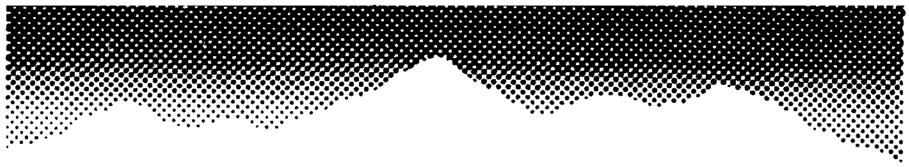

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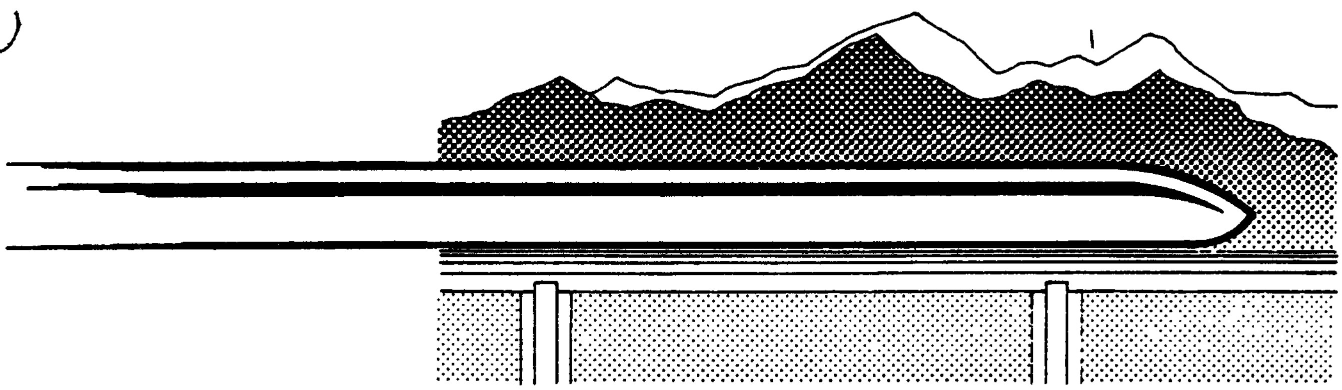
HIGH SPEED GROUND TRANSPORTATION

SAN FERNANDO TO PALMDALE ROUTE ALIGNMENT AND TECHNOLOGY STUDY



CITY OF LOS ANGELES
DEPARTMENT OF AIRPORTS

PREPARED BY
ICF KAISER ENGINEERS (CALIFORNIA) CORPORATION

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HIGH SPEED GROUND TRANSPORTATION

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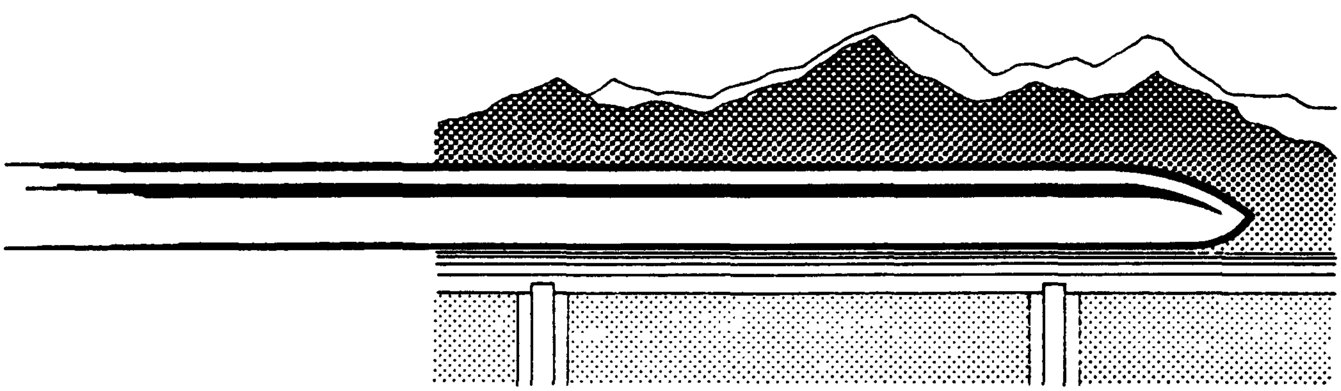

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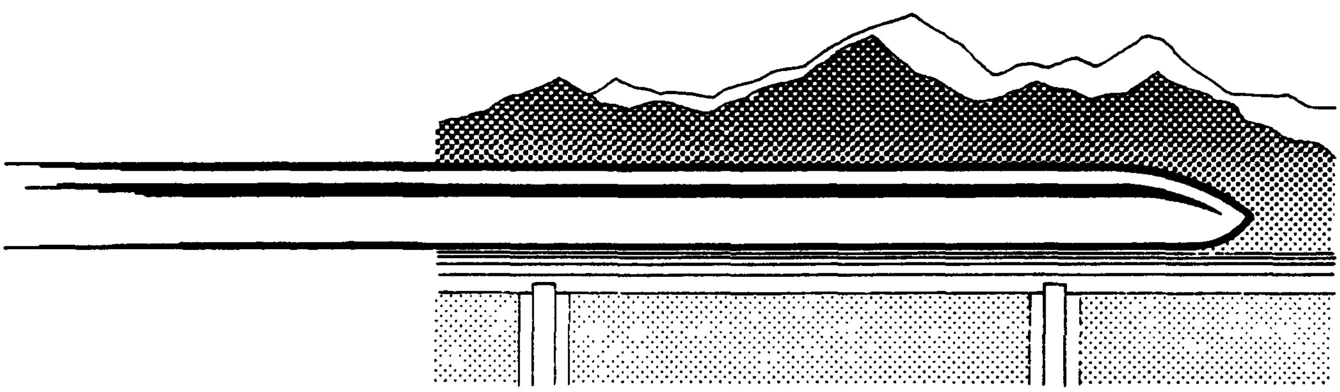
D R A F T   R E P O R T

HIGH SPEED GROUND TRANSPORTATION

SAN FERNANDO TO PALMDALE
ROUTE ALIGNMENT AND TECHNOLOGY STUDY



C I T Y   O F   L O S   A N G E L E S
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P R E P A R E D   B Y
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REPORT NO.
90-011-RE
MAY 1990

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1. Introduction

1. INTRODUCTION

The report presents the results of a study of the physical and operational characteristics of two High Speed Ground Transportation (HSGT) alternatives and one Super Speed alternative between San Fernando and Palmdale Regional Airport. Also included is an assessment of environmental impacts and conceptual capital and operating cost estimates for the alternatives.

This effort constitutes Phase II of a study of HSGT systems between Los Angeles International Airport (LAX) and the Palmdale Airport.

Phase I, which consisted of an assessment and updating of Kaiser Engineers' 1970/72 studies of an HSGT system between LAX and San Fernando, was completed and submitted to the Los Angeles Department of Airports (DOA) in November 1989.

The Phase I route commenced at an LAX HSGT terminal located in the east end of Parking Lot C and extended northerly along Sepulveda Boulevard and the San Diego Freeway to a passenger terminal (San Fernando North) in the vicinity of I-405/I-5 in San Fernando. Intermediate passenger stations were proposed at Wilshire Boulevard and at I-405/US-101 (San Fernando South Station).

Conventional high speed steel wheel/steel rail vehicle technology with a maximum speed of 125 mph was assumed for the Phase I study.

Phase II covered in this report addresses the extension of the Phase I system from San Fernando North Station to a Los Angeles DOA terminal at Palmdale Regional Airport and encompasses the following aspects of the proposed extension:

- Alternative route alignments that use existing highway and railroad alignments where appropriate as well as a more direct route suitable for Super Speed train operation.
- Proposed locations for terminal and intermediate passenger stations and conceptual plans for station facilities and station sites.
- Train simulation studies both for the baseline 125-mph rail technology and for the Super Speed (250 mph) MagLev technology (LA-Las Vegas or equivalent).
- Environmental impact assessments and possible mitigation measures.
- Conceptual definitions of system and facility elements, including vehicle technology, electrification, control and communication, and vehicle storage and maintenance facilities.
- Conceptual operating and maintenance plans for an assumed level of train service.
- Preliminary implementation schedules and conceptual capital costs and operating and maintenance costs estimates.

2. Summary

2. SUMMARY

2.1 GENERAL

This report presents the results of a high speed ground transportation (HSGT) route alignment and technology study between the north end of San Fernando Valley and Palmdale Regional Airport.

The contract between the Los Angeles DOA and ICF Kaiser Engineers mandated that the following two vehicle technologies be studied:

1. Conventional steel wheel/steel rail HSGT technology with maximum speed capability of 125 mph.

2. Super Speed MagLev technology with maximum speed capability of 250 mph.

2.2 ROUTE ALIGNMENTS

The routes extend from the end of the Phase I LAX to San Fernando North Study at Rinaldi Street to a passenger terminal station integrated into DOA's proposed interim terminal at Palmdale Regional Airport..

The alignment adjacent to the airport terminal must be located so as <u>not</u> to preclude future extension to an ultimate airport terminal to the east of the interim terminal as well as to a possible future extension to Las Vegas via Victorville or Barstow.

Three alternative route alignments were developed as follows:

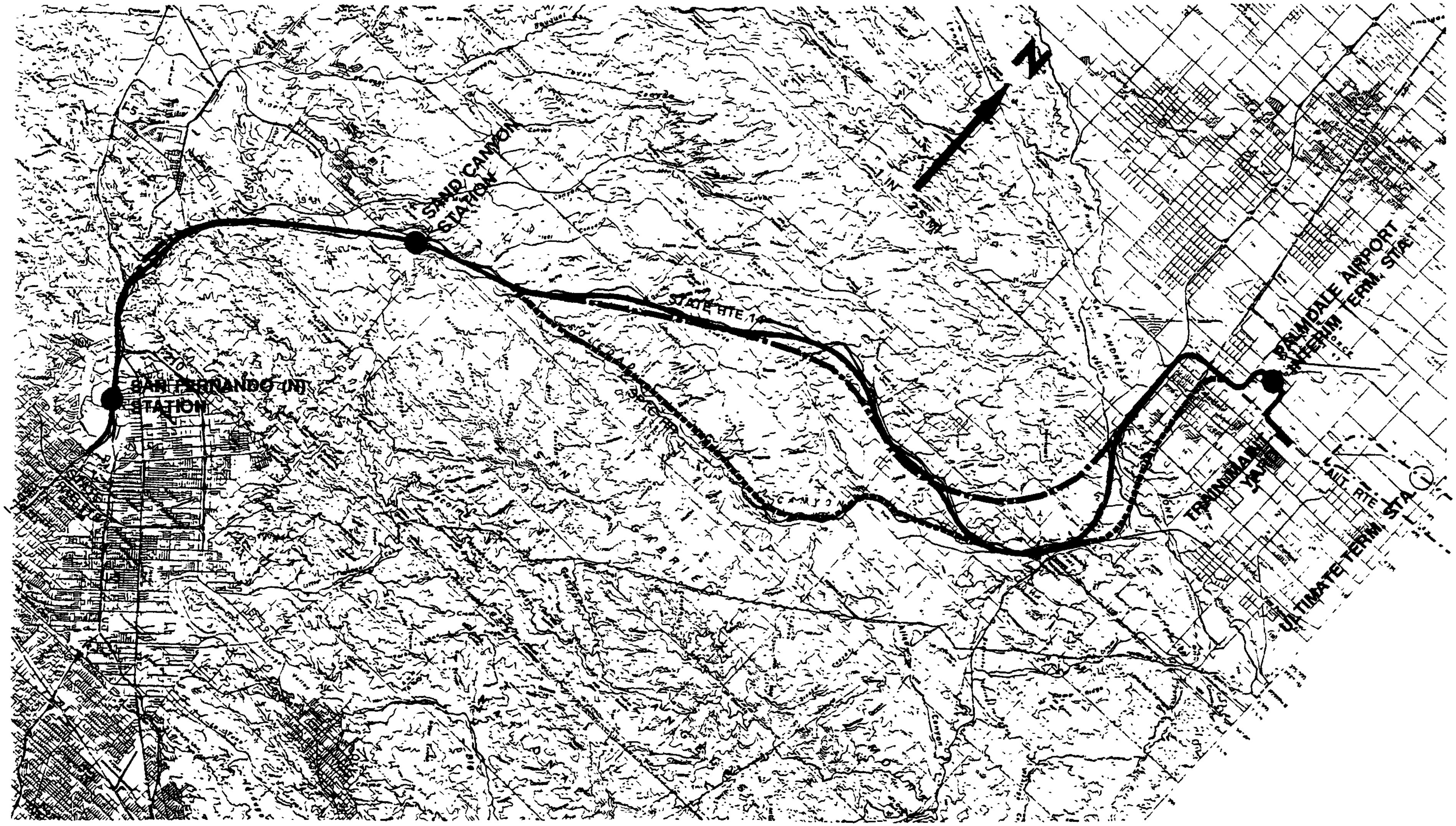
- Alt. 1, Highway Alignment - HSGT Technology
- Alt. 2, Railroad Alignment - HSGT Technology
- Alt. 3, Super Speed Alignment - MagLev Technology

See Regional Route Map, Figure 2-1, for alignment location.

2.2.1 Alt. 1 - Highway Alignment

The highway alignment generally follows the alignment of the San Diego (I-405), Golden State (I-5), and Antelope Valley (State Route 14) freeways to Avenue P-8 in Palmdale, where it turns east to the Interim Palmdale Regional Airport Terminal and Train Maintenance and Storage Yard to the east of the Terminal Station.

In order to improve system speed, the highway alignment deviates from the State Route 14 alignment in order to provide larger radius curves and longer tangents.



LEGEND:

- HSGT HIGHWAY ROUTE
- HSGT RAILROAD ROUTE
- SUPER SPEED ROUTE
- PASSENGER STATION

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May 1990

Figure 2-1
Regional Route Map
San Fernando to Palmdale
HSGT Study

The highway alignment is mostly in aerial configuration with segments at-grade along State Route 14 and three short tunnels. See Table 2-1 for lengths of guideway configurations.

The total length of the highway alignment from Rinaldi St. to the Train Maintenance and Storage Yard in Palmdale is 234,000 ft ~ 44.3 miles.

2.2.2 Alt. 2 - Railroad Alignment

The railroad alignment is identical to the highway alignment along San Diego and Golden State freeways and State Route 14 to Lang, where it leaves the highway route to follow the existing Southern Pacific Transportation Company (SPTC) railroad corridor through Soledad Canyon and the City of Palmdale to Avenue P-8. where it re-joins the highway alignment.

In its passage through Soledad Canyon, the railroad alignment deviates from the winding SPTC railroad alignment in order to provide larger radius curves and longer tangents.

The railroad alignment is generally in aerial configuration with at-grade segments and three short tunnels. See Table 2-1.

Table 2-1
Lengths of Guideway Configurations
(Distance in Miles)

Alignment Alternatives	At-Grade	Aerial	Tunnel	Totals
Alt. 1 Highway Route	11.6	31.4	1.3	44.3
Alt. 2 Railroad Route	6.5	35.3	1.6	43.4
Alt. 3 Super Speed Route	3.2	24.1	14.3	41.6

2.2.3 Alt. 3 - Super Speed Alignment

The Super Speed alignment generally follows the highway alignment, but in order to take advantage of the very high speed capability of the MagLev technology, the alignment follows a more direct route with large radius curves and long tangents. As a result, the Super Speed alignment has several tunnels in the mountainous area along State Route 14, with the remainder of the alignment in aerial configuration with some at-grade segments interspersed between the tunnels. See Table 2-1. The total length of the Super Speed alignment from Rinaldi St. to the Maintenance Yard in Palmdale is 219,850 ft ~ 41.6 miles.

2.3 PASSENGER STATIONS

Three passenger stations are proposed as follows:

- San Fernando North Station located at Roxford Street in San Fernando.
- Sand Canyon Station located on the south side of State Route 14 west of Sand Canyon Road.
- Palmdale Regional Airport Terminal Station incorporated into DOA's proposed Interim Terminal at 20th St. north of Avenue. P.

See Regional Route Map, Figure 2-1, for station locations.

The three passenger station locations are identical for the three route alternatives.

The stations have high-level, side-platforms on an upper level with ticketing and baggage handling facilities on the ground floor below. The stations will provide full accessibility for elderly and handicapped passengers.

The stations will be designed to accommodate access by pedestrians, bicycles, motorcycles, buses, and automobiles. Patron parking will be provided at San Fernando North Station (1,000 spaces) and at Sand Canyon Station (600 spaces). At the Terminal Station at Palmdale Regional Airport, parking is assumed to be integral with equivalent facilities provided to serve airport needs.

Distances between passenger stations are shown in the table below.

Alignment Alternatives	San Fernando North	Sand Canyon	Palmdale Reg. Airport	Totals
Alt. 1 Highway Route	57,650 ft ~10.9 mi		157,750 ft ~29.9 mi	215,400 ft ~40.8 mi
Alt. 2 Railroad Route	57,650 ft ~10.9 mi		153,050 ft ~29.0 mi	210,700 ft ~39.9 mi
Alt. 3 Super Speed Route	57,500 ft ~10.9 mi		143,750 ft ~27.2 mi	201,250 ft ~38.1 mi

2.4 OPERATIONAL ANALYSES

2.4.1 Train Performance Investigation

A computer simulation program was used to determine train performance characteristics, run times, average speeds, and power requirements for operation over the three route alternatives. The analyses examined system performance during peak operation, assuming 2,000 passengers per hour in each direction.

One representative technology was chosen for each of the HSGT and Super Speed systems. The HSGT technology chosen was a steel wheel/steel rail system using an ALP-44 electric locomotive pulling 5-6 passenger cars. The Super Speed technology chosen was the Transrapid 07 MagLev system. Shown in the table below are the run times and average operating speeds resulting from the operational analyses. The run times and average operating speeds include 60-second dwell time at Sand Canyon Station.

Alignment Alternatives	Travel Direction	Run Time (Minutes)	Average Operation Speed (mph)
Alt. 1	Eastbound	29:02	84:5
Highway Route	Westbound	27:28	89:3
Alt. 2	Eastbound	28:06	85:4
Railroad Route	Westbound	26:43	89:8
Alt. 3	Eastbound	14:13	160:0
Super Speed Route	Westbound	14:13	160:0

Additional computer simulations show that if two locomotives are used with each train and if some trains do not stop at Sand Canyon, the non-stop average speeds will be slightly greater than 100 mph.

2.4.2 Operating and Maintenance Plans

Operating plans for the HSGT and Super Speed systems were developed based on the results of the train performance investigations and assumed operating headways of 12 minutes during peak periods, which will accommodate the assumed 2,000 passengers per hour in each direction.

Headways for mid-day and evening services of 30 minutes were assumed with late night service frequency of 60 minutes. In addition 60-seconds dwell time at Sand Canyon Station and turn-back times of 10 minutes each at San Fernando North and Palmdale Airport Terminal for the HSGT technology were assumed. These assumptions include the time required for moving of locomotive to the outbound end of the train.

For the Super Speed system the turn-back times are reduced to 5 minutes each end because of this system's capability of operation in both directions.

Fleet sizes were determined based on the operating plans. For the HSGT technology (Alts. 1 and 2), it was found that 7 locomotives and 35 cars were required for on-line operations with 2 locomotives and 5 cars needed as spares for a total of 9 locomotives and 40 cars.

For the Super Speed technology, 24 vehicles were required for on-line operation, while 18 spare vehicles were assumed for a total of 42 vehicles. The number of spare vehicles includes consideration for the isolated application of the MagLev Technology and thus the need for complete maintenance capability.

Conceptual maintenance plans which included maintenance philosophies, methods, and requirements for the equipment maintenance and fixed plant maintenance functions have been developed.

2.5 ENVIRONMENTAL IMPACT ASSESSMENT

The two HSGT alternatives and the Super Speed alternative could have significant environmental impacts. These impacts relate to visual/aesthetic, noise, land acquisition, and traffic impacts during construction and operation phases of the project. Other environmental categories that have potentially significant impacts include ecologically sensitive areas and endangered species, cultural resources, and hazardous waste.

Prior to project implementation and final design, the implementing agency would be required to conduct a thorough environmental analysis as defined by the California Environmental Quality Act (CEQA) and/or the National Environmental Policy Act (NEPA) should federal funding or the use of any federal lands or facilities be involved in any phase of the project. The purpose of the CEQA/NEPA process is to delineate and explain any environmental impacts resulting from approval of the proposed project, identify appropriate mitigation measures designed to eliminate, avoid or reduce environmental impacts to a level below significance, and identify alternatives to the project.

2.6 SYSTEM AND FACILITY ELEMENTS

2.6.1 Vehicle System Technology

The Amtrak Metroliner is the basis for the HSGT system. One ALP-44 locomotive of Swedish design pulls a train of five to six passenger cars each carrying 80 passengers and their baggage. The locomotive receives 25-kV AC power from an overhead catenary and inverts it to direct current using on-board inverters to power the DC traction motors.

The propulsion system is designed to operate on standard railroad grades of less than 3 percent, and on higher grades (such as are found in the Alt. 1 and 2 alignments) the locomotive's acceleration capability is reduced.

The Super Speed alternative is based on the Transrapid 07 MagLev technology.

Attractive forces between electromagnets in the vehicle and ferromagnetic stator packs arranged in two strips on the underside of the guideway levitate the vehicle. The control system maintains a constant gap between the surfaces of the vehicle and the guideway and keeps the vehicle positioned laterally in its track between the steel guiderails.

A synchronous long stator linear induction motor mounted in strips on the underside of the guideway provides propulsion and braking. An externally generated and controlled three-phase AC electromagnetic travelling wave, together with the field of the support magnets, provides the propulsion frequency of the phase current, and braking is achieved by changing the polarity of the magnetic field.

Energy for the support and guidance systems in the vehicle and for on-board services in the vehicle is supplied through linear generators in the support magnets. All of these systems are contactless, thereby eliminating mechanical vibration, noise, and wear.

The Transrapid MagLev is designed to operate on grades of up to 10 percent.

As for the HSGT technology, the Super Speed vehicle carries 80 passengers and their baggage. Five to six vehicles comprise each train, and trains are bi-directional.

2.6.2 Electrification

For both the HSGT and the Super Speed systems, power is received from the electric utility system at traction power substations (TPS) and transmitted to operating locomotives or vehicles via a distribution system.

The distribution system for the HSGT system is an overhead catenary. The Super Speed MagLev distribution system consists of cables running to the linear induction motor stator packs mounted on the underside of the guideway.

System power requirements are derived from studies done using the Transit Operational Model (TOM) computer simulation program. Using this information and train headways, the required number of traction power substations and their capacities are calculated as shown below.

Alignment Alternatives	Number of Substations	Substation Capacity (Megawatts)
Alt. 1 Highway Route	3	10
Alt. 2 Railroad Route	3	10
Alt. 3 Super Speed Route	4	10

2.6.3 Train Control and Communication

The train control system has two main objectives: operational safety and operational efficiency. The train control system envisaged for both the HSGT and Super Speed systems maintains train safety, monitors train movements, and directs train operations. The system includes two-way working tracks; centralized control; remote switching; and automatic door operation and control of station facilities.

The communications system furnishes dependable, continuous two-way voice, video and data links via cable or radio frequency transmission between central control, operating trains, and stations.

2.6.4 Guideway Structures

As shown in Table 2-1, at-grade, aerial, and tunnel configuration will be used in the alignment alternatives.

The typical aerial guideway structure would be a double-track structure with "T" bents and single column supports. Guideway girders would typically span about 80 ft between the supports.

Tunnel configuration would typically consist of two single track tunnels with cross connections.

The tunnel cross sectional area for the Super Speed tunnels will be increased to abate the impact of the piston effect, which is pronounced at very high speeds.

2.6.5 Storage and Maintenance Facility

A suitable site for train storage and maintenance facilities has been identified at E. 30th Street and Avenue P-8 in Palmdale. The size of the site is adequate to handle storage and maintenance functions for system extension to LAX.

The storage and maintenance facility will accommodate the basic requirements of operations, equipment maintenance, and facility maintenance.

2.7 SCHEDULES AND COST ESTIMATES

2.7.1 Implementation Schedules

Implementation schedules for the San Fernando to Palmdale alternative systems show that the HSGT alternatives can be implemented and ready for revenue operation in a 7½-year time span using conventional contracting methods. This includes time for the required EIR/EIS process at the front end as well as time for acceptance testing at the tail end. If turnkey procedures were used, the 7½-year implementation period could possibly be reduced, perhaps by as much as 1½ years.

Implementation of the MagLev alternative would take 9 years using conventional methods, and again if turnkey procedure were used, this time frame may be reduced perhaps 1 to 2 years.

2.7.2 Conceptual Cost Estimates

The conceptual construction and operating costs for the three alternative systems are presented in Table 2-2.

Table 2-2
Conceptual Capital and Operating Costs
(Millions of 1990 Dollars)

Alignment Alternatives	Capital Costs	Annual O&M Costs
Alt. 1 Highway Route	1,721	44.7
Alt. 2 Railroad Route	1,834	47.7
Alt. 3 Super Speed Route	2,732	79.2

Construction costs include allowances for right-of-way, engineering and construction management, and contingencies.

The costs are expressed in 1990 dollars; no escalation costs are included.

Annual operating and maintenance costs are shown for each alternative. These costs are also expressed at 1990 cost levels.

3. Route Analysis

3. ROUTE ANALYSIS

Presented below are guideway geometrics criteria for the HSGT and Super Speed technologies. These criteria were used to develop the route alignments shown on the plan and profile drawings in Appendix A; verbal descriptions of the route alignments are included in this section.

All the route alignments extend from the north end of the Phase I Study at Rinaldi Street in San Fernando to the Palmdale Regional Airport Terminal Station.

3.1 HSGT GUIDEWAY GEOMETRICS CRITERIA

CONVENTIONAL RAILROAD TECHNOLOGY WITH MAXIMUM SPEED OF 125 MPH

Horizontal Clearances

The following side clearances from centerline of track shall apply:

- To an obstruction: 6 ft 6 inches - tangent; 7 ft 6 inches - curve; 8 ft 6 inches - preferred

- To adjacent track centerline:
  - Without catenary support poles between tracks: 15 ft 0 inches
  - With catenary support poles between tracks: 17 ft 0 inches

A minimum clear space of 3 ft 0 inches shall be provided for an emergency walkway located between the tracks or on the outside of each track.

Vertical Clearances

The minimum distance from the top of the high rail to an overhead obstruction shall be:

- Typical (desirable): 20 ft 0 inches
- Underpasses and subways: 15 ft 0 inches

Vertical clearances under aerial guideway structures shall be as follows:

- Over railroad top of rail: 23 ft 6 inches

- Over roadways
  - Freeways and expressways — 16 ft 6 inches
  - Other — 15 ft 0 inches

Horizontal Alignment

Wherever possible, the track alignment shall be designed to accommodate the maximum design speed.

The alignment shall be composed of tangents, circular curves, and spiral transitions. Superelevation shall be used to maximize running speeds.

Tangents

The minimum tangent length between curves shall be 100 ft. The alignment of all stations platforms and for a minimum of 75 ft beyond the ends of platforms shall be tangent. All turnouts shall be located on tangents.

Circular Curves

Circular curves shall be defined by the arc definition and specified by their degree of curvature and radii as determined by the following formula:

$$R = \frac{5.729.58}{D}$$

Where: R = radius in feet
D = degree of curvature

- The minimum radii for yard and service tracks shall be 300 ft.
- The minimum length of a superelevated, circular curve shall be 100 ft.

Spiral Transition Curves

Spiral curves shall be as defined by the *AREA Manual for Railway Engineering.*

The minimum length of a spiral shall be the greater of the lengths determined from the following formulas (rounded off to the nearest 10 ft), but preferably not less than 100 ft.

L_s (minimum) = 31 E
L_s (minimum) = 1.22 UV
L_s (minimum = 1.17 EV

Where:

L_s = spiral length in feet
E = actual superelevation in inches

U = unbalance in inches (the unbalance being the difference between equilibrium superelevation and the superelevation actually being used)
V = curve design speed in mph

Superelevation

Superelevation shall be developed by raising the outer rail above the profile line. When used, superelevation shall be developed within the length of the spiral. Yard and service tracks shall not be superelevated.

The equilibrium superelevation is the sum of the actual superelevation (E) and the unbalance (U). The maximum values of these shall be:

E (desirable maximum) = 4 inches
E (absolute maximum) = 6 inches
U (absolute maximum) = 3 inches

Curve Design Speed

The design speed for a circular curve shall be determined by the following formula:

$$E + U = 3.839 \frac{V^2}{R}$$

Where:

V = design speed, through the curve, mph
R = radius of curve, feet

Values of actual superelevation (E) shall be rounded to the nearest 1/4 inch. For a total superelevation (E + U) of 1 inch or less, no actual superelevation (E) need be applied.

Minimum curve radius for 125 mph speed: 6,665 ft.

Vertical Alignment

The profile grade shall be defined as the elevation of the low rail. Vertical curves shall be defined by parabolic curves having a constant rate of grade change.

Vertical Tangents

The minimum length of vertical tangent shall be 100 ft. The track at a station shall be on a vertical tangent that extends 75 ft beyond each end of the platform unless otherwise authorized. Special trackwork shall be located on vertical tangents.

Vertical Grades

The following vertical grade limitations shall apply:

- Mainline tracks

Maximum	6%
Minimum (elevated and subway)	0.3%

- Stations

Maximum	1%

- Yard tracks

Desirable maximum	0%
Absolute maximum	1%

- Yard storage tracks

Desirable	±0.2%
Maximum	±0.35%

Vertical Curves

The lengths of vertical curves shall be determined as follows:

$$L = \frac{AV^2}{75}$$

Where:

L = length of vertical curve, feet
A = algebraic difference in grades connected by the vertical curve, percent
V = design speed through the curve, mph

Vertical curves shall be provided for all grade intersections where the algebraic difference in grades is more than 0.1 percent.

3.2 SUPER SPEED GUIDEWAY GEOMETRICS CRITERIA

MAGLEV TECHNOLOGY WITH MAXIMUM SPEED OF 250 MPH

Horizontal Clearances

The following side clearances from centerline of track shall apply:

• To an obstruction:	8 ft 0 inches - tangent 9 ft 0 inches - curve 10 ft 0 inches - preferred
• To adjacent track centerline:	18 ft 0 inches

A minimum clear space of 3 ft 0 inches shall be provided for an emergency walkway located between the tracks or on the outside of each track.

Vertical Clearances

The minimum distance from the top of the guideway beam to an overhead obstruction shall be:

• Typical (desirable)	12 ft 0 inches

Vertical clearances under aerial guideway structures shall be as follows:

• Over railroad top of rail	23 ft 6 inches
• Over roadways	
- Freeways and expressways	16 ft 6 inches
- Other	15 ft 0 inches

Horizontal Alignment

Wherever possible, the track alignment shall be designed to accommodate the maximum design speed.

The alignment shall be composed of tangents, circular curves, and spiral transitions. Superelevation shall be used to maximize running speeds.

<u>Tangents</u>

The minimum tangent length between curves shall be 100 ft. The alignment of all stations platforms and for a minimum of 75 ft beyond the ends of platforms shall be tangent. All turnouts shall be located on tangents.

Circular Curves

Circular curves shall be defined by the arc definition and specified by their degree of curvature and radii as determined by the following formula:

$$R = \frac{5,729.58}{D}$$

Where: R = radius in feet
D = degree of curvature

- The minimum radii for yard and service tracks shall be 300 ft.

- The minimum length of a superelevated, circular curve shall be 100 ft.

Spiral Transition Curves

Spiral curves shall be as defined by the *AREA Manual for Railway Engineering.*

The minimum length of a spiral shall be determined to produce a variation in guideway bank angle (superelevation) on transition curves of no more than $0.22^{o}/31$ feet of curve.

Superelevation

Superelevation shall be developed by banking (tilting) the guideway beam above the profile line. When used, superelevation shall be developed within the length of the spiral. Yard and service tracks shall not be superelevated.

Curve Design Speed

The design speed for a circular curve shall be determined by the following formula:

$$\text{Bank angle (degrees)} = 3.839 \frac{V^2}{R}$$

Where:

V = design speed, through the curve, mph
R = radius of curve, feet

Values of guideway bank angle shall be rounded to the nearest one-quarter degree.

Minimum curve radius for 250 mph speed: 20,000 ft.

Vertical Alignment

The profile grade shall be defined as the elevation of the guideway beam. Vertical curves shall be defined by parabolic curves having a constant rate of grade change.

Vertical Tangents

The minimum length of vertical tangent shall be 100 ft. The track at a station shall be on a vertical tangent that extends 75 ft beyond each end of the platform unless otherwise authorized. Special trackwork shall be located on vertical tangents.

Vertical Grades

The following vertical grade limitations shall apply:

- Mainline tracks

Maximum	10%
Minimum (elevated and subway)	0.3%

- Stations

Maximum	1%

- Yard tracks

Desirable maximum	0%
Absolute maximum	1%

- Yard storage tracks

Desirable	±0.2%
Maximum	±0.35%

Vertical Curves

The lengths of vertical curves shall be determined as follows:

$$L = \frac{AV^2}{75}$$

Where:

L = length of vertical curve, feet
A = algebraic difference in grades connected by the vertical curve, percent
V = design speed through the curve, mph

Vertical curves shall be provided for all grade intersections where the algebraic difference in grades is more than 0.1%.

3.3 ALTERNATIVE ROUTE ALIGNMENTS

3.3.1 General

Three alternative route alignments were developed: two for the HSGT technology and one for the Super Speed technology. All alignments are described from south to north and begin at Rinaldi Street and end at Palmdale Airport. The three alignments use the same station locations. See Regional Route Map, Figure 2-1. The southernmost station, San Fernando North Station, is located on the west side of the Golden State Freeway (I-5), immediately south of Roxford Street in San Fernando. An intermediate station, Sand Canyon Station, is located on the south side of the Antelope Valley Freeway (SR 14) and west of Sand Canyon Road. The northernmost and terminal station is located at Palmdale Regional Airport at DOA's proposed Intermediate Terminal.

The first of the two High Speed alignments, Alternative 1, generally follows existing highway alignments. The second High Speed alignment, Alternative 2, follows the same alignment as the first to a point east of Sand Canyon Station, then diverges from the Antelope Valley Freeway to follow the existing Southern Pacific Transportation Company (SPTC) railroad corridor through Soledad Canyon. The Super Speed alignment generally follows the route along existing highways to the Golden State Freeway and Antelope Valley Freeway interchange. North of the interchange, this alignment follows a much more direct route to the Palmdale Regional Airport than the first two alternatives in order to allow for higher train speeds.

3.3.2 Route Along Existing Highways - Alternative 1

See Appendix A for plan and profile drawings.

The highway alignment (Alt. 1) was developed with consideration given to the use of large radius curves enhancing high speed operation, and to minimize earthwork and impacts on existing facilities and structures as well as surrounding communities.

The alignment begins at the centerline of Rinaldi Street (Sta 1290+00), which is where the Phase I study alignment ended, and proceeds northerly first along the west side of the San Diego Freeway. It then diverges from the freeway and follows the eastern edge on the defunct lower Van Norman Lake Debris Basin to a location along the west side of Golden State Freeway. San Fernando North Station is located on the west side of the freeway, about 400 feet south of Roxford Street. From the station the alignment continues north along the west side of the Golden State Freeway and transitions from the west side to the east side of the frontage road parallel to the freeway to avoid impacting a large electrical substation. The alignment continues northerly between the frontage road and the Golden State Freeway, passing over San Fernando Road, the SPTC railroad tracks, and then the Balboa Boulevard overcrossing. The alignment continues north generally between the SPTC railroad tracks and the Golden State Freeway.

About 2,000 feet north of Balboa Boulevard, the alignment passes over the SPTC railroad tracks and San Fernando Road, and then continues northerly along the embankment on the west side of Connector "C." At the interchange of the

Antelope Valley and Golden State freeways, the alignment proceeds on a 3,000-ft radius curve along the outside edge of Connector "C," passing over the northbound and southbound five auto lanes, under Connector "L," over Weldon Canyon Road and the southbound and northbound five-lane truck route, and finally under Connector "M" to a location on the western side of the Antelope Valley Freeway (State Route 14).

The alignment continues east along the north side of State Route 14, passing over the Los Angeles Aqueduct, under electrical transmission lines, and over Placerita Canyon Road, Golden Valley Road, Cedar Valley Road, Via Princessa Road, and several freeway ramps.

East of the Via Princessa interchange, the alignment crosses the Santa Clara River and transitions from the northwest side to the southeast side of State Route 14 to Sand Canyon Station which is located about 2,200 feet west of Sand Canyon Road. The mobile homes on the north side of the Sand Canyon Mobile Home Park will be impacted by the station.

East of Sand Canyon Station, the alignment passes over Sand Canyon Road and continues along the south side of State Route 14. The alignment generally follows that of the freeway and is located within Caltrans right-of-way except where larger radii curves are required to allow higher speeds. While the freeway curves are typically 3,000 ft, the HSGT curves are typically 5,000 ft to allow speeds of about 110 mph.

East of Sand Canyon the alignment passes over several roadways and interchanges, including Oak Spring undercrossing, Soledad Canyon Road and ramps, and Spring Canyon Road. East of Spring Canyon Road, the alignment is primarily located at-grade on either cut sections or fill sections to west of Agua Dolce Road.

