a high growth area of the county, and improves the county's overall ranking.

- Strength of activity centers and downtowns. Los Angeles-Long Beach scored a low 72.4 (100 is the average score in this area). By contrast, Palmdale features a variety of residential and employment centers providing a strong sense of identity for the community.

- Accessibility of the street network. An interconnected street network scores highly under this factor. Los Angeles-Long Beach scores high (123.3) on this factor. Palmdale has an interconnected major street system that is coordinated with the Los Angeles Master Plan of Highways.

As is discussed below, Palmdale is a satellite new town community. While many of the region's planning policies in the 80's and 90's focused on development contiguous to or

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[105] Southern California Association of Governments, State of the Region 2002 (December 2002).

[106] USC Lusk Center for Real Estate and Urban Land Institute, Reality Check on Growth (2002)(assembly of regional leaders "opted for new 'satellite cities' to accommodate a significant share of the population growth – these were complete new communities with employment centers and downtowns, not just tracts of new housing.")

[107] R. Ewing, R. Pendall, & D Chen, *Measuring Sprawl and its Impact* (Smart Growth America, 2002).

[108] U.S. Census Bureau, Table GCT-PH, Population, Housing Units, Area, and Density, at factfinder.census.gov. reports that the Los Angeles-Long Beach PMSA has 805.5 housing units per square mile, or 1.26/acre.

within existing urban centers as an element of smart growth, new analysis has shown the inability of existing infill sites and centers to accommodate future growth. The lack of available land in infill sites has led to the new regional efforts to actively encourage new communities that provide the balance of jobs and housing reflected in Palmdale.

A similar example is the Albuquerque/Bernalillo County, New Mexico's Planned Growth Strategy (PGS). The PGS concludes that only a portion of the regional demand for new housing can be accommodated in infill locations. Accordingly, the plan calls for encouraging new communities with adequate infrastructure and walkable designs to complement regional policies that support development in existing areas.[109] Other states, such as Florida, activity admonish local governments to consider satellite communities as one solution to urban sprawl.[110]

H. Demographic/Social

The Los Angeles metropolitan area is one of the most demographic regions in the nation. It experiences a high rate of immigration and domestic migration.[111] The Los Angeles metropolitan area captured the highest Hispanic and second highest Asian population increases in the nation from 1990-1998.[112] Consistent with national trends, the region is also expected to experience a dramatic increase in the number of retiring baby boomers and "echo boomers" starting new families over the next decade.[113] These trends will create regional needs for a variety of housing types, ranging from low density living to mixed use apartments. Palmdale's diverse land use categories provide an assortment of housing types to meet these needs.

I. Quality of Life

Palmdale's built form will improve the quality of life for both new and existing residents. The City's generous pedestrian infrastructure and open space system provide a range of recreational opportunities. The transit plan provides alternatives to work related trips on congested roads. Further, its mixed use character, coupled with new urbanist design elements, build on a proven concept in similar communities that experience a high rate of resident satisfaction.[114]

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[109] See Robert H. Freilich, Smart Growth In Western Metro Areas, 43 Nat. Res. J. 687 (Summer 2003) (comparing Albuquerque with Kansas City, Missouri).

[110] Florida Statutes § 163.3177(11)(b) (encouraging use of "innovative," "flexible" and "creative" planning strategies such as "new towns" and "satellite communities").

[111] W. Frey and R. DeVol, America's Demography in the New Century: Aging Baby Boomers and New Immigrants as Major Players (Milken Institute, March 8, 2000), at 19.

[112] Frey and DeVol, at 22.

[113] Congress for the New Urbanism, The Coming Demand (2001)(based on research by D. Myers, E. Gearin, T. Banerjee, & A. Garde of the University of Southern California School of Policy, Planning, and Development for Funder's Network for Smart Growth and Livable Communities).

[114] Frantz, Celebration, U.S.A. : Living In Disney's Brave New Town (1999); Ross, The Celebration Chronicles: Life, Liberty, and the Pursuit of Property Value in Disney's New Town (1999); Eppi & Tu, Valuing the new urbanism (Urban Land Institute, 2000).

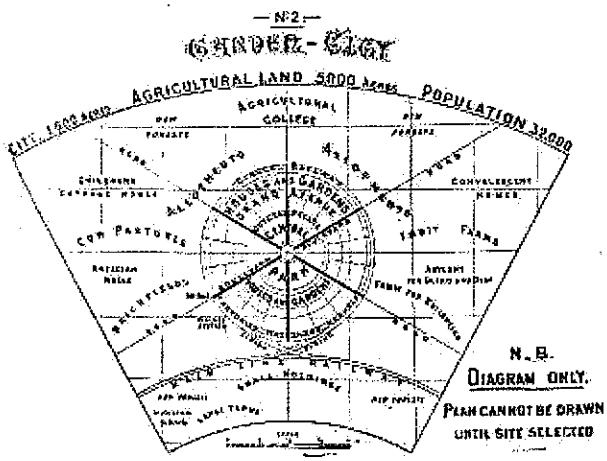
VII. Non-Sprawl Alternatives Accomplished by Palmdale

A. New Towns

Palmdale and other "smart growth" new town communities promote smart growth concepts by providing denser, more diverse residential areas, with a mix of local retail shops and public facilities without low-density sprawl.

1. Garden Cities (1900-1914)

The concept of the new town dates back to Ebenezer Howard (the originator of the "new town" movement) at the end of the 19th century. Few know, however, that Howard's new town concept was based upon a community concept of six interlinked neighborhoods (or "wards") of about 5,000 people each, focused on an elementary school, bounded by major streets, and containing a variety of residential accommodations. The new town was called a "garden city" because it was to be separated from contiguous urban growth by a "greenbelt" or "garden". Unfortunately, Howard's neighborhood concept was divorced from his garden city concepts and eventually became independently accepted in England and later the United States. In the American adaptation, neighborhoods were typically based on quarter sections (160 acres) with major streets bounding neighborhoods one-half mile apart with no through traffic. Americans adapting his garden city concept did not consider his vision to be one of "sprawl and scatter."[115] A key element of Howard's vision involved the "planned dispersal" of employment and population to self-contained towns that provide a mix of industry, services and residential dwelling types.[116]



As early as the 1920s, emphasis on lower density single-family detached housing in the emerging suburbs. This required an increase in the size of the neighborhood to assure sufficient population to support the walk-in school. By the late 1940s, advocates of the

115 F. Osborn, Green-Belt Cities, at 29 (2nd ed., 1971).

116 Osborne, supra, at 32.

"neighborhood unit" were promoting neighborhoods one-mile square (equal to 640 acres), with a half-mile walk to school, and major streets one mile apart on section lines. Eventually, the neighborhood concept gave way to suburban residential sprawl characterized by dependency on the automobile. The demise of the original neighborhood concept continues today with the increase in auto dependent suburban sprawl. The other part of Howard's concepts (the New Town) has had a far greater impact on planning for today's 21st Century California.

2. New Towns in America (1925-1929)

Clarence Stein and Henry Wright imported Howard's "garden city" concept to the United States. In Radburn (Fair Lawn, New Jersey), the designers incorporated a series of individual subdivisions known as superblocks in order to address America's "automobile-based suburban market."[117] The superblock involved long cul-de-sacs to the front of homes, with sidewalks connecting the homes at the rear. The sidewalks framed an internalized open space system and the entire community was separated by a greenbelt from adjacent development.

3. New Deal New Towns (1934-1941)

Stein's ideals were incorporated into three new towns built during the New Deal: Greenbelt, Maryland; Greenhills, Ohio; and Greendale, Wisconsin.[118] These towns were built simultaneously by the New Deal's Resettlement Administration, but were never fully implemented and were eventually sold to private entities.[119]

4. World War II New Towns (1941-1945)

New Towns during the World War II era were prompted by government initiative. These include the small towns of the Tennessee Valley Authority (TVA) and the "atomic cities" of Los Alamos, Richland, Oak Ridge and Hanford.[120] These communities were established by the Atomic Energy Commission in 1947 to provide employee housing.[121] The hydroelectric plants and atomic energy facilities of these towns provided a local economic base.[122] These were essentially government "company towns, but were eventually sold to the private sector as the result of the complexities of government ownership.[123]

5. Private New Towns (1960-1968)

Private new towns emerged during 1960-1968 with the development of Reston, Virginia; Columbia, Maryland; Irvine, California.[124] These are large-scale, mixed use communities

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117 Gause, J.A., Great Planned Communities, at 21 (Urban Land Institute, 2002).
118 G. Breckenfeld, Columbia and the New Cities (1971), at 115.
119 Breckenfeld, at 116-19.
120 F. Osborn & A. Whittick, The New Towns: The Answer to Megalopolis (Rev. 1969), at 151.
121 D. Hagman & J. Juergensmeyer, Urban Planning and Land Development Control Law § 16.3 (2nd ed. 1986).
122 Osborn & Whittick, supra.
123 Hagman & Juergensmeyer, supra, § 16.3.
124 Forsyth, Planning Lessons from Three U.S. New Towns of the 1960s and 1970s, 68 APA J. 387 (2002).

with neighborhoods organized around villages and town centers. These developments emerged as a response to market demands and developers' visions, and are continuing their buildout today. These communities have achieved many of their objectives. For example, Reston has excellent jobs-housing balance with 40,000 jobs and 63,000 residents.[125]

6. Public-Private Towns (1967 – 1972)

Public-private new towns from 1967-1972 were developed under the New Communities Act of 1968 (formerly 42 U.S.C. §§ 3901-14).[126] The concepts of the New Communities Act were carried forward by the Urban Growth and New Community Development Act of 1970 (formerly 42 U.S.C. § 4511), which increased federal incentives for new community development.[127] Communities developed under the new community's legislation included Jonathan, Minnesota; The Woodlands; Texas; St. Charles Communities, Maryland; and Park Forest South, Illinois.[128]

Patterns of growth have been dramatically impacted over the past decade by a consortium of ideas on developing more compact, walkable, mixed use energy/environmentally sustainable communities designed to combat urban sprawl and promote revitalization of cities and older suburbs. The "New Urbanism" movement has an array of architects, economists, designers, planners, transit proponents, housing specialists, ecologist, builders, engineers and lawyers working on hundreds of new urbanist projects from "conservation subdivisions in rural areas; new urban "walkable communities" and "town centers", city center "town squares" and "grayfield conversions of older malls, industrial buildings and warehouses.[129]

B. The Palmdale "New Town"

The concept of new towns separated from existing urban areas is an accepted planning technique that has been successfully utilized in Palmdale. Palmdale constitutes a distinct new town community separate from Los Angeles by the Angeles National Forest. Its density, mixed use neighborhoods and extensive infrastructure are based upon and reflect the new town characteristics. The characteristics of Palmdale as a satellite new town are well exemplified by the Florida experience.