The alignment passes under electrical transmission lines and then crosses over Agua Dolce Road and Escondido Road on aerial structure. From here the alignment continues east along the southern side of the freeway passing over Ward Road and the two ramps at Ward Road. Then the alignment passes over Red River Mine Road and leaves the Caltrans right-of-way in order to allow larger radii curves than the freeway provides.

Proceeding east, the alignment passes over Crown Valley Road, Santiago Road and its ramps, and Soledad Canyon Road, and then turns northeast on a 6,800-ft radius curve, passing over Soledad Canyon Road again. From here the alignment proceeds northeast along the northwest side of Soledad Canyon Road, passing under electrical transmission lines. South of the State Route 14/Sierra Highway interchange, the alignment transitions from the west side to the east side of Soledad Canyon Road and passes over the Sierra Highway, the Los Angeles Forrest Highway, the Pearblossom Highway overcrossing, and two ramps. North of the interchange, the alignment turns northwest on a 6,800-ft radius curve and proceeds along the northeastern edge of State Route 14.

The alignment is aerial as it proceeds alongside the freeway passing over the LA Aqueduct, the San Andreas Rift Zone, Barrel Springs Road, Avenues S, R, and Q, and Palmdale Boulevard. Three-thousand feet south of Avenue P-8, the alignment diverges from the freeway, turning on a 3,000-ft radius curve to proceed east parallel to and south of Avenue P-8. At 15th Street, the alignment turns northerly on a 1,000-ft radius curve and proceeds northerly parallel to and east of 15th Street. At Palmdale Regional Airport, the alignment turns on a 1,000-ft radius curve and proceeds east to Palmdale Airport Station located at DOA's proposed Interim Terminal. Leaving the Airport Station, the alignment proceeds east to 25th Street where it turns south on another 1,000-ft radius curve. It then proceeds south parallel to and west of 25th Street. At Avenue P-8 the alignment turns again on a 1,000-ft radius curve and proceeds east parallel to P-8 to the proposed maintenance yard site on the south side of Avenue P-8 opposite the sewage disposal plant.

3.3.3 Route Along Existing Highways and Railroads

This alignment follows the same route as the alignment along existing highways (Alt. 1) to a point just east of Soledad Canyon Road interchange. At this point the alignment diverges from State Route 14 turning on a 5,000-ft radius curve to generally follow the SPTC railroad corridor located within Soledad Canyon. Soledad Canyon is a river canyon with steep slopes on both sides. It runs approximately east-west. The portion of the canyon that the alignment travels through is populated by numerous trailer parks, campgrounds with lakes, and other recreational facilities. The SPTC railroad traverses along the northern edge of the canyon on small curves, unsuitable for high speed operation.

The HSGT alignment through Soledad Canyon was developed with consideration for three objectives: to use large radius curves to provide as many opportunities as possible for high speed operation; to minimize earthwork; and to minimize impacts on the riverbed environment, including impacts to the campgrounds and trailer parks. The resulting alignment typically is located on the north side of the canyon along the slopes bordering the riverbed (in order to minimize impacts to the riverbed), but the alignment does infringe upon the recreational areas in the riverbed in some places because of the need to provide large radius curves and to minimize earthwork.

After turning into the canyon, the alignment proceeds along a 3,200-ft radius curve in order to follow the outer edge of a ridge jutting south into the canyon. A 2,500-ft-long tunnel segment is required here.

The alignment continues easterly, crossing over the SPTC railroad eleven times and Soledad Canyon Road twice. The alignment continues east along the north side of Soledad Canyon and then turns northeast on a 6,000-ft radius curve, crossing over Soledad Canyon Road and the SPTC railroad twice each. The alignment continues northeasterly between Soledad Canyon Road and the SPTC railroad, then traverses on two 4,000-ft radius reverse curves, and passes over the SPTC railroad and Crown Valley Road in the vicinity of Acton. From here the alignment proceeds easterly on a 6,800-ft radius curve, passing over Soledad Canyon Road, Crown Valley Road, the SPTC railroad tracks twice, and then Aliso Canyon Road. The alignment crosses over the SPTC railroad tracks again, and then proceeds along the southeastern side of Soledad Canyon Road to join the alignment along existing highways (Alt. 1) at Vincent.

East of Vincent the railroad alignment again diverges from the highway alignment, proceeding east along the southeastern side of Soledad Canyon Road, skirting the outer edge of the State Route 14/Sierra Highway interchange, and passing over the Sierra Highway and the Los Angeles Forrest Highway. Past the interchange, the alignment proceeds on a 5,000-ft radius curve, passing over the SPTC railroad and the Sierra Highway three times to a final location parallel to and east of the SPTC railroad. Approximately 150 feet of Sierra Highway near Una Lake will have to be relocated in order to provide space for a 5,000-ft radius curve.

The alignment continues northerly, parallel to and east of the SPTC tracks, passing over the LA Aqueduct, the San Andreas Rift Zone, Avenues S and R, Palmdale Boulevard, and finally Avenue Q.

Past Avenue Q, the alignment turns on a 2,000-ft radius curve to join the highway alignment (Alt. 1).

3.3.4 Super Speed Alignment - Alternative 3

The Super Speed alignment (Alt. 3) is laid out to provide as large radii horizontal curves as possible and feasible with attention paid to the resulting alignment facilities costs and environmental impacts. This alignment is the same as the highway alignment (Alt. 1) to the I-5/State Route 14 interchange except that there is one 7,500-ft radius curve instead of the two 3,000-ft radius curves north of Rinaldi Street. Then, the alignment turns on a large radius curve (R=16,000 ft), passing behind the refinery located on the west side of State Route 14. The alignment is in tunnel, behind the refinery, and then changes to aerial configuration, passing over San Fernando Road once and the Sierra Highway twice.

From here the alignment proceeds northeasterly and passes over the Sierra Highway, then proceeding easterly in tunnel, passing under Golden Valley Road. The alignment comes to grade and passes through a 2,000-ft segment of residential development, then transitions to aerial structure, and passes over the ramps of the Via Princessa interchange. The alignment continues northeasterly on tangent, passing over the SPTC railroad tracks, the Santa Clara River, and State Route 14, after which the alignment turns on a 5,000-ft radius curve and continues northeasterly parallel to State Route 14 to Sand Canyon Station. Leaving the station, the alignment passes over Sand Canyon Road and then turns on a 5,000-ft radius curve and a 20,000-ft radius curve before proceeding northeasterly on a long tangent section alternating between aerial, at-grade, and tunnel configurations, passing under Agua Dolce Road.

At Margarita Canyon, the alignment turns southeasterly on a 16,000-ft radius curve, and at Crown Valley Road, it turns northerly on a 16,500-ft radius curve, crossing over State Route 14. That alignment joins the alignment along existing highways (Alt. 1) at Lake Palmdale. For the remainder of the route, the Super Speed alignment is identical to the highway alignment.

Beginning at Escondido Canyon, the alignment is in tunnel for 3.5 miles; then it transitions to aerial configuration and passes over Escondido Canyon Road, Red River Mine Road, and finally Governor's Mine Road. The alignment transitions to a 1-mile-long tunnel configuration again east of Acton Canyon. East of the tunnel, the alignment transitions to aerial structure and then passes over State Route 14 and the Sierra Highway before entering a 4-mile-long tunnel under the Sierra Pelona Hills south of Palmdale. Emerging from the tunnel, the alignment transitions to aerial configuration, passing over Barrel Spring Road, the California Aqueduct, the San Andreas Rift Zone, and finally State Route 14. From here to the end of the alignment, the profile is the same as that for the highway alignment (Alt. 1).

4. Passenger Stations

4. PASSENGER STATIONS

4.1 GENERAL

Three stations are proposed in the first stage development of the proposed HSGT and Super Speed system between Palmdale and the San Fernando Valley. The Palmdale Terminal Station is proposed to be incorporated within the future airline terminal building; the San Fernando-North Station would be located near the intersection of the San Diego and Golden Gate freeways; and an intermediate station is proposed adjacent to the Antelope Valley Freeway at Sand Canyon Road.

Presented in the following are passenger station design criteria followed by a short narrative concerning the three proposed passenger stations. Included in Appendix B are drawings of the three passenger stations as well as a layout of a prototypical side-platform, aerial passenger station.

4.2 PASSENGER STATION DESIGN CRITERIA

The station design criteria that follow are general and subject to technology, baggage handling, and code-related issues.

4.2.1 Functions

The primary functions to be accommodated at the passenger stations include the following:

- Processing of patrons from entry to the stations to boarding the HSGT/ Super Speed train, including the collection of fares or transfer devices.
- Provision of an information office to assist patrons and facilitate station security.
- Orientation of patrons with respect to use of the stations and related transportation modes.
- Special provisions to accommodate elderly and handicapped patrons.
- Provision of a physical environment for patrons which is safe and comfortable and in keeping with the transitorial function of the stations.
- Special provisions for baggage handling and transfer, segregated from public circulation within the fare-paid zone.
- Housing of operational electrical and mechanical equipment.

4.2.2 Trackway and Platform

A 600-ft-long platform is assumed. Should projected system operations indicate that a greater or lesser train capacity is appropriate, the platform length will be adjusted accordingly.

A side-platform station configuration is preferable if baggage handling is to be segregated from public circulation areas at platform level. The station platforms shall be a high-level-type platform to accommodate the handicapped and for easy loading and unloading.

Platform width shall be determined by patronage and code requirements. The minimum distance between the edge of platform and any continuous platform obstruction shall be 8 ft 0 inches. Any obstruction not over 18 inches long may encroach 6 inches into the 8 ft 9 inches.

The guideway shall extend a minimum of 75 ft beyond the platform on both horizontal and vertical tangents.

4.2.3 Station Amenities

- Weather Protection

  A canopy shall be provided over the entire length of the platform and wind screens shall be installed as required.

- Benches

  Provide benches at one or more locations along the platform.

- Public Restrooms

  Public restrooms shall be provided at stations.

- Other Station Amenities

  Additional passenger amenities shall include a route map and schedule display case, trash receptacles, public and emergency telephones, and a public address system. Lighting of platform and other public station areas shall comply with established industry standards for public transit facilities.

4.2.4 Handicapped Accessibility

The passenger stations shall be fully accessible by elderly and handicapped passengers. The State of California regulations pertaining to barrier-free design shall be followed.

4.2.5 Vertical Circulation

Where changes in level occur, vertical circulation elements consisting of escalators, stairways, elevators, and ramps shall be provided as required.

4.2.6 Fare Collection

A fare collection barrier consisting of a railing or low partition containing fare gates and a service gate shall be provided in the station concourse area. This barrier will divide the station into a "free area" and a "paid area." One swing-type, remotely actuated service gate shall be provided in each fare barrier for use by handicapped persons and maintenance personnel and equipment.

4.2.7 Station Site Design

The design of station sites shall accommodate access by the following modes:

- Pedestrian
- Bicycle
- Motorcycle
- Bus
- Automobile.

Kiss-and-Ride and Park-and-Ride facilities shall be provided at all station sites, based on anticipated demand.

4.2.8 Prototypical Station

Drawing 4-1 in Appendix B illustrates a prototypical elevated-side platform station based on the above design criteria.

4.3 PALMDALE TERMINAL STATION

The Palmdale Station shall be incorporated into the proposed airport terminal building to consolidate these facilities and simplify transfers between the HSGT/ Super Speed system and the airport. A two-level side-platform station is proposed with public access provided at grade through the main air terminal entrance. Passengers arriving by car/bus/taxi and transferring from aircraft shall buy tickets and check baggage on this level. Escalators, elevators, and stairs shall access platform level, and baggage handling shall be totally segregated from public areas on this level. Long-term and short-term parking is assumed to be integral with equivalent facilities provided to serve airport needs.

Drawing 4-2 in Appendix B illustrates the terminal station's relationship to the Palmdale Airport Terminal and related facilities.

4.4 SAND CANYON STATION

The Sand Canyon Station is proposed to be located on the southeast side of the Antelope Valley Freeway at Sand Canyon Road. The station shall be an elevated structure of side-platform configuration. The station's entrance, ticketing, and baggage handling shall be at-grade, and the boarding platforms shall be on the second level. On-site parking shall provide 26 short-term and handicapped spaces and 573 long-term spaces. Exclusive bus and taxi zones shall be provided adjacent to the station entrance. A new road will be required from Sand Canyon Road to provide vehicular access to the station.

See Drawing 4-3 in Appendix B for general arrangement.

4.5 SAN FERNANDO-NORTH STATION

The San Fernando-North Station is proposed to be located on the southwest side of the Golden State Freeway (Interstate Route 5) at Roxford Street. The statio shall also be a two-level side-platform station with the guideways and passenger boarding platform at the upper level.

A lobby, baggage handling facilities and ticket office shall be located at the lower level. Parking shall be provided for about 1,000 cars - 190 spaces for short-term and handicapped parking and 810 spaces for long-term parking. Exclusive bus and taxi zones shall also be provided adjacent to the station entrance. Vehicular access to the station shall be from a new road connecting Roxford Street to the north to Rinaldi Street to the south.

See Drawing 4-4 in Appendix B for general arrangement.

5. Operational Analyis

5. OPERATIONAL ANALYSIS

Presented in this section are train performance analyses for the HSGT and Super Speed technologies between San Fernando and Palmdale Regional Airport, followed by descriptions of conceptual operating and maintenance plans for the HSGT and Super Speed alternative systems.

5.1 TRAIN PERFORMANCE INVESTIGATION

5.1.1 Criteria

Following are train performance analyses of the High Speed (up to 125 mph) alternatives, and the Super Speed (up to 250 mph) alternative linking the northern end of San Fernando Valley with Palmdale Regional Airport.

Train performance characteristics, run times, average speeds, and power requirements for operation over alternative routes were developed using ICF Kaiser Engineers' Transit Operational Model (TOM) computer simulation program.

This analysis evaluates operations over the three alternative routed described in Section 3 and Appendix A.

System performance during peak operation was evaluated assuming that the system transports 2,000 passengers per hour in each direction.

One representative system technology was chosen for the High Speed and Super Speed alternatives. The High Speed alternative technology consists of a steel wheel on steel rail system using an electric locomotive, the ALP-44, pulling passenger cars. This train configuration currently operates in Amtrak's Northeast Corridor and achieves operational speeds of 125 mph. The Super Speed alternative technology is a magnetically levitated (MagLev) system using the Transrapid 07 system under development in the Federal Republic of Germany. There are currently no MagLev systems in revenue service anywhere in the world, but the Transrapid 07 is the closest to achieving commercial operation. (See Section 7.1 of this report for details of these two systems.)

The following sections document the investigations done for each system.

5.1.2 High Speed System

The ALP-44 electric locomotive was used as the baseline for steel wheel on steel rail high speed system technology. The TOM simulation assumed one locomotive to pull five to six passenger cars, each carrying 80 passengers and baggage. Operating headways (time spacing between operating trains) of 12 minutes will allow the system to accommodate the assumed peak patronage of 2,000 passengers per hour each way. Turnback times at the ends of the route are assumed to be 10 minutes to allow the locomotive to be decoupled from the train at the end of the line and recoupled to the other end for the return trip. The assumed station dwell time at the intermediate (Sand Canyon) station is 60 seconds.

Table 5-1 shows the analysis results for the Highway and Railway Alignments (Alts. 1 and 2), as well as for the Super Speed Alignment (Alt. 3).

Table 5-1
Train Performance Investigation Results

Alignment Alternatives	Travel Direction	Alignment Distance (miles)	Run Time (minutes)	Average Operating Velocity (mph)
Alt. 1	eastbound	40.9	29:02	84.5
Highway	westbound	40.9	27:28	89.3
Alt. 2	eastbound	40.0	28:06	85.4
Railway	westbound	40.0	26:43	89.8
Alt. 3	eastbound	37.9	14:13	160.0
Super Speed	westbound	37.9	14:13	160.0

Estimated eastbound and westbound trip times and average speeds are similar for both High Speed alignments. Since the eastern terminal of both lines is at a higher elevation than the western terminal, both routes have longer trip times and lower average velocities in the eastbound direction. Average velocities are a little higher on the railroad alignment than on the highway alignment due to the railroad alignment's lower grades. Average train power requirements (described in Section 7.2) are essentially the same for both routes.

Figures 5-1 and 5-2 show the allowable operating and average velocity profiles derived from the simulation runs in both directions for the High Speed alignment alternatives. These figures illustrate the following factors that limit train speed:

1. Curve speed restrictions confine the system's allowable speed to under 125 mph over much of the alignment.

2. The assumed locomotive is unable to maintain high train operating speeds on 3-5 percent grades. Locations of these grades are shown in the velocity profiles by regions where the operating velocity curve flattens or falls when it is not constrained to do so by the allowable velocity due to curvature.

Figure 5-1
Highway Alignment Velocity Profiles

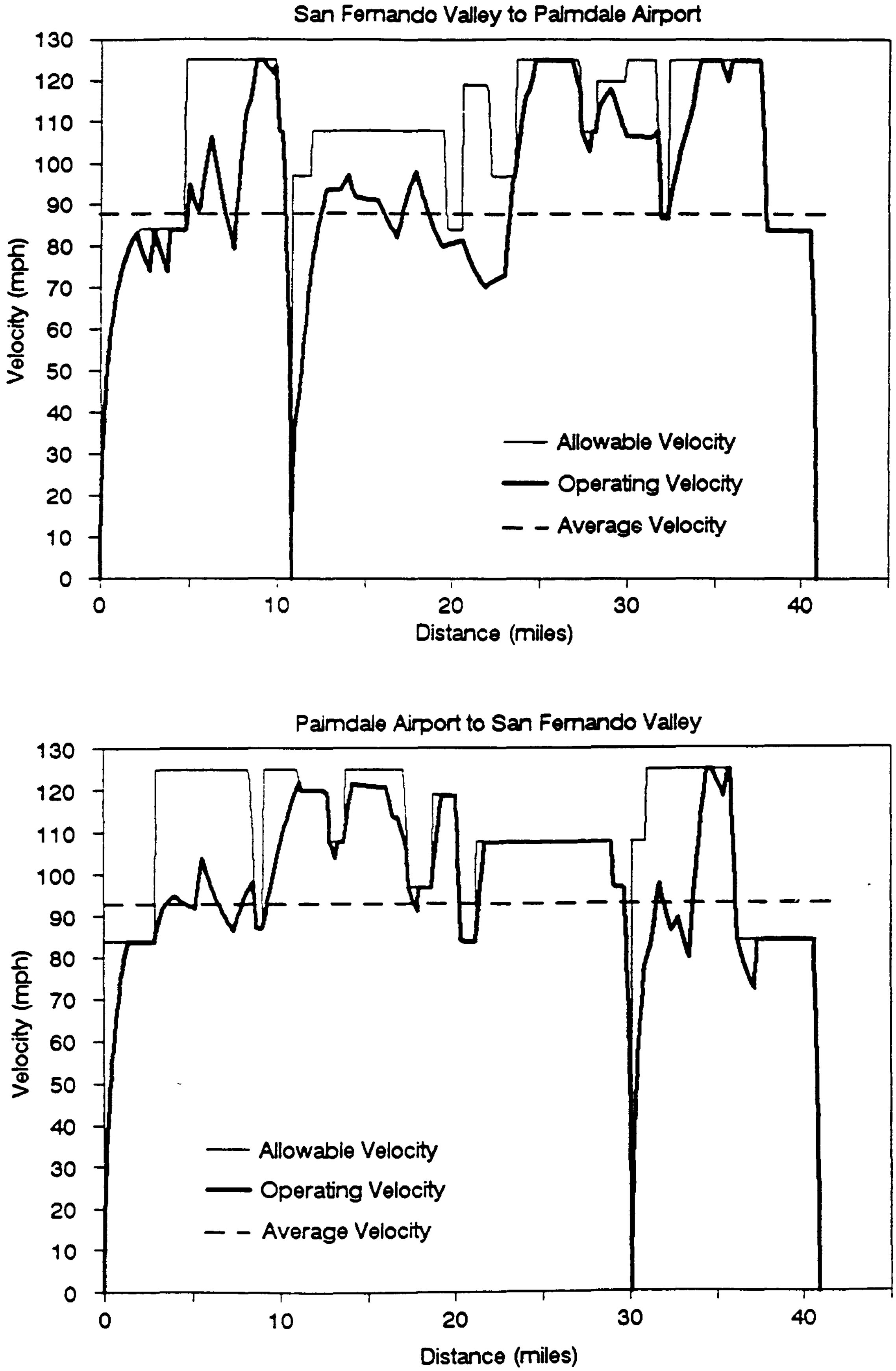
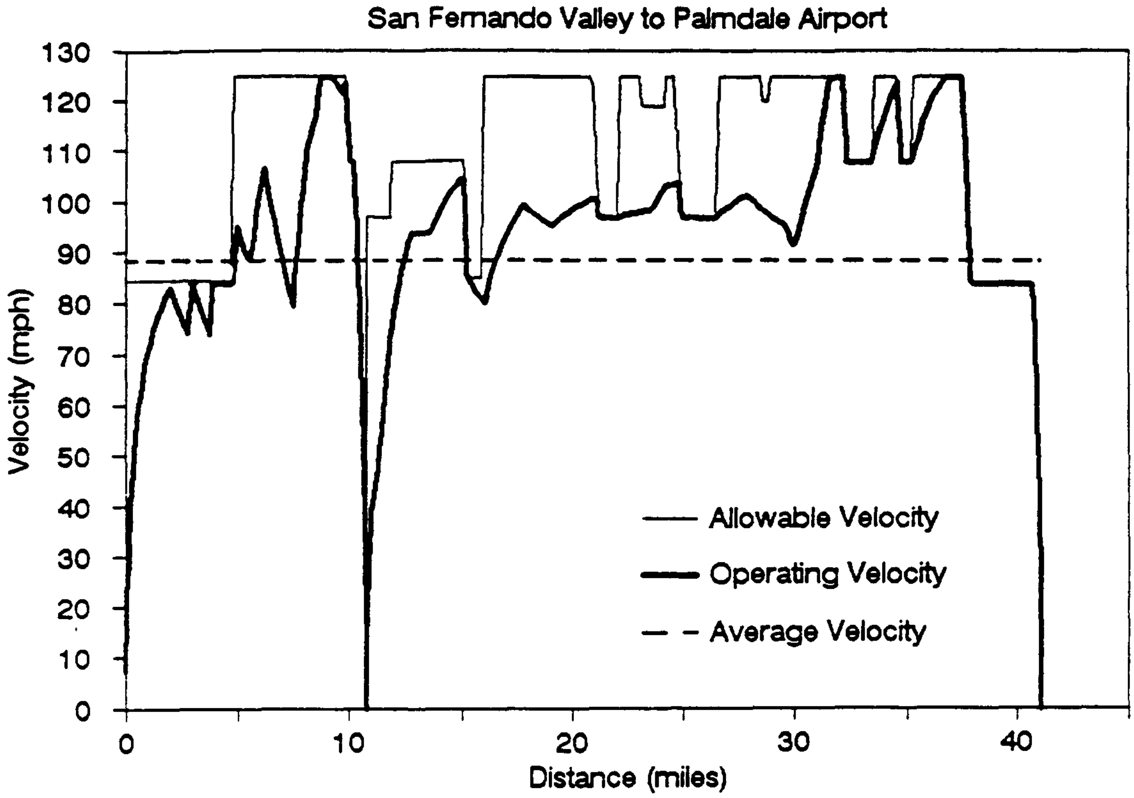
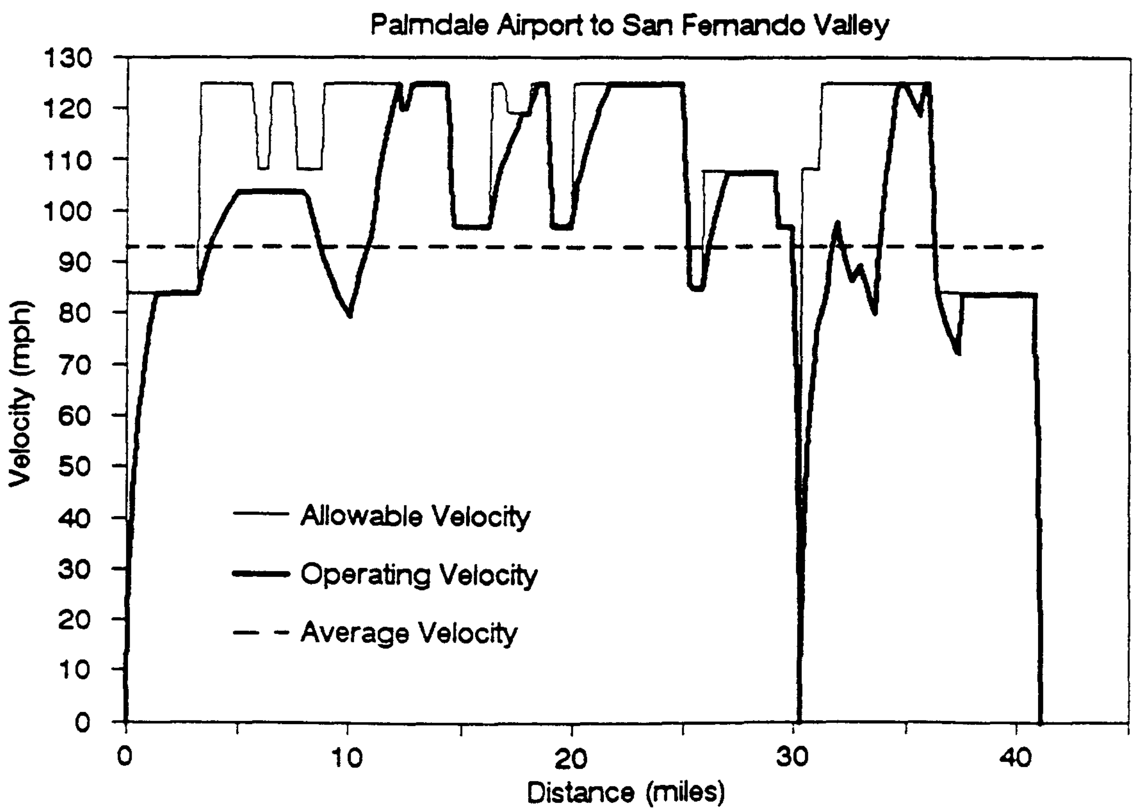


Figure 5-2
Railway Alignment Velocity Profiles





Characteristics of the locomotive's DC traction motors cause poor train performance on grades because these motors provide limited tractive effort at high speeds. Additional computer simulations show that if two locomotives are used with each train, trains can achieve run times of approximately 25.5 minutes and average speeds of about 96 mph over these alignments. If the intermediate stop at Sand Canyon is removed from the alignments and two locomotives are used, trains can achieve trip times of about 24 minutes and average speeds of around 103 mph.

Simulations show that the power requirements for the two alignments are essentially the same because route length and train performance over the alignments are similar. (See Section 7.2 for more information on power consumption.)

5.1.3 Super Speed System

The Transrapid 07 MagLev train assumed for the computer simulation consists of five to six vehicles. Each vehicle is powered and carries 80 passengers plus baggage. Operating headways are 12 minutes, allowing the system to accommodate 2,000 passengers per hour. The station dwell time at Sand Canyon is 60 seconds. Because the system is bi-directional, turnback times at terminal stations are assumed at 5 minutes.

Table 5-1 shows the analysis results for the Super Speed system simulation. The Transrapid 07 system achieves an average velocity of 160 mph in both directions, significantly lower than the 250 mph maximum velocity of which the system is capable. Two reasons for this are:

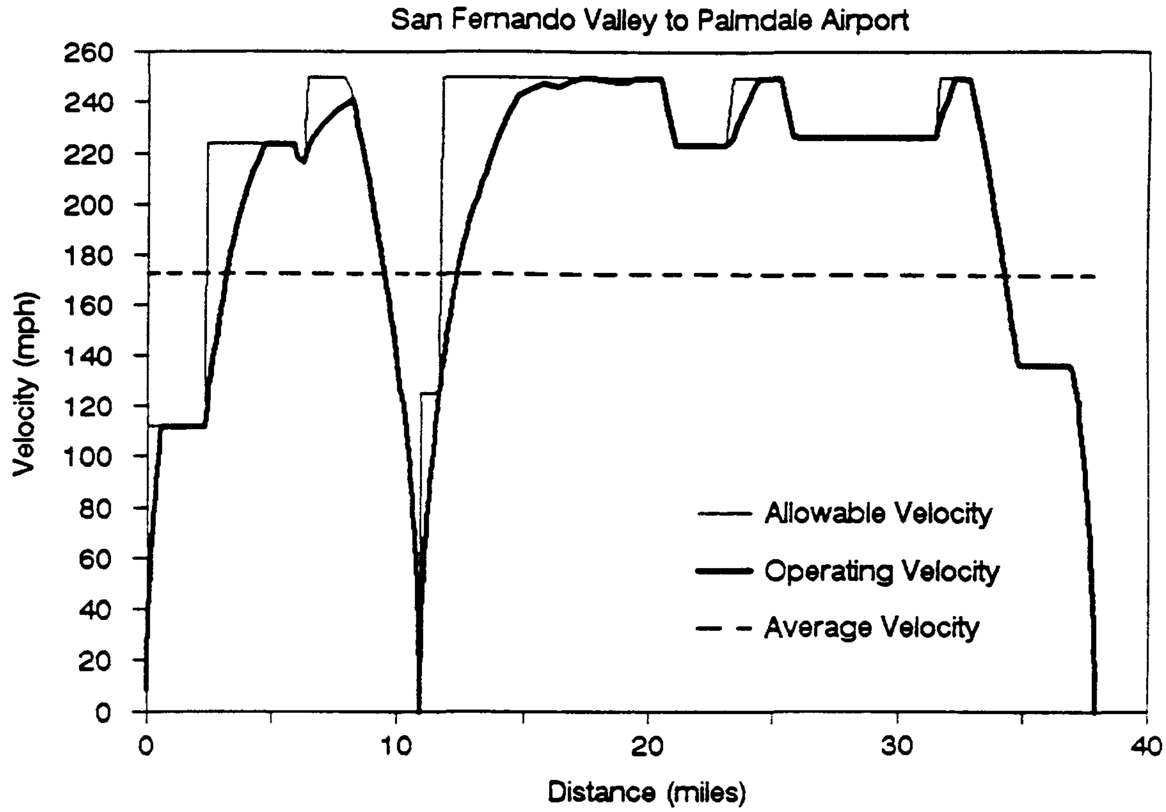
1. Curve speed restrictions hold the maximum allowable velocity to below 250 mph over much of the alignment.

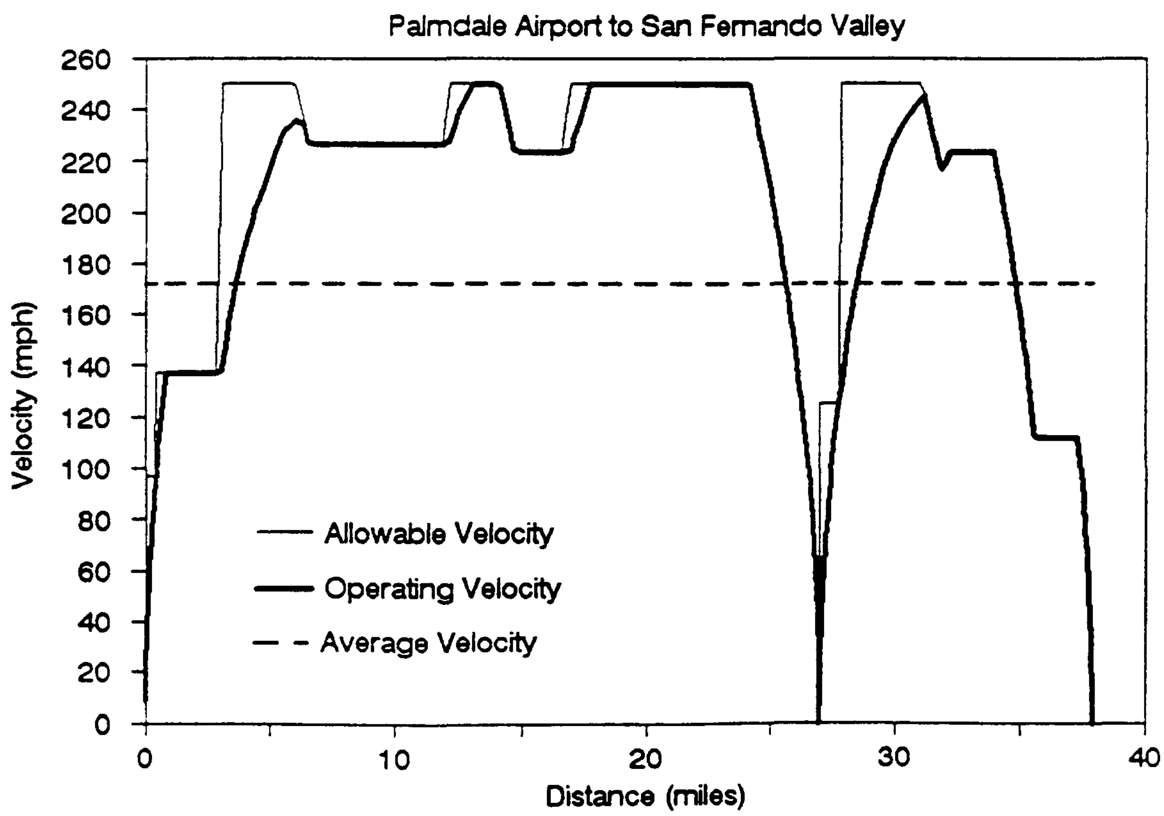
2. Since station-to-station run times are relatively short for a system with a 250-mph top speed, a proportionally large part of the station-to-station run times are taken up by starting acceleration and stopping deceleration. This allows only a relatively short amount of time cruising at maximum possible operating velocity.

Though the route is more uphill in the eastbound direction, trip times are equal in eastbound and westbound directions because the Transrapid 07 can operate on grades up to 10 percent, and the maximum grade on this route alignment is maintained at 5 percent. Consequently, the propulsion system is powerful enough to provide high acceleration on all alignment grades.

Figure 5-3 shows the eastbound and westbound profiles for allowable velocity, operating velocity, and average velocity. The train performs well over the route profile with the operating velocity profile very close to the allowable velocity

Figure 5-3
Super Speed Velocity Profiles





profile and the operating velocity decreasing only when constrained to do so by the allowable velocity in curves.

The power requirement for the Super Speed MagLev system is approximately 30% higher than that of the High Speed system because the Transrapid 07 operates at a higher performance level and higher speeds than does the High Speed system. (In light of the considerable speed and performance advantage of the Transrapid 07 over the steel wheel on steel rail system, its higher power requirement is not excessive. The Transrapid's frictionless support system and lighter vehicle weight help lower its power requirement.)

5.2 OPERATING AND MAINTENANCE PLANS

The conceptual operating and maintenance (O&M) plans for the conventional High Speed steel wheel/steel rail technology and the Super Speed technology are presented below. The conceptual operating plans include assumed service levels, fleet sizes, and operational methodologies and requirements. The conceptual maintenance plans include maintenance philosophies, methods, and requirements for the equipment maintenance and fixed plant maintenance functions. The O&M plan material is presented by category rather than by technology in order to avoid duplication of common information and to allow data to be compared more easily.

5.2.1 Operating Plans

The operating plans are based upon certain assumptions which are common to both of the technologies and to all of the proposed alignments as well as upon other assumptions which are specific to each technology and/or alignment.

5.2.1.1 Assumptions

The assumptions common to all technologies and alignments are as follows:

A. Patronage: 2,000 passengers in peak hour in each direction

B. Stations: San Fernando North
Sand Canyon (average station dwell = 60 seconds)
Palmdale Regional Airport
(All three stations are side-platform configuration.)

C. Service Levels:

1. Hours of Operation: 24 hours per day, 7 days per week assumed, but could be compatible with airport operations if different.

2. Operating Headways:

Service Periods	Weekdays	Weekends
a. Peak	12 minutes	N/A
b. Mid-Day/Evening	30 minutes	20 minutes
c. Late	60 minutes	60 minutes

The basic operating assumptions for the HSGT and Super Speed systems including route distances, travel times, and average speeds are shown in Table 5-1.

D. Equipment - General Information:

	125-mph Equipment	250-mph Equipment
Power Source	Electric (25kV)	Magnetic levitation
Train consist	ALP-44 electric locomotive with trailer coaches (individual cars)	Transrapid TR-07 (three unit sets per train)
Length	Locomotive = 52 feet Coach = 85 feet	Each unit = 82 feet Two unit set = 164 feet
Width	Approximately 10 feet	Approximately 12 feet
Seated Capacity	80 per car with allowance for baggage	80 per unit or 150 per unit set with allowance for baggage.

5.2.1.2 Fleet Size

Fleet size is calculated based upon peak hour ridership, seated capacity, total round trip travel time (including terminal station turnback or layover time), peak hour operating headway or train consist (whichever is available or assumed), and spare equipment requirements. The calculation is as follows:

$TC = (PHR \div SC) \div TPH$ (assumes desired peak headway)

$FS = (TRT \div PH) \times TC + SE$

Where: TC = train consist (number of cars or units)
PHR = peak hour ridership
SC = seated capacity (per car or unit)
TPH = trains per hour (60 ÷ peak headway, in minutes)
FS = fleet size
TRT = total round trip time (in minutes)
PH = peak headway (in minutes)
SE = spare equipment

The fleet size and equipment requirements for each assumed operating headway for each technology are shown below. Note that the fleet requirements for the 125-mph technology applies to either the highway alignment or the railroad alignment because the travel time is essentially the same for both.