Florida, which has the nation's most rigorous system of statewide planning, requires local plans to consider "new towns" and "satellite communities" as a method to encourage greater land use efficiencies.[130] Research shows that better interconnectivity of streets in

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125 Gause, supra, at 812.

126 Hagman & Juergensmeyer, supra, § 16.4.

127 Hagman & Juergensmeyer, supra, § 16.4.

128 Hagman & Juergensmeyer, supra, § 16.4.

129 See Francesca Ortiz, Smart Growth and Innovative Design: An Analysis of the New Community, 34 Envt.L.Rptr.10003 (2004); Calthorp, The Next American Metropolis (Princeton, 1993); New Urbanism Comprehensive Report and Best Practices Guide (New Urban News, 2001); Watson, An Introduction to Urban Design, 43 Planning Commissioners Journal 6 (Summer 2001); and Duany-Plater-Zyberk & Company "Smart Code", Municipal Code Publishers, 2003) (an inclusive new urban code for community thoroughfares, civil places, urban zones, site plans, terms and definitions).

130 Florida Statutes § 163.3177(11)(b).

lieu of cul-de-sacs, smaller blocks, proximity to light rail, and pedestrian accessibility to shops and other commercial users has created a class of buyers willing to pay more to live in a new urban unity. The Florida Department of Community Affairs (FDCA), which administers the growth management statutes, defines a "new town" as follows:[131]

> "(79) "New town" means a new urban activity center and community designated on the future land use map and located within a rural area or at the rural-urban fringe, clearly functionally distinct or geographically separated from existing urban areas and other new towns. A new town shall be of sufficient size, population and land use composition to support a variety of economic and social activities consistent with an urban area designation. New towns shall include basic economic activities; all major land use categories, with the possible exception of agricultural and industrial; and a centrally provided full range of public facilities and services. A new town shall be based on a master development plan, and shall be bordered by land use designations which provide a clear distinction between the new town and surrounding land uses."

The FDCA requires local governments to evaluate new towns, rural villages or rural activity centers to determine how they discourage urban sprawl.[132] New towns that allow the conversion of rural and agricultural lands to other uses while protecting environmentally sensitive areas, maintaining the economic viability of agricultural and other predominantly rural land uses, and providing for the cost-efficient delivery of public facilities and services, are recognized as a method to discourage urban sprawl.[133] As an incentive, developments that meet development of regional impact (DRI)[134] thresholds are assigned points under the Florida Quality Development (FQD) program[135] for "New Town or New Community" principles that incorporate features of Traditional Neighborhoods.

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131 Florida Administrative Code § 9J-5.003.

132 Florida Administrative Code § 9J-5.006(4)(j)16.

133 Florida Administrative Code § 9J-5.006(4)(l).

134 A DRI is defined as "any development, which, because of its character, magnitude, or location, would have a substantial effect upon the health, safety, or welfare of citizens of more than one county." Florida Statutes § 380.06(1). The Florida Statutes establish a regional review process for developments that meet designated size and acreage thresholds under this statute.

135 The FQD program is designed to "encourage development which has been thoughtfully planned to take into consideration protection of Florida's natural amenities, the cost to local government of providing services to a growing community, and the high quality of life Floridians desire. It is further intended that the developer be provided, through a cooperative and coordinated effort, an expeditious and timely review by all agencies with jurisdiction over the project of his or her proposed development." Florida Statutes § 380.061(1).

C. New Urbanism

Palmdale combines new town principles with many features of the emerging concept of "New Urbanism."[136] New Urbanist projects include the following elements:[137]

- Mixing of Land Uses: While suburban dwellers must drive from one single use to the next, i.e. from residential to commercial areas, neotraditionalists make it possible live, work, walk and shop in the same vicinity.

- Increased Density: Increased density is another attribute common to neotraditional communities. By increasing the density of a community, it is likely that people will begin to walk, car pool or rely on public transit to meet their transportation needs.

- Walkability: Neotraditionalists are known for striving to make the communities they develop walkable by linking the community with a network of sidewalks. Additionally, efforts are made to ensure that one-quarter of a mile is the furthest distance between uses.

- Distinct Architectural Design Features: Neotraditional communities are sometimes easy to spot due to defining design features. Such places often re-invent their cities by modeling architectural design standards on historical and regional tastes.

Research shows that better interconnectivity of streets in lieu of cul-de-sacs, smaller clocks, proximity to light rail, new traditional design including porches and rear garages and pedestrian accessibility to shops and other commercial users has created a class of buyers willing to pay more to live in a new urban community.[138]

In order to encourage walkability and to replicate the traditional urbanism of new town and older cities, most "greenfield"[139] new urbanism projects feature short blocks with few cul-de-sacs. Few developments include all of the design features desired by new urbanist practitioners. In many of the new "hybrid" projects, such as Otay Ranch in Chula Vista, non-urban features such as gates, six-lane arterial roads and cul-de-sacs coexist with

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[136] See Francesca Ortiz, Smart Growth and Innovative Design: An Analysis of the New Community, 34 Envirt.L.Rptr.10003 (2004); Calthorp, The Next American Metropolis (Princeton, 1993); New Urbanism Comprehensive Report and Best Practices Guide (New Urban News 2001); Watson, An Introduction to Urban Design, 43 Planning Commissioners Journal 6 (Summer 2001); and Duany-Plater-Zyberk & Company "Smart code", Municipal Code Publishers, 2003) (an inclusive new urban code for community thoroughfares, civil places, urban zones, site plans, terms and definitions).

[137] White & Jourdan, The New Urbanism and Neotraditional Development: A Legal Analysis, Land Use L. & Zoning Dig., at 3 (Aug. 1997).

[138] New Urbanism and House Values, National Center For Smart Growth Research For Education, University of Maryland (2003)

[139] A "Greenfield" project refers to a new subdivision in an undeveloped area, as opposed to an infill project in an existing neighborhood.

mixed uses and generous pedestrian infrastructure.[140] The most successful and renowned greenfield new urbanist projects have been satellite communities similar to new towns, rather than infill projects. Examples include Seaside, Florida; Celebration (Orlando, Florida); Laguna West (Sacramento, California); The Kentlands (Gaithersburg, Maryland); Carpenter Village (Cary, North Carolina); and Southern Village (Chapel Hill, North Carolina). These experiences demonstrate that satellite locations can promote Smart Growth and good urbanism while providing housing, jobs and walkable streets.

In determining whether a project is representative of sprawl or Smart Growth it is important to answer the following questions:[141]

1. Is it located in an already developed area?

2. Is there a mix of housing, office space, schools, retail shopping, outdoor recreation and civic open spaces?

3. Does the housing include multiple types, from single family detached to multifamily condos, and does it have a range of prices from luxury to affordable?

4. Does the project convert prime agricultural land or environmentally sensitive land, or odes its density consume less agricultural and environmental land than the average sprawl development?

5. Does the project use compace energy-efficient and green building methods?

6. Is there access to public transit?

7. Does the design and layout of buildings and streets promote real neighborhood interaction and compatible style?

8. Has the local government adopted zoning codes that give as much support for mixed use communities as it does for segregated single use Euclidean zoning?[142]

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[140] Egan, "A Development Fuels a Debate on Urbanism," New York Times (June 14, 2002), at A20.

[141] Joel Hirschhorn and Paul Souza, Report to the National Governors' Association: New Community Design to the Rescue (2001).

[142] See, e.g., Wellington, Colorado won the 2002 award for Smart Growth achievement from the Environmental Protection Agency and is cited as one of ten examples of good planning decisions by the Colorado Sprawl Action Center. United States Environmental Protection Agency, 2002 National Award for Smart Growth Achievement, at www.epa.gov/smartgrowth; Colorado Sprawl Action Center, Smart Growth Hall of Fame 2001.

Street-facing garages and cul-de-sac in Carpenter Village, a New Urbanist community in Cary, North Carolina.

D. National Examples

A number of notable systems demonstrate the importance of development of transportation corridor cities as the spine of an effective transit and rail system.

1. Seattle (establishing major "activity centers" on transit or transportation corridors)

The Central Puget Sound Regional Council's 1985 *Vision 2020* Plan, provides an excellent example of utilization of outlying centers for urban transportation and land use. *Vision 2020* established a hierarchy of "outlying central places" to guide growth to 15 mixed use centers that are served by a more efficient transportation system. The central places concept is a growth management technique used to achieve compact development with a reordering of transportation investment priorities.

By reason of vision 2020 – the $11 billion transit system[143] was enabled because the ridership had been built up in the mixed use centers.[144]

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[143] Freilich, Garvin & White, _____ _____ Puget Sound L.Rev.

[144] R. FREILICH, FROM SPRAWL TO SMART GROWTH: SUCCESSFUL LEGAL, PLANNING, AND ENVIRONMENTAL SYSTEMS (American Bar Association, 1999), at 137-43.