A. HSGT Technology

Service	Headway (Min)	Trains On-Line	Consist Loco/Car	Total On-Line Loco/Car	Spares Loco/Car	Total Loco/Car
Peak	12	7	1/5	7/35	2/5	9/40
Mid-Day/ Evening	30	3	1/5	3/15	N/A	N/A
Late	60	2	1/2	2/4	N/A	N/A

The required fleet size is 9 locomotives and 40 cars, based upon the following:

1. Total round trip time of 75 to 77 minutes (28 to 29 minutes eastbound plus 27 to 28 minutes westbound plus 20 minutes total for terminal turnback time).

2. Total terminal station turnback time of 20 minutes (10 minutes at each terminal for off-loading, moving the locomotive to the outbound end of the train, pre-departure testing, and passenger loading).

3. Spare equipment requirements of one train (locomotive and 5 cars) plus an additional locomotive to allow for major component change-outs (e.g., traction motors) and major overhaul cycles (may involve movement off-line to a major shop facility).

It should be noted that an alternative approach exists for the operation of the High Speed (125-mph) technology. The alternate operation is based upon a goal of achieving an average speed of at least 100 mph for the San Fernando to Palmdale Airport routs.

The alternate operation uses two locomotives with each five car train. By placing one locomotive at each end of the train, the turnback time at the terminal stations can be reduced to 10 minutes total (versus a total of 20 minutes if the locomotive has to be moved from one end of the train to the other). The use of two locomotives also increases system reliability because one locomotive can handle the train (at reduced speed) if the other one fails.

The alternative operation also avoids the station stop at Sand Canyon in order to achieve a higher average speed (the average speed is 95.2 mph eastbound and 97.0 mph westbound if the station stop is made).

Given the use of two locomotives per train and no intermediate station stop, the following results can be achieved:

- Average speed is 102.3 mph eastbound and 104.2 mph westbound.

- The total trip time is approximately 24 minutes, one-way, in either direction or 58 minutes round trip, including turnback time.

- Fleet requirements change from 9 locomotives and 40 cars to 12 locomotives and 30 cars. The faster travel time requires only 5 trains on-line for the 12-minute peak headway versus the previous requirement for 7 trains on-line.

B. Super Speed Technology:

Service	Headway (Min)	Trains On-Line	2-Unit Sets Per Consist	Total 2-Unit Sets On-Line	Spare 2-Unit Sets	Total 2-Unit Sets
Peak	12	4	3	12	9	21
Mid-Day/ Evening	30	2	3	6	N/A	N/A
Late	60	1	1	1	N/A	N/A

The required fleet size is 7, three-unit sets (equivalent to 21, two-unit sets or 42 individual units) based upon the following:

1. Total round trip time of 38 minutes (14 minutes eastbound plus 14 minutes westbound plus 10 minutes total for terminal turnback time).

2. Total terminal turnback time of 10 minutes (5 minutes at each terminal for off-loading, changing ends of the train by the crew, pre-departure testing, and passenger loading).

3. Spare equipment requirements of 3, three-unit train sets (equivalent to 9, two-unit sets or 18 individual units) in order to provide one "ready use" train set and two maintenance spare train sets. The spare equipment requirements include consideration for the isolated application of the MagLev technology and thus, the need for "complete" maintenance capability.

5.2.1.3 Operating Philosophy

Train operations for both technologies are assumed to be conducted in accordance with the following basic philosophy of operations:

A. All aspects of train operations, station operations, security and emergency response and coordination, and main-line-related maintenance activities will be monitored, controlled, and/or coordinated from a central dispatcher's office located at the yard and shop site.

B. During normal revenue operations, all trains will operate over the entire route and will stop at all stations. Travel time will be as consistent as possible for all service periods and service will be based upon a goal of providing a seat for every passenger.

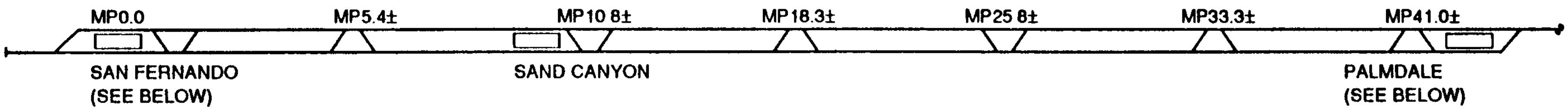
C. Crossovers and other special trackwork or guideway structure will be provided to allow operations to continue around main line maintenance activities, train and wayside equipment failures, or other abnormal conditions whenever necessary. See Figure 5-4 and Figure 5-5 for the locations of special track/guideway structures for the High Speed and Super Speed technologies, respectively.

D. Station operations will include staff for assisting passengers with fare payment and/or information, train schedule information, baggage handling, and other passenger-related activities.

E. On-board train personnel will include four to five employees. The High Speed train crew may consist of engineer, brakeman, and conductor positions if the operation is similar to Amtrak's in the Northeast Corridor. The Super Speed train crew may consist of train operator and passenger service employee positions if the operation is similar to that proposed for the Las Vegas system.

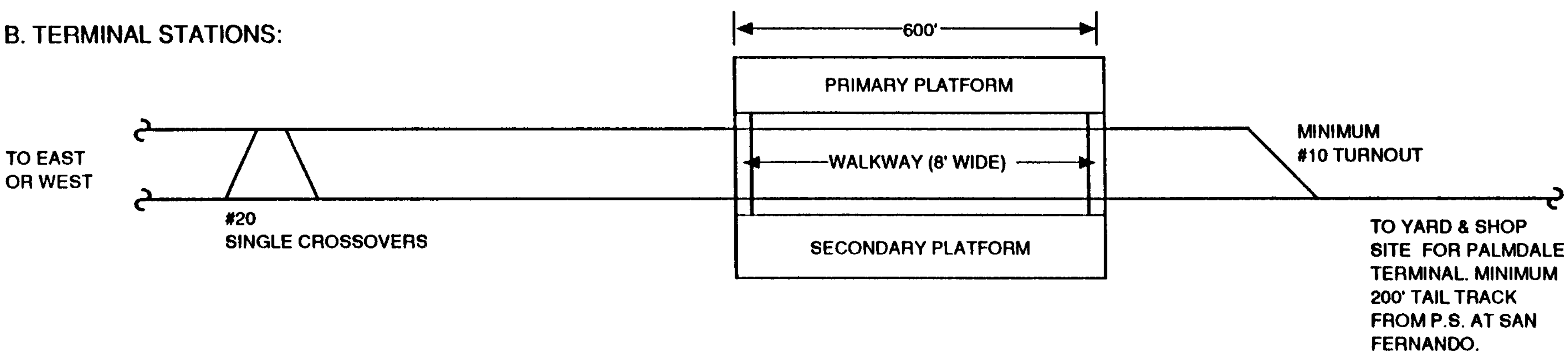
Figure 5-4
Special Trackwork Requirements - 125-mph High Speed Technology

A. MID-ROUTE (FOR BOTH HIGHWAY & RAILROAD ALIGNMENTS):



(MP = MILEPOST)
ALL MID-ROUTE TURNOUTS ARE #30, MINIMUM (WITH SWING-NOSE FROGS)

B. TERMINAL STATIONS:



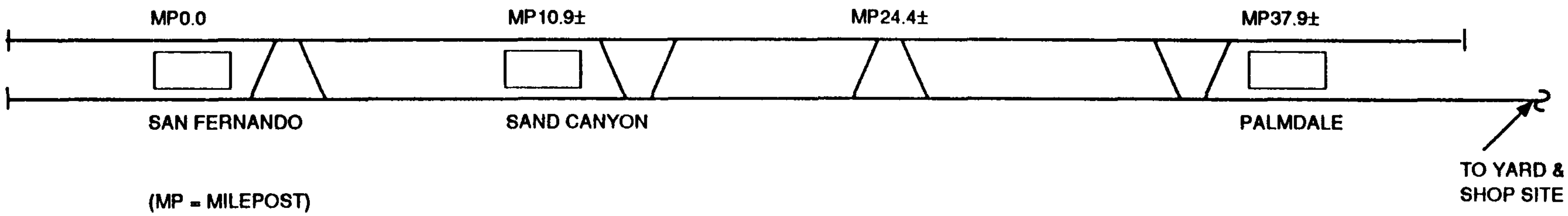
NOTE 1: STATION TRACKS ON 13' OR 14' CENTERS.

NOTE 2: TERMINAL & STATION PLATFORMS TO ACCOMODATE 5 CARS PLUS SPACE FOR LOCOMOTIVE AT EACH END (FOR TURNBACK) BETWEEN CROSSWALKS.

NOT TO SCALE

90084-008,Drwg 1WD

Figure 5-5
Special Guideway Requirements - 250-mph High Speed Technology



NOTE 1: ALL GUIDEWAY SWITCHES ADJACENT TO STATIONS ARE 67-METER, LOW-SPEED TYPE. SWITCHES AT ±MP24.4 ARE 132.1-METER, HIGH-SPEED TYPE.

NOTE 2: TAIL GUIDEWAYS (TWO AT SAN FERNANDO, ONE AT PALMDALE) TO BE MINIMUM LENGTH OF 600' BEYOND STATION PLATFORM.

NOTE 3: STATION PLATFORMS TO BE MINIMUM 600' IN LENGTH WITH CROSSWALKS AT EACH END OF SIDE PLATFORM AREAS.

NOT TO SCALE

90084-008,Drwg 2WD

5.2.2 Maintenance

The overall philosophy and requirement for planned, controlled maintenance applies to both the High Speed and the Super Speed technologies. Controlled maintenance over the life of any system is economical, contributes to increased safety and availability, and is conductive to lower operating costs.

5.2.2.1 Maintenance Philosophy

Maintenance of equipment and fixed facilities is based upon the following philosophy for maintenance:

A. Maintenance is a service responsible for making available to operations, on a timely basis, the equipment and facilities necessary to perform their intended functions safely, efficiently, and economically. Maintenance is divided into several different programs, each of which has differing requirements.

A1. Preventive maintenance programs consist of routine tasks which are scheduled and performed at specified intervals. They are established to reduce service failures and resultant corrective repairs, to prolong facility and equipment life, and to ensure operational safety and system dependability.

A2. Corrective repair programs consist of troubleshooting, repairing failed equipment on line or removing and replacing the lowest level replaceable unit, testing, (either on line or in a component repair shop), and returning equipment to service. Corrective repair programs provide the capability to restore operations and/or failed equipment to service as quickly as possible.

A3. Contract repair programs may be used to repair and overhaul certain assemblies or components or to provide routine cleaning of equipment and/or facilities. Such programs would be performed under contract to local service shops or to the original equipment manufacturers. The decisions as to which work is contracted must be based upon evaluation of the following factors:

1. Availability of suitable contractors
2. Labor agreements
3. Special skills and/or equipment requirements
4. Liability implications
5. Equipment warranty implications
6. Logistics, inventory, and material handling requirements
7. Complexity and criticality consideration
8. Relative costs.

B. To facilitate and control the above programs, a maintenance scheduling function is used to provide support to equipment and facilities maintenance. This function maintains workload schedules and maintenance records and documentation and coordinates maintenance activities and requirements with operations, engineering, and inventory control personnel.

5.2.2.2 Maintenance Functions

The maintenance organization assumed for these alternatives consists of the following functional areas or groups:

- Equipment maintenance
- Facility maintenance
- Maintenance support.

Equipment maintenance involves the servicing, maintenance, repair, and overhaul of all revenue equipment such as locomotives, trailer cars, and train sets. Non-revenue equipment, such as specialized maintenance vehicles, may also be included under this function.

Facility maintenance (or maintenance-of-way) involves the servicing, maintenance, repair, and overhaul of fixed facilities and equipment such as track or guideway, train control, traction power, communications, fare collection equipment, buildings and structures, and landscaping and fencing.

Maintenance support includes activities such as scheduling, inventory and material control, training, and maintenance engineering.

The maintenance organization will coordinate the performance of its functions with those of system operations in order to minimize the impact of maintenance upon train operations. Whenever possible, maintenance activities which interfere with main line operations will be performed at times other than during peak service hours. General guidelines for the performance of maintenance operations are as follows:

A. Equipment Maintenance

1. Train cleaning and washing - performed daily during mid-day and late hours.

2. Preventive maintenance - performed daily during mid-day and late hours.

3. Corrective repair - performed as required during mid-day and late hours.

4. Response to in-service problems - performed during all hours of service.

B. Facility Maintenance

1. Response to critical problems - performed during all hours of service, especially for track or guideway, train control, traction power, and communications.

2. Track or guideway - preventive maintenance and non-critical repairs performed during late hours. Inspection performed daily during mid-day hours.

3. Train control and traction power - preventive maintenance and non-critical repairs performed during mid-day hours (for activities which involve substations, train control equipment bungalows, or other off-main locations) and during late hours (for track/guideway or catenary activities on the main line).

4. Communications - performed during all hours of service.

5. Fare collection equipment - performed during mid-day and evening hours.

6. Buildings, stations, landscaping, fencing, etc. - performed during day-time hours on weekdays. Station janitorial work performed during mid-day or evening hours. Emergencies responded to by on-call personnel.

Facilities maintenance is performed using radio-equipped, specialized maintenance vehicles and standard automotive vehicles. Maintenance vehicles will transport personnel, equipment, tools and spare parts and supplies to the work site. Specialized maintenance vehicles consist of hi-rail-equipped trucks or guideway-compatible vehicles which travel on the track or guideway to the work site or problem location. Specialized maintenance vehicles include the following:

- Train recovery or re-railing equipment vehicle
- Aerial work trucks (cherry-picker-type equipment)
- Track or guideway maintenance crew truck (with crane)
- Crew-cab pickups and utility body trucks (4-wheel drive)

Standard automotive vehicles include pickups, utility vans, and sedans for crews and supervisors whose duties do not require access to rough terrain areas.

5.2.3 Operations and Maintenance Concerns

With respect to the High Speed and Super Speed technologies, there are certain operations and maintenance (O&M) related issues, which are discussed below.

A. Train Crew Requirements

For both technologies, the number of employees required on each train will depend upon the actual labor agreement which is negotiated. The O&M cost estimate presented in this report assume that only one employee is required to operate a train. This estimate is practical given that controls can be provided which, if the operator fails to respond at preset intervals, activate the train's brakes. It is conceivable, however, that demands will be made to require at least two employees in the operating cab, especially true for the Super Speed technology.

B. MagLev Technology

MagLev technology is very complex and has yet to be used in revenue service applications. As a result of the lack of service-proven information, the following concerns exist:

- Train movement from one track to another is accomplished by actual movement of the switch guideway in a pre-determined area from one alignment to the other by traversing the support frames in a synchronized and accurately controlled manner. Fail-safe design principles must be incorporated to preclude train operation through an open or partially open switch.

- Because of the massive and complex nature of the switching guideway, provision for future line extensions and additional guideway expansion should be included in the initial system construction. Otherwise, future installation of switch guideways will significantly impact train operations. It should also be noted that at-grade guideway-across-guideway crossings are not possible. Grade-separated guideway crossings at future line interchange locations will be required.

- At very low speeds or when at rest, MagLev vehicles use support skids or small wheels. Various categories of failures will need to be analyzed during system design to establish operating failure management procedures for such conditions as pulling or pushing a failed train, train operation with a failed vehicle in the consist, and restricted speed operations.

- The effects of blowing and drifting sand must also be addressed in the design of a MagLev system.

C. Yard and Shop Facilities

Given the potential routes for either the High Speed or Super Speed technology, consideration should be given to the construction of a common, centralized storage and maintenance facility. A centralized facility would be beneficial for the LAX to Palmdale, Palmdale to Las Vegas, and Palmdale to Northern California routes.

6. Environmental Impact Analysis

6. ENVIRONMENTAL IMPACT ASSESSMENT

6.1 INTRODUCTION

The purpose of this section is to document potentially significant environmental impacts associated with the proposed HSGT and Super Speed alternatives. Environmental impact discussions presented below address project construction, operation, and possible mitigation and are limited to those categories where obvious adverse environmental impacts could result from project implementation (land acquisition and displacement, noise and vibration, traffic and parking, and visual/aesthetic). A general impact discussion is presented for other environmental categories. All environmental categories and the potential impacts are summarized together in a matrix format for each proposed technology and alignment (Figures 6-1, 6-2, and 6-3). Identified project environmental impacts are presented to document potentially significant, moderately significant, and slightly significant adverse environmental impacts and to outline areas for further environmental work and coordination. Under all project scenarios, a draft Environmental Impact Report/Environmental Impact Statements (EIR/EIS) to meet CEQA and NEPA requirements will be required prior to environmental clearance.

6.2 LAND ACQUISITION AND DISPLACEMENT

For both alignments and technologies, land acquisition and business/residential relocation will be a significant issue. In many cases land will need to be acquired from the Los Angeles National Forest. Acquisition of land taken from the National Forest will need to be coordinated with the California Department of Parks and Recreation and the United States Department of Interior.

Except for the Palmdale Airport Station, private land acquisition for station sites and adjoining park-and-ride lots will be required.

6.2.1 Construction Impact

Due to the nature of the type of construction necessary for either a HSGT or Super Speed system, large parcels of land will be required for construction material staging and storage. Exact locations should be identified during the preliminary engineering phase of the project.

6.2.2 Operation Impact

HSGT Freeway Alignment - The proposed HSGT freeway alignment will be adjacent to the freeway for the entire route. In some locations, in order to maintain high speed operations, the guideway will cross the freeway in an uninterrupted bridge span. Land acquisition impacts associated with this alignment will be numerous and significant.

Figure 6-1
HSGT - Freeway Alignment

Environmental Category	Possible Significant Adverse Impact	Possible Moderate Adverse Impact	Slight Impact	No Impact	Unknown Impact
Land Acquisition and Displacement	●				
Noise and Vibration	●				
Traffic and Parking	●				
Visual	●				
Ecologically Sensitive Areas/ Endangered Species	●				
Hazardous Waste					●
Cultural Resources	●				●
Land Use and Zoning		●			
Flooding			●		
Community Disruption		●			
Wetlands	●				
Air Quality			●		

Figure 6-2
HSGT - Railroad Alignment

Environmental Category	Significant Impact	Moderate Impact	Slight Impact	No Impact	Unknown Impact
Land Acquisition and Displacement	●				
Noise and Vibration	●				
Traffic and Parking	●				
Visual	●				
Ecologically Sensitive Areas/ Endangered Species	●				
Hazardous Waste					●
Cultural Resources	●				●
Land Use and Zoning		●			
Flooding			●		
Community Disruption		●			
Wetlands	●				
Air Quality			●		

Figure 6-3
Super Speed - Freeway Alignment

Environmental Category	Significant Impact	Moderate Impact	Slight Impact	No Impact	Unknown Impact
Land Acquisition and Displacement	●				
Noise and Vibration	●				
Traffic and Parking	●				
Visual	●				
Ecologically Sensitive Areas/ Endangered Species	●				
Hazardous Waste					●
Cultural Resources	●				●
Land Use and Zoning		●			
Flooding			●		
Community Disruption		●			
Wetlands	●				
Air Quality			●		

For the HSGT freeway alignment, the potential exists for residential units to be displaced in the vicinity of Avenue P-8 and Q, east of Division Street in Palmdale. Preliminary conversations with Caltrans indicate that property in this area will be required for State Route 138 which will also impact this residential area. Future phases of both projects (HSGT and SR 138) will better define exact property requirements in this area.

HSGT Railroad Alignment - Along the freeway portion of the project, land acquisition and displacements will be identical to that of the HSGT freeway alignment. However, due to the necessity to expand several curve radii following the railroad, property needs significantly increase. Property requirements in the Soledad Canyon area are significant. At least four residential units will be acquired in the Soledad Canyon area and property takes will be necessary in the Thousand Trails trailer park. Depending on the final design and EIR/EIS findings, additional residential units in a subdivision near the Vincent Fire Station may be required. In addition, land will be required from the Los Angeles National Forest.

Super Speed Alignment - The Super Speed alignment essentially follows the alignment proposed for the HSGT freeway alignment. However, due to super speed operation, curve radii will need to be expanded and some curves eliminated. The Super Speed alignment will, therefore, require a greater amount of land acquisition in more sensitive areas than the HSGT freeway alignment.

Stations - Land for stations and park-and-ride functions will be required for the San Fernando North Station and the Sand Canyon Road Station. For the San Fernando North Station, approximately 14 acres of land will be required to accommodate a station site and 1,000 parking spaces.

For the Sand Canyon Road Station, approximately 10 acres of land will be required to accommodate a station site and 600 parking spaces. It is estimated that the Sand Canyon Road Station may require the displacement of up to ten mobile homes and one strip business center.

6.2.3 Mitigation

Mitigation will be necessary for the acquisition of property and relocation of businesses and residents as prescribed in the California Government Code, Chapter 16, Section 7260 *et seq.* (California Uniform Relocation Assistance and Real Property Acquisition Policies Act).

6.3 NOISE AND VIBRATION

Noise and vibration will be a significant issue during construction and operation. The proposed alignments could pass within a sensitive distance of residential units near Sand Canyon Road, in the Palmdale vicinity, and scattered other locations. Recreational uses within the noise impact area include Soledad Canyon and the

Santa Clara River. Business uses are limited to areas in the vicinity of the Sand Canyon Station and the Palmdale vicinity. Specific noise impacts and associated mitigation(s) will be addressed during the preliminary engineering and EIR/EIS stages of the project.

6.3.1 Construction

One of the impacts associated with high speed rail operation is the short term noise and vibration impact of construction activity. As with any large project, construction will involve the use of machines and procedures which can result in intense noise levels and occasionally high vibration levels.

6.3.2 Operation Impact

Both HSGT (steel wheels on steel rails) and MagLev technologies are being considered for Super Speed implementation in this corridor. Regarding the HSGT technology, the most obvious concern is the wheel/rail noise. Noise generated by aerodynamics will be identical for the two technologies. Noise data obtained from vehicles manufacturers suggest that, in general, the wayside noise of a passing HSGT train will be no louder than that of heavy highway traffic. Further, the wayside noise of a passing HSGT train will be about 95 dbA at 82 feet from the track (this is less than normal urban freeway traffic noise at the same distance). It should be noted that portions of the alignment pass through less urban and rural areas and/or portions of the freeway that have lower volumes than in the San Fernando area and thus have a lower ambient noise environment. In these areas, a 95 dbA would have a much greater noise impact than in the more urban San Fernando areas.

Operation of either technology or alignment will occur in close proximity to residential uses along Sand Canyon Road and Soledad Canyon Road and within Palmdale and near recreational uses in the vicinity of Soledad Canyon and the Santa Clara River. Investigation of precise noise and vibration impact and possible noise and vibration mitigation measures are recommended during a future study phase.

6.3.3 Mitigation

Construction

There are many techniques available for reducing the noise due to construction, some of which involve little or no cost and some of which involve considerable cost. In some instances, modifications of procedures or use of different procedures and equipment can result in much lower noise levels and impact. For many projects one of the effective procedures is to include noise limit specifications in the construction contracts in order to reduce or limit noise impacts. Examples of other noise reduction measures to be used in noise-sensitive areas include:

- Replacement of individual operations and techniques by less noisy ones, e.g., using drilled piles or vibratory pile drivers instead of impact pile drivers, using welding instead of riveting, mixing concrete offsite instead of onsite, and employing prefabricated structures instead of assembling them on site.

- Selecting the quietest of alternative items of equipment, e.g., electric instead of diesel-powered equipment, hydraulic tools instead of pneumatic impact tools.

- Scheduling of equipment operations to keep average levels low, to have noisiest operations coincide with times of highest ambient levels, and to keep noise levels relatively uniform in time; also turning off idling equipment.

- Keeping noisy equipment as far as possible from site boundaries.

- Providing enclosures for stationary items of equipment and barriers around particularly noisy areas on the site or around the entire site.

Use of the above techniques can result in a 5 to 15 percent reduction in noise generation from specific construction equipment or operations.

Operation

As shown in Figure 7-3, the guideway will be designed to accommodate a noise barrier where necessary. Noise barrier locations will be identified during the EIR/EIS phase of the project.

6.4 TRAFFIC AND PARKING

Current design concepts for the HSGT and Super Speed systems propose that a significant portion of the alignment be aerial and entirely grade separated. With an aerial and grade-separated project, traffic and parking impacts associated with the proposed project (except potential station area impacts) will almost exclusively be related to the construction phase of the project. Traffic and parking impacts will be nearly identical for the different technologies and alignments.

6.4.1 Construction

The closure of freeway traffic lanes during certain construction activities may be required. When crossing interchanges and/or sides of the freeway to expand radii, large bridge spans will be required and could necessitate freeway lane interruptions/closures for construction materials and/or equipment for short durations.

6.4.2 Operation

Traffic and parking could be a concern in the vicinity of station sites. Currently, a 1,000-car parking lot is proposed at the San Fernando North Station and a 600-car parking lot at the Sand Canyon Road Station. Should these facilities not be able to accommodate demand, some spill-over parking into neighborhoods would occur.

During peak demand periods, station ingress/egress will create additional traffic and congestion in and around station sites. However, travel forecasting, traffic planning, and local government coordination can mitigate station area impacts.

6.4.3 Mitigation

Freeway lane closures during construction periods will be limited to off-peak and evening hours. When necessary, temporary lanes should be constructed to maintain freeway capacity.

Detailed travel forecasting, traffic planning, and parking demand estimates and traffic studies will be required prior to final design.

6.5 VISUAL IMPACT

Currently, the proposed alignment is planned to be predominately aerial, with some at-grade and tunnel sections proposed. Visual impacts associated with the proposed project for both technologies and alignments will be significant. The visual impact of the guideway for the alignment following the railroad could be very significant due to the slope cuts required in Soledad Canyon and the size of the guideway required. As shown in Figures 7-2 through 7-5, the guideway cross sections for the at-grade, aerial, and tunnel vary from approximately 30 feet to about 50 feet. Support column heights for the aerial cross section will also vary significantly depending on the height requirements for safe clearance. In order to safely clear existing aerial freeway ramps, guideway heights in some locations could reach heights up to 80 feet. In most cases the guideway will be above grade. Locations of at-grade and tunnel sections are proposed at this level of study for engineering reasons.

6.5.1 Construction

Visual impacts during construction are associated with required slope cuts to accommodate train guideways physically. Several of these slope cuts will be located in the Los Angeles National Forest.

6.5.2 Operation

Visual impacts associated with operation of either technology or alignment will also be significant. In some locations the guideway will be located in rural, environmentally sensitive areas (Soledad Canyon, Santa Clara River) or adjacent to residential locations. Views from the trains (aerial structure) into residential areas will be an area of concern.

6.5.3 Mitigation

Visual impacts of aerial structures are difficult to mitigate. In some locations visual impacts could be avoided through tunneling. In other locations proper design of the structures and landscaping the right-at-way could assist in softening the visual impacts.

6.6 ECOLOGICALLY SENSITIVE AREAS/ENDANGERED SPECIES

All alignments considered traverse potentially ecologically sensitive areas. The freeway alignment for both the HSGT and Super Speed could locate guideway supports in the Santa Clara River and the Los Angeles National Forest areas. The HSGT railroad alignment would locate guideway columns in Soledad Canyon either in slope cuts or within identified wetland areas. These areas are ecologically sensitive and contain several species of plant and animal life. Soledad Canyon possesses several populations of the unarmored threespine stickleback. This species was found in the Los Angeles, San Gabriel, and Santa Ana River but is now restricted to the Santa Clara River and San Francisquito Canyon. For these reasons and due to threats to its habitat, it has been placed on the state and Federal endangered species lists.

The Santa Clara River is also the only major river draining the San Gabriel Mountains that has not been channelized. The vegetation consists of fresh marsh water, coastal sage scrub, oak woodland, and riparian woodland communities. This type of broad wash is unlike that found in steeper mountain canyons and is exceedingly difficult to find in the Los Angeles basin. The trees also serve as habitat for many raptorial bird species. The red shouldered hawk is restricted to this community and is becoming increasingly uncommon in Southern California due to habitat destruction.

The Ritter Ridge area contains an excellent combination of desert and foothill plant species and has one of the finest mixed stands of joshua trees and California junipers in the country. The California Department of Fish and Game and United States Department of Interior would need to be contacted for more specific information on endangered plant and animal species that have been identified for the alignment areas. A complete biological survey identifying any endangered plant and animal species will be required in the EIR/EIS.

6.7 HAZARDOUS WASTE/MATERIALS

Field reconnaissance indicates that areas within the river beds have been used as wildcat dumping grounds. Oil cans, tires, and trash bags were observed in some locations. During the EIR/EIS phase of the project, these areas should be surveyed for evidence of hazardous waste.

Along the west side of the Golden State Freeway (I-5) and State Route 14, several oil pumping stations and refineries were observed. These areas should be surveyed for possible hazardous waste/material contamination. Depending upon the materials discovered, special handling may be required.

6.8 CULTURAL RESOURCES

Field reconnaissance indicates that the alignment may be in areas of archeological significance (Santa Clara River, Soledad Canyon). During the EIR/EIS phase of the project, potential archeological sites and their significance will need to be identified.

6.9 LAND USE AND ZONING

The proposed alignments conflicts with current land uses and zoning in several locations. Specifically, the alignment infringes into residential and recreational areas. These conflicts should be further documented during the EIR/EIS phase of the project.

In areas where stations are proposed, development pressures will increase. Future station land use and zoning policies should be developed to complement the implementation of the HSGT/Super Speed project and coordinated simultaneously with local governments and property owners to assure compatibility and protection to sensitive surrounding uses.

6.10 FLOODING

The proposed project will not create additional flood danger. Increased runoff will be created by parking lots at the Sand Canyon Road and San Fernando North Station. The exact amount of runoff will be determined in future hydrological studies. However, at this level of detail, it is not expected that the proposed project will have an adverse impact on flooding.

6.11 COMMUNITY DISRUPTION

Due to the nature of the construction for a project of this magnitude, some community disruption could be expected. Roads could be temporarily closed or construction noise and inconvenience could result. Operation of the project would not create significant community disruption.

6.12 WETLANDS

Preliminary alignment drawings indicate that the project could be placed in identified wetland locations. Wetland impacts will be more significant during periods of construction than during operation.

6.13 AIR QUALITY

Negative air quality impacts are associated with construction of the project and relate to equipment diesel emissions and dust associated with earth movement operations. Vehicles could be equipped with diesel emission traps, and appropriate dust control should be practiced.

Overall, due to vehicle mode shift and vehicle miles travelled reduction (VMT), the project appears to have a positive effect on local air quality.

6.15 CONCLUSION AND SUMMARY

Based on the level of environmental review conducted in this study, the project, as proposed, could have significant environmental impacts. These impacts relate to visual/aesthetic, noise, land acquisition, and traffic impacts during the construction and operation phases of the project. Other environmental categories that have potentially significant impacts include ecologically sensitive areas and endangered species, cultural resources, and hazardous waste.

Prior to project implementation and final design, the project will be required to submit a thorough environmental analysis as defined by the California Environmental Quality Act (CEQA) and/or the National Environmental Policy Act (NEPA) should Federal funding or the use of any federal lands or facilities be involved in any phase of the project. The purpose of the CEQA/NEPA process will be to delineate and explain any environmental impacts resulting from approval of the proposed project, identify appropriate mitigation measures designed to eliminate, avoid, or reduce environmental impacts to a level below significance, and identify alternatives to the project.

7. System and Facility Elements

7. SYSTEM AND FACILITY ELEMENTS

Presented in this section are descriptions of vehicle system technologies, electrification, train control and communications, guideway structures, vehicle storage and maintenance facility, and other applicable vehicle technologies.

7.1 VEHICLE SYSTEM TECHNOLOGY

Two types of vehicle system technologies are considered as follows:

- HSGT system - Conventional steel wheel/steel rail technology with maximum speed of 125 mph.
- Super speed system - MagLev technology with maximum speed of 250 mph.

7.1.1 HSGT System

At present, two alternative systems operate at 125-mph maximum velocities in North America. These are the Bombardier Light Rapid Comfortable (LRC) train and the Amtrak Metroliners operating in the Northeast Corridor of the United States. Other trains operate at this speed in Great Britain, Italy, and West Germany. (In addition, systems achieving maximum velocities of over 160 mph operate in France and Japan.) All of the above are steel-wheel-on-steel-rail systems. This kind of high speed transit system has been operating in revenue service for many years. It has proven to be reliable, and its features are well understood.

The Amtrak Metroliner is the basis for this report's analysis of the High Speed system. The Metroliner employs an electric locomotive of Swedish design, the AEM-7, to pull unmotorized passenger cars. This study uses the same concept. One ALP-44 locomotive (a newer version of the AEM-7) pulls a train of five to six passenger cars each carrying 80 passengers and their baggage.

The locomotive receives alternating current (AC) power from an overhead catenary at 25 kV and inverts it to direct current (DC) using on-board inverters to power the DC traction motors. The propulsion system is designed to operate on standard railroad grades of less than 3 percent, and on higher grades (such as are found in the study alignments), the locomotive's acceleration capability is reduced.

This system is designed to be mono-directional, that is, the locomotive can pull a train at high speeds but it cannot safely push it! Therefore, at the end stations of the alignment, the locomotive must be decoupled from the train and recoupled to the opposite end for the return journey.

7.1.2 Super Speed System

Magnetically levitated (MagLev) train technology is the basis for the Super Speed system study. These systems use magnetic forces between the vehicles and the guideway, rather than wheels on rails, to support the vehicles. Currently, there are three prototype MagLev systems:

- Japanese National Railways MLU
- Japan Air Lines HSST-400
- West German Transrapid 07.

At this time, no MagLev systems have been proven in revenue service, and the first commercial application of each system can expect to experience technical problems before a reliable level of service is attained.

The Super Speed study is based on Transrapid 07 technology because it is the closest of all MagLev systems to commercial applicability. Figure 7-1 shows a diagram of the Transrapid vehicle. Attractive forces between electromagnets in the vehicle and ferromagnetic stator packs arranged in two strips on the underside of the guideway levitate the vehicle. The control system maintains a constant gap between the surfaces of the vehicle and the guideway and keeps the vehicle positioned laterally in its track between the steel guiderails.

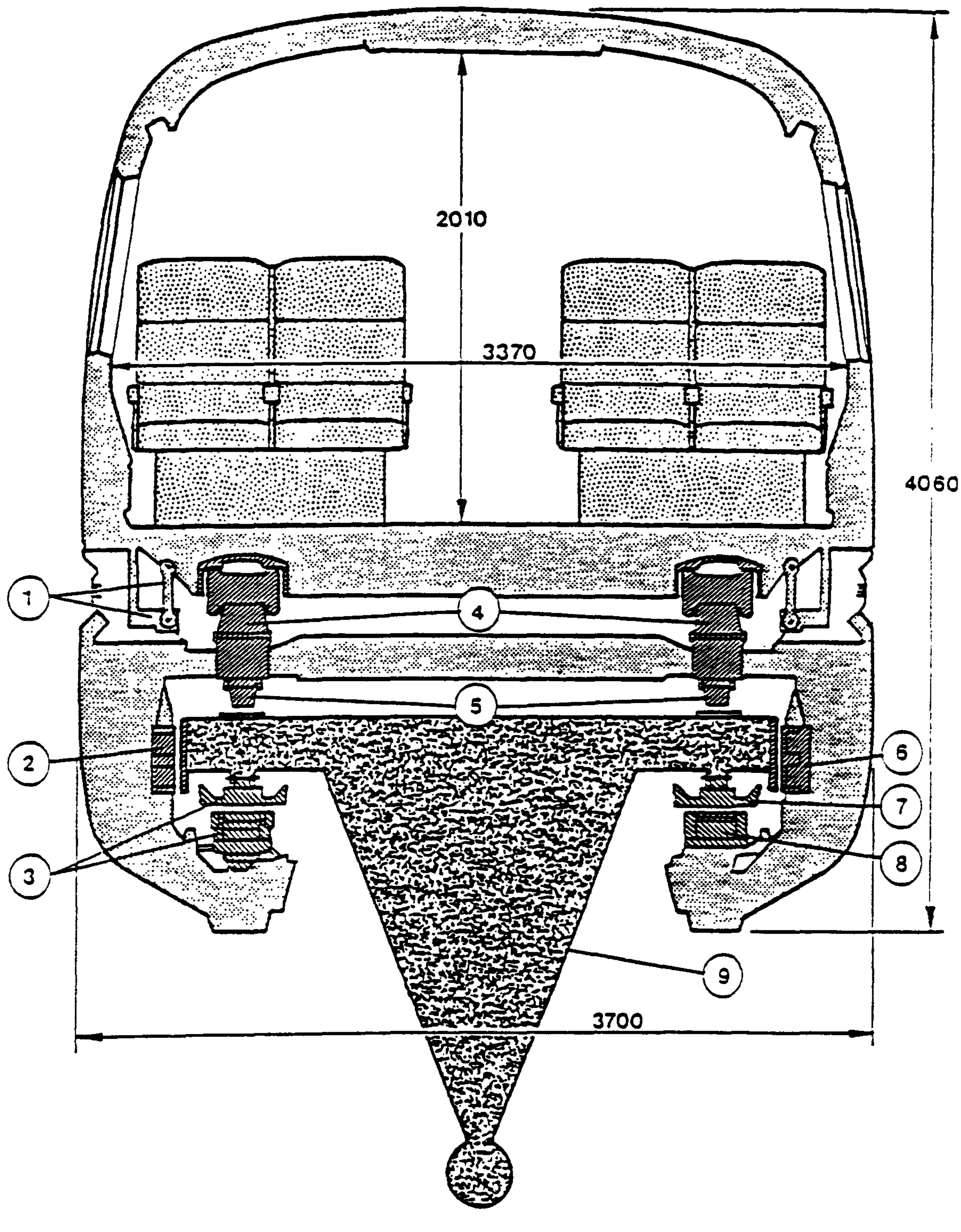
Each vehicle is "powered" (although the main part of the motor is mounted on the guideway). A synchronous long stator linear induction motor mounted in strips on the underside of the guideway provides propulsion and braking. An externally generated and controlled three-phase AC electromagnetic travelling wave, together with the field of the support magnets, provides the propulsion force for the vehicle. Speed is controlled by variation of the power and the frequency of the phase current, and braking is achieved by changing the polarity of the magnetic field.