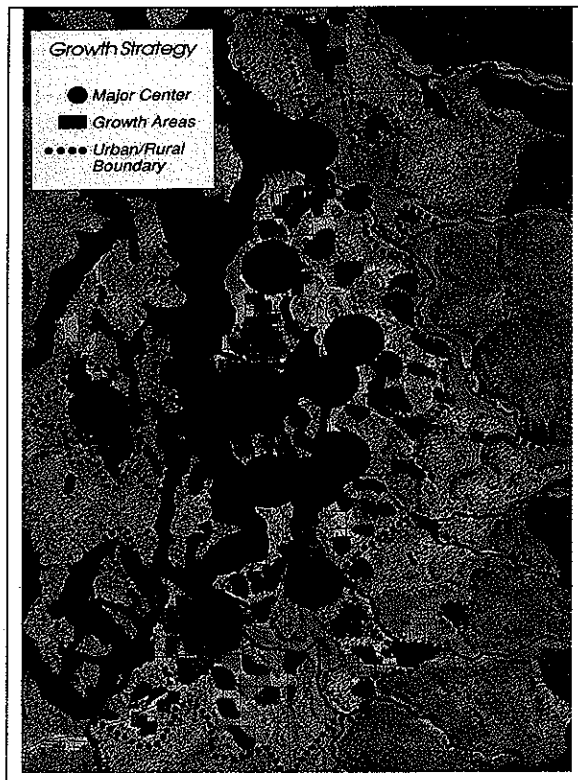
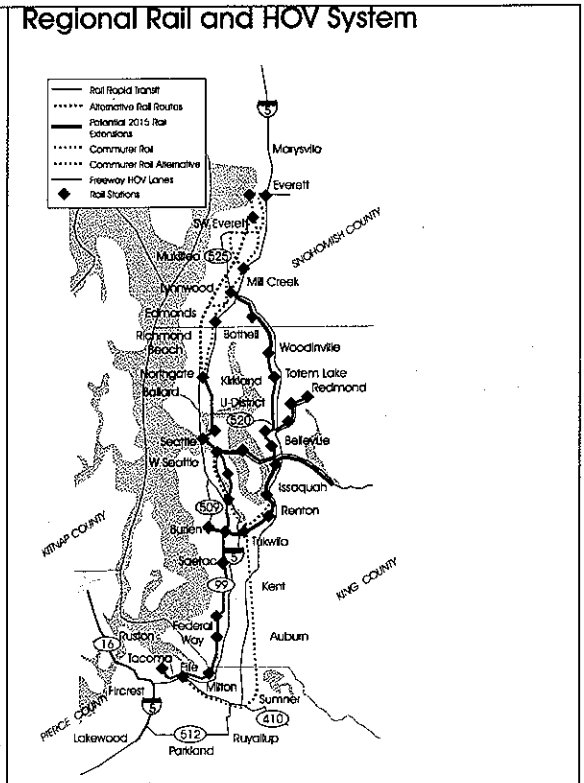


Figure 6 Puget Sound *Vision 2020* Plan



2. San Diego (New Town Corridor Centers)

The 1979 Growth Management Element of the General Plan established a major tier system, delineating the existing urbanized areas of the city (Tier I), from the Planned Urbanizing Area (Tier II) and areas not to be developed until the 21st Century (Tier III, "Future Urbanizing Area").[145] The key to the system were the high density mixed use "new towns" to be developed on the Interstates – I-5 and I-15 – North University City and North City West.[146] The Tier II strategy made the entire transit system for San Diego possible by developing the ridership at key corridor centers. Prior to 1979, 90% of new growth was occurring in Tiers II and III, which was reversed by 1983 with 50% of the growth returning to Tier I with substantial growth at transit oriented zoning centers.[147]

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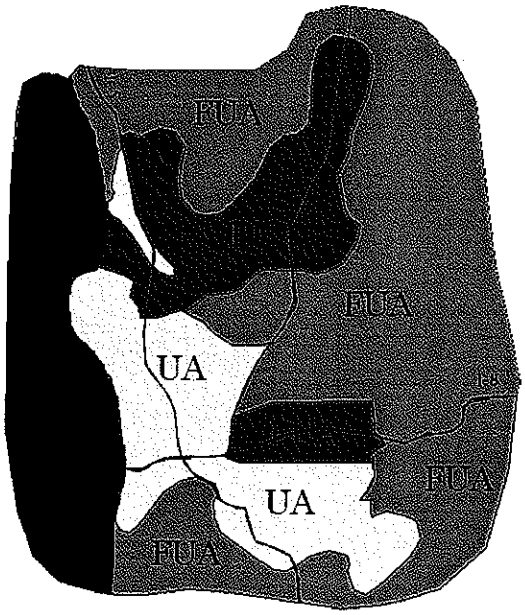
[145] See Robert H. Freilich, From Sprawl to Smart Growth: Successful Legal, Planning and Environmental Systems (American Bar Association, 1999).

[146] North City West was an entirely "new town" designed to accommodate 40,000 people in a high density mixed use new urbanist community and to promote transit along the I-5 corridor of Tier II. The high densities of the new town were opposed by the City of DelMar as being inconsistent with the "regional general welfare" of the sprawling suburban low density. For an excellent history of the plan, the "new towns" and a complete rejection of Del Mar's claims. See *City of Del Mar v. City of San Diego*, 183 Cal.Rptr. 898 (4th Dist.App. 1983).

[147] The innovative concept that made infill work was the use of "facility benefit assessments" in Tier II areas to cover the full cost of infrastructure the need for which is created by new development. Tier I existing urbanized areas were exempt because they already had roads, schools and other facilities. The FBA concept was upheld in *J.W. Jones Companies v. City of San Diego*, 203 Cal. Rptr. 580 (4th Dist. App. 1984).



Legend	
	Urbanized Area
	Planned Urbanizing Area
	Future Urbanizing Area

Building Permits Issued	
1979	9,000 BPs
	8,000 Outside
	1,000 Inside
1983	16,000 BPs
	8,000 Outside
	8,000 Inside

Figure 7 San Diego Tier System

3. Howard County, Maryland (Columbia New Town) (1965 to 2000)

The Washington, DC experience is instructive because it has successfully integrated transit with land use policies. The Washington-Baltimore region adopted a Year 2000 Radial Corridor Plan in 1969 to channel growth into transportation corridors and corridor centers. Jurisdictions in the region have developed plans using the regional infill concept to support rail transit. Howard County, Freilich, Leitner & Carlisle developed a plan that combined transit-supportive corridor and center growth in the Columbia "new town" with agricultural protection measures such as transfers of development rights. The plan won the 1991 American Planning Association award for Outstanding Comprehensive Planning. The State of Maryland has followed suit with statewide smart growth legislation that directs infrastructure to be provided in existing developed areas or in new towns.[148]

[148] David L. Winstead, Smart Growth, Smart Transportation: A New Program To Manage Growth In Maryland, 30 Urban Lawyer 537 (1998).

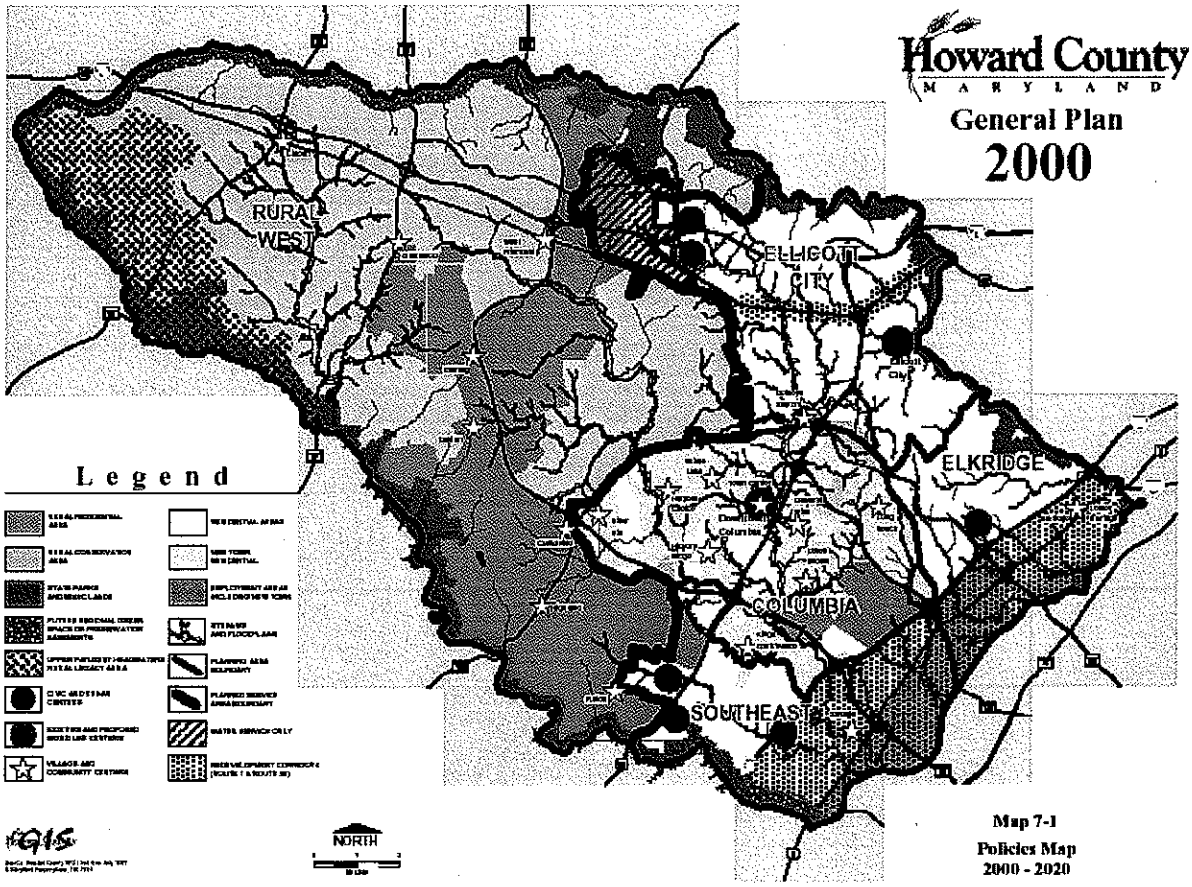


Figure 8 Howard County General Plan 2000

VIII. Palmdale Mixed Use Transportation Center

The State EIR Summary (at S-24) states: "To the degree they are concentrated (growth) impacts are likely to be focused on property surrounding freeway interchanges and airports." The Antelope Valley has an existing, multi-modal transportation network that accommodates this growth in an efficient manner. The City of Palmdale has supported high speed rail infrastructure with its own dollars. The Palmdale Transportation Center currently under construction provides supporting infrastructure for a variety of transportation alternatives. This is acknowledged in the State EIR Evaluation Matrix (§ 6.4.3, page 6-57): "The Palmdale Transportation Center would potentially serve the Antelope Valley population. This station option maximizes opportunities for intermodal connectivity. It is close to Palmdale Airport, with the opportunity for convenient shuttle or people-mover service, and it is the Metrolink station for Palmdale and a hub for local bus services. The Palmdale Transportation Center would reduce travel times and access costs for the Antelope Valley population."