Energy for the support and guidance systems in the vehicle and for on-board services in the vehicle is supplied through linear generators in the support magnets. All of these systems are contactless, thereby eliminating mechanical vibration, noise, and wear.

The Transrapid MagLev is designed to operate on grades of up to 10 percent. Besides providing better performance on grades, this system feature allows greater flexibility in route siting as compared with wheel-on-rail systems.

As for the High Speed system, the Super Speed study assumes that each vehicle carries 80 passengers and their baggage. Five to six vehicles comprise each train, and trains are bi-directional (allowing forward movement by the train in either direction).

Figure 7-1
Configuration of Transrapid 07 Vehicles



1 Cabin suspension
2 Guidance magnet
3 Linear generator windings
4 Pneumatic springs
5 Support skids
6 Eddy-current brake magnet
7 Stator pack with motor windings
8 Support magnet
9 Guideway structure

Source:
"An Introduction to Transrapid Maglev " March 1990

7.2 ELECTRIFICATION

7.2.1 Demand Analysis

For both the High Speed and the Super Speed systems, power is received from the electric utility system at traction power substations (TPS) and transmitted to operating vehicles via a distribution system. The distribution system for the High Speed system is an overhead catenary. The Super Speed MagLev distribution system consists of cables running to the linear induction motor stator packs mounted on the underside of the guideway.

System power requirements are derived from studies done using the Transit Operational Model (TOM) computer simulation program as outlined in Section 5.1. The simulation gives the average root mean square (RMS) power necessary to propel a train at scheduled speeds over the alignment. Using this information and train headways, the required number of traction power substations and their capacities are calculated. The results for each of the three alignment alternatives are shown by Table 7-1.

Table 7-1
Required Substation Capacities

Alignment Alternative	Number of Substations	Substation Capacity (Megawatts)
Highway	3	10
Railway	3	10
Super Speed	4	10

The TPS for the HSGT system used with the highway and railway alignments are located near the San Fernando North, Sand Canyon, and Palmdale Airport stations. In addition to the required three TPS, the system used with these alignments requires a switching station (tie between the eastbound and westbound catenaries) between Sand Canyon Station and the Palmdale Airport to boost system voltage regulation.

For the Super Speed system, TPS are located near the San Fernando-North, Sand Canyon, and Palmdale Airport stations and at a location approximately equidistant between the Sand Canyon and Palmdale Airport stations.

The following sections provide details of the TPS for the alternative systems.

7.2.2 High Speed System

The locomotive used as a basis for the High Speed system uses single phase (1ø) alternating current (AC) power, and the electric utility provides 3ø AC power.

The utility has stated that it is unwilling to provide 1ø power of the magnitude required by the TPS because doing so would cause excessive unbalance in its power system. Consequently, 3ø AC power from the utility is converted to direct current (DC) and then converted to 1ø AC power for use by the trains.

Drawing 7-1 (Appendix C) shows the electrification design for the High Speed system. Power at 66 kV, 3ø, 60 Hz from the utility company is stepped down to 13.8 kV, 3ø, 60 Hz voltage by using one outdoor oil-filled power transformer rated at 10/12.5 MVA open air/forced air cooling (OA/FA) at three TPS. An oil circuit breaker with appropriate relays serves as the primary side protection for the power transformer.

The 13.8-kV power transformer secondary voltage is converted to 2.6-kV DC via three identical 3-MW transformer-rectifier (T-R) units. These units operate in parallel between the 13.8-kV bus and the 2.6-kV DC bus. Metal clad 15-kV AC switchgear rated 1,200 A is used at the input side of the T-R units, and a 4,000-A DC bus with 2,000-A cathode breakers are used on the output side.

Voltage at 2.6-kV DC is inverted back to 1ø, 25-kV AC voltage for use at the catenary distribution system. The return current path is provided by the steel running rails of the track. Smoothing reactors are used at the input of the inverters for proper operation of the inverters. The power to the vehicle propulsion system and steel rails is controlled by 25-kV, 1ø, 2-pole switchgear rated at 1,200 A.

7.2.2 Super Speed System

Drawing 7-2 (Appendix C) shows the electrification plan for the super speed system. Power at 66 kV, 3ø, 60 Hz from the utility company is stepped down to 13.8-kV, 3ø, 60-Hz voltage using outdoor oil-filled power transformers rated at 10/12.5 MVA OA/FA at four TPS. Other outdoor equipment at each substation is as follows:

- One oil circuit breaker (OCB).
- 15-kV metal-clad switchgear.
- Four 13.8-kV, 3ø, 60-Hz AC to 3ø variable voltage, variable frequency converter units (including the output power transformer).
- All control components associated with voltage conversion units.
- 8-kV switchgear compatible with the 3ø variable voltage/variable frequency power for the Super Speed propulsion system.
- Set of feeder cable systems #1 and #2 running along the side of the guideway.
- Vacuum switching stations located at intervals along the guideway that control power to the motor fixed stator sections.

Power distribution equipment and ratings are listed below:

- One outdoor 5,000-MVA, 1,200-A, 66-kV, 3ø OCB complete with isolating switches and appropriate protective relays.
- One indoor 15-kV, 3ø, 60-Hz, 1,200-A, 18 kA interrupting capacity metal-clad switchgear unit with five individual breakers.
- Four indoor 13.8-kV, 3ø, 60-Hz, 1,200-A, 2.5-MVA variable voltage, variable frequency converter units operating in parallel (including matching output power transformers).
- Two 1,500-A, 3ø, variable frequency, variable voltage feeder systems running alongside the guideway system.
- Vacuum contractors appropriately rated to suit vehicle power requirements.

7.3 TRAIN CONTROL AND COMMUNICATIONS

7.3.1 Train Control

The train control system has two main objectives: operational safety and operational efficiency. The train control system envisaged for both the High Speed and Super Speed systems maintains train safety, monitors train movements and directs train operations. The system includes two-way working tracks; centralized control; remote switching; and automatic door operation and control of station facilities.

For the High Speed system, interaction between operating vehicles and fixed facilities is accomplished via electronic signals passing between train wheels and the rails. Train control strategies for MagLev systems are less well defined, but vehicle/fixed facility interaction for the Transrapid 07 may be accomplished using trackside fiber optic cabling and radio transponders. The following defines train control functions for the two systems:

- Two-way working tracks - Permits eastbound or westbound train movement on both tracks of the alignment in order to allow for normal system operation during maintenance of track sections.
- Centralized control - Provides facilities for monitoring data such as train location, speed and energy consumption and for remote opening and closing of switches.
- Automatic door operation and station stop - Allows automatic station stops and opening and closing of vehicle doors.
- Automatic train protection - Ensures that trains do not have head-on or rear-end collisions, exceed speed limits, or move when doors are open.

In addition to these functions, the High Speed steel-wheel-on-steel-rail system has the following capabilities:

- Cab signalling - Displays train operating velocity and maximum permissible velocity for the train operator in the cab. If allowable speeds are exceeded or if speed codes are not acknowledged by the operator, the cab signalling system automatically brings the train to a complete stop.

- Train detection - Detects the presence of other trains on the system ahead of each operating train. This information is used as input to determine safe operating speeds and is transmitted to the train via rail and wheels.

7.3.2 Communications

The communications system furnishes dependable, continuous two-way voice, video, and data links via cable or radio frequency transmission between central control, operating trains, and stations. Communications encompasses the following:

- Radio communication system to provide two-way voice and data communications for train operations between central control and train operations; yard and maintenance operations between dispatcher and maintenance personnel or between maintenance personnel; and emergency operations between security and fire personnel for underground installation.

- Telephone system to provide private voice communication circuit for administrative, operations, maintenance, and emergency services.

- Public address system to provide central control operations with the capability to make announcements to selected stations or to all passenger stations simultaneously; also allows station agents to make announcements within the station.

- Closed circuit television system to provide the surveillance personnel at central control or station agent with the capability to monitor selective activities in each passenger station at the platforms, fare collections, entrance and exit gates, elevators, and escalators.

- Fire and smoke detection system to provide control, alarms, indication, and activation of fire extinguishing/suppression equipment for each major equipment room such as substations, communication and train control rooms, electrical rooms, computer room, and offices.

- Security and intrusion alarm systems to provide access control to personnel and the public for entry to restricted buildings or rooms such as substations, train control and communications room, computer room, central control room, and maintenance building.

- Supervisory control and data acquisition system (SCADA) to provide full duplex exchange of digital data between central control and remote stations. Central control operations provides control and command functions to remote stations and will transmit status and alarm indications from the remote stations back to central control.

7.4 GUIDEWAY STRUCTURES

Described in this section are typical guideway configurations, followed by special concerns for small angle guideway crossings of freeways, and Super Speed technology system in tunnel configuration.

7.4.1 Guideway Configurations

There will be three basic types of guideway configurations that will require structures at-grade, aerial, and in subway.

These three configurations will be connected by the transition structures, including sloped and retained cuts and fills and tunnel portals.

Figures 7-2, 7-3, and 7-4 depict typical cross sections of the three basic guideway structure types for the conventional steel-wheel/steel-rail technology.

Figure 7-5 shows a typical Super Speed train system aerial structure (MagLev, Transrapid Technology).

For at-grade configuration, the Transrapid guideway may be supported on spread footings at about 20-40-ft spacing depending on soil conditions; and in tunnels the Transrapid guideway is continuous supported in the tunnel invert.

The aerial guideway structure for both technologies may be supported on pile foundations, spread footings, or cast-in-place drilled-hole piles (caissons) depending on existing soil conditions.

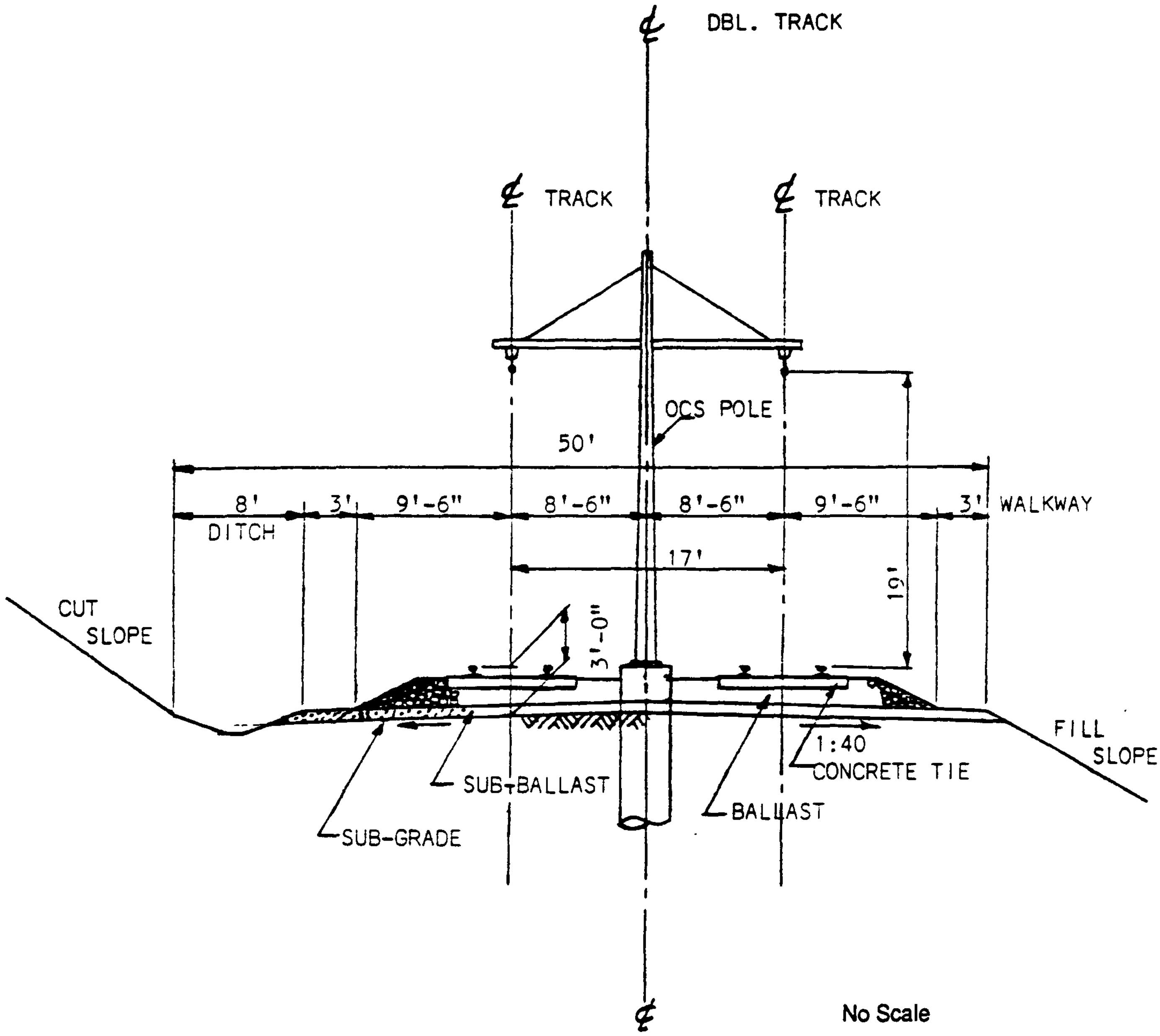
Further study of optimum span length will be performed in subsequent design phases.

When the aerial guideway is located along freeways, care has to be taken to place the supporting columns consistent with future freeway widening requirements. For example, along State Route 14, columns need to be located a minimum of 75 ft from existing freeway centerline to provide for future widening plans.

7.4.2 Freeway Crossings at Small Skew Angles

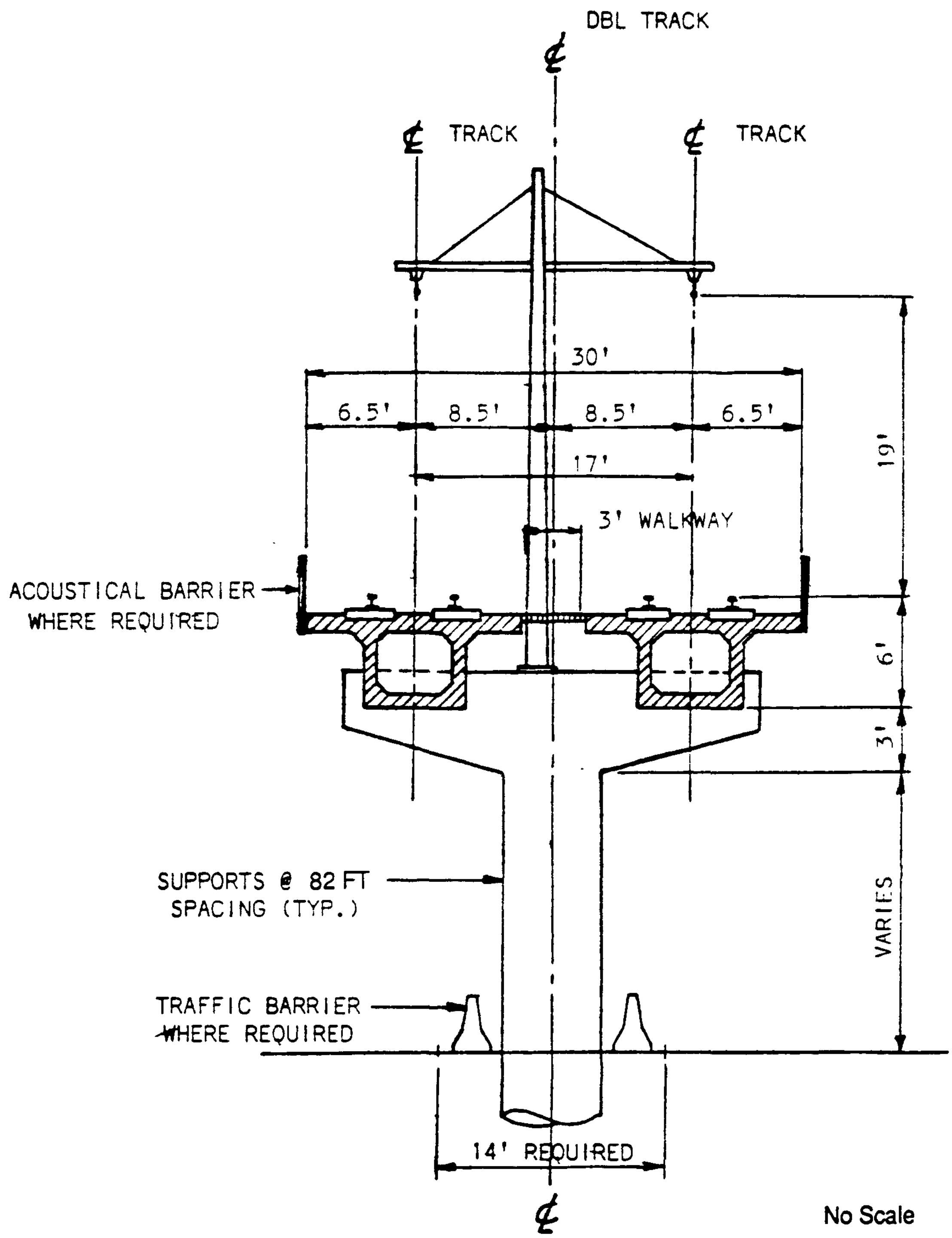
When the proposed guideway alignment parallels freeways, guideway crossings of the freeway will result in small skew angles between the freeway and guideway alignments. This is particularly troublesome in those cases where Caltrans will not permit an intermediate support in the freeway median. In those cases several straddle bents spanning the entire freeway, including future widening, will be required. To reduce the number of these costly straddle bents, longer guideway spans of up to 150-200 ft will be considered.

Figure 7-2
Typical Double HSGT Track
At Grade
(Railroad Technology)



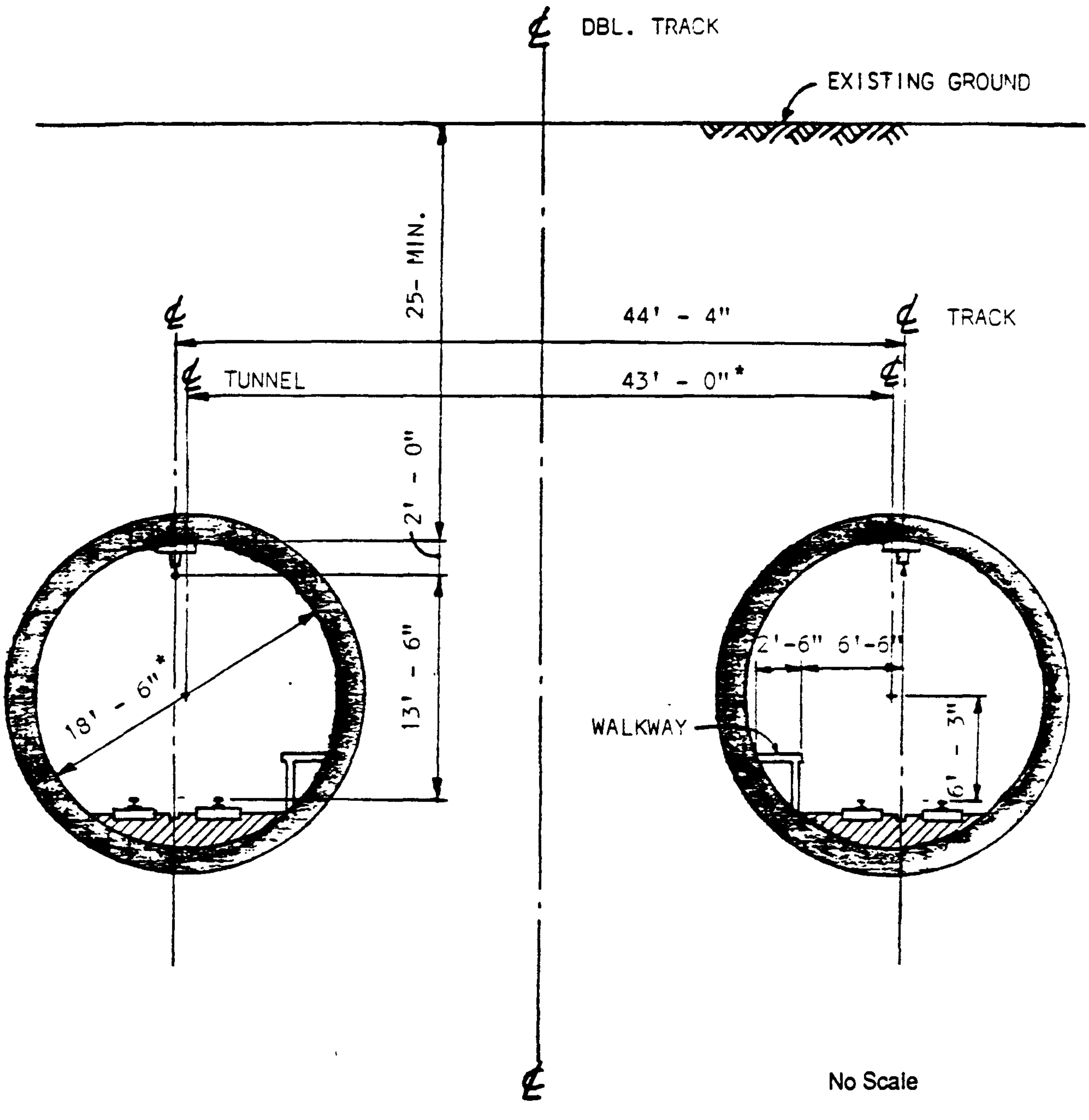
No Scale

Figure 7-3
Typical Double HSGT Track
Aerial Structure
(Railroad Technology)



No Scale

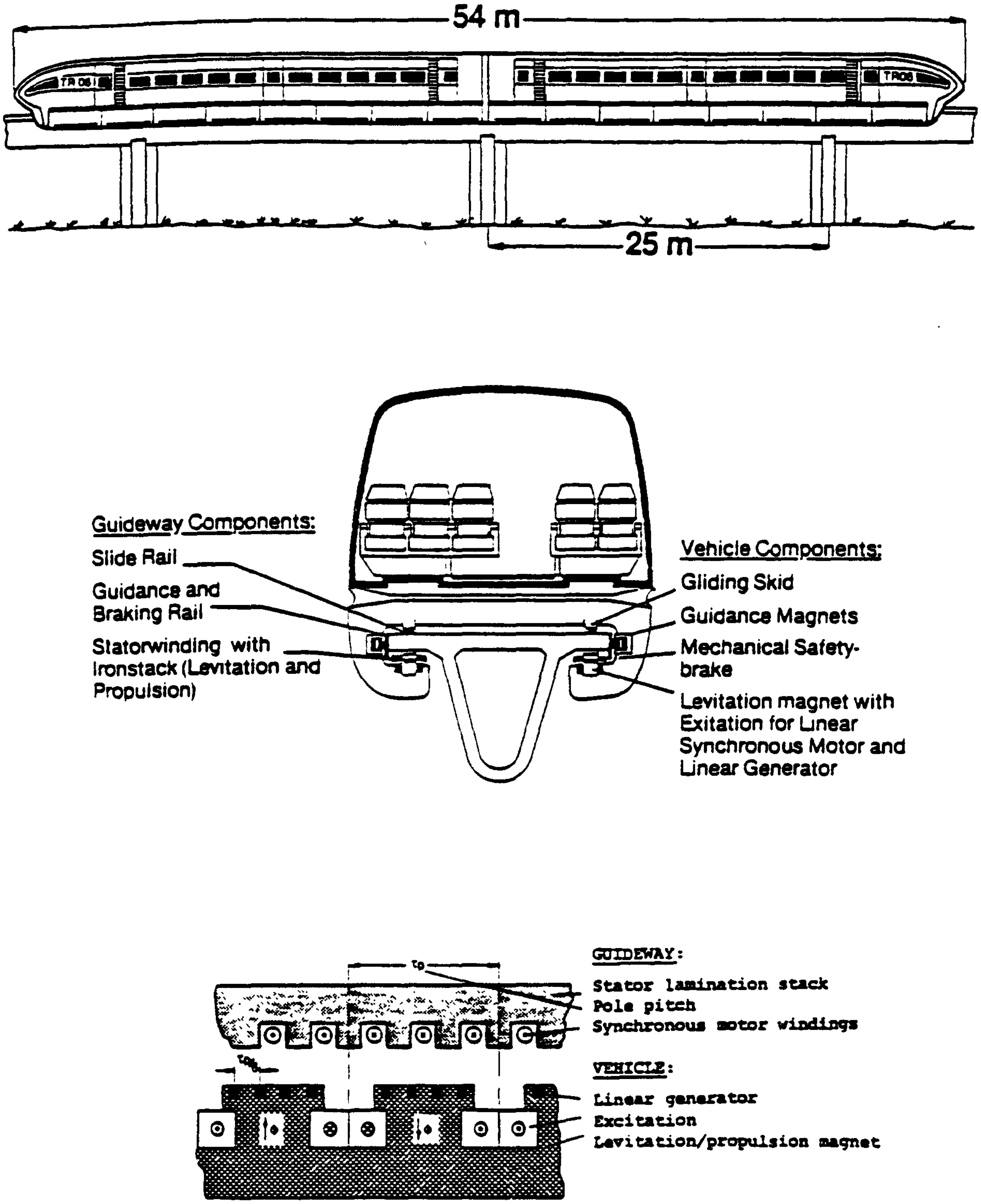
Figure 7-4
Typical Double HSGT Track
Bored Tunnel
(Railroad Technology)



No Scale

* For MagLev technology, the inside tunnel diameter shall be 22 ft. 6 inches and the distance between tunnel centerlines: 50 ft.

Figure 7-5
Super Speed Ground Transportation System



TRANSRAPID 06, showing the disposition of suspension and guidance magnets and detail of the EMS suspension and linear synchronous motor components.

Source:
"Super-Speed Ground Transportation System Las Vegas/Southern California Corridor, Phase II. MAGLEV TECHNOLOGY ASSESSMENT." Report prepared by The Canadian Institute of Guided Ground Transport, for Department of Super-Speed Train Development, City of Las Vegas, Nevada. December 1985

7.4.3 Super Speed Technology Options in Tunnel Configuration

Because of the very high train speeds, particular attention must be paid to the air resistance to train movement when the alignment is in tunnel configuration.

This so-called piston effect adversely impacts power consumption and crates pressure transients in the tunnel resulting in buffeting involving wayside and train borne equipment. It may also affect passengers (the cars in particular) unless the vehicles are airtight. To help reduce the impacts of the piston effect, it is recommended that the tunnel cross sectional area be at least 2.5 times the area of the vehicle cross section, which results in a single track tunnel cross section of 400 ft^2 and 700 ft^2 for a double track tunnel. Also tunnels need to be provided with flared entrances. These tunnel sections are substantially larger than those required for the HSGT system and will result in higher construction costs.

7.5 VEHICLE STORAGE AND MAINTENANCE FACILITY

A suitable train storage and maintenance facility site will be located near the Palmdale Airport Station for either technology. The potential site for the facility occupies an area of approximately 21 acres and is approximately 350 ft in width and 2,600 ft in length. Space for the future extension of the main line will be provided along one side of the site. See Figure 7-6 and Figure 7-7 for the general site layout for the High Speed and Super Speed technologies, respectively.

7.5.1 Facility Requirements

The storage and maintenance facility will accommodate the basic requirements of operations, equipment maintenance, and facility maintenance. The storage and maintenance facility requirements for each of these functions are discussed below.

7.5.1.1 Operations

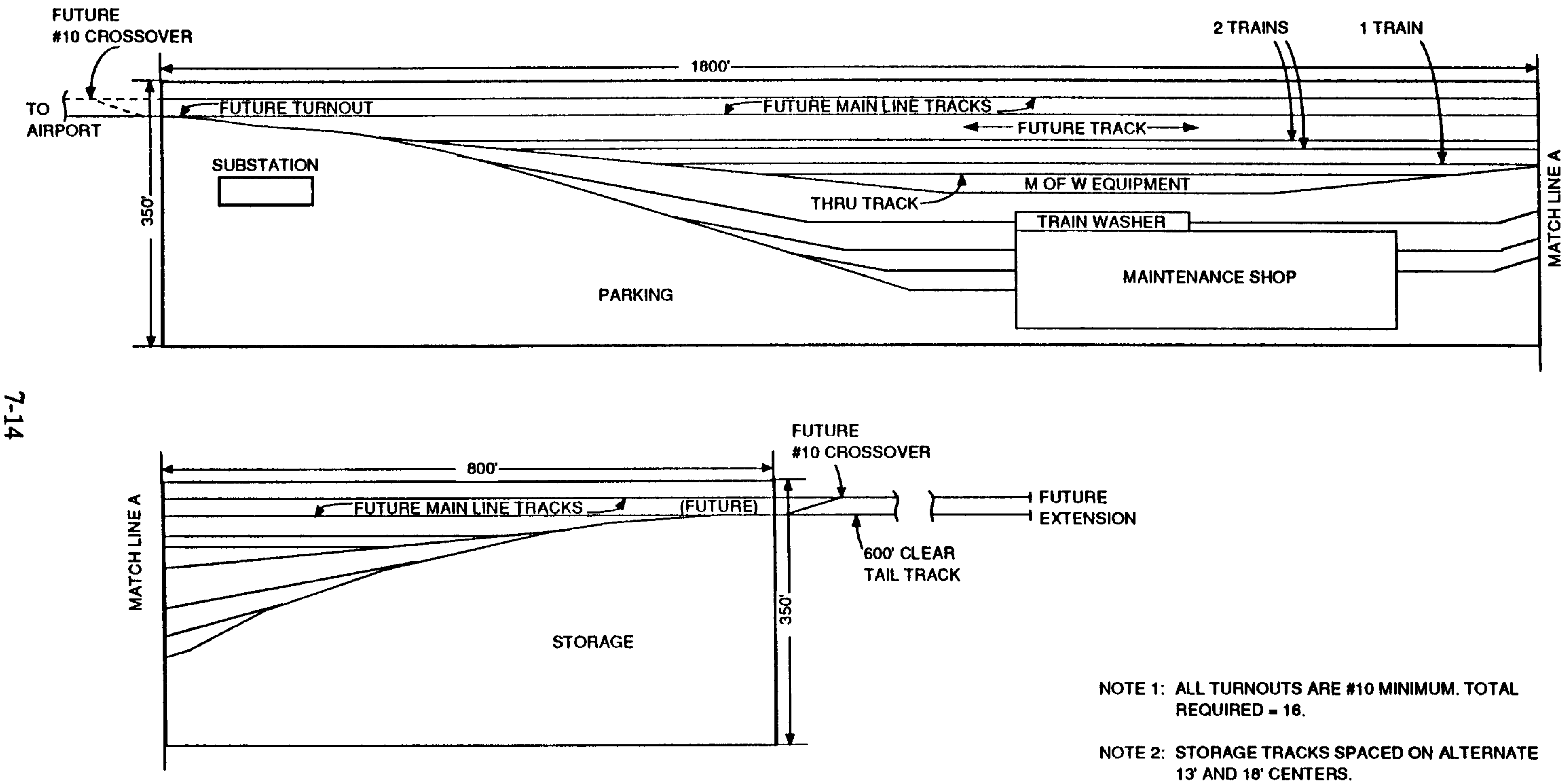
The requirements for operations and storage include the following:

- Train storage for the initial fleet with provision for future expansion. Storage tracks or guideway will be provided in increments of full train lengths to the maximum extent possible. Storage space will be provided for the total initial fleet, but with the consideration that some of the fleet may remain in the shop. Storage tracks for the High Speed technology will be double-ended in order to facilitate the moving of locomotives to the proper end of the train. Storage guideway for the Super Speed technology will be configured as stub-end storage due to the high cost of the special guideway switches.

- A central dispatcher's office for system train dispatching personnel and the associated train control, traction power, communications, and other controls and alarms. The central dispatcher's office may be located on the mezzanine level.

- Train operations personnel facilities including locker room, rest room, and layover room space. These facilities may be located on the mezzanine level.

Figure 7-6
Yard And Shop Facility - 125-mph High Speed Technology



NOTE 1: ALL TURNOUTS ARE #10 MINIMUM. TOTAL REQUIRED = 16.

NOTE 2: STORAGE TRACKS SPACED ON ALTERNATE 13' AND 18' CENTERS.

NOTE 3: MAIN LINE TRACKS AND TWO SINGLE CROSSOVERS TO BE ADDED WHEN FUTURE EXTENSION IS CONSTRUCTED. ALSO APPLIES TO SECOND MAIN TRACK BETWEEN TERMINAL AND YARD.

NOT TO SCALE

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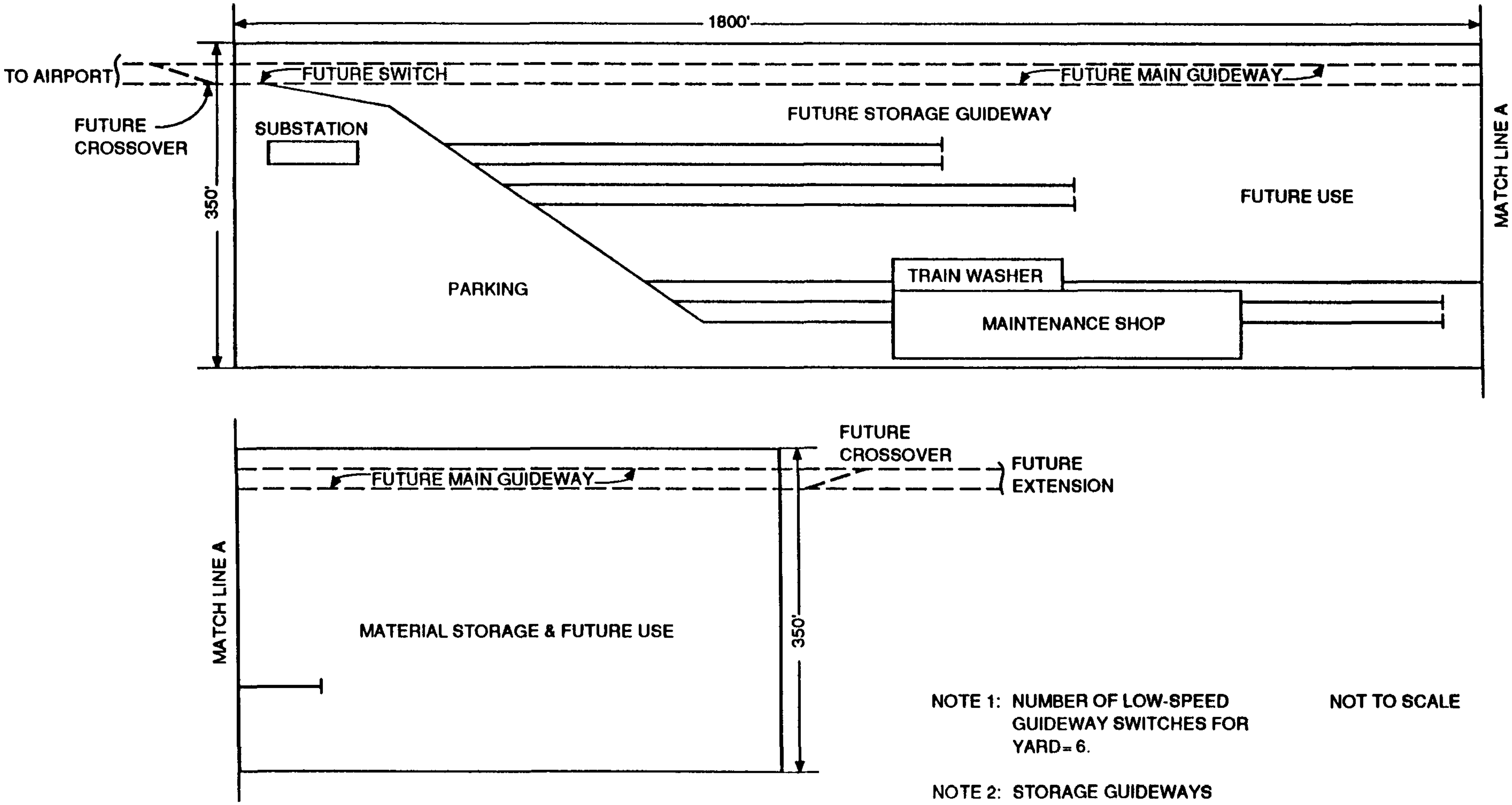
Figure 7-7
Yard And Shop Facility - 250-mph Super Speed Technology



NOTE 1: NUMBER OF LOW-SPEED GUIDEWAY SWITCHES FOR YARD = 6.