This will not only facilitate ridership on the high speed rail network, but will also encourage the more efficient utilization of other transportation infrastructure investments such as the Palmdale Regional Airport, the Metro commuter rail system, and the Antelope Valley regional bus system. Complementing this with the Antelope Valley high speed rail alignment is a wise use of the state's transportation dollars, and further reinforces growth patterns favored by state and regional land use policies.

A. Transportation Costs

1. Travel Characteristics

The design and form of new development has a significant influence on travel modes and the impacts of new development on roadway capacity. These include:

- reductions in the number of trips per person or household ("trip generation")
- reductions in trip length, typically measured in vehicle miles of travel ("VMT")
- encouraging multiple modes of travel, rather than an exclusive reliance on the automobile.

Some of these studies are summarized below.

The compact development pattern of Palmdale will significantly reduce VMT. While population growth in metropolitan Los Angeles increased by only 44% over the past 20 years, VMT nearly doubled.[149] VMT increased at three times the rate of population growth from 1980-1990, but the rate of growth slowed to a pace equal to population growth during the 1990s.[150] A recent study by Reid Ewing of Rutgers University and Rolf Pendall of Cornell University developed a sprawl index based on density, mix of uses, strength of centers, and street accessibility. A 25-unit decline or one standard deviation in the sprawl index was associated with an increase of two miles in daily VMT.[151] A difference of 10 miles of VMT per vehicle per day was identified between some sprawling (e.g. Atlanta) and non-sprawling (e.g. Portland) regions. The United States Department of Transportation documented that during a recent period, only 36% of the growth in VMT nationally is attributable to demographic changes. The balance is attributable to land use changes. These changes led to a 38% increase in trip length and a 25% increase in trip generation.[152]

A comparative analysis of 12 metropolitan areas by Robert Cervero showed that walking and cycling consistently declined throughout each area, but that more than 15% of all

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149 Sprawl Hits the Wall, at 17.

150 SCAG, The State of the Region 2002 (Dec. 2002), at 43-44.

151 Measuring Sprawl, at 18.

152 United States Environmental Protection Agency, Our Built and Natural Environments: A Technical Review of the Interactions between Land Use, Transportation, and Environmental Quality (EPA 231-R-01-002, January 2001), at 21 (citing U.S. Department of Transportation, Federal Highway Administration, " 1990 Nationwide Personal Transportation Survey".)

journeys to work were by nonvehicular modes (R. Cervero, *Suburban Gridlock* (Rutgers, 1986), at 37). Cervero recommends that sidewalks, trails and pathways be coordinated with a larger system and not end abruptly (id. at 64-65). While less than 1% of all trips in the nation are by walking and cycling, office parks with integrated pedestrian systems and on-site amenities such as showers can increase bike travel to 3-5% (id. at 116). Impact is more meaningful where employees are concentrated within 1-3 miles of the employment center (id.). 20% of the workers at the Xerox research facility in Silicon Valley commute by bicycle (id. at 206).

Cervero has further documented how lack of design amenities often discourages pedestrian and bike travel in suburban employment centers (SECs) (R. Cervero, *America's Suburban Centers: The Land-Use Transportation Link* (1989), at 64). Most walk trips in SECs are for non-work purposes, but walking comprises only 21.5% of non-work trips (id.) Foot travel is discouraged by long blocks, disconnected sidewalks, and limited mid-block crosswalk opportunities (id.) Consumers are more likely to walk on avenues with shops, parks and other interesting destinations where a number of trip purposes can be accomplished (id. at 64-65).[153]

In an extensive summary of research on the issue, Reid Ewing has compiled a listing of pedestrian and transit-friendly features (see Reid Ewing, *Pedestrian & Transit-Friendly Design* (Public Transit Office, Florida Department of Transportation, March 1996):

ESSENTIAL	HIGHLY DESIREABLE	NICE ADDITIONS
Medium-high density (7-50 du/ac)	Supportive Commercial Uses	Street walls
Mixed land uses	Grid Streets	Functional Street Furniture
Short-to-Medium Length Blocks (300-500')	Traffic calming of access routes	Coherent, Small-Scale Signage
Transit Routes every ½ mile	Closely Spaced Shade Trees on Access Routes	Special Pavement
2-4 Lane Streets	Lack of Dead Space (or Visible Parking)	Public Art
Continuous sidewalks 4-8' wide	Nearby Parks/Public Spaces	

[153] For a detailed discussion of design amenities, see Moudon & Hess, et al., *Effects Of Site Design On Pedestrian Travel In Mixed-Use, Medium-Density Environments* (May 1997, Report No. WA-RD 432.1); *Pedestrian Facilities Guidebook: Incorporating Pedestrians Into Washington's Transportation System* (September 1997). The seminal works on pedestrian site design are Untermann, Accommodating the Pedestrian: Adapting *Towns and Neighborhoods for Walking and Bicycling* (1984) and D. Appleyard, *Livable Streets* (1981); see also S. Breines & W. Dean, *The Pedestrian Revolution: Streets without Cars* (1974); A. Moudon, *Public Streets for Public Use* (1987); B. Rudofsky, *Streets for People: A Primer for Americans* (1969).

Safe Street Crossings (5-10' radii)	Small-Scale or Articulated Large Buildings
Buffering from Traffic (e.g. street parking)	Attractive Transit Facilities
Street-Oriented Buildings	
Comfortable/Safe Places to Wait	

B. *Transit Station Siting Principles*

The Palmdale Transportation Center is consistent with best practices for transit station siting, which include the siting of stations in satellite or suburban locations. The Federal Transit Agency recommends the following station siting principles:[154]

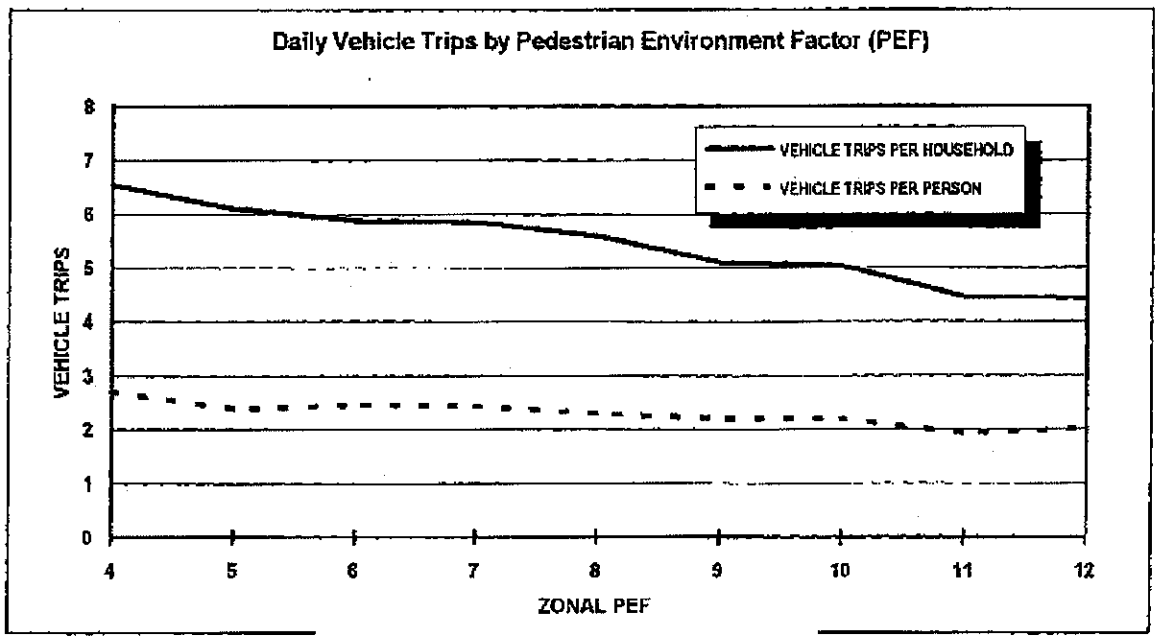
1. Each city should have a station located in or near the central business district. This is mandatory for larger Metropolitan Statistical Areas (MSAs), with metropolitan populations of 150,000 or more, since to do otherwise would undermine the inherent advantages of rail passenger systems. ... This center city station should have direct access to local transit systems (bus, rail, taxi, etc.) as well as appropriate amounts of parking for private cars.

2. One or more suburban stations need to be provided in the larger metropolitan areas with easy access to the local primary road system in order to accommodate potential riders living outside the city centers. Classic successful examples of suburban or beltway stations are Route 128 outside of Boston, MA and New Carrollton, MD outside of Washington, D.C. These "beltway"-type stations cater to automobile-oriented riders and thus need to have many hundreds, if not several thousand, parking spaces to fulfill their role in corridor transportation.

3. Every effort should be made to have each corridor station serve as a regional intermodal passenger terminal for all forms of regional and local transportation systems. ....

[154] U.S. Department of Transportation, Federal Railroad Administration, *Railroad Corridor Transportation Plans A Guidance Manual* (Rev. December 16, 2002).

The literature also provides support for the trip reduction potential of walkable communities such as traditional neighborhood developments (TND). There are few empirical studies due to the lack of well-established new communities with a "new urbanist" design emphasis. A study of traditional and modern conventional subdivisions in Austin, Texas found that persons walked to the store six times more in traditional subdivisions than in the modern conventional subdivisions, and the walk trips were a substitute for driving trips (Susan Handy, *Urban Form and Pedestrian Choices: A Study of Austin Neighborhoods* (Community and Regional Planning Program, School of Architecture, University of Texas at Austin, April 1996)). A study by 1000 Friends of



Source: 1000 Friends of Oregon

Oregon demonstrated substantial reductions in VMT and trips based on four "Pedestrian

Environmental Factors" (PEF): (1) Ease of street crossings; (2) sidewalk continuity; (3) local street characteristics (grid vs. cul de sac); and (4) topography. The study demonstrates that vehicle trips per household decline as much as 30% with increases in PEF (see "Figure 9"). 1000 Friends of Oregon, *Making Land Use Transportation Air Quality Connections, The Pedestrian Environment*, Vol. 4A (Dec. 1993)(at www.bts.gov/ntl/docs/tped.html). A study by Susan Handy related that residents in an older community in the San Francisco area walked to the supermarket more than sprawling subdivisions, and the pedestrian mode share was at 8% (Handy, "Understanding the Link Between Urban Form and Nonwork Travel Behavior," *J. Planning Education & Research* 15:183-198 (1996)).

Other studies demonstrate trip reductions for mixed use/transit-oriented/new urbanist development (see Crane, ''Cars and Drivers in the New Suburbs: Linking Access to Travel in Neotraditional Planning," 62 *APA Journal* 51 (Winter 1996)(summarizing studies). Some studies have shown that mixed use development can reduce trip generation rates by as much as 25%. Cervero, "Land-Use Mixing and Suburban Mobility," *Transportation Quarterly* (citing Colorado/Wyoming Section Technical Committee, "Trip Generation for Mixed Use Developments," *ITE Journal* 57, 2 (1987): 27-32). An American Society of Civil Engineers simulation study estimated that Traditional Neighborhood Development (TND) produces 57% of the Vehicle Miles Traveled (VMT) of a conventional suburban development, with a 9.78% reduction in the Volume to Capacity ratio (V/C) for arterials (0.83 v. 0.92), a 7.45% reduction for collectors (0.87 v. 0.94), and 4.55% reduction for local streets (0.22 v. 0.21) (American Society of Civil Engineers, *Traditional Neighborhood Development-Will the Traffic Work?* (ASCE 1990)(summarized on Bookout, "Neotraditional Town Planning: Cars, Pedestrians & Transit," *Urban Land* (Feb. 1992), at 10, 15)). Further, conventional suburban neighborhoods were found to have trip rates 60% higher than traditional neighborhoods in San Francisco Bay area (Crane, *supra*). A study by Handy in San Francisco was inconclusive about substitution, but her later studies in Austin confirmed that many walk trips do substitute for car trips.

Some studies have documented that residents of older neighborhoods travel less in terms of mileage and number of trips (Handy (1996), supra; Friedman, Gordon & Peers, "Effect of Neotraditional Neighborhood Design on Travel Characteristics," *Transportation Research Record* 1466: 63-70 (1993); Holtzclaw, *Explaining Density and Transit Impacts on Land Use* (Presented by the Natural Resources Defense Council and the Sierra Club to the State of California Energy Resources Conservation and Development Commission, April 19, 1990); Kitamura, Ryuichi, Mokhtarian & Laidet, *A Micro-Analysis of Land Use and Travel in Five Neighborhoods in the San Francisco Bay Area* (Institute of Transportation Studies, University of California at Davis, Nov. 1994)).

Publication/Article	Description	Findings		
		Trip Generation	Trip Length	Other
1000 Friends of Oregon, Making Land Use Transportation Air Quality Connections, The Pedestrian Environment, Vol. 4A (Dec. 1993)(at	Utilized Western Bypass around Portland Oregon; identified alternate land use	Model suggests that a 10% reduction in the VMT can be achieved with a region-wide increase in the quality		Unlike other determinants of travel behavior, the built environment can

Publication/Article	Description	Findings		
		Trip Generation	Trip Length	Other
www.bts.gov/ntl/docs/tped.html)	development patterns that reduce travel demand & increase use of alt. travel modes; developed reliable transportation modeling that forecast travel behavior assoc. with the alternate land use patterns	of pedestrian environments to a level comparable to Portland's most pedestrian oriented zones.		be modified by public policy and investments.
Kulash, "Traditional Neighborhood Development-Will the Traffic Work?" American Society of Civil Engineers, (ASCE 1990);	Addresses traditional neighborhood design in relationship to traditional traffic planning criteria: vehicular capacity, travel speed, and safety.	TND has a superior traffic capacity unrelated to travel demand reduction.	Superior capacity is unrelated to reduction of travel distances. TND has shorter trip lengths. TND has lower trip speed, but comparable trip time to conventional suburban development.	TDN offers greater route alternatives. There are no criteria that measure livability.
Bookout, "Neotraditional Town Planning: Cars, Pedestrians & Transit," Urban Land (Feb. 1992), at 10, 15.	Notes a 1990 ASCE hypo found that a 700 acre TND had 57% VMT of conventional development applicable only to trips internal to the development	ASCE does not estimate # of trips generated by a TND design.	Nationwide VMT increased 41% b/t 1983 and 1990, pop. Increased by 6%.	
Cervero & Kockelman, "Travel Demand and the 3Ds: Density, Diversity, and Design, Transportation Resource-D, Vol. 2, No. 3 (1997)	Expectation: density, diversity, and pedestrian orientated design should lower personal vehicle trip rates. Studied 50 San Francisco neighborhoods.	Compact, mixed-use, pedestrian friendly designs can "degenerate" vehicle trips. It was 56% more likely a person would drive alone to a neighborhood shop if all buildings are surrounded by front and side lot parking versus if all buildings have rear lot parking. Vehicle usage generally increases with non-work trip distance. Paid parking within neighborhoods can encourage people to walk to shops and other non-work destinations.	Compact, mixed-use, pedestrian friendly designs can "degenerate" vehicle trips. Neighborhood retail stores that were vertically mixed verses neighborhoods with retail with no vertical mix averages 11.1 fewer vehicle-miles-traveled (VMT) per household per day. Neighborhoods with all four-way stop intersections verses all three-way stop intersections averages 32 fewer VMT per household each day. Four-way intersections encourage walking and non-motorized trips by providing controlled street crossings and more access points.	Model suggests that plentiful neighborhood retail shops and pedestrian oriented designs, not residential densities, are significant factors in encouraging people to commute by transit & non-motorized means.
Cervero, "Land-Use Mixing and Suburban Mobility," Transportation Quarterly (1988)	Utilizes Institute of Transportation Engineers *Trip Generation Manual* to look at effects of a hypothetical 1,000 sf mixed-use development compared to same	A mix of 25,000 sf of office, 25,000 sf of R&D, 40,000 sf of multi-family residential and 10,000 sf of specialty retail would drop trip generation by 18.7 percent and spread		Trips are more evenly spread across the day in the mixed-use project reducing peak-hour volumes.

Publication/Article	Description	Findings		
		Trip Generation	Trip Length	Other
	square footage of general office space.	trips more evenly across the day.		
Colorado/Wyoming Section Technical Committee, "Trip Generation for Mixed Use Developments," ITE Journal 57, 2 (1987): 27-32)	Study purpose to determine whether trip generation rates for mixed-use development are lower than those predicted by strict application of ITE rates.	Total daily trips generated by a mixed-use site can be accurately estimated using ITE rates. An 8% differential found in the study determined not to be statistically significant. Peak hour trip generation for mixed-use based on ITE rates may be overestimated by average of 2.5%.		
Crane, "Cars and Drivers in the New Suburbs: Linking Access to Travel in Neo-traditional Planning," 62 APA Journal 51 (Winter 1996);	Crane is skeptical about the benefits of a grid-like subdivision form. He thinks shorter trips will be offset by more trips and traffic benefits are more likely the result of "traffic calming" and cluster destinations. He notes a lack of empirical studies.			
Friedman, Gordon & Peers, "Effect of Neo-traditional Neighborhood Design on Travel Characteristics," Transportation Research Record 1466: 63-70 (1993)	Comparison of trip generation reported by residents of pre-World War II and post-war residential developments.	Traditional households generate 25% fewer daily trips by all modes than suburban households, and 32% fewer auto-driver trips.		Variable factors: proximity and access to large employment concentrations; internal jobs-housing balance; individual neo-traditional design characteristics; amount of free parking; transit quality
Holtzclaw, "Using Residential Patterns and Transit to Decrease Auto Dependence and Costs" (1994)	28 communities in CA were analyzed regarding 4 factors; 1) residential density, 2) transit access, 3) neighborhood shopping, 4) pedestrian access. Goal: to allow at least one method of calculating annual transportation cost savings for an individual house or neighborhood compared to a base case of a typical low density suburb.	Findings: communities with double the density will have 25-30% less driving per family when the impacts of all conditions generally accompanying higher density are included. (better transit more local shopping, and pedestrian friendly environment.		Variations in automobile usage per household and in personal transportation costs between communities can be quantified fairly accurately through two equations defined.
JHK & Associates. Transportation-Related Land Use. Strategies to Minimize Motor Vehicle Emissions: An Indirect Source Research Study, Final Report. Sacramento: California	Analysis of trip generation and VMT for various communities in San Francisco Bay region.	Trips ranged from 210 per person per year in downtown San Francisco to 900 in suburban Walnut Creek (328%	VMT ranged from 1,560 in downtown to 6,940 in suburban area (344% difference)	Automobile mode share ranged from 40% in San Francisco to 66% in suburban area