NOTE 2: STORAGE GUIDEWAYS SHOULD BE 600' CLEAR LENGTH, MINIMUM.

NOT TO SCALE

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- Operations administrative offices for supervisory training, scheduling, and clerical personnel. Secured storage for portable radios, train service keys, and other such items is also provided. These offices may be located on the mezzanine level.

7.5.1.2 Equipment Maintenance

The requirements for equipment maintenance are based upon performing routine maintenance in train set configurations in order to preclude the need to uncouple/couple trains consists constantly. Facilities for the following equipment maintenance activities will be provided:

- Train exterior washing and interior cleaning
- Daily inspection
- Preventive maintenance and corrective repair
- Major component changeout
- Component repair and overhaul
- Scheduled overhaul or major maintenance
- Parts and material storage
- Support and ancillary facilities
- Wheel truing (High Speed technology only).

It should be noted that capability must be provided for scheduled overhaul or major maintenance due to the isolated nature of the system and the maintenance needs for either electric locomotives or MagLev trains. Should this system be compatible with the Palmdale to Las Vegas system, consideration could be given to centralizing the maintenance facilities, especially with respect to major maintenance.

The support and ancillary facilities for equipment maintenance include offices for supervisory, training, scheduling, engineering, and clerical personnel and conference, lunchroom, locker, shower, and restroom facilities.

See Figures 7-8 and 7-9 for the general shop floor plan for the High Speed and Super Speed technologies, respectively.

7.5.1.3 Facility Maintenance

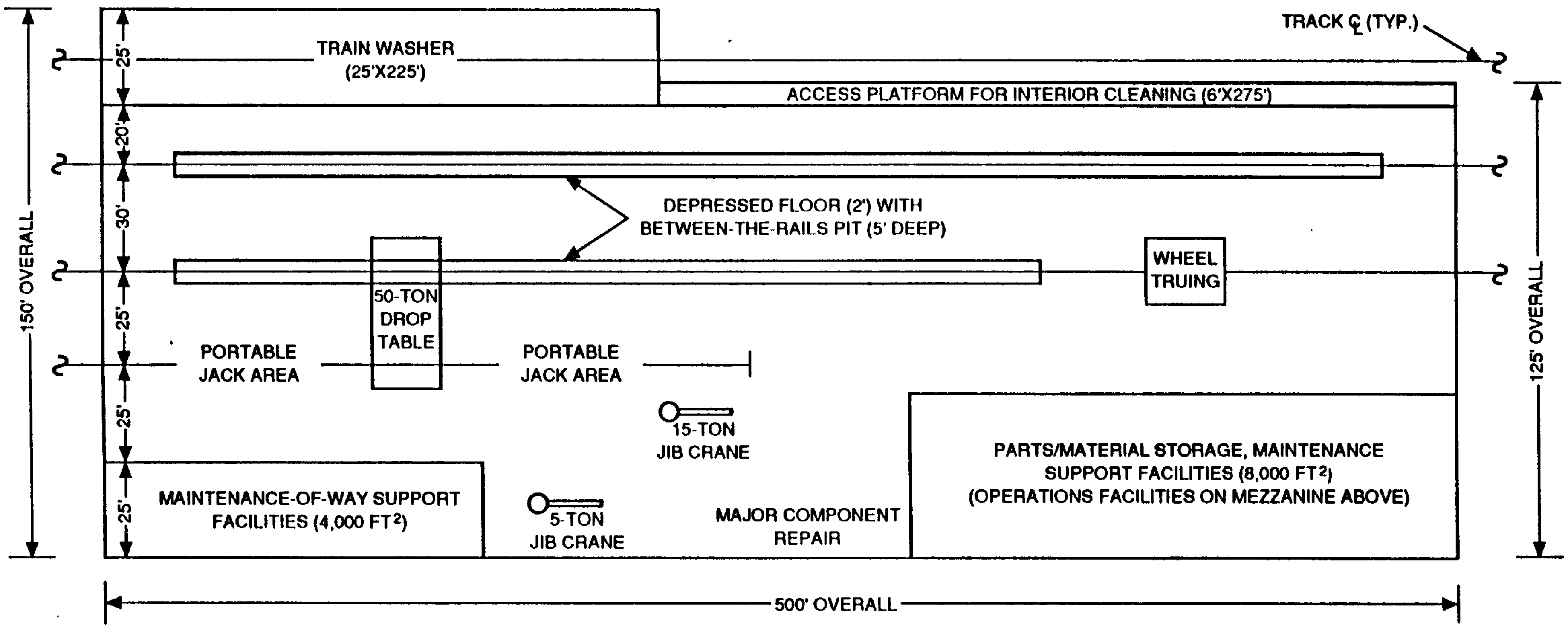
The requirements for facility maintenance which will be accommodated at the storage and maintenance facility site are as follows:

- Supported and ancillary facilities, including offices, locker rooms, and restrooms.

- Parts and material storage, including indoor and outdoor storage.

- Parking space for specialized maintenance vehicles and other system automotive vehicles.

Figure 7-8
Maintenance Facility - 125-mph High Speed Technology
Conceptual Floor Plan



FIRST FLOOR	= 62,500 FT^2
MEZZANINE	= 8,000 FT^2
TRAIN WASHER	= 5,625 FT^2
TOTAL	= 76,125 FT^2

NOT TO SCALE

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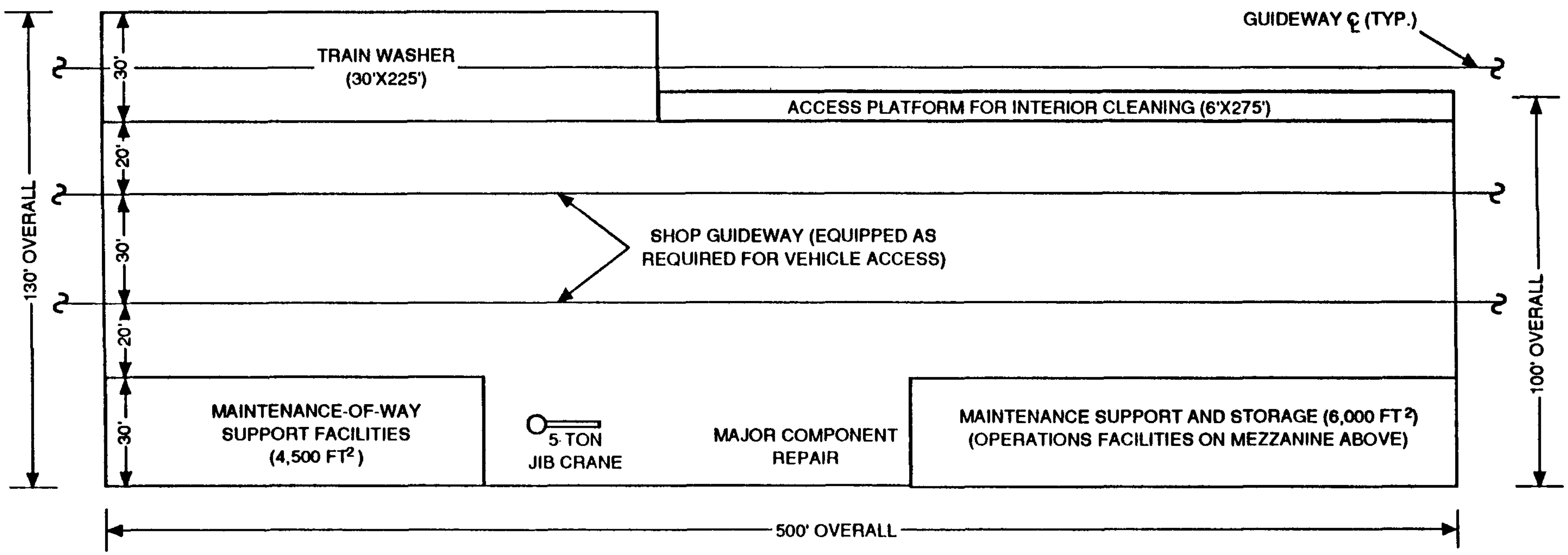
Figure 7-9
Maintenance Facility - 250-mph Super Speed Technology
Conceptual Floor Plan



FIRST FLOOR	= 50,000 FT^2
MEZZANINE	= 6,000 FT^2
TRAIN WASHER	= 6,750 FT^2
TOTAL	= 62,750 FT^2

NOT TO SCALE

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7.5.1.4 Other Facility Requirements

In addition to the requirements discussed above, the storage and maintenance facility will also include the following features:

- Perimeter fencing
- Roadways and access aisles
- Guardhouse (at the main entrance)
- Parking for employees and visitors
- Adequate lighting and fire protection
- Traction power substation (if appropriate).

7.6 OTHER APPLICABLE TECHNOLOGIES

During the performance of this study, other technologies were identified which could potentially be applicable to the San Fernando to Palmdale Airport corridor. While some of these potential technologies would require longer travel times, the distance involved (approximately 40 miles) contributes to their feasibility. The other potentially applicable technologies are as follows:

7.6.1 French TGV

This steel-wheel-on-steel-rail system is capable of operating at a maximum speed of approximately 186 mph. The system can accommodate grades up to 5 percent and has a capacity of 400 to 500 passengers per train. Each train consists of eight or nine cars plus an electric powered locomotive at each end. The travel time and quite possibly the capital and operating costs for this system would fall between the costs for the conventional rail and the MagLev technologies.

7.6.2 Diesel Push-Pull Commute

This common technology is capable of operating at maximum speeds of 60 to 80 mph. The trains can climb grades of 3.5 percent, but speed is sacrificed. Each train consists of a diesel-electric locomotive at one end and up to ten cars, the last of which contains cab controls for operation in the reverse direction. Maximum seated capacity per train ranges from 800 to 1,500 passengers, depending upon the type of cars used (e.g., single-level or bi-level). While the travel time will be longer, the capital and operating costs will be lower. Note that the same can be said of other diesel-powered technologies such as the Bombardier LRC train.

8. Schedule and Cost Estimates

8. SCHEDULES AND COST ESTIMATES

8.1 IMPLEMENTATION SCHEDULES

There are at least two types of implementation schedules for rail service between San Fernando and Palmdale: traditional and turnkey. The traditional process for the two technologies under consideration is shown in Figures 8-1 and 8-2. The first step in this process is obtaining the environmental clearance for the project. This is done through the completion of a state Environmental Impact Report and, if Federal actions are required, an Environmental Impact Statement. The engineering work is divided into two steps with a review and go/no decision made at approximately the 30% design level. Engineering continues with reviews at the 60% and 85% levels of completion. Bid packages are prepared at the end of the engineering tasks. Bids for equipment and construction are reviewed and awards are made. The final activities are actual construction, testing, and revenue service. As shown on the figures, implementation could take 7 to 9 years depending upon the selected technology.

An alternative method would be to use a turnkey approach to procurement. This is the method that is proposed for the Southern California-Las Vegas Super Speed Train in which a franchise is awarded to design, build, and operate the system. It would be the responsibility of the franchisee (design-build contractor) to complete the environmental work, do the design, construct the system, test it, and either turn it over to the agency or even be responsible for the operation for a designated period of time. This approach may be applicable to the San Fernando to Palmdale corridor, particularly if it is an extension of the Southern California-Las Vegas system. Using a turnkey approach could significantly reduce the time required to implement the selected project. The savings could come on the time between the steps presented in the traditional design-procurement approach. The same team would be responsible for all elements of design and construction. For example, the work could proceed from design to construction without a delay for the preparation, review, and award of construction and procurement bids. This type of approach also could be used by the implementing agency to control costs. The design build or franchise award contract could be made early in the process at an agreed-upon fixed price.

Figure 8-1
Implementation Schedule
125-mph High Speed Technology

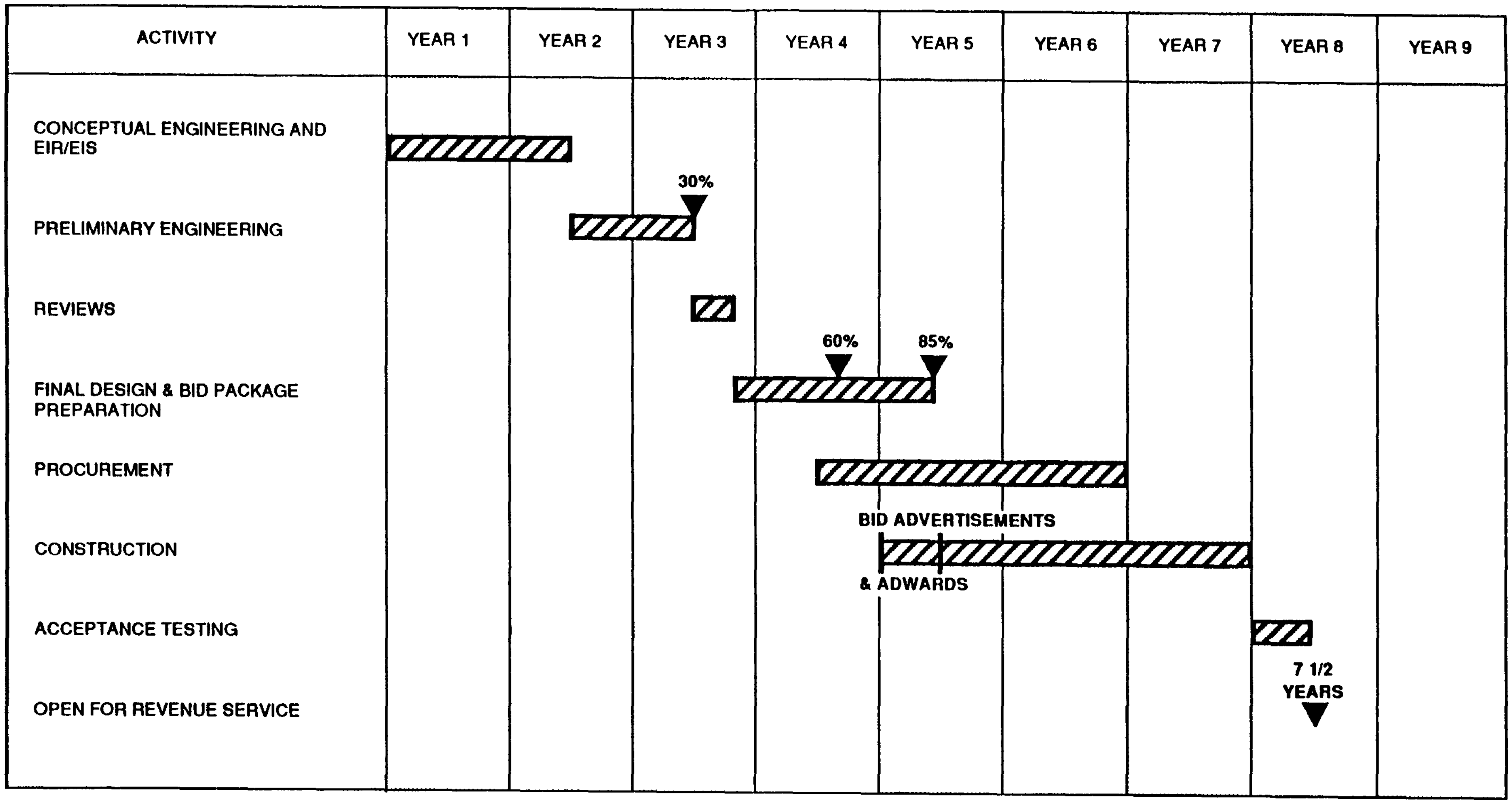

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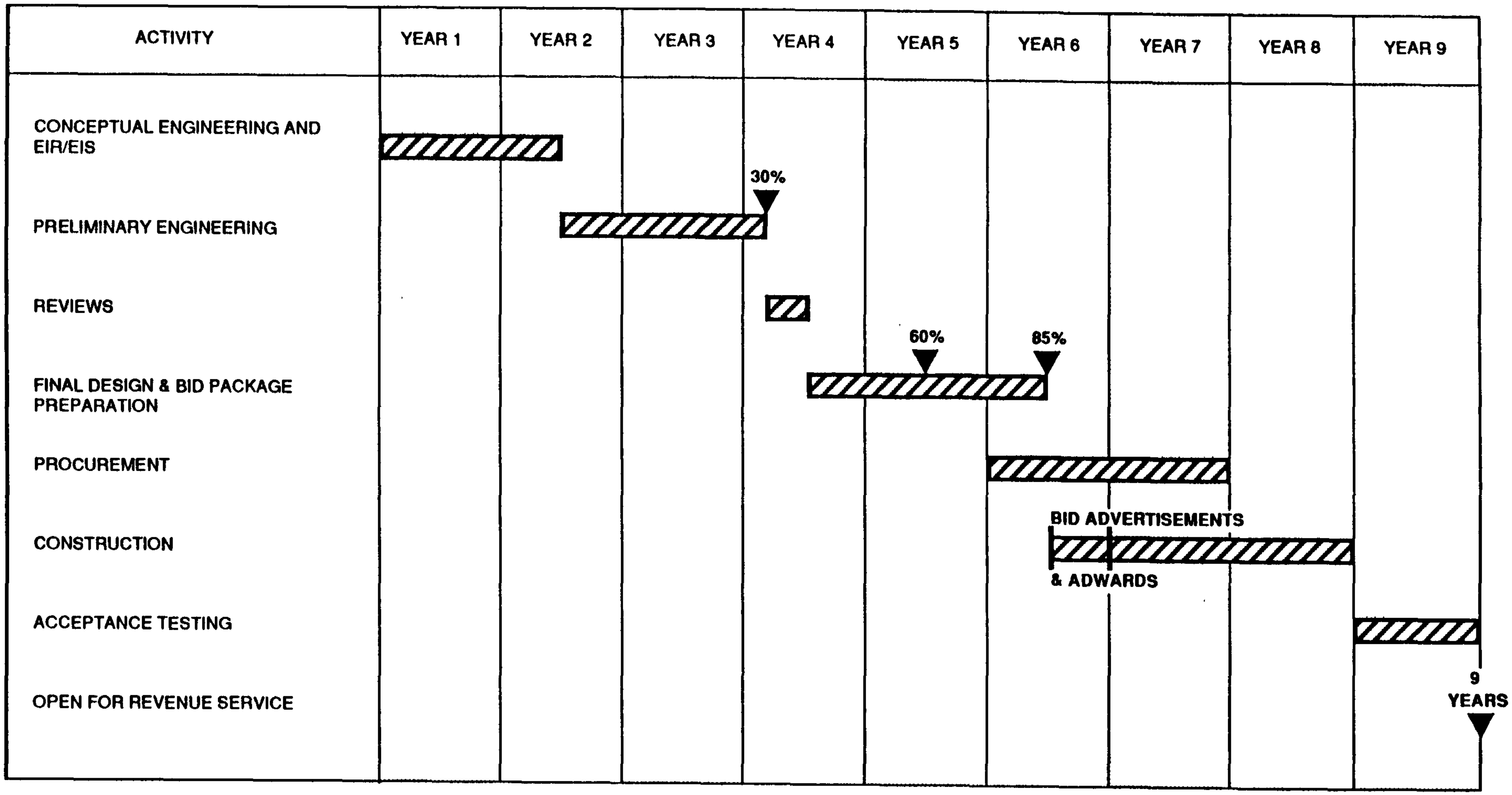
Figure 8-2
Implementation Schedule
250-mph Super Speed MaGLev Technology



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8.2 ANNUAL OPERATING AND MAINTENANCE COSTS

The annual operating and maintenance (O&M) cost estimates for the High Speed and Super Speed technologies are presented in this section. The annual O&M cost estimates are based upon a percentage of the total capital cost projections. This approach is used because of inconsistency in the data necessary for a reasonable level of confidence in itemizing O&M costs. The same approach was also used for estimating some of the O&M costs for the proposed Las Vegas-Southern California Corridor because actual cost data for an operating MagLev system is not available.

8.2.1 O&M Cost Categories

The annual O&M cost estimates include consideration for the following categories of costs:

A. Operations

- Central dispatching labor and miscellaneous supplies.
- Train operations labor, train supplies, and miscellaneous non-labor.
- Station operations labor and miscellaneous non-labor (excludes ticket sales costs).

B. Equipment Maintenance

- Labor, parts and materials, contract services, and miscellaneous non-labor for:
  - Cleaning and servicing
  - Preventive maintenance and corrective repair
  - Component repair and overhaul
  - Maintenance facility operation.

C. Facility Maintenance

- Labor, parts, and materials, contract services, and miscellaneous non-labor for:
  - Track/guideway inspection, maintenance, and repair
  - Train control and communications inspection, maintenance, and repair
  - Traction power inspection, maintenance, and repair

- Other facilities inspection, cleaning, maintenance, and repair (e.g., stations, maintenance facility, and maintenance equipment and vehicles).

D. Propulsion Energy

- Energy and demand charges.

E. Administration/Other

- Labor and non-labor costs associated with the following:
  - Administrative personnel
  - Ticket sales
  - Land use fees
  - Insurance
  - Contingency.

8.2.2 Annual O&M Cost Estimates

The annual O&M cost estimates for the High Speed and Super Speed technologies are shown on Table 8-1. Also shown on Table 8-1 are O&M costs per available annual seat mile and per main line track or guideway mile.

8.3 CONCEPTUAL CONSTRUCTION COSTS

Conceptual construction cost estimates have been prepared for the HSGT and Super Speed systems.

The procedures in preparing these estimates are outlined in the following, and a Conceptual Construction Cost Summary, Table 8-2, is included at the end of the section. Additional cost estimating data can be found in Appendix D.

8.3.1 Cost Estimating Criteria

Project Definition Documents

The conceptual cost estimate is based on the plan and profile drawings and passenger station layouts included in Appendices A and B. The MagLev technology assessment report dated July 28, 1986 prepared by C.I.G.G.T for the Super Speed Ground Transportation System in the Las Vegas/Southern California Corridor, Phase II, was used as a reference for MagLev system costs. The descriptions of systems and facility elements contained in Section 7 of this report were used along with sketches and photos from site visits in the preparation of the cost estimates. In addition, various assumptions have been made by the cost estimator.

Table 8-1
Annual O&M Cost Estimates

Cost Category		**Highway Alignment**	**Railroad Alignment**	**Super High Speed**
1.	O & M percent of total capital costs	2.6	2.6	2.9
2.	Percent of O&M Costs:			
	Operations	12	12	13
	Equipment Maintenance	16	16	11
	Facility Maintenance	21	21	14
	Propulsion Energy	23	23	32
	Administration/Other	28	28	30
		100%	100%	100%
3.	Total Capital Cost	$1,720,800,000	$1,834,500,000	$2,731,700,000
4.	O&M Cost:			
	Operations	$ 5,368,836	$ 5,723,519	$10,298,600
	Equipment Maintenance	7,158,448	7,631,360	8,714,200
	Facility Maintenance	9,395,463	10,016,161	11,090,800
	Propulsion Energy	10,290,269	10,970,080	25,350,400
	Administration/Other	12,527,284	13,354,880	23,766,000
5.	Total O & M Cost	$44,740,300	$47,696,000	$79,220,000
6.	O & M Cost per Available Annual Seat Mile (Cents)	$13.8*	$14.7*	$22.1*
7.	O & M Cost per Track or Guideway Mile:	$507,300	$552,000	$955,600
	Avail Annual Seat Miles	325,264,480	325,264,480	358,659,200
	Track/Guideway Miles	88.2	86.4	82.9

*This cost is higher than those estimated for the Las Vegas to Los Angeles system due to the difference in route mileage (40 versus 230-250 miles).

Estimate Format

The estimate for each alternative has been subdivided into two segments and a systemwide segment, which includes the maintenance facility and a central control facility. A segment estimate was prepared for each segment. The segments for this project are described in Appendix D. Each segment estimate is broken down into transportation system elements: site modifications and guideway, stations, trackwork, traction power, train control, communications, fare collection, and landscaping. A systemwide segment includes the yard and shops, vehicles, central control facility, and right-of-way.

Quantity

Parametric quantities were taken off by segment. Route length for all segments has been measured through the Palmdale Terminal Station, including future main line track as far as East 30th Street. Detailed quantity take-offs were made for typical sections with allowances made for items where design definition was not available.

Pricing

All unit costs include labor and burden, construction equipment usage, material, and overhead and profit. Craft rates applicable to Los Angeles were used. Using this pricing information, typical costs for various guideway configurations were developed and may be found in the typical costs section. Recent cost experiences from other transit projects were used as reference. Where sufficient definition was not available, allowance has been made based on experience on similar projects. Factors have been applied on the segment summary sheets, where appropriate, to reflect non-typical specific conditions.

Contingency

Contingency has been evaluated at 25 percent of construction cost, considering the design information provided and the estimating methods used.

Cost Exclusions

1. Baggage handling equipment
2. Administration facilities
3. Owner's cost for administration, insurance, legal, financing, start-up, etc.
4. Escalation
5. Project reserve.

Estimate Discussion

It was assumed that design of the various structures will be similar to that of other transit systems of comparable size and function and that standard construction and constructing practices will apply.

The MagLev estimate relies heavily on MagLev technology assessment report dated July 28, 1987, but has been adjusted, based on our experiences with numerous other transit projects.

The estimate includes many allowances. Information about existing utilities is based on the site visit. Soil and geological conditions have also been assumed, based on the site visit.

KAISER ENGINEERS
HSGT STUDY
JOB NO. 90084-003 (REV. #0)

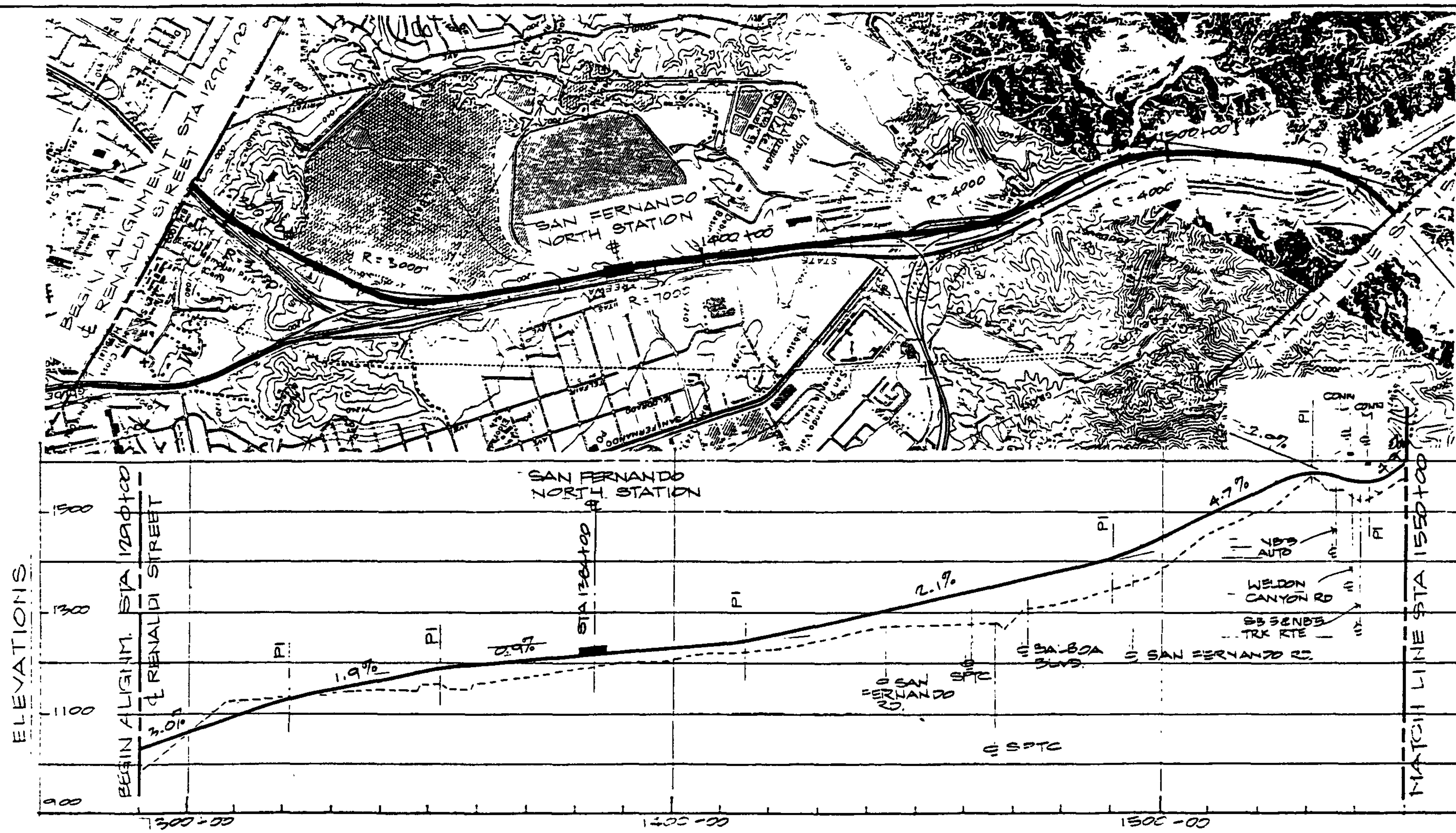
ALL COSTS IN $1,000'S
1990 DOLLARS

Table 8-2
Project Summary: HSGT Study

DESCRIPTION	UNIT	ALT.: ALT_1 QTY	COST	ALT.: ALT_2 QTY	COST	ALT.: ALT_3 QTY	COST	QTY	COST	QTY	COST	QTY	COST	QTY	COST	QTY	COST	QTY	COST
SYSTEM DATA																			
ROUTE LENGTH	RF	232900	0	228200	0	218750	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACK LENGTH	TF	465800	0	456400	0	437500	0	0	0	0	0	0	0	0	0	0	0	0	0
NUMBER OF STATIONS	EA	3	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
CONSTRUCTION COSTS																			
SITE MODIFICATIONS-DEMOLITIONS	RF	232900	1165	228200	1141	218750	1094	0	0	0	0	0	0	0	0	0	0	0	0
-UTILITY RELOCATIONS	RF	232900	4658	228200	4564	218750	2188	0	0	0	0	0	0	0	0	0	0	0	0
-STRUCT. MODIFICATIONS	LS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUIDEWAY AERIAL -STD SPAN SNGL TRACK	LF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-STD SPAN DBL TRACK	RF	164700	575132	186100	649861	126450	385268	0	0	0	0	0	0	0	0	0	0	0	0
GUIDEWAY AT GRADE -AT GRADE OFF STREET	RF	28300	3566	7100	852	5660	2219	0	0	0	0	0	0	0	0	0	0	0	0
-AT GRADE - CUT ROCK	RF	27100	28936	21100	24861	12300	24606	0	0	0	0	0	0	0	0	0	0	0	0
-AT GRADE-CUT RIPPABLE	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-AT GRADE - FILL	RF	5800	1352	5600	1243	4600	9196	0	0	0	0	0	0	0	0	0	0	0	0
-RETAINED CUT/FILL	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUIDEWAY TUNNEL -DBL 18.5'DIA,BY TBM	RF	2000	20790	2600	26072	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-DBL 22.5'DIA,BY TBM	RF	0	0	0	0	75400	895752	0	0	0	0	0	0	0	0	0	0	0	0
-TUNNEL-DRILL & BLAST	RF	5000	40000	5700	45600	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STATIONS -AT GRADE	EA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-AERIAL	EA	3	19018	3	19018	3	19018	0	0	0	0	0	0	0	0	0	0	0	0
-PARKING LOT	LS	2	5260	2	5260	2	5260	0	0	0	0	0	0	0	0	0	0	0	0
GUIDANCE RAIL & LONG - STATOR PACKS	TF	0	0	0	0	443460	111309	0	0	0	0	0	0	0	0	0	0	0	0
TRACKWORK	TF	478350	99121	468950	101331	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKWORK SPECIAL	LS	3	3414	3	3414	3	5616	0	0	0	0	0	0	0	0	0	0	0	0
TRACTION POWER SUPPLY	TF	478350	119211	468950	116861	443160	110790	0	0	0	0	0	0	0	0	0	0	0	0
SIGNALING	TF	478350	51336	468950	50396	443160	56677	0	0	0	0	0	0	0	0	0	0	0	0
COMMUNICATIONS	TF	478350	23918	468950	23448	443160	26590	0	0	0	0	0	0	0	0	0	0	0	0
FARE COLLECTION	STA	3	900	3	900	3	900	0	0	0	0	0	0	0	0	0	0	0	0
LANDSCAPING	LS	3	1290	3	1290	3	1416	0	0	0	0	0	0	0	0	0	0	0	0
YARDS & SHOPS	LS	1	22727	1	22727	1	22220	0	0	0	0	0	0	0	0	0	0	0	0
VEHICLES	EA	49	98245	49	98245	42	171360	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal CONSTRUCTION COSTS :			$1120039		$1197084		$1851479		$0		$0		$0		$0		$0		$0
NON CONSTRUCTION COSTS																			
RIGHT OF WAY & AGREEMENTS	LS	1	32578	1	31068	1	19154	0	0	0	0	0	0	0	0	0	0	0	0
ENGINEERING & MANAGEMENT		0	224008	0	239417	0	314751	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal NON CONSTRUCTION COSTS :			$256586		$270485		$333905		$0		$0		$0		$0		$0		$0
CONTINGENCY																			
CONTINGENCY		0	344156	0	366893	0	546346	0	0	0	0	0	0	0	0	0	0	0	0
ESCALATION																			
ESCALATION		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PROJECT RESERVE																			
PROJECT RESERVE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL :			$1720781		$1834462		$2731730		$0		$0		$0		$0		$0		$0