Publication/Article	Description	Findings		
		Trip Generation	Trip Length	Other
Air Resources Board, June 1995.		difference)		
Kulash, Anglin, & Marks, Traditional Neighborhood Development: Will the Traffic Work?, Development 21 (July/Aug.), 21-24	Simulation of conventional versus traditional neighborhood forms		57% reduction in VMT	
Moudon & Hess, et al., Effects Of Site Design On Pedestrian Travel In Mixed-Use, Medium-Density Environments (May 1997, Report No. WA-RD 432.1);	Effect of site design characteristics and safe pedestrian systems on incidence of pedestrian travel in mixed-use, medium density environments.			Holding other variables constant, urban versus suburban difference in route directness and completeness of pedestrian facilities (block size, sidewalk length, etc.) affects pedestrian volume. Avg. urban pedestrian volume: 37.7 pedestrians/hr. Avg. suburban volume: 12.5 pedestrians/hr.
Kitamura, Mokhtarian, Laidet, "Micro Analysis of Land Use and Travel in Five Neighborhoods in San Francisco" (Institute of Transportation Studies, University of California at Davis, Nov. 1994).	Premise: attitudes and lifestyle choices are relevant to the selection of a neighborhood and to travel behavior. Concludes that trip generation is largely determined by demographic and socio-economic factors, not land use.			Eight attitude factors: Pro-environment, pro-transit, suburbanite, automotive mobility, time pressure, urban villager, transportation control measures, workaholic.
Parsons, Brinckkerhoff Quade and Douglas Inc., "Building Orientation" – supplement to Pedestrian Environment Vol.4B, 1994.	Setback and building orientation of commercial structures, as they influence household vehicle miles of travel (VMT).	Number of trips by transit increase as proportion of buildings oriented toward street, i.e. pre-1951, increases.	An increase in residential density from 3 to 4 households per zonal acre corresponds to decrease of .8 miles in household vehicle travel. An increase of 30% in the proportion of commercial bldgs. in the zone built pre 1950 corresponded to a decrease of 1.3 miles (5%) in daily household VMT.	Variation in Portland building orientation at zonal level can account for changes of 10% or more in VMT per household.
Pushkarev & Jeffrey Zupan, Public Transportation and Land Use Policy (1977)	Study addresses relationships between urban densities, transit demand, and public transportation supply.	Density of 7 to 30 dwellings/acre is needed to sustain significant transit use in range of 5-40% of all trips. Density exceeding 60 dwellings/acre results in 50% of trips are made by public transportation. The higher the density of the non-residential destination the greater		

Publication/Article	Description	Findings		
		Trip Generation	Trip Length	Other
		the likelihood that auto owners will use transit.		
Frank & Pivo, Relationships between Land Use and Travel Behavior in the Puget Sound Region, WA St Trans Center, Seattle, 1994.	Greater employment density, population density, land-use mix and job-housing balance are associated with less auto use.	Significant movement from single occupant vehicles (SOV) to other modes does not occur to thresholds are met. Work trips: 50-75 employees/gross acre or 12 dwellings units per acre. Shopping trips: 75 employees/gross acre or 20 dwelling units per acre.	Population density, employment density and land-use mix at trip origins were all negatively correlated with trip distance.	
U.S. Department of Transportation, Federal Highway Administration, " 1990 Nationwide Personal Transportation Survey".)	National survey of travel characteristics	Sprawling development patterns increased trip generation by 25% nationally	Sprawl increased average trip distance by 38%	

1. Capital Costs

a. Urban Highways

The reduced trip lengths for compact development, documented above, leads to a direct saving to the community for roads and highways. These cost savings are manifested in several different ways. First, compact development requires fewer lane-miles of roadways than more efficient, compact development patterns. By reducing road lengths, fiscal impacts for capital costs are reduced. Further, environmental impacts are reduced because compact development patterns require significantly less impervious surface.

Second, the reduced impervious surface coverage produces savings in roadway maintenance. As cars and trucks travel longer distances, increased demands are placed on pavement, drainage and other maintenance needs. These increased demands occur over increasingly longer distances. Federal Highway Administration data indicate that over 70% of the nation's roads are in poor, mediocre or fair condition.[155] The diversion of road monies to capital costs diverts monies available for maintenance. These include costs not only to expand and widen roads, but also to add turn lanes to service uncontrolled growth along collector and arterial roads.[156] The reduced road mileage and impervious surface resulting from transit supportive development in Palmdale avoids this spiraling effect of capital expansion coupled with deferred roadway maintenance.

Third, compact development patterns minimize the growth inducing impacts of new development. These include minimizing new highways to other locations, and the phenomenon of "induced travel." Induced travel refers to increase in vehicular travel

[155] Surface Transportation Policy Project, Decoding Transportation Policy & Practice #9, "The State of Our Nation's Roads: Half of All Major Roads Are in Less Than Good Condition" (January 30, 2003), citing Federal Highway Administration. Highway Statistics Series 1997 and 2001. Table HM-64.
[156] Maine State Planning Office, at 9.

produced by an increase in highway expansion. A 1997 study identified a 0.6 – 0.7% increase in vehicle miles traveled on state highways for each 1 percent increase in highway miles.[157] This increase can offset the capacity of the incremental highway expansion. Compact development patterns more effectively utilize increases in roadway capacity by providing realistic access to alternative travel modes.

Finally, the environmental impacts of roadway expansions are well documented. These include: degradation of air quality, impairment of water quality associated with deposition of air pollutants, greenhouse gas emissions, traffic noise, and water quality impacts from activities associated with vehicle use such as oil spills.[158] Impervious surfaces collect pollution from the atmosphere, pollution and other sources, contribute to stream warming and impair stream biodiversity.[159] Smart growth patterns that minimize road construction not only avoid these impacts, but also free up land for green infrastructure, such as greenways.

The fiscal benefits of compact development and the costs of sprawl are well documented.[160] Compact development patterns reduce response times for public safety and services such as police, fire, and emergency management. In turn, this allows service providers more time to respond effectively to other events. More effective use of infrastructure also translates into cost savings for the service providers.

b. Emergency Services, Police and Fire Protection

Sprawling development patterns create inefficiencies in providing emergency services and police and fire protection. This is attributable in part to inefficient roadway patterns and increased distances from existing stations to low density development areas. This has the effect of increasing response times. Due to sprawling development patterns, some states have had to hire more police officers despite a declining crime rate.[161] A 1999 study by Northern Illinois University found that response times for sprawling development were longer than in compact jurisdictions by the following amounts:

Service	Percent increase in response time over compact development
Police	600%
Ambulance	50%

[157] U.S. EPA, supra, at 22; Mark Hansen and Yuanlin Huang, "Road Supply and Traffic in California Urban Areas," Transportation Research-A, 31:3 (1997), pp. 205-218; Transportation Research Board, Expanding Metropolitan Highways: Implications for Air Quality and Energy Use, TRB Special Report 245, Washington, DC: National Academy Press, 1995,.

[158] U.S. EPA, supra, at 25 (citing U.S. Environmental Protection Agency, Office of Policy. Indicators of the Environmental Impacts of Transportation: Highway, Rail, Aviation, and Maritime Transport. October, 1999, EPA 230-R-99-001.)

[159] Schueler, "The Importance of Imperviousness.", in Watershed Protection Techniques Vol. 1, No. 3 (Center for Watershed Protection, Fall 1994).

[160] Burchell, et al. *The Costs of Sprawl—Revisited.* Transportation Research Board, National Research Council, TCRP Report 39, 1998 (summarizing studies); Real Estate Research Corporation (RERC). 1974. The Costs of Sprawl: Environmental and Economic Costs of Alternative Residential Development Patterns at the Urban Fringe: (Volume I: Detailed Cost Analysis; Volume II: Literature Review and Bibliography). Washington, DC: U.S. Government Printing Office.

[161] Maine State Planning Office, at 9.

Fire	33%
Source: A. Ann Sorensen & J. Dixon Esseks, *Living on the Edge: The Costs and Risks of Scatter Development* (DeKalb, Illinois: Northern Illinois University. Center for Agriculture in the Environment; American Farmland Trust, Jan. 1999).	

In addition, sprawling development patterns are associated with an increased frequency of traffic accidents.[162] A recent study reported a difference of 29 fatalities per 100,000 residents between the most and least sprawling areas of the nation.[163] Despite safety improvements in vehicles, sprawling development has increased the amount of traffic safety work required for police.[164]

c. School Buses

The lack of neighborhood schools in sprawling subdivisions increases busing costs. Some states face rising costs to bus children even though school enrollment is declining.[165] The Northern Illinois University study also found that students in sprawling subdivisions spent from 30-58% more time on school buses than those in compact communities.[166] Students in sprawl subdivisions spent 159 hours or 24 equivalent school days per year in buses.

d. Substations

Palmdale's compact development form will also require fewer substations to provide services. As travel time and response times increase, service providers such as fire and police must provide substations and hire new staff persons.[167] This burdens existing public revenues for new capital, operating and salary expenses. This additional burden also constrains the service provider's ability to provide salary increases at competitive levels. This burden makes it difficult for the service provider to retain or to attract qualified personnel. Palmdale avoids these costs by locating residences within a reasonable distance of new fire and other service facilities, with the developer bearing the cost of those facilities.

C. Palmdale is a Regional Transportation Center

Palmdale is positioned as a regional center with a mix of transportation facilities. The City's planning area contains 11 miles of freeway frontage along SR-14. A large portion of the frontage is undeveloped, giving the city ongoing opportunities to attract quality development. A large area (17,750 acres) is designated, as a Regional Airport owned by the City of Los Angeles Department of Airports. More than 12,000 acres of vacant land are adjacent to the Airport site.[168]

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162 Measuring Sprawl, at 20.
163 Measuring Sprawl, at 20.
164 Maine State Planning Office, at 9.
165 Maine State Planning Office, The Cost of Sprawl (May 1997), at 8.
166 Sorenson, supra, at 9.
167 Sorenson, supra, at 8.
168 city's downtown area to provide transit supportive land use development envisioned by the state Transit Village Planning Act. At the same time, existing single family development within and around the city occurs at densities consistent with commuter rail,

and other long-range transportation systems are being furthered by multi-use traditional new development being built within Palmdale. The densities needed to support high speed rail systems are lower than those needed to support light rail and other high capacity transit systems that have more frequent headways and shorter resident-to-employment destinations. High speed rail benefits from executive housing, retirement populations, and workers in high tech industries such as aerospace and software. The Antelope Valley alignment maximizes those opportunities.

The Antelope Valley has an abundant supply of vacant, undeveloped land already served by transportation infrastructure (including arterials, transit, and airports), water, sewer, and other public utilities. By placing high capacity transportation infrastructure in the Antelope Valley, the region can absorb additional growth without extending new infrastructure beyond presently served areas. The Antelope Valley can accommodate this growth without further loss of agricultural lands, environmental resources, and significant increases in trip lengths, air quality degradation, and declines in infrastructure capacity. In addition, the Antelope Valley's existing land use patterns are ideal for high speed rail infrastructure. There are abundant opportunities in the city's downtown area to provide transit supportive land use development envisioned by the state Transit Village Planning Act. At the same time, existing single family development within and around the city occurs at densities consistent with commuter rail, and other long-range transportation systems are being furthered by multi-use traditional new development being built within Palmdale.

High speed rail benefits from executive housing, retirement populations, and workers in high tech industries such as aerospace and software. The Antelope Valley alignment maximizes those opportunities. Palmdale's land use policies support high speed rail because:

- Existing land use patterns are already served by a variety of transportation options and public facilities.
- The City's General plan policies support Smart Growth
- Transit Village Planning Act is available to provide densities that will support ridership at the Palmdale Transportation Center.
- Multi-use traditional new development will create walk ability and transit-supportive land use patterns.
- Appropriate densities are available for sustainable development.
- Appropriate demographics, economic development and revenue sources will support high speed rail utilization.

Conclusion

In summary, the Antelope Valley alignment is superior to the Grapevine alignment on all of the local, regional, state and federal land use environmental and smart growth policies. It protects agricultural resources from accelerated spillover growth, maximizes ridership, and supports regional and local land use patterns. To bypass Antelope Valley would

create an enormous gap between the high speed rail infrastructure and a large population searching for alternative transportation options. The Commission should approve the Antelope Valley alignment as it moves forward with this project.

The Palmdale development does not reflect or promote urban sprawl or leapfrog development. On the contrary it promotes all of the county's existing and draft General Plan objectives by introducing the full complement of Smart Growth techniques.

The Antelope Valley station should be included in order to comply with state smart growth mandates. First, the Antelope Valley alignment furthers state, regional and local smart growth policies. Second, it protects the state's valuable agricultural land from excessive conversion to urban uses. Third, it allocates the population impacts of high speed rail infrastructure in a way that supports regional smart growth policies. Fourth, it puts transportation facilities and related growth in places where infrastructure is already in place. Fifth, it positions the Palmdale Transportation Center as mixed use transportation corridor center. Finally, it takes advantage of local land use policies that already support high speed rail infrastructure and joint development opportunities that will generate revenue and ridership for the system. By approving the Antelope Valley alignment, you will take an important step to implement the state's essential smart growth policies.

Bibliography

County of Los Angeles, Los Angeles County General Plan, Housing Element 1998-2005 (adopted by Los Angeles County Board of Supervisors, October 23, 2001).

State of California, Department of Finance, E-1 City/County Population Estimates, with Annual Percent Change, January 1, 2002 and 2003. Sacramento, California, May 2003.

State of California, Department of Finance, County Population Estimates and Components of Change, July 1, 2001-2002, with Historical 2000 and 2001 Estimates. Sacramento, California, January 2003.

State of California, Department of Finance, E-4 Population Estimates for Cities, Counties and the State, 2001-2003, with 2000 DRU Benchmark. Sacramento, California, May 2003.

State of California, Department of Finance, Cities/Counties Ranked by Total Population, Numeric Change, and Percent Change, January 2003.

State of California, Department of Finance, All-County Rankers by Size, Numeric Change and Percent Change Rankers, and by Alphabetical Ranking, July 2002.

VIII. Palmdale's Land Use Policies Support High Speed Rail Infrastructure

Palmdale's existing land use patterns, coupled with its general plan policies, are ideal for high speed rail infrastructure. There are abundant opportunities in the city's downtown area to provide transit supportive land use development envisioned by the state Transit Village Planning Act. At the same time, existing single family development within and around the city occurs at densities consistent with commuter rail, and other long-range transportation systems are being furthered by multi-use traditional new development being built within Palmdale. The densities needed to support high speed rail systems are lower than those needed to support light rail and other high capacity transit systems that have more frequent headways and shorter resident-to-employment destinations. High speed rail benefits from executive housing, retirement populations, and workers in high tech industries such as aerospace and software. The Antelope Valley alignment maximizes those opportunities.

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State of California, Department of Finance, Interim County Population Projections — Estimated July 1, 2000 and Projections for 2005, 2010, 2015 and 2020

U.S. Department of Commerce, Bureau of Census. Profiles of General Demographic Characteristics, 2000 Census of Population and Housing, California 2000. May 2001.

United States Census 2000, Demographic Profiles: 1990 and 2000 Comparison Tables.

U.S. Environmental Protection Agency. *EPA Guidance: Improving Air Quality Through Land Use Activities.* (EPA420-R-01-001, January 2001)

USC Lusk Center for Real Estate and Urban Land Institute, Reality Check on Growth (2002).

Palmdale General Plan, at 1-5.

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Bibliography

County of Los Angeles, Los Angeles County General Plan, Housing Element 1998-2005 (adopted by Los Angeles County Board of Supervisors, October 23, 2001).

State of California, Department of Finance, E-1 City/County Population Estimates, with Annual Percent Change, January 1, 2002 and 2003. Sacramento, California, May 2003.

State of California, Department of Finance, County Population Estimates and Components of Change, July 1, 2001-2002, with Historical 2000 and 2001 Estimates. Sacramento, California, January 2003.

State of California, Department of Finance, E-4 Population Estimates for Cities, Counties and the State, 2001-2003, with 2000 DRU Benchmark. Sacramento, California, May 2003.

State of California, Department of Finance, Cities/Counties Ranked by Total Population, Numeric Change, and Percent Change, January 2003.

State of California, Department of Finance, All-County Rankers by Size, Numeric Change and Percent Change Rankers, and by Alphabetical Ranking, July 2002.

State of California, Department of Finance, Interim County Population Projections — Estimated July 1, 2000 and Projections for 2005, 2010, 2015 and 2020

U.S. Department of Commerce, Bureau of Census. Profiles of General Demographic Characteristics, 2000 Census of Population and Housing, California 2000. May 2001.

United States Census 2000, Demographic Profiles: 1990 and 2000 Comparison Tables.

U.S. Environmental Protection Agency. *EPA Guidance: Improving Air Quality Through Land Use Activities.* (EPA420-R-01-001, January 2001)

USC Lusk Center for Real Estate and Urban Land Institute, Reality Check on Growth (2002).

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Riverside County Transportation Commission: Robin Lowe, Hemet

Ventura County Transportation Commission: Bill Davis, Simi Valley

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STATEMENT OF CERTIFICATION

The signature below certifies that on Thursday June 3, 2004, the Regional Council of the Southern California Association of Governments, by unanimous vote, took action to adopt the Compass Growth Vision and Implementation Framework Program for the six-county, 17,000 square mile Southern California region.

In signing this document, I declare under penalties of perjury that the foregoing certifications and assurances, and any other statements made by me with reference to the Compass Growth Vision and Implementation Framework Program are true and correct.

Metropolitan Planning Organization (MPO) Authorizing Signature
Mark Pisano, Executive Director

8/25/04
Date

NO. 453

SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS

June 3, 2004

MINUTES

THE FOLLOWING MINUTES ARE A SUMMARY OF ACTIONS TAKEN BY THE REGIONAL COUNCIL. AUDIO CASSETTE TAPE OF THE ACTUAL MEETING IS AVAILABLE FOR LISTENING IN SCAG'S OFFICE.

The Regional Council of the Southern California Association of Governments held its meeting at the Temecula Creek Inn, Temecula, California. The meeting was called to order by the President Councilmember Ron Roberts, City of Temecula. There was a quorum.