Appendix A

Alternative 1
Highway Alignment
Drawings 3-1 to 3-9



ALT 1 - HIGHWAY ALIGNMENT

STA 1290+00 TO 1550+00

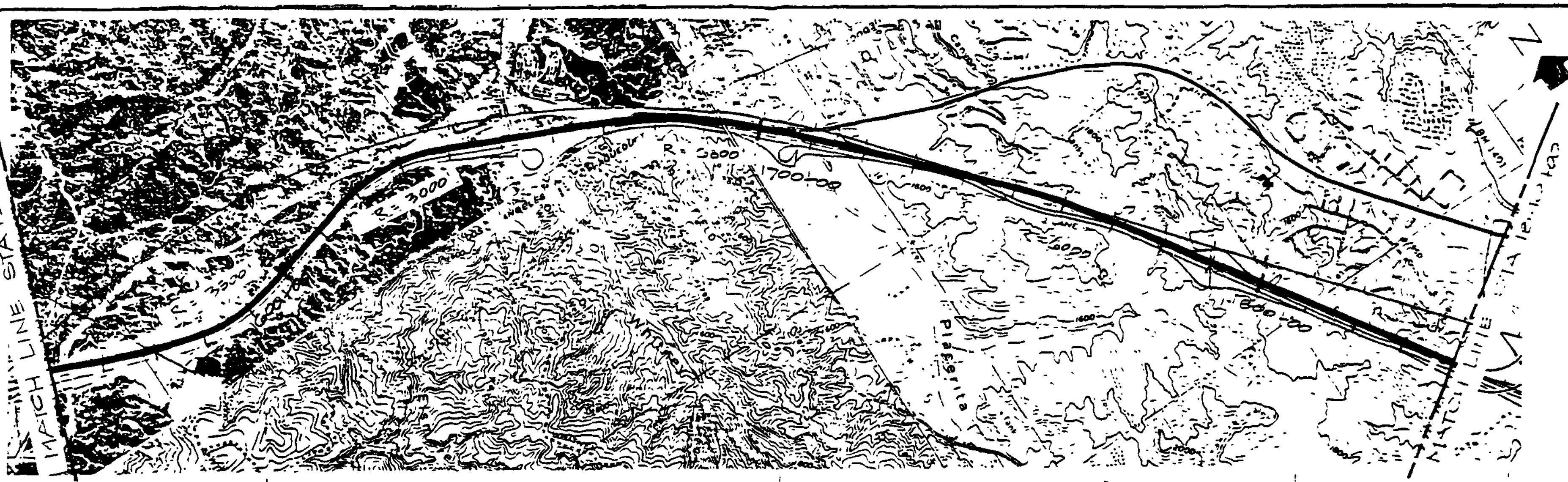
H.S.G.T. STUDY

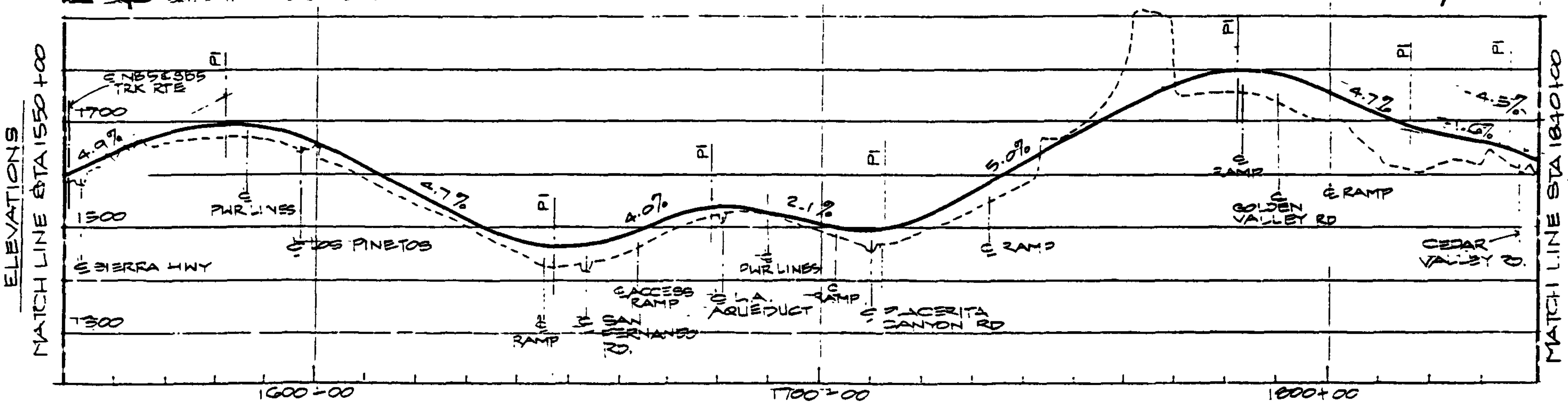
SAN FERNANDO TO PALMDALE

1" = 2000'-0" 2000' 0' 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-1





STATIONING

ALT 1 - HIGHWAY ALIGNMENT

STA 1550+00 TO 1840+00

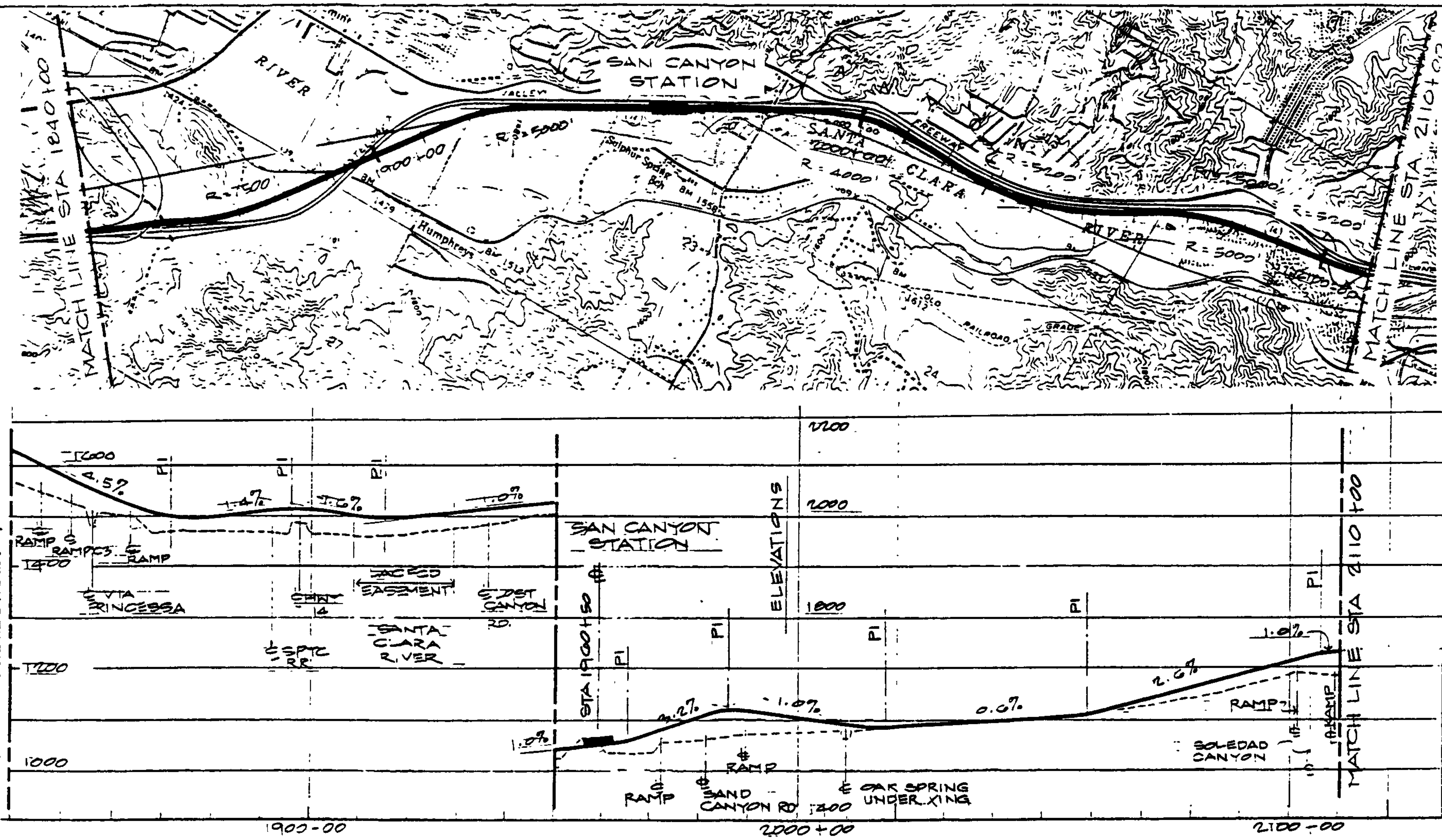
H.S.G.T. STUDY

SAN FERNANDO TO PALMDALE

1"=2000'-0" 2000' 0 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-2



STATIONING

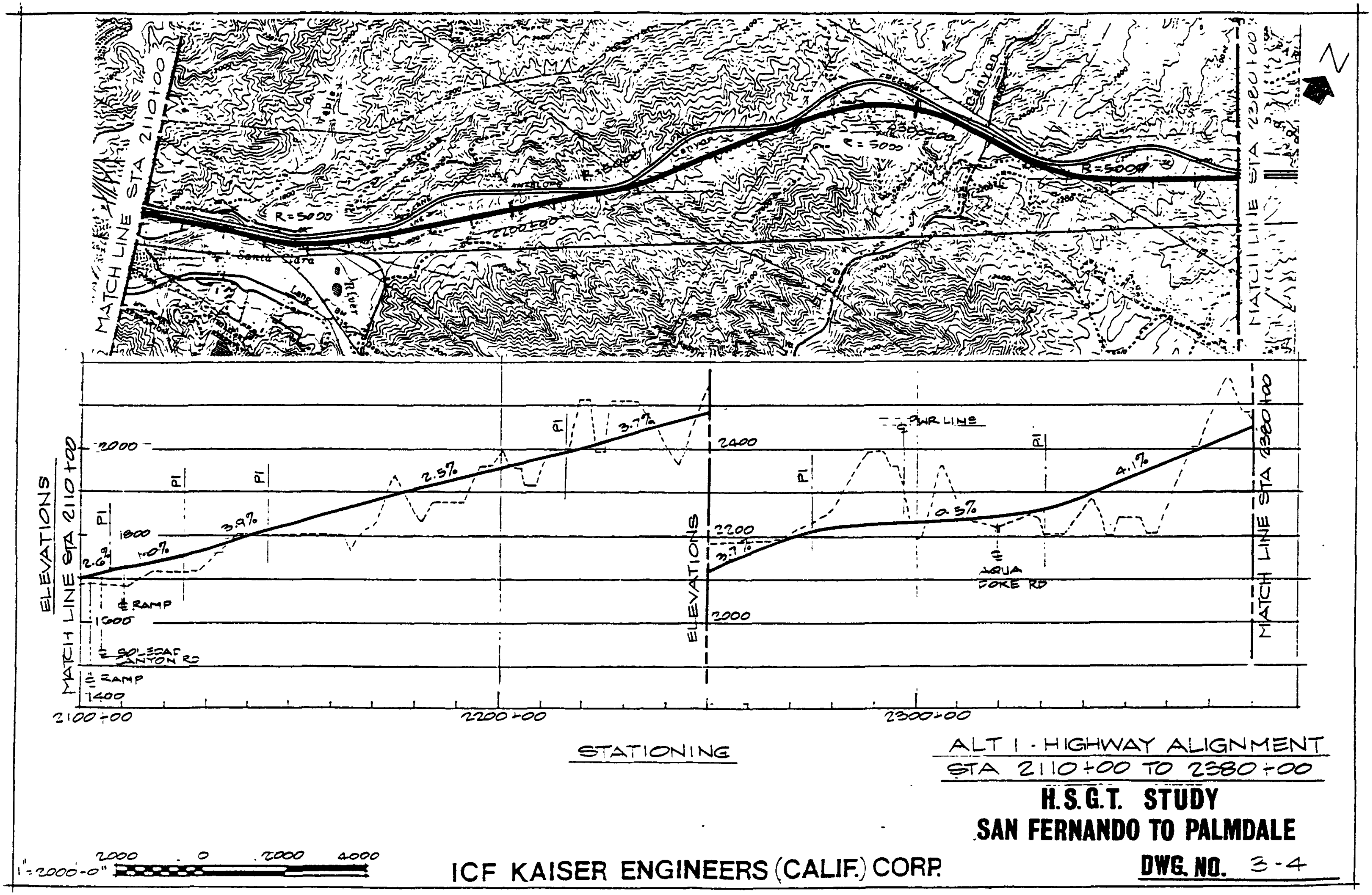
ALT. 1-HIGHWAY ALIGNMENT
STA 1840-00 TO 2110-00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1" = 2000'-0" — 2000' 0' 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-3



ALT I - HIGHWAY ALIGNMENT

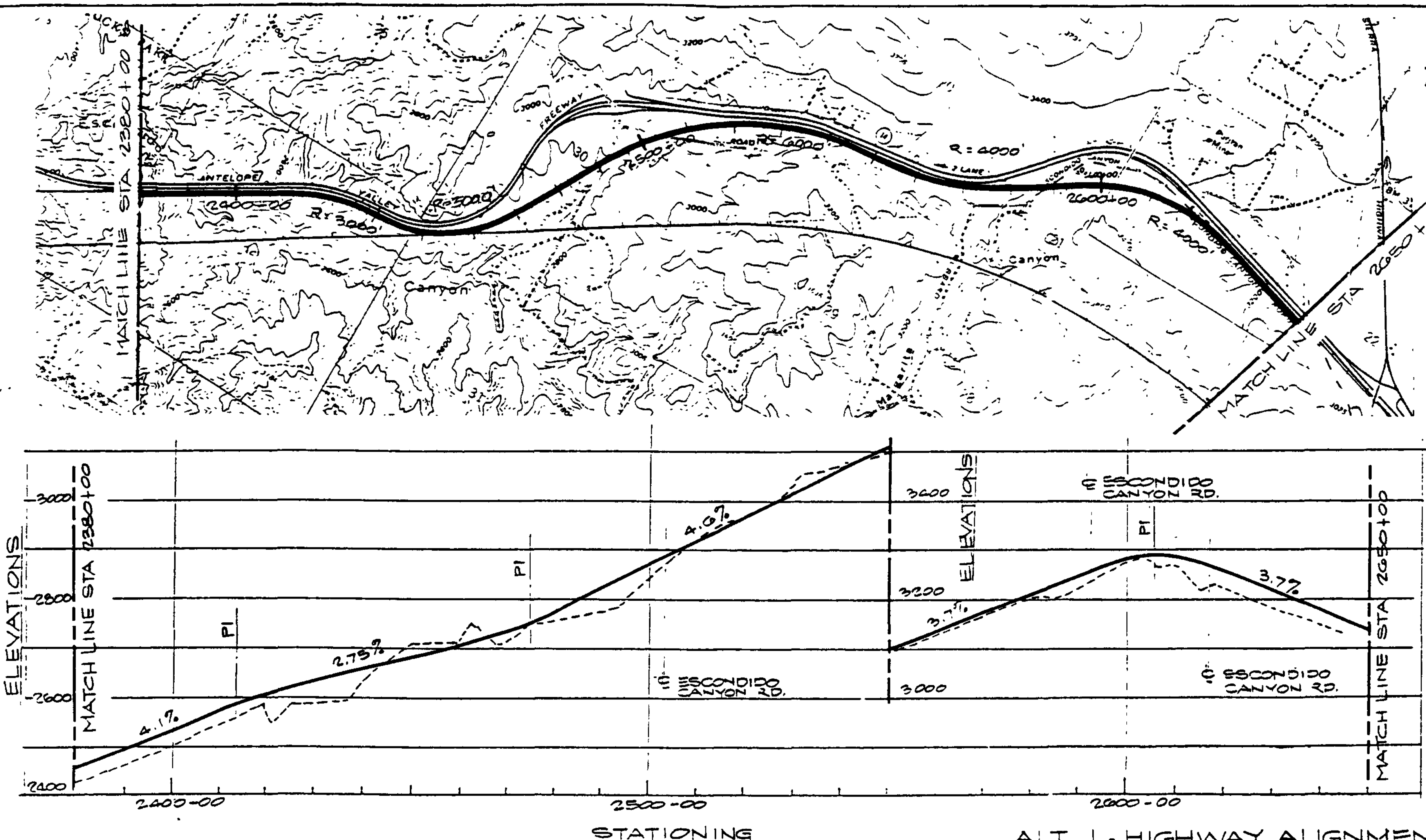
STA 2110+00 TO 2380+00

H.S.G.T. STUDY

SAN FERNANDO TO PALMDALE

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-4



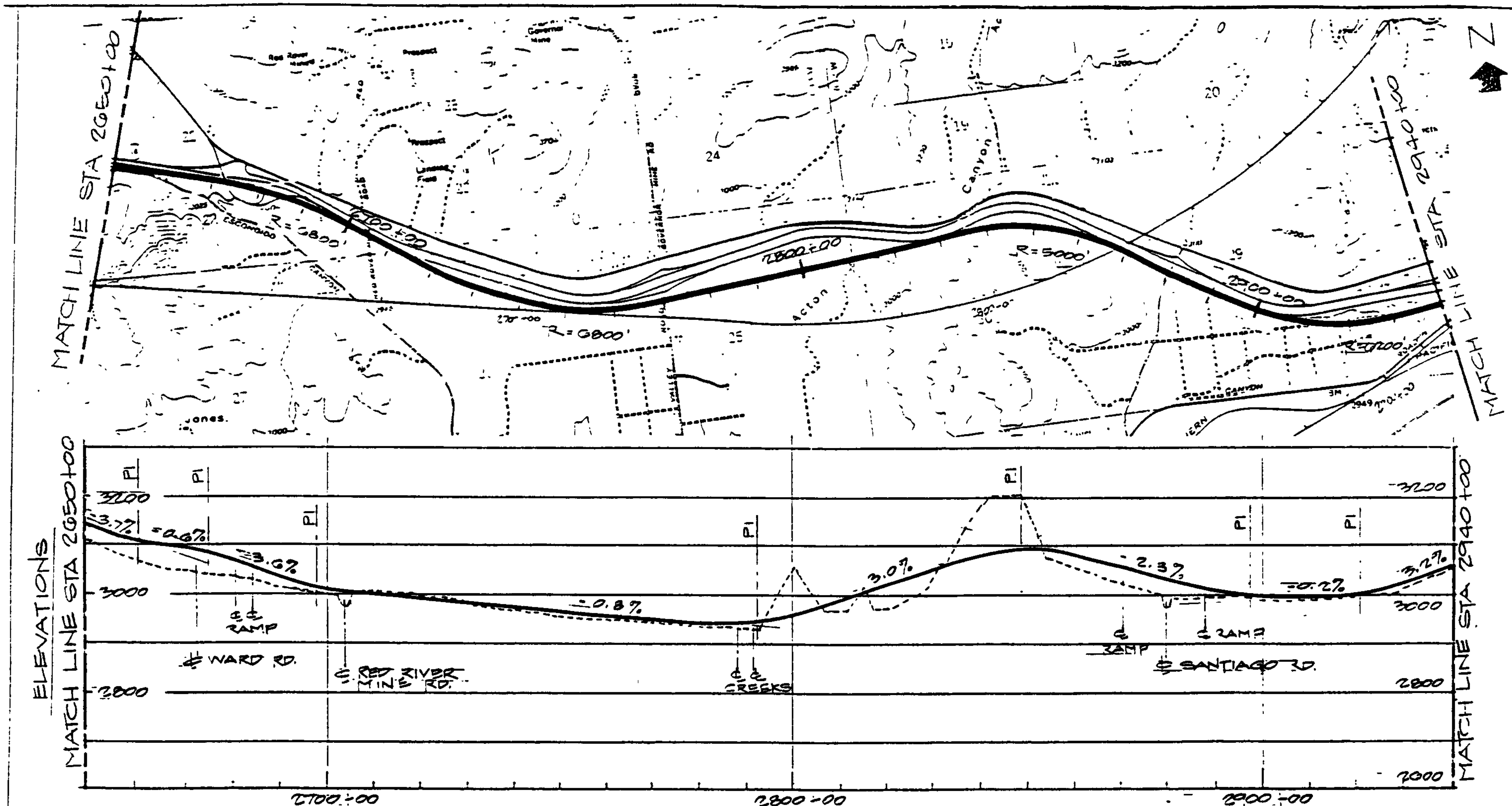
ALT. 1 - HIGHWAY ALIGNMENT
STA. 2380+00 TO 2650+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1"=2000'-0" 2000' 0' 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-5



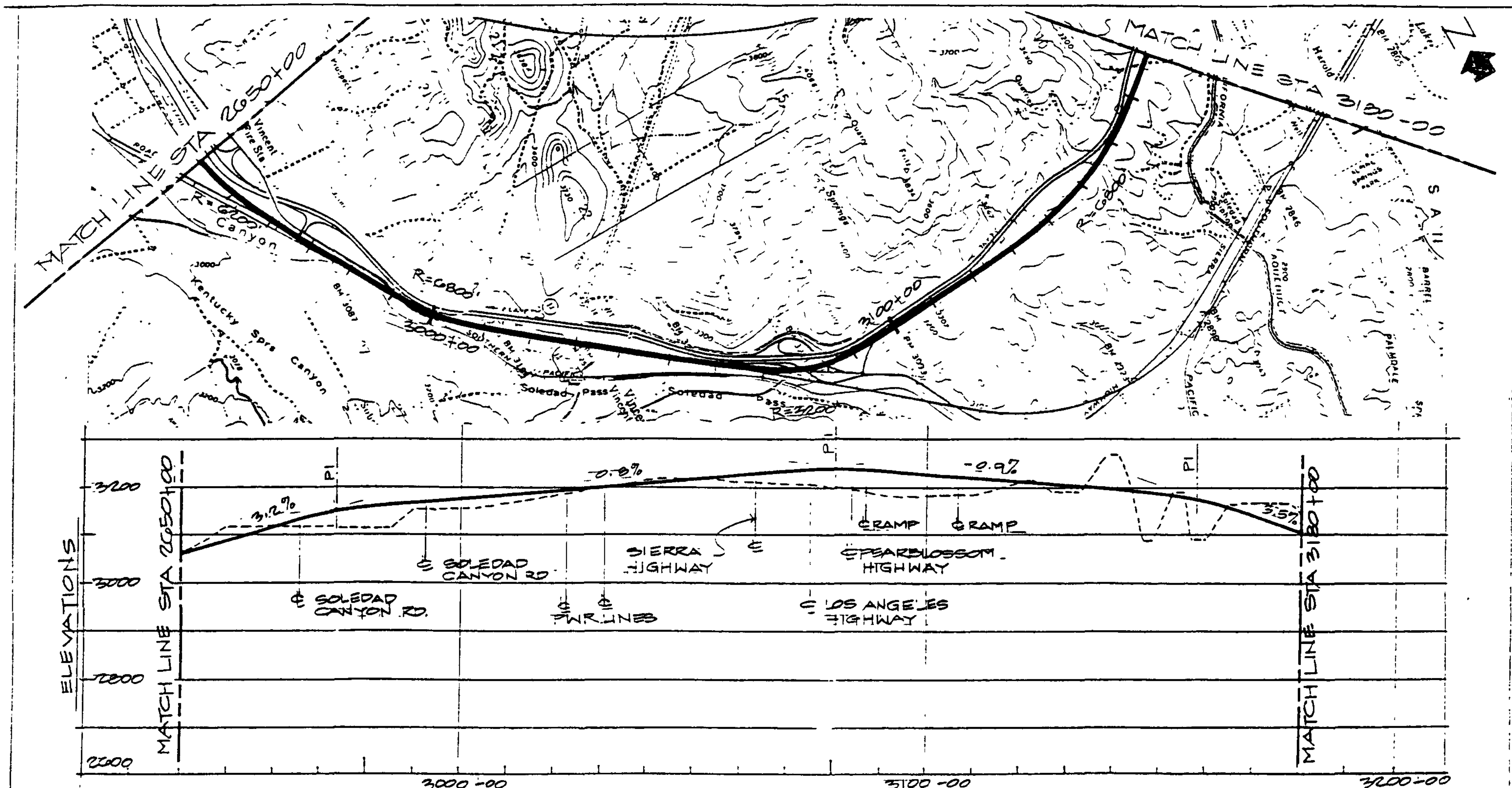
ALT. I HIGHWAY ALIGNMENT
STA 2650+00 TO 2940+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1"=2000'-0" 2000' 0' 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-6



STATIONING

ALT I - HIGHWAY ALIGNMENT

STA. 2940+00 TO 3180+00

H.S.G.T. STUDY

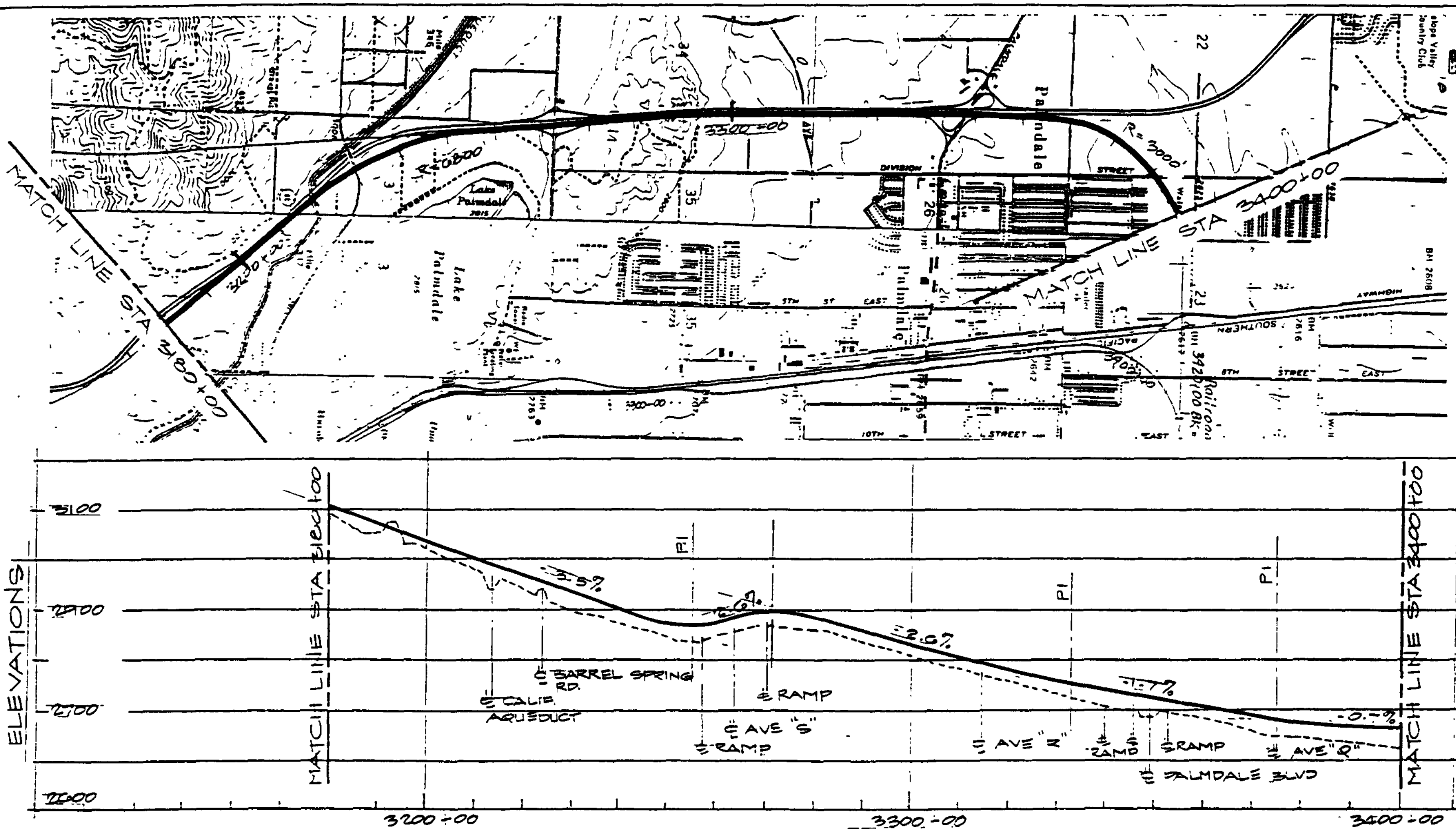
SAN FERNANDO TO PALMDALE

2000' 0' 2000' 4000'

1" = 2000'-0"

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-7



ALT 1-HIGHWAY ALIGNMENT

STA 3180+00 TO 3400+00

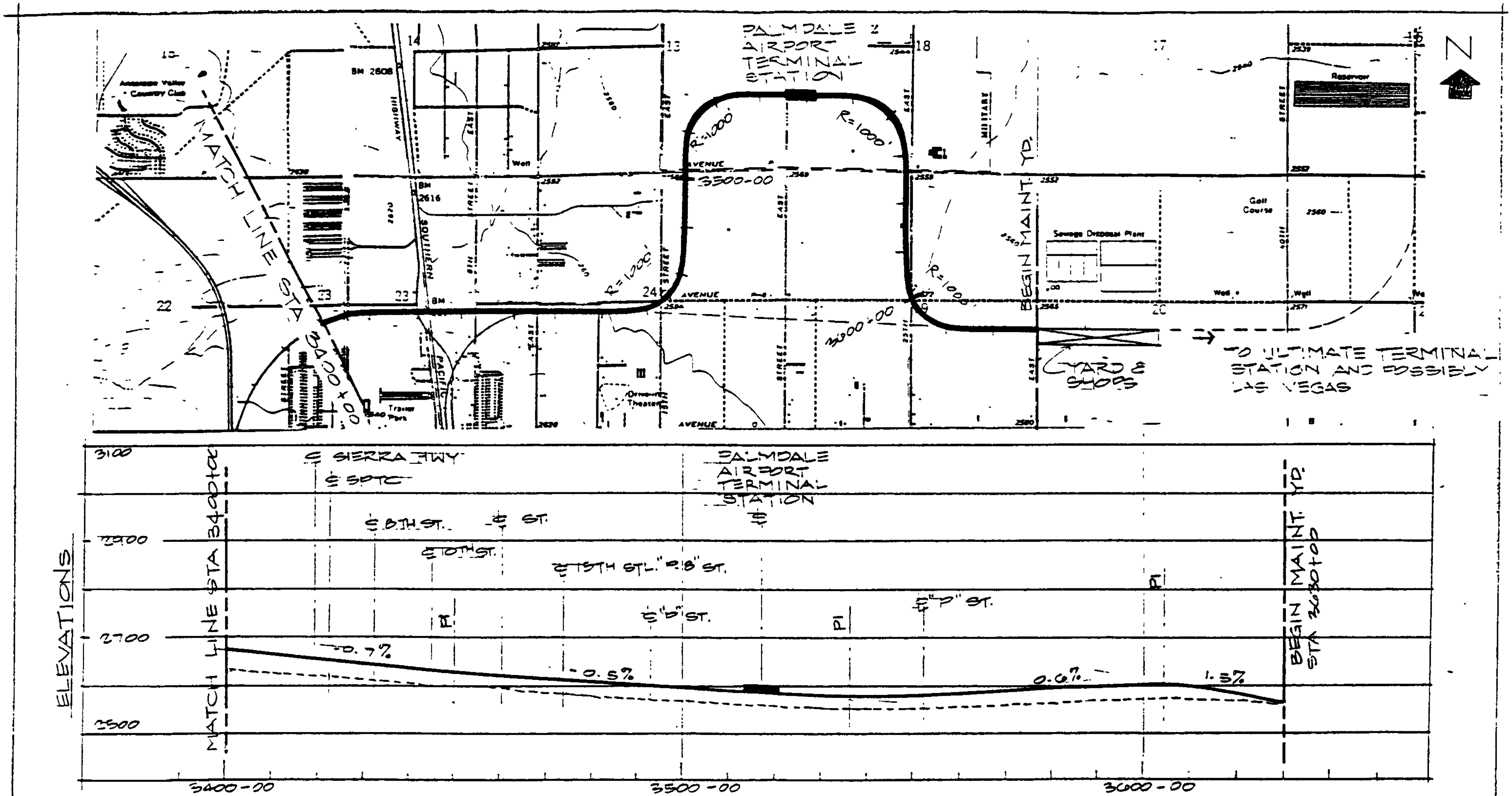
H.S.G.T. STUDY

SAN FERNANDO TO PALMDALE

1" = 2000'-0" -2000' 0' 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-8



ALT 1 - HIGHWAY ALIGNMENT

STA 3400+00 TO PALMDALE AIRPORT STATION

H.S.G.T. STUDY

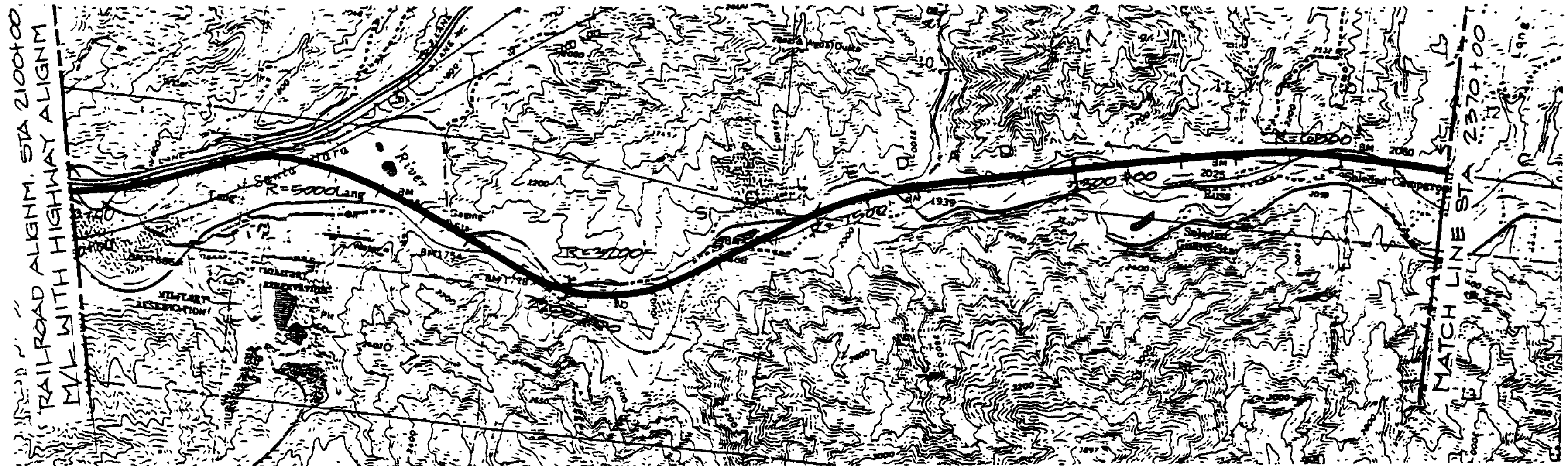
SAN FERNANDO TO PALMDALE

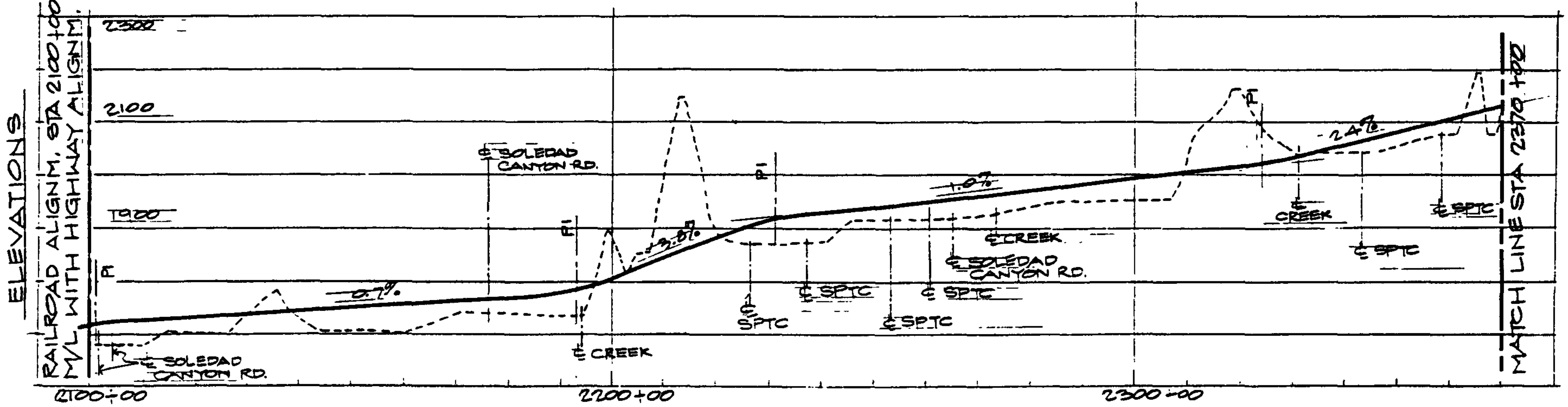
1"=2000'-0" 2000' 0 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-9

Alternative 2
Railroad Alignment
Drawings 3-10 to 3-15





STATIONING

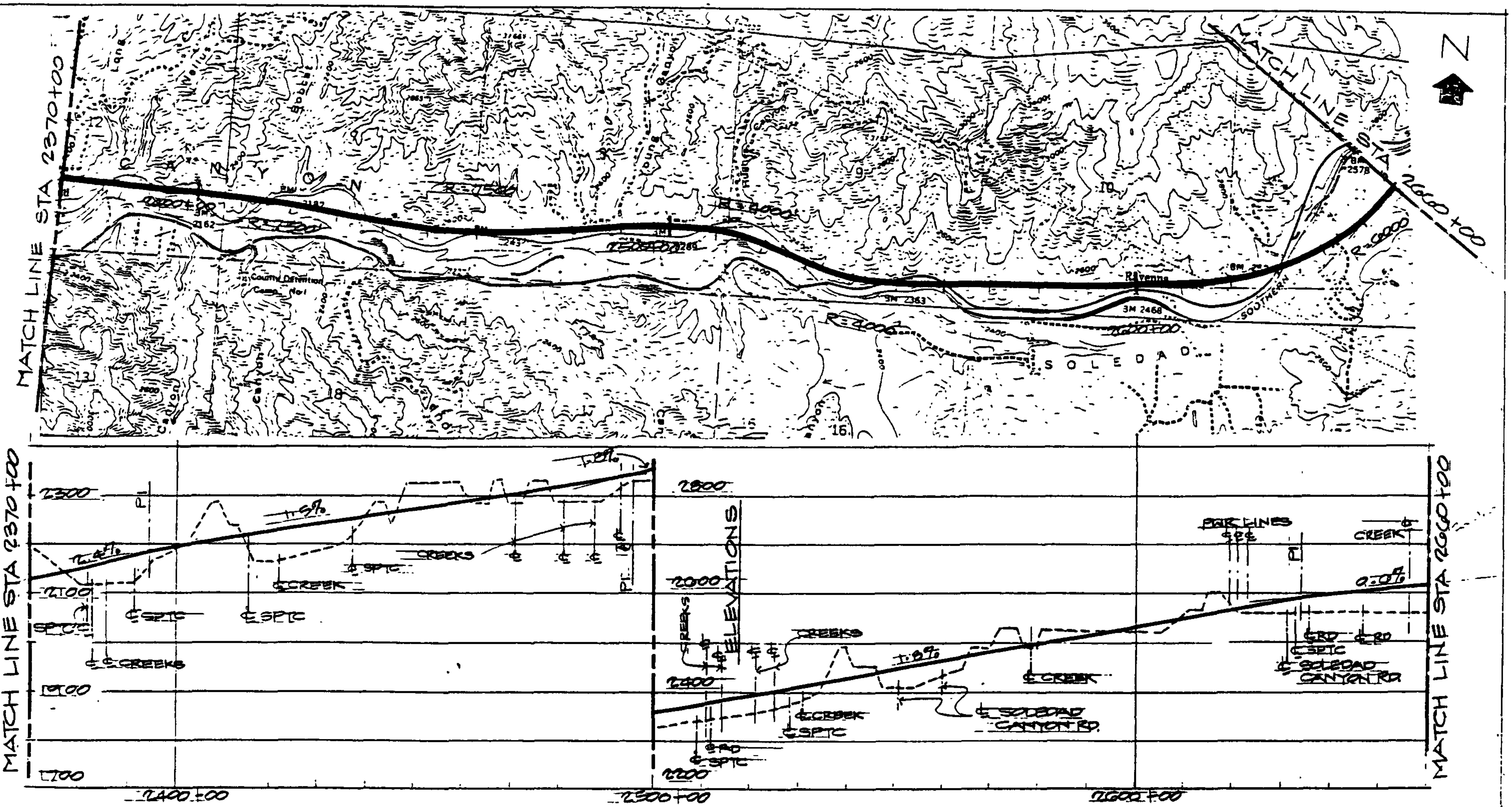
ALT. 2 - RAILROAD ALIGNMENT
STA. 2100+00 TO 2370+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1"=2000-0" 2000' 0 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-10