Members Present

Councilmember Ron Roberts, Temecula, President	District 5
Supervisor Hank Kuiper, Imperial County, 1st VP	
Mayor Toni Young, Port Hueneme, 2nd VP	District 45
Councilmember Bev Perry, Brea, Immediate Past President	District 22
Supervisor Marion Ashley, Riverside County	
Supervisor Paul Biane, San Bernardino County	
Supervisor Chris Norby, Orange County	
Councilmember Bonnie Flickinger, Moreno Valley	District 3
Mayor Ron Loveridge, Riverside	District 4
Mayor Lee Ann Garcia, Grand Terrace	District 6
Councilmember Deborah Robertson, Rialto	District 8
Mayor Bill Alexander, Rancho Cucamonga	District 9
Mayor Gary Ovitt, Ontario	District 10
Mayor Lawrence Dale, Barstow	District 11
Councilmember Richard Dixon, Lake Forest	District 13
Councilmember Tod Ridgeway, Newport Beach	District 14
Councilmember Lou Bone, Tustin	District 17
Councilmember Ron Bates, Los Alamitos	District 20
Councilmember Art Brown, Buena Park	District 21
Councilmember Paul Bowlen, Cerritos	District 23
Councilmember Gene Daniels, Paramount	District 24
Councilmember Keith McCarthy, Downey	District 25
Councilmember Frank Gurule, Cudahy	District 27
Councilmember Tonia Reyes-Uranga, Long Beach	District 30
Councilmember Margaret Clark, Rosemead	District 32
Councilmember Paul Talbot, Alhambra	District 34
Councilmember Harry Baldwin, San Gabriel	District 35
Councilmember Llewellyn Miller, Claremont	District 38
Councilmember Paul Nowatka, Torrance	District 39
Councilmember Jim Aldinger, Manhattan Beach	District 40
Councilmember Pam O'Connor, Santa Monica	District 41
Councilmember Dennis Washburn, Calabasas	District 44

Councilmember Thomas Buckley, Lake Elsinore	District 63
Councilmember Debbie Cook, Huntington Beach	District 64
Councilmember Ted Burgnon, Town of Apple Valley	District 65
Councilmember Robin Lowe, Hemet	RCTC
Supervisor Charles Smith, County of Orange	OCTA

Members Not Present

Supervisor Judy Mikels, Ventura County	
Supervisor Zev Yaroslavsky, LA County	
Supervisor Yvonne Burke, LA County	
Councilmember Jo Shields, Brawley	District 1
Councilmember Greg Pettis, Cathedral City	District 2
Councilmember Susan Longville, San Bernardino	District 7
Councilmember Cathryn De Young, Laguna Niguel	District 12
Councilmember Alta Duke, La Palma	District 18
Councilmember Richard Chavez, Anaheim	District 19
Councilmember Isadore Hall, Compton	District 26
Councilmember Judy Dunlap, Inglewood	District 28
Councilmember Bonnie Lowenthal, Long Beach	District 29
Councilmember Dick Stanford, Azusa	District 33
Councilmember Sid Tyler, Pasadena	District 36
Councilmember Tom Sykes, Walnut	District 37
Councilmember Bob Yousefian, Glendale	District 42
Councilmember Glen Becerra, Simi Valley	District 46
Councilmember Carl Morehouse, San Buenaventura	District 47
Councilmember Ed Reyes, Los Angeles	District 48
Councilmember Wendy Greuel, Los Angeles	District 49
Councilmember Dennis Zine, Los Angeles	District 50
Councilmember Tom LaBonge, Los Angeles	District 51
Councilmember Jack Weiss, Los Angeles	District 52
Councilmember Tony Cardenas, Los Angeles	District 53
Councilmember Alex Padilla, Los Angeles	District 54
Councilmember Bernard Parks, Los Angeles	District 55
Councilmember Jan Perry, Los Angeles	District 56
Councilmember Nate Holden, Los Angeles	District 57
Councilmember Cindy Miscikowski, Los Angeles	District 58
Councilmember Greig Smith, Los Angeles	District 59
Councilmember Eric Garcetti, Los Angeles	District 60
Councilmember Antonio Villariagosa, Los Angeles	District 61
Councilmember Janice Hahn, Los Angeles	District 62
Mayor James Hahn, Los Angeles	At-Large
Mayor Bill Davis, Simi Valley	VCTC

Staff Present

Mark Pisano, Executive Director
Jim Gosnell, Deputy Executive Director
Heather Copp, Chief Financial Officer

Colin Lennard, General Counsel
Karen Tachiki, Chief Counsel
Hasan Ikrata, Director, Planning & Policy
Huasha Liu, Acting Director, Information Services
Shelia Stewart, Executive Assistant

1.0 CALL TO ORDER & PLEDGE OF ALLEGIANCE

Led by Councilmember Ron Bates, City of Los Alamitos

2.0 PUBLIC COMMENT PERIOD

There were no comments presented at this time. However Councilmember Bates announced his resignation after 30 years of public service. He thanked Regional Council members for their work on regional projects as well as the efforts to accomplish goals for the SCAG region. In addition he thanked SCAG staff for their help and work over the years.

SPECIAL PRESENTATION

President Roberts stated that outgoing Regional Council members as well as Chairs and Vice Chairs of policy committees were presented service awards at the 2004 General Assembly (GA). Mayor Bill Alexander was unable to attend the Awards Luncheon at the GA and was presented a service award by the President for serving as Chair of Community, Economic, and Human Development Committee for year 2004.

3.0 CONSENT CALENDAR

Items 3.1.3 and 3.1.6 were pulled for discussion The remaining consent calendar items were MOVED (Kuiper), SECONDED (Alexander) and UNANIMOUSLY APPROVED

3.1 Approval Items

3.1.1 Approve Minutes of May 6, 2004

It was noted that Supervisor Charles Smith attended the May & June meeting.

3.1.2 Contracts

- National Engineering Technology Corporation (NET)
- Rafiq & Associates

3.1.4 Approve New MOU with Riverside Transit Agency for ITS Transit Project

3.1.5 Approve Joint Meeting with Santa Barbara County Association of Governments to be held in July, 2004

3.1.7 Adopt Resolution #04-453-1 authorizing Executive Director to delegate authority to the Deputy Executive Director

3.1.8 Authorization to Execute MOU between SCAG & Calif. State University LA (CSULA) for grants awarded to CSULA by the FTA

3.1.9 Approve Submittal of Letter Supporting House & Senate Bill Provisions to Fund Transportation Programs for Indian Reservations in the Reauthorization of TEA-21

3.1.10 Support Housing Legislation AB 2158 (Lowenthal) and AB 2348 (Mullin)

Items Pulled

3.1.3 Authorize Submittal of Letter in Support of S.1107 (Thomas)

S. 1107 makes permanent a user fee presently collected as demonstration project by the National Park Service. The fees are used for visitor services, maintenance and repair of facilities, and cultural and natural resource management. The EEC was supportive of the bill however asked that a letter be sent to the author addressing Congress' ongoing need to commit funds to parks and extend the bill to the National Forest Service.

Councilmember Clark offered a substitute motion and recommended that a letter not be sent due to certain restrictions within the bill. It was MOVED and SECONDED. There were 7 AYES and 31 NOES. The motion failed

Main Motion

It was MOVED and SECONDED. There were 31 AYES and 7 NOES to send a letter of support. The motion passed.

3.1.6 Consideration to Adopt Master Fund Transfer Agreement

Karen Tachiki, Chief Counsel, stated that late in calendar year 2003, Caltrans requested all MPO's, in the state, including SCAG to enter into a new proposed Master Fund Transfer Agreement (MFTA). The MFTA is the agreement by which Caltrans administers the Consolidated Planning Grant funds.

It is recommended that the Executive Director be authorized to take appropriate action regarding the new Proposed MFTA. It was MOVED (Perry), SECONDED (Washburn) and UNANIMOUSLY APPROVED.

3.2 Receive & File

3.2.1 Contracts & PO between $5,000 - $25,000

3.2.2 Conflict of Interest Listing

3.2.3 SCAG Legislative Matrix

3.2.4 Key Issues from Policy Committees Meeting on May 6, 2004

3.3 PRESIDENT'S REPORT

3.1.1 Announcement of Chairs & Vice Chairs

CEHD – Councilmember Deborah Robertson selected as Chair
Councilmember Paul Bowlen selected as Vice Chair

TCC – Councilmember Lee Ann Garcia selected as Chair
Councilmember Harry Baldwin selected as Vice Chair

EEC – Supervisor Hank Kuiper selected as Chair
Councilmember Margaret Clark selected as Vice Chair

The Chair and Vice Chair for the Administration Committee will be announced at the August meeting.

3.3.2 Report on June Retreat

President Roberts stated that the retreat held on June 2 and June 3 at Temecula Creek Inn in the City of Temecula was well attended.

The focus of the retreat included discussions on Conformity and Funding Implications; Fiscal Year 2004-2005 Work Program Objectives; Task Force Review; and Succession Planning

In addition he gave a brief overview regarding the subcommittee and task forces. President Roberts stated he would adhere to the same process as last year. Subcommittee and task force members will be contacted to find out if they are still interested in serving in their current capacity.

Cancellation of July Meeting

It was MOVED (Perry), SECONDED (McCarthy) and UNANIMOUSLY APPROVED to cancel the July meetings and authorize the Executive Committee to convene in July if there is a need to act on any contract and forward to the Regional Council for ratification in August.

3.3.3 Appointments

There were no appointments however, President Roberts welcomed new RC member, Councilmember Jim Aldinger, Manhattan Beach. Councilmember Aldinger will represent District #40.

3.4 EXECUTIVE DIRECTOR'S REPORT

Mark Pisano noted that the items contained within his report were covered during the retreat. However he would be available to answer any questions regarding his report.

4.0 ACTION ITEMS

4.1 Community & Human Development Committee (CEHD) Report

4.1.1 Compass Growth Vision

Mayor Alexander, Chair, reported that on May 6, 2004 the CEHD unanimously approved Compass Growth Visioning Report and Implementation Framework. The report is culmination of 4 years of effort lead by CEHD's Growth Visioning Subcommittee. He stated that the report represented a broad consensus on the future of the region and has had participation of thousands of residents. The CEHD recommended that the Regional Council approve the report.

A power point presentation was given by John Fregonese, Consultant, on the Compass Growth Visioning Project. After the presentation and questions, it was MOVED (Alexander), SECONDED (Kuiper) UNANIMOUSLY APPROVED to approve the Compass Growth Vision and Implementation Program.

4.1.2 Report on Housing Summit

Councilmember Robertson gave a report on Housing Summit. There were approximately 200 attendees. Staff was thanked for their hard work and efforts in making the summit a successful event.

- **Off Agenda Item**

The need to take action arose after the posting of the agenda
It was MOVED (Alexander) and SECONDED (Perry) that AB 2702 (Steinberg) be added to agenda for action.

AB 2702 is intended to increase the supply of housing and spur in-fill development by limiting local governments' ability to deny or place restrictions on the development of second housing units.
While SCAG supports the concept of in-fill housing, AB2702 places restrictions on local government policy making ability and attempts to