STATIONING

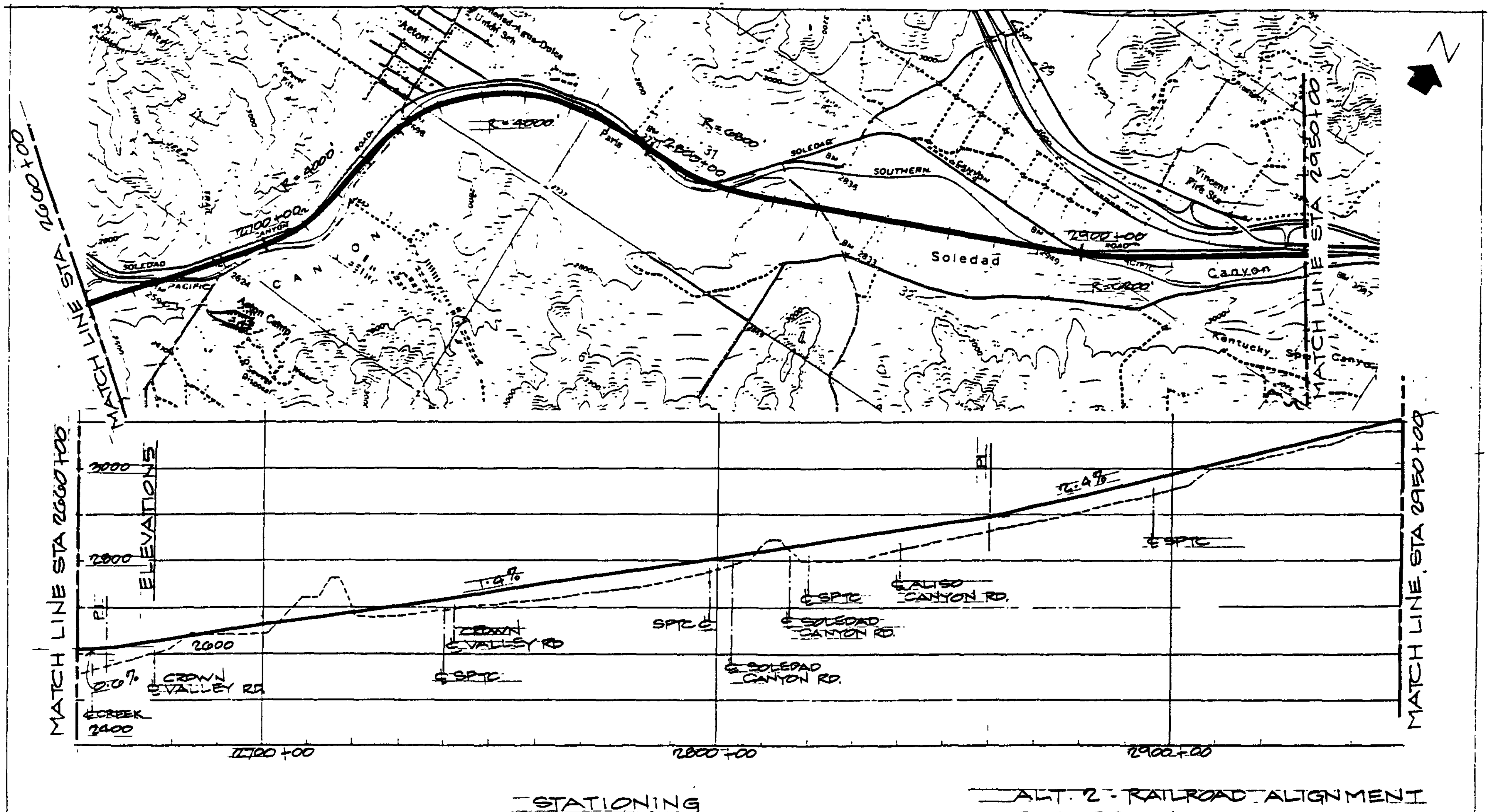
ALT 2 - RAILROAD ALIGNMENT
STA 2370+00 TO 2660+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1" = 2000'-0"   2000'   0'   2000'   4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-11



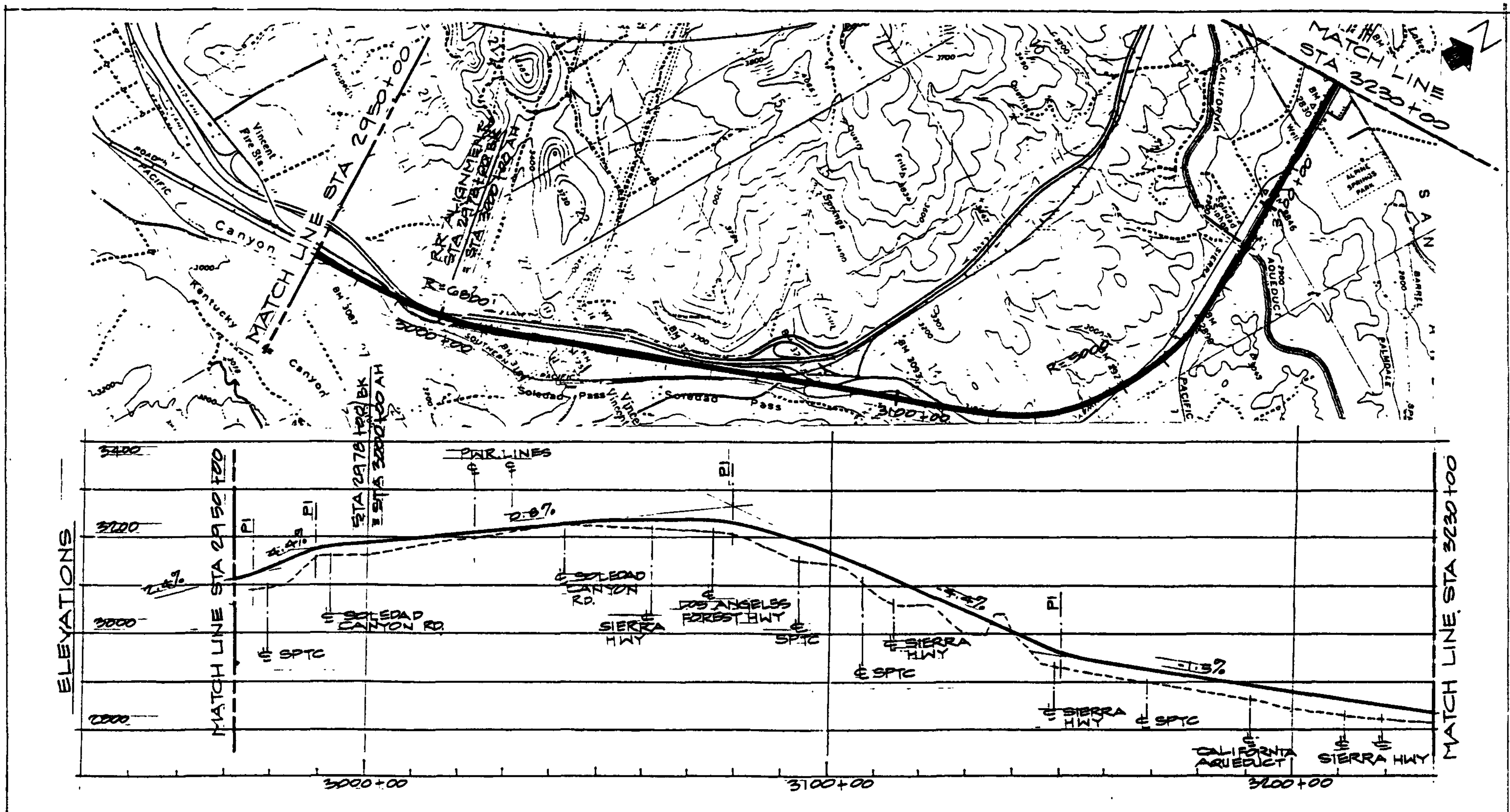
ALT. 2 - RAILROAD ALIGNMENT
STA 2660+00 TO 2950+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1"=2000-0" 2000' 0' 2000' 4000

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-12

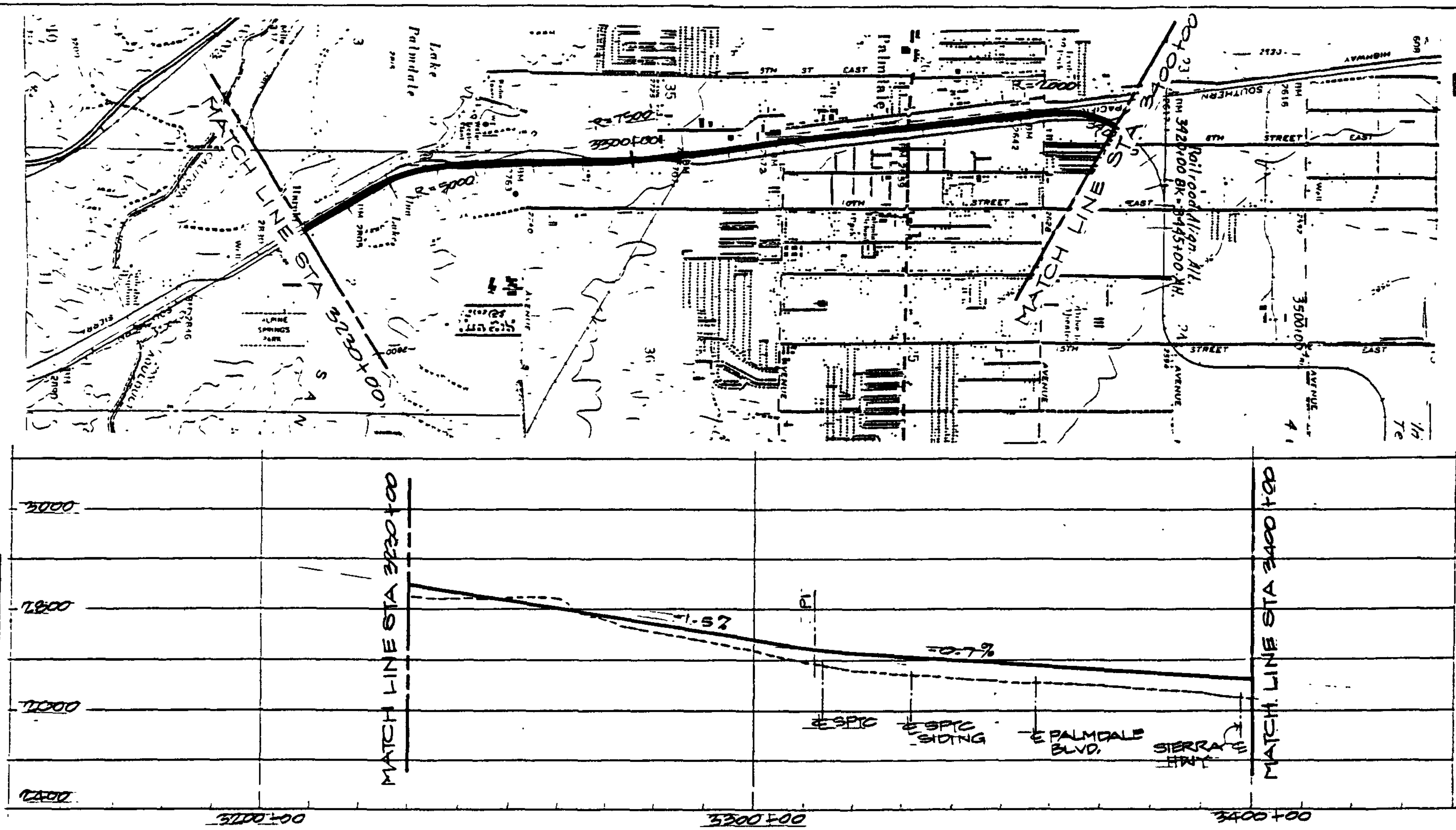


ALT 2 - RAILROAD ALIGNMENT
STA 2950+00 TO 3230+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-13



STATIONING

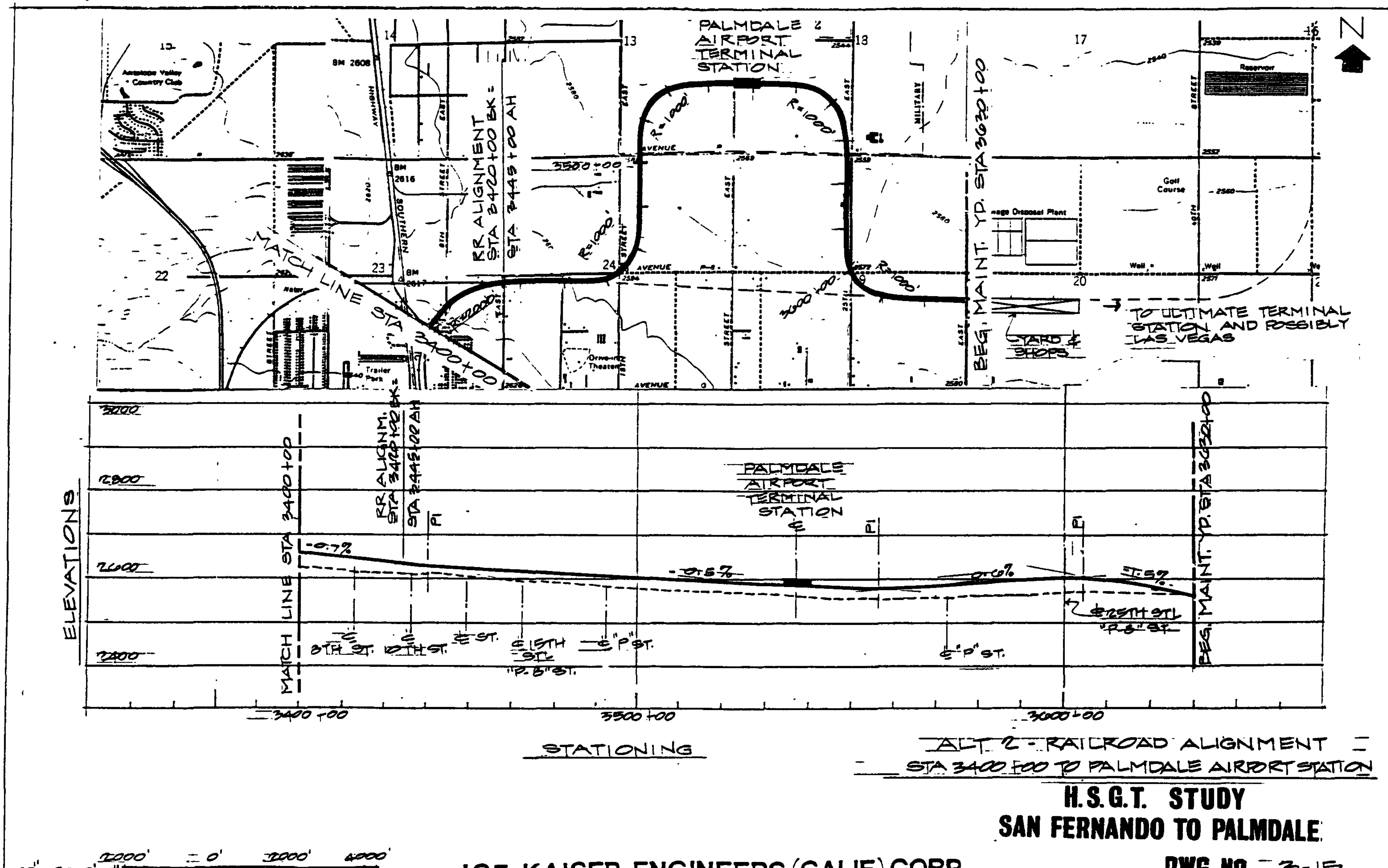
ALT 2 - RAILROAD ALIGNMENT
STA 3230+00 TO 3400+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1" = 2000'-0" 2000' 0' 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-14



ALT. 2 - RAILROAD ALIGNMENT

STA 3400+00 TO PALMDALE AIRPORT STATION

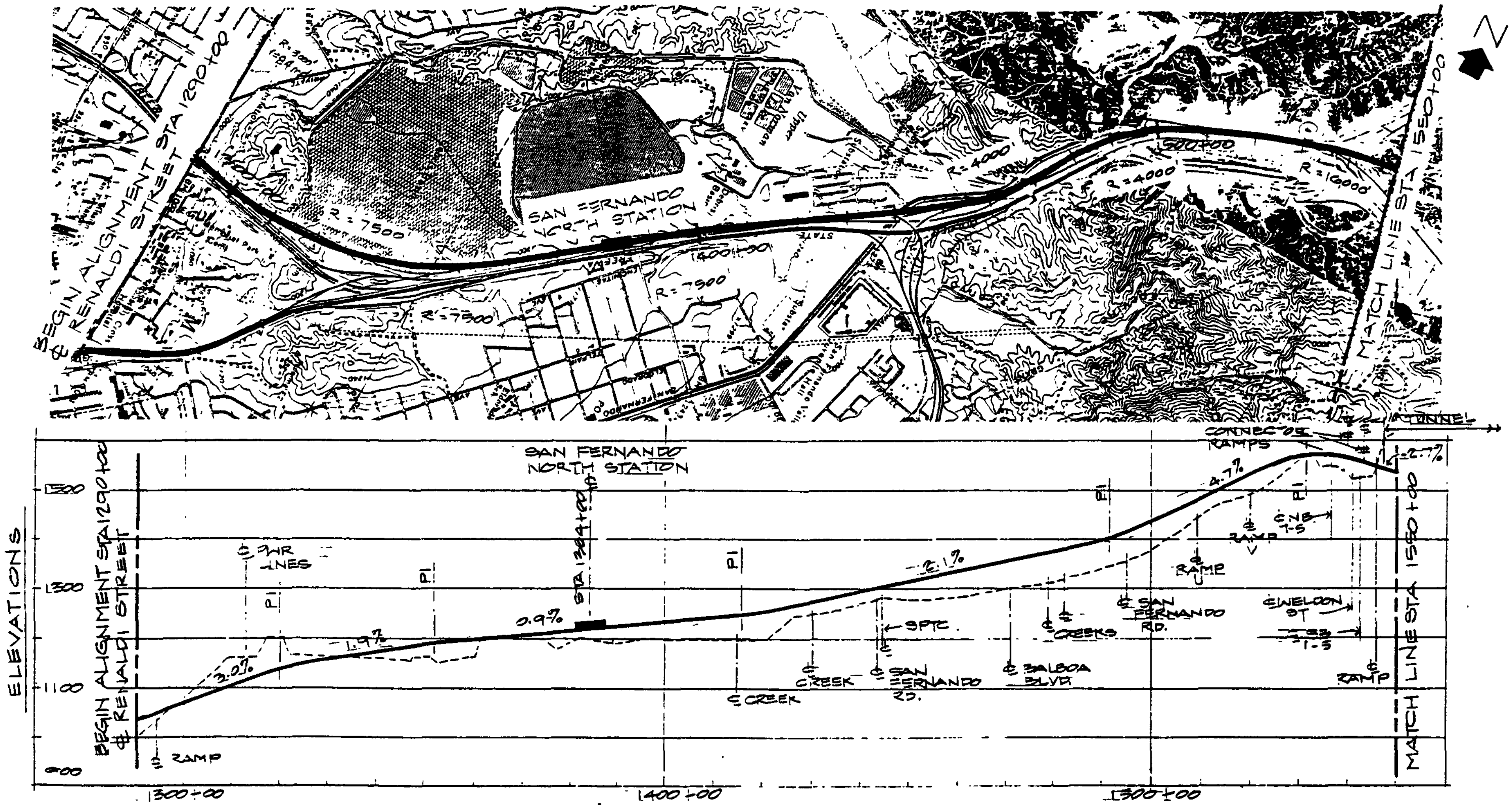
H.S.G.T. STUDY

SAN FERNANDO TO PALMDALE

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-15

Alternative 3
Super Speed Alignment
Drawings 3-16 to 3-24



STATIONING

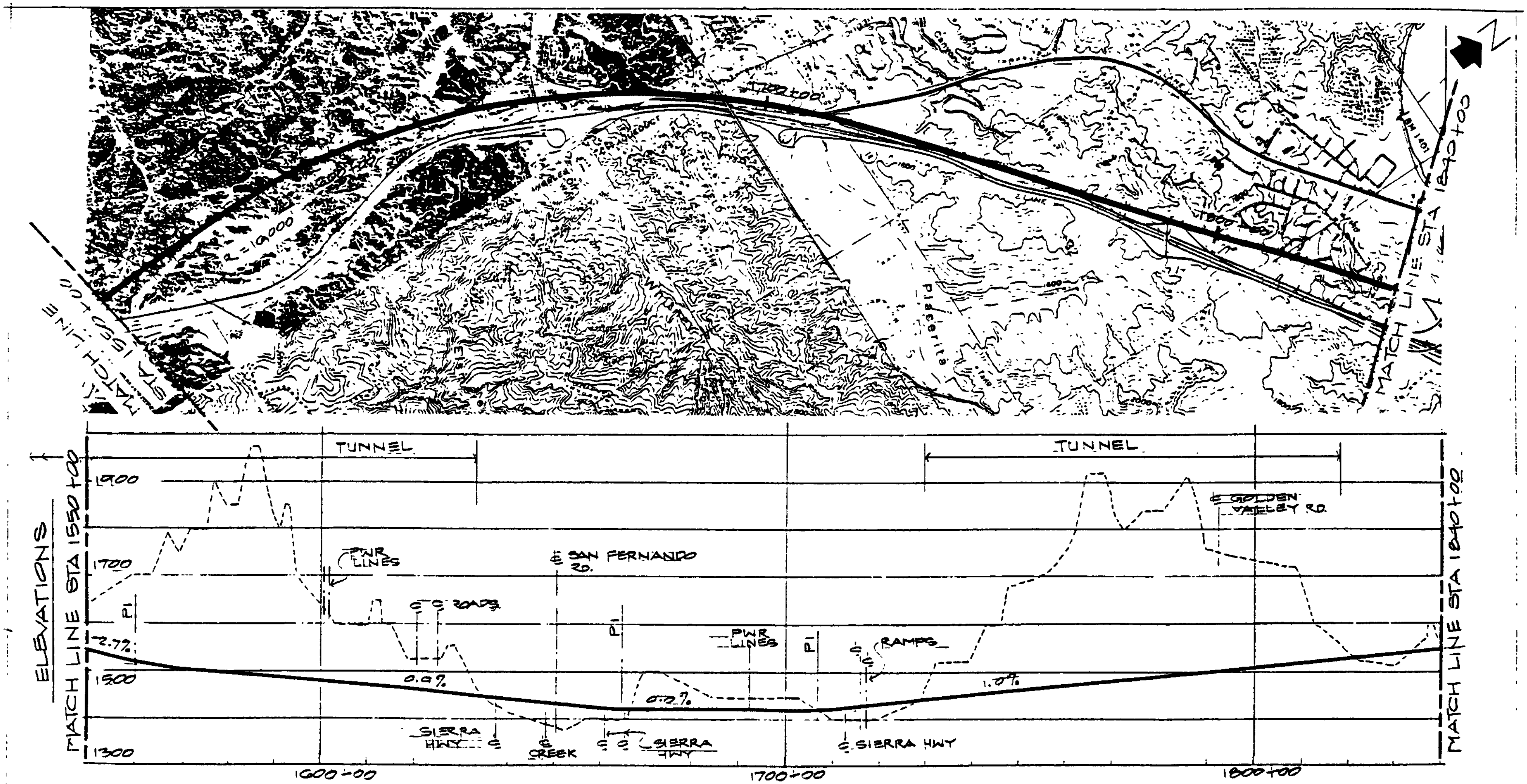
ALT 3- SUPER SPEED ALIGNMENT
STA 1290+00 TO 1350+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1" = 2000'-0" 2000' 0' 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-16



STATIONING

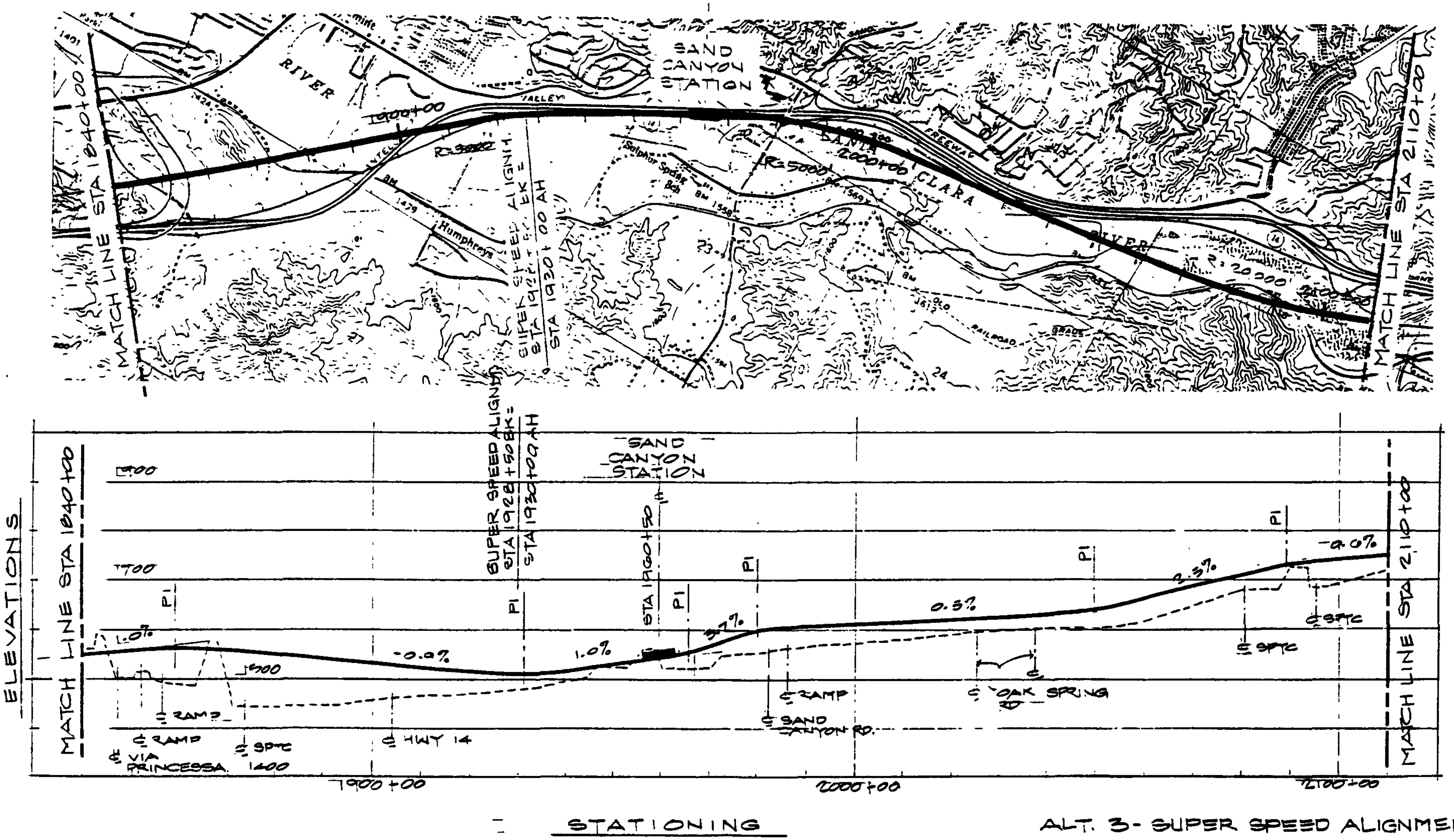
ALT. 3 - SUPER SPEED ALIGNMENT
STA 1530+00 TO 1840+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1"=2000'-0" 2000' 0' 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-17



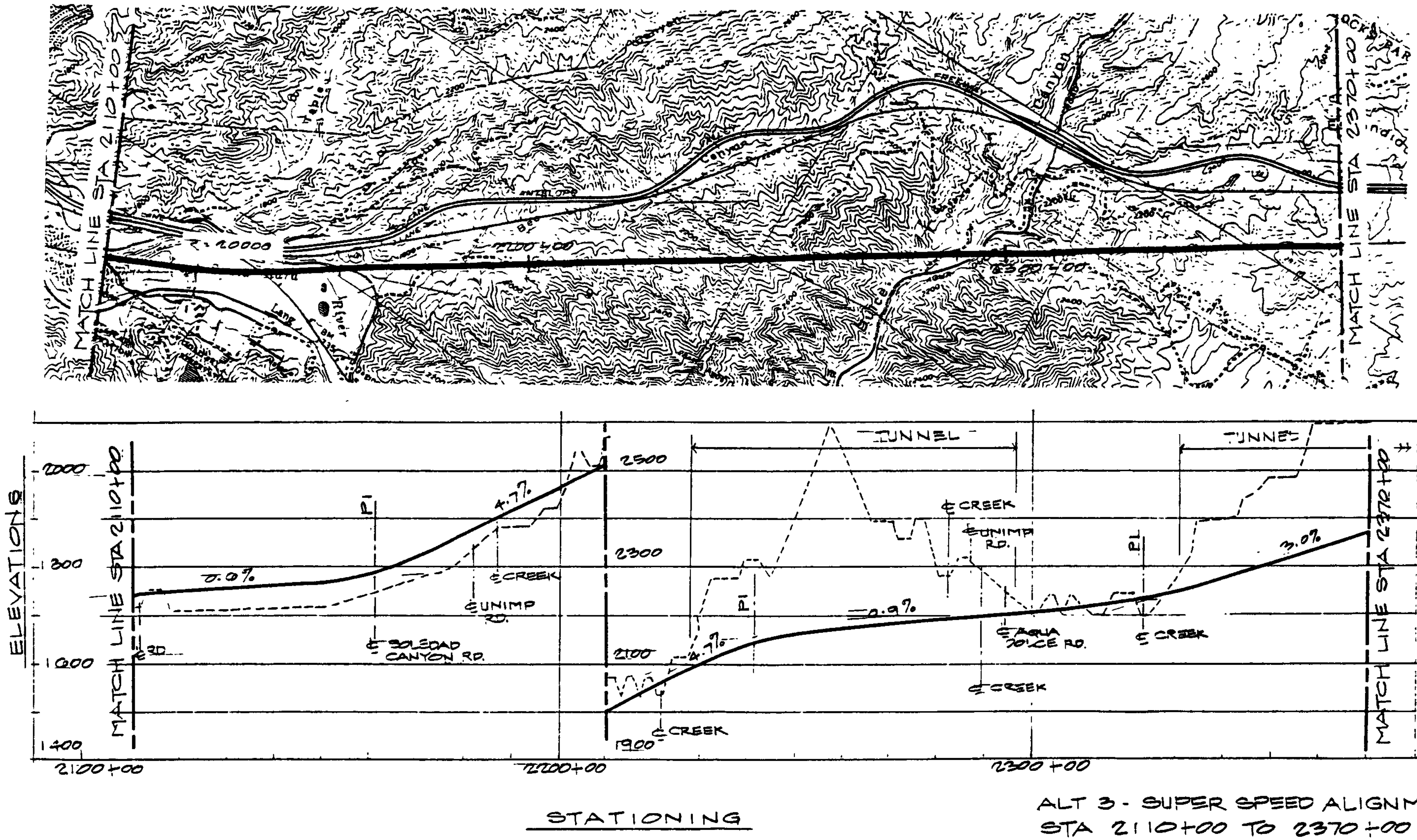
ALT. 3- SUPER SPEED ALIGNMENT
STA 1840+00 TO 2110+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1" = 2000'-0"   2000' 0' 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-18

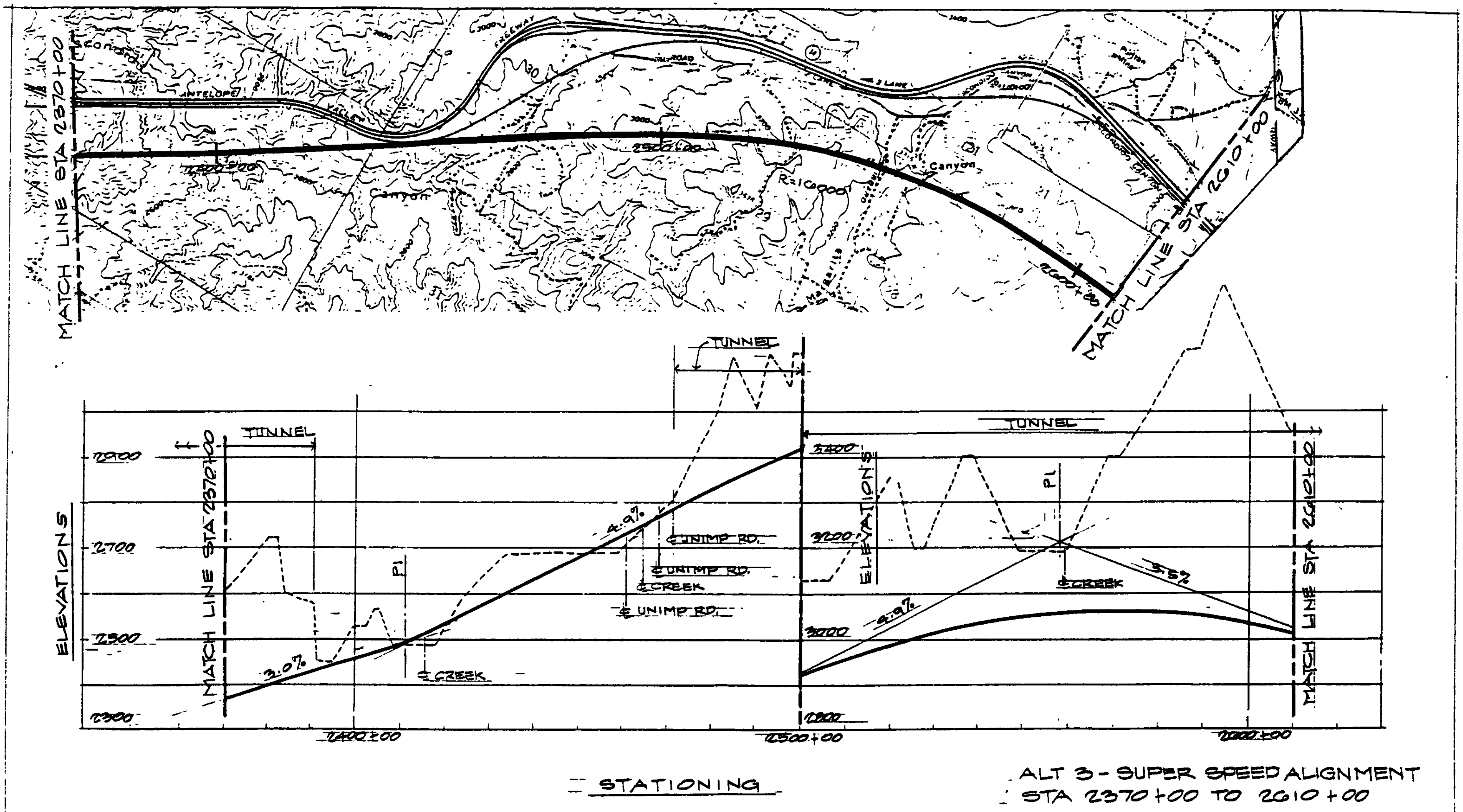


ALT 3 - SUPER SPEED ALIGNMENT
STA 2110+00 TO 2370+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-19

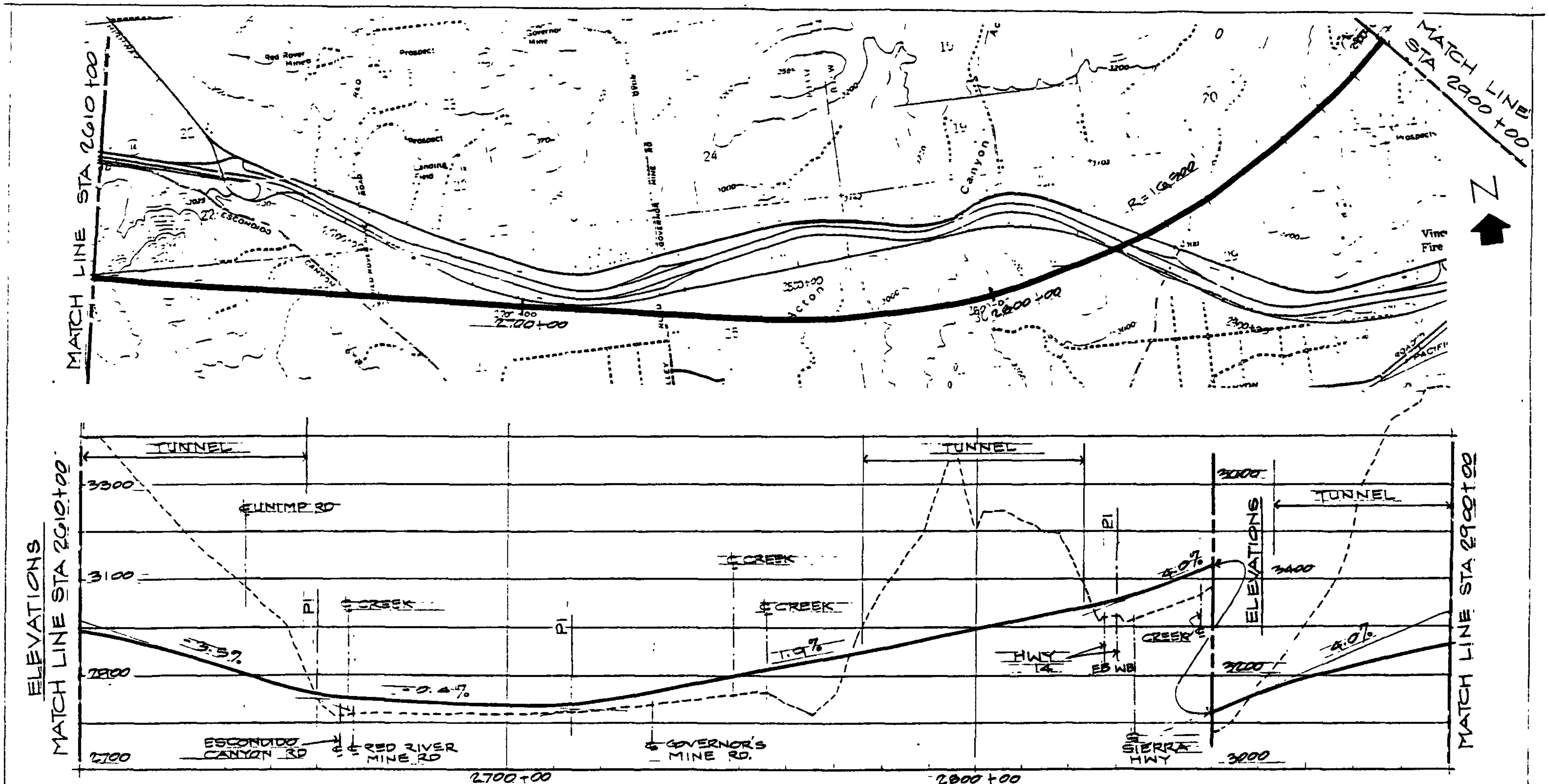


ALT 3 - SUPER SPEED ALIGNMENT
STA 2370+00 TO 2610+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-20



STATIONING

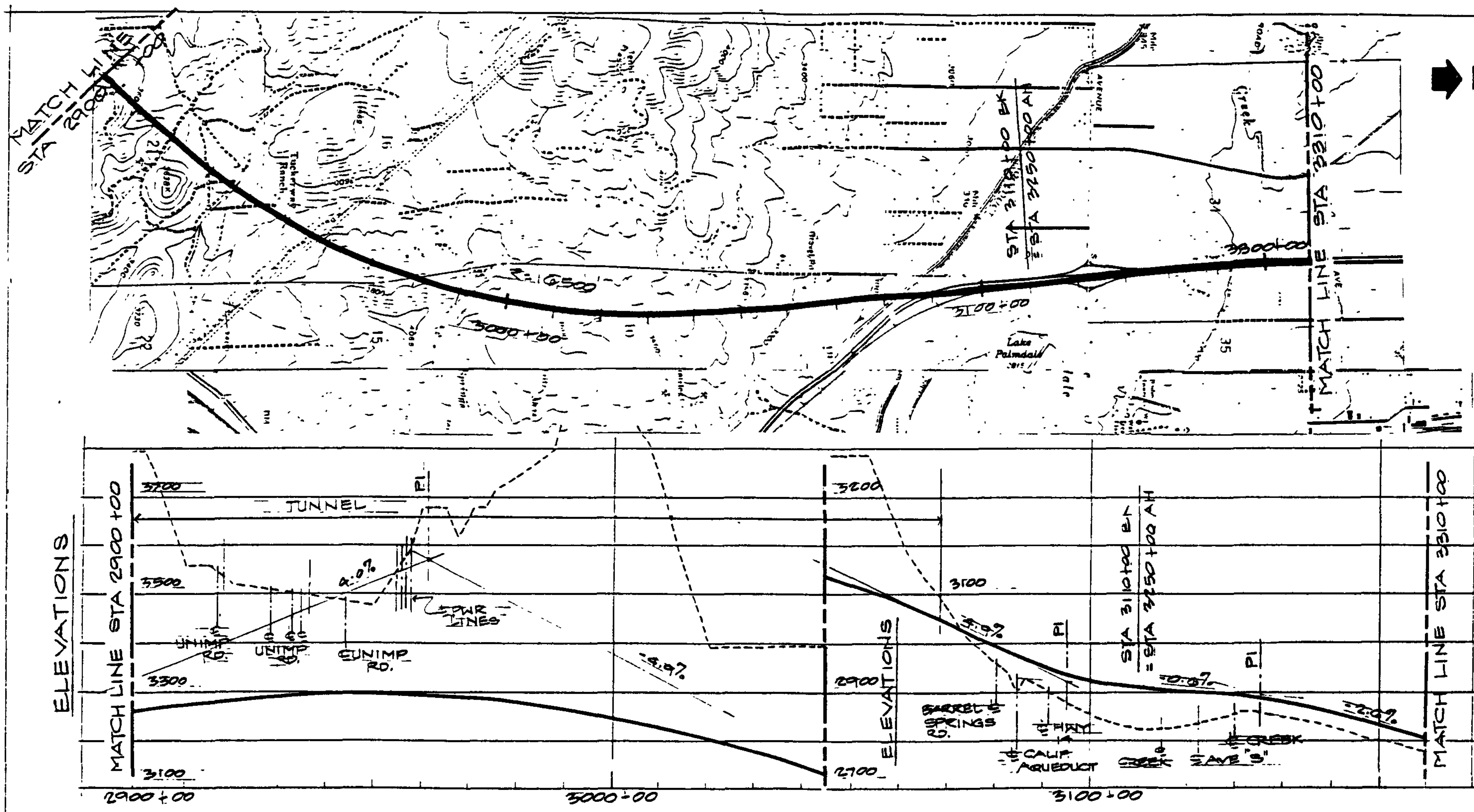
ALT 3 - SUPER SPEED ALIGNMENT
STA 2610+00 TO 2900+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1" = 2000'-0" 2000' 0' 2000' 4000'

ICF KAISER ENGINEERS (CALIF.) CORP.

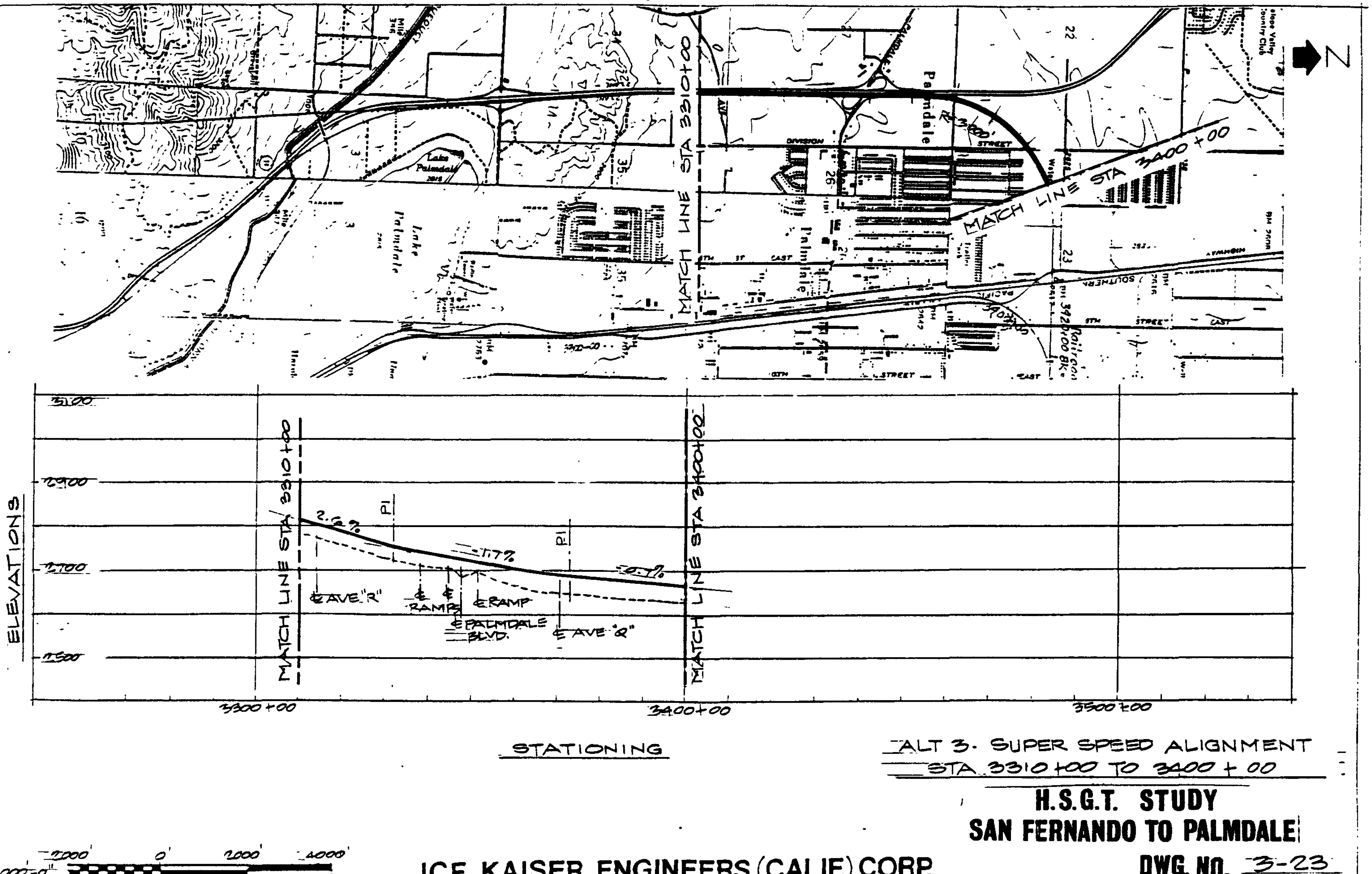
DWG. NO. 3-21



ALT. 3 - SUPER SPEED ALIGNMENT
STA 2900+00 TO 3310+00

H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE
DWG. NO. 3-22

ICF KAISER ENGINEERS (CALIF.) CORP.



ALT 3 - SUPER SPEED ALIGNMENT

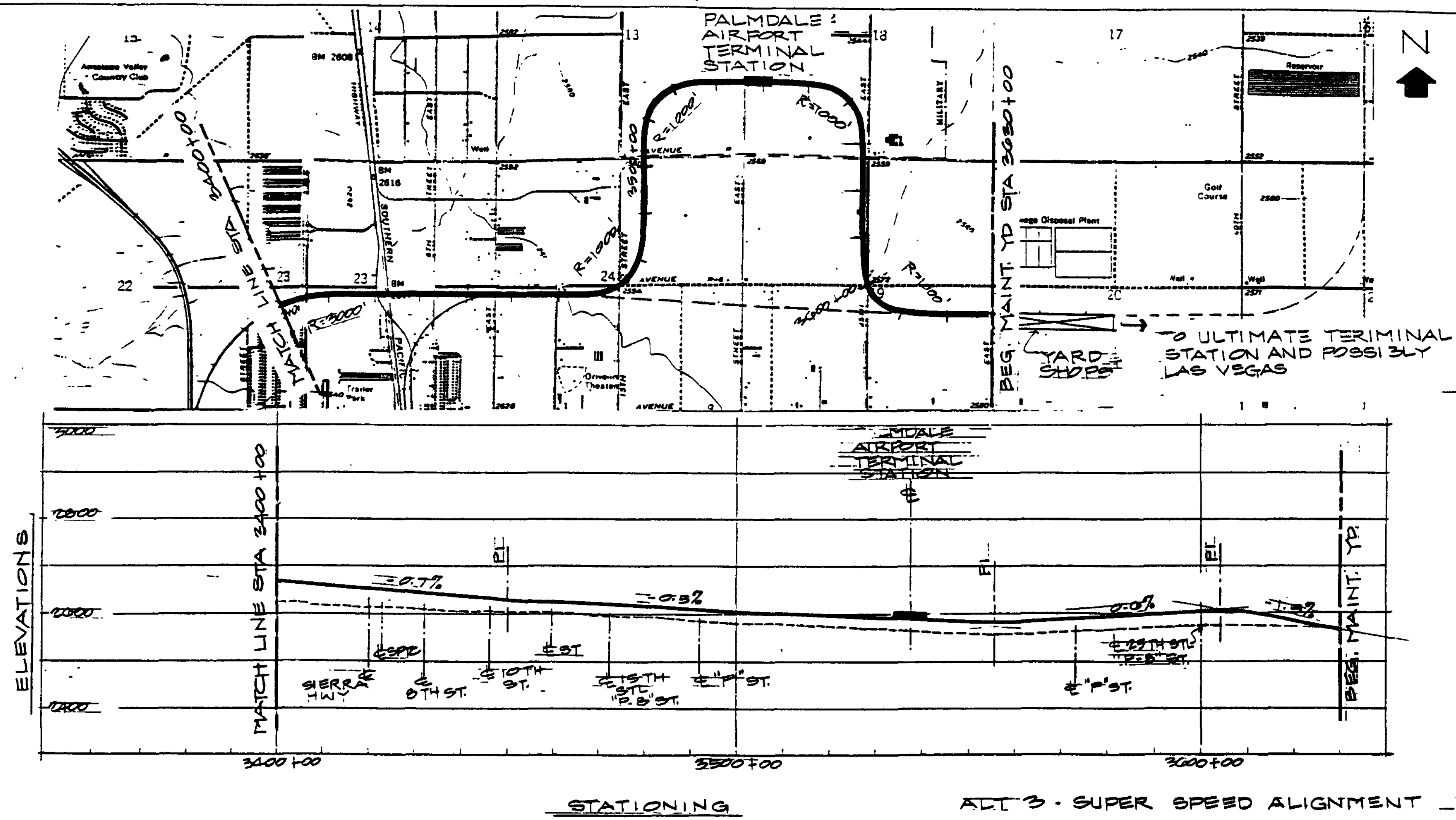
STA 3310+00 TO 3400+00

H.S.G.T. STUDY

SAN FERNANDO TO PALMDALE

ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-23



ALT 3 - SUPER SPEED ALIGNMENT
STA 3400+00 TO PALMDALE AIRPORT STATION

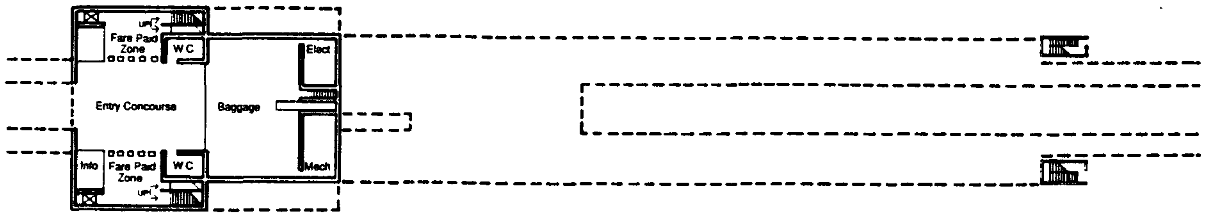
H.S.G.T. STUDY
SAN FERNANDO TO PALMDALE

1" = 2000'-0" — 2000' 0' 2000' 4000'

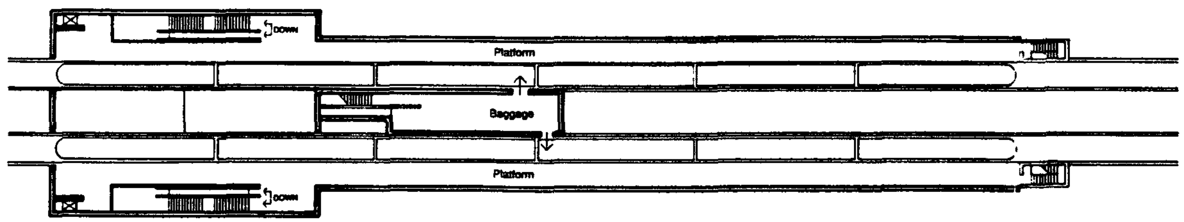
ICF KAISER ENGINEERS (CALIF.) CORP.

DWG. NO. 3-24

Appendix B



Concourse Level



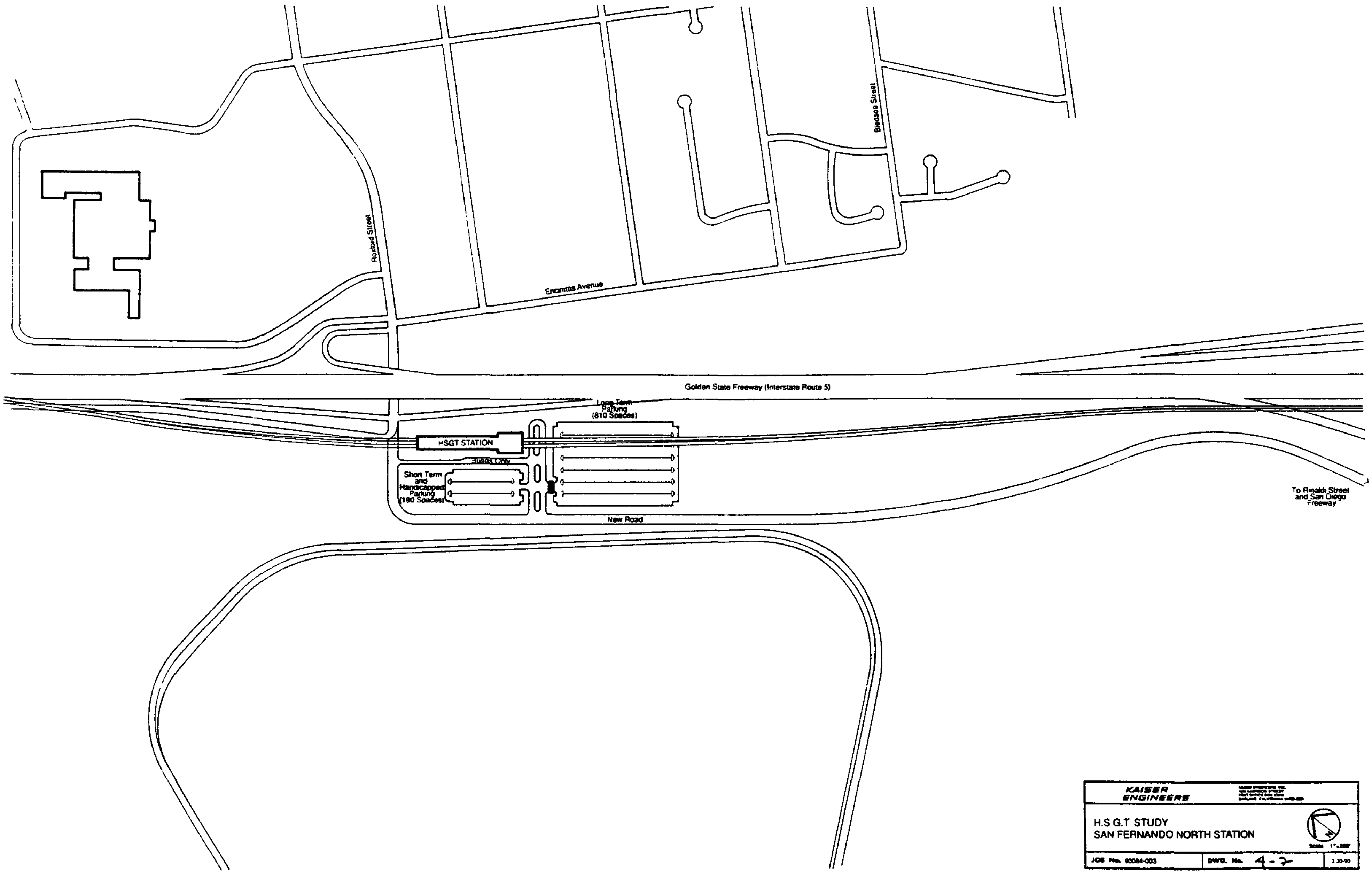
Platform Level

KAISER ENGINEERS

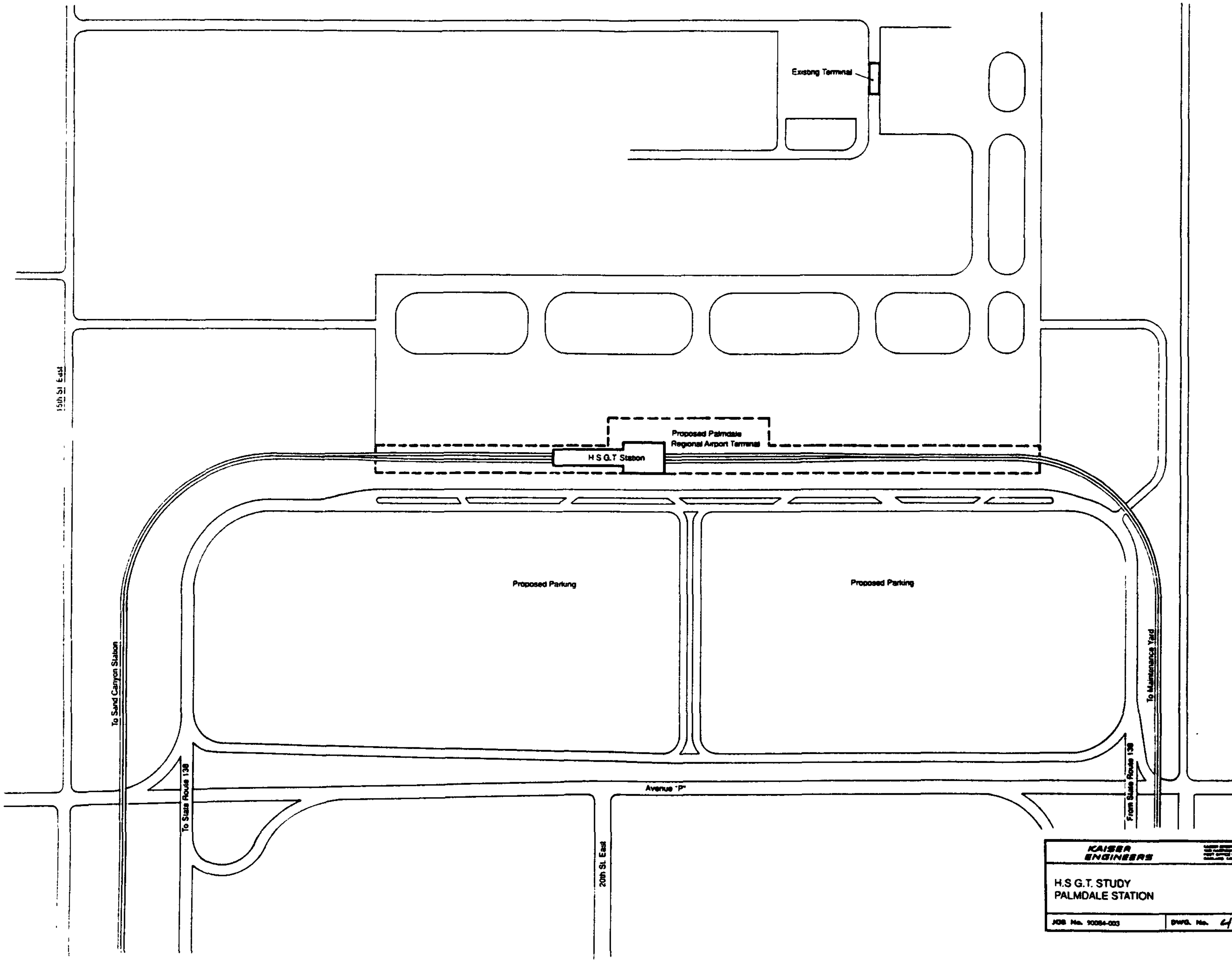
H S G.T. STUDY
PROTOTYPICAL
SIDE PLATFORM
STATION

Scale: 1" = 30'

Job No. 90084-003	Dwg. No. 4-1	3-30-90



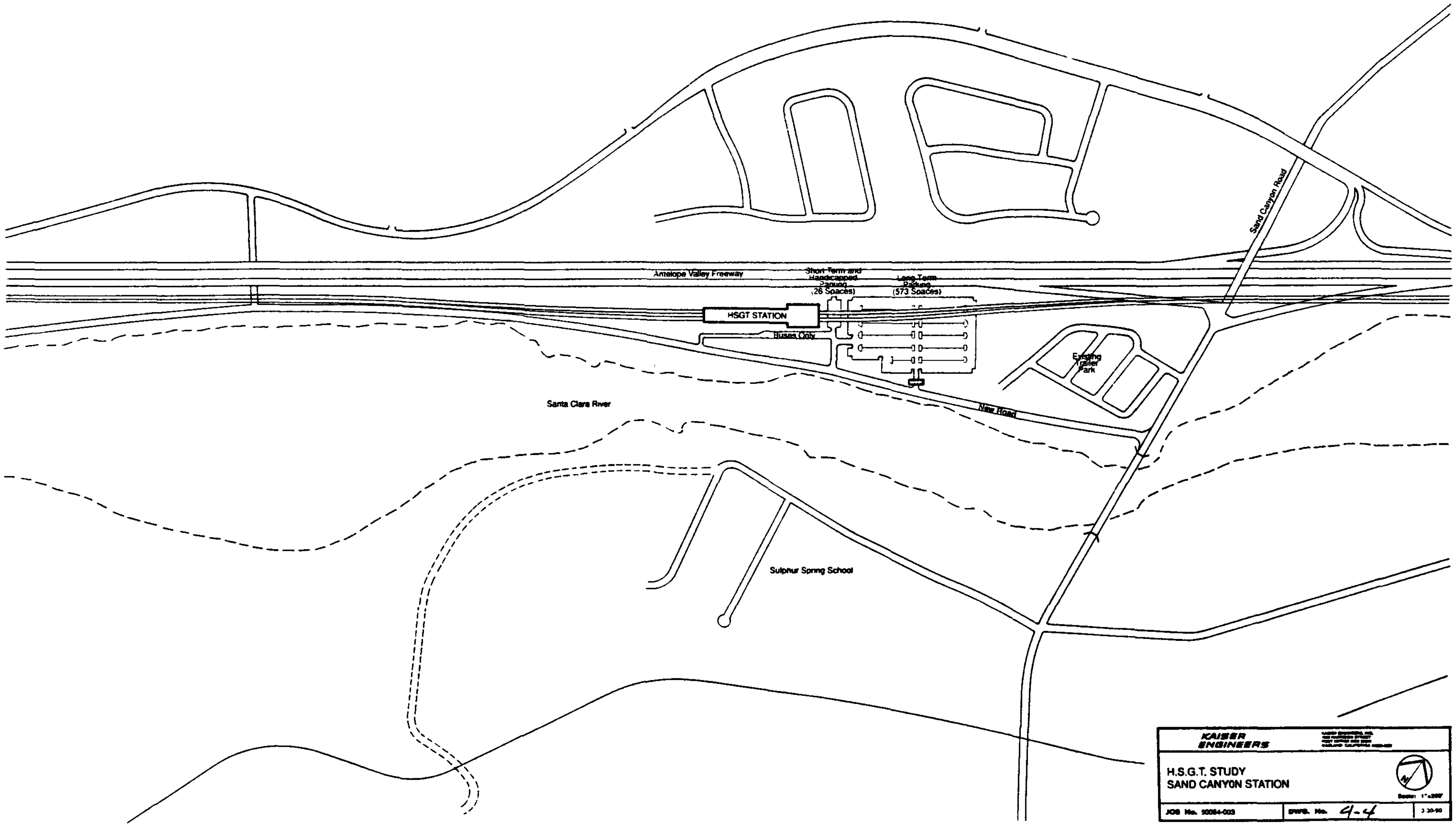
Roxford Street
Encinitas Avenue
Bledsoe Street
Golden State Freeway (Interstate Route 5)
Long-Term Parking (810 Spaces)
HSGT STATION
Buses Only
Short Term and Handicapped Parking (190 Spaces)
New Road
To Rinaldi Street and San Diego Freeway
KAISER ENGINEERS
H.S G.T STUDY
SAN FERNANDO NORTH STATION
Scale 1"=200'
JOB No. 90054-003
DWG. No. 4-2
3 30-90



KAISER ENGINEERS

H.S G.T. STUDY
PALMDALE STATION

JOB No. 90084-003 | DWG. No. 4-3



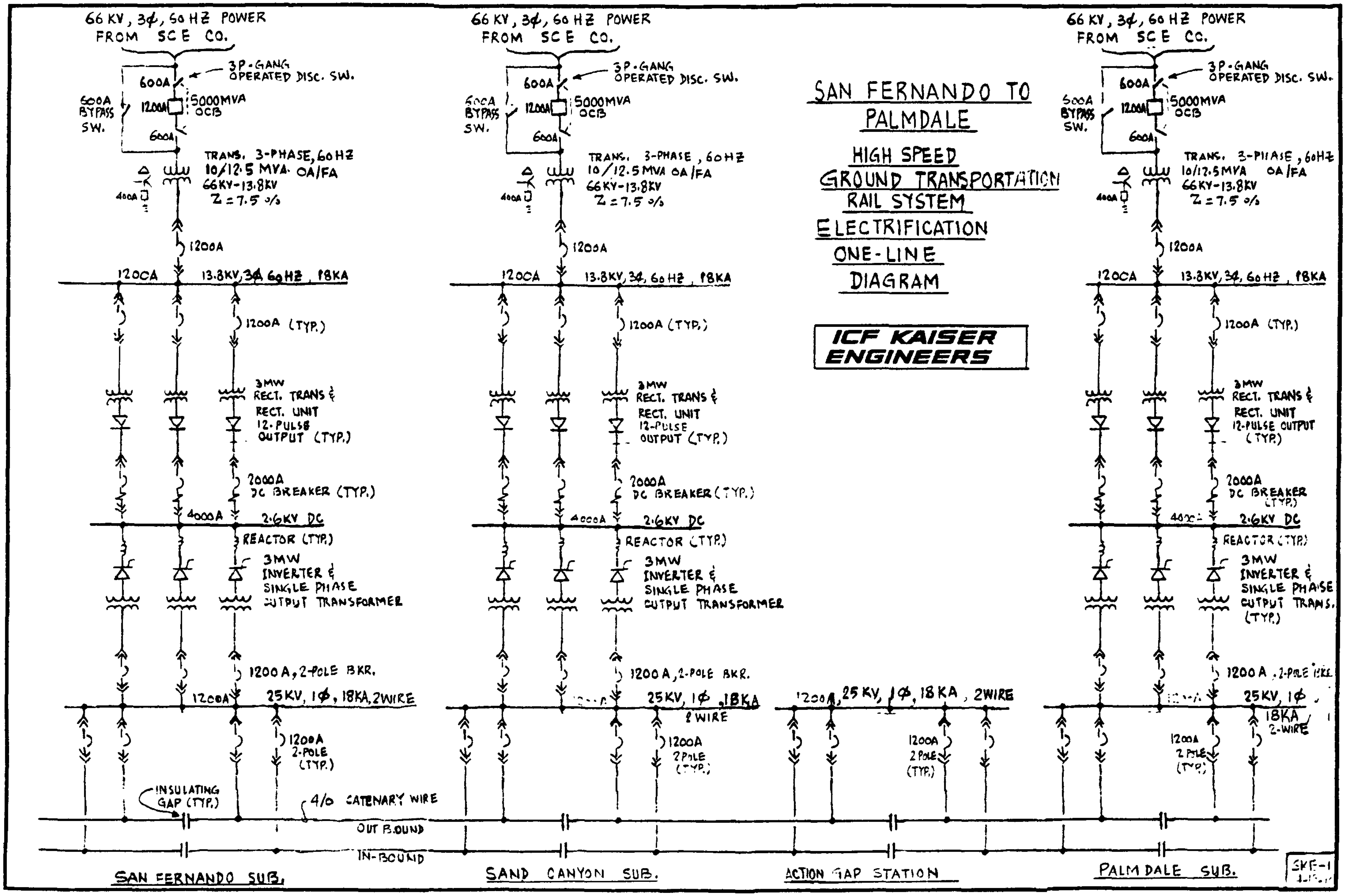
KAISER ENGINEERS

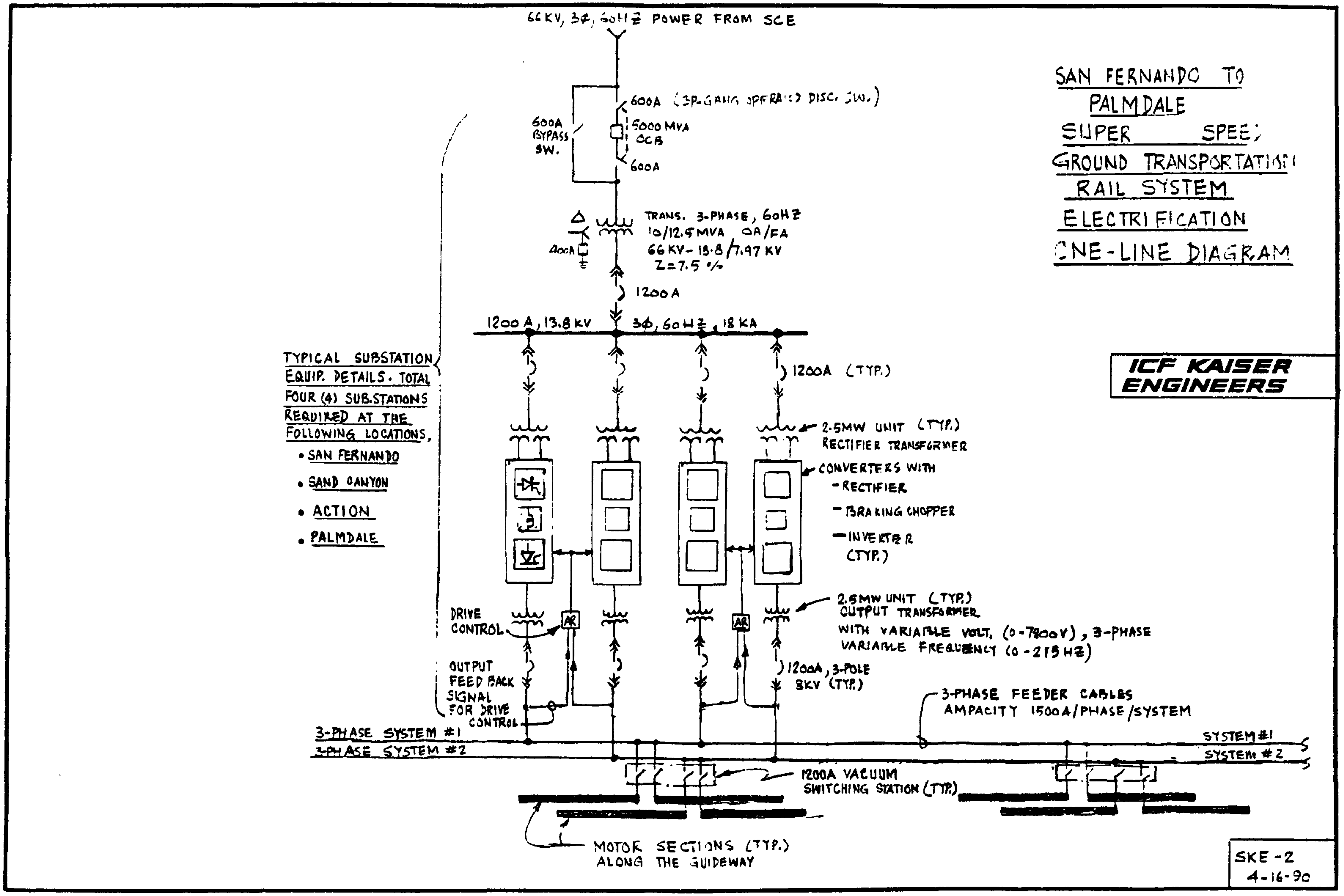
H.S.G.T. STUDY
SAND CANY0N STATION

Scale: 1"=200'

JOB No. 90084-003 | DWG. No. 4-4 | 3-30-90

Appendix C


SAN FERNANDO TO PALMDALE
HIGH SPEED GROUND TRANSPORTATION RAIL SYSTEM ELECTRIFICATION ONE-LINE DIAGRAM
ICF KAISER ENGINEERS
66 KV, 3φ, 60 HZ POWER FROM SCE CO.
3P-GANG OPERATED DISC. SW.
600A
600A BYPASS SW.
1200A
5000MVA OCB
TRANS. 3-PHASE, 60 HZ 10/12.5 MVA OA/FA 66KV-13.8KV Z = 7.5 %
400A
1200A
13.8KV, 3φ, 60 HZ, 18KA
1200A (TYP.)
3MW RECT. TRANS & RECT. UNIT 12-PULSE OUTPUT (TYP.)
2000A DC BREAKER (TYP.)
4000A
2.6KV DC
REACTOR (TYP.)
3MW INVERTER & SINGLE PHASE OUTPUT TRANSFORMER
1200A, 2-POLE BKR.
25KV, 1φ, 18KA, 2WIRE
1200A 2-POLE (TYP.)
INSULATING GAP (TYP.)
4/0 CATENARY WIRE
OUT BOUND
IN-BOUND
SAN FERNANDO SUB.
SAND CANYON SUB.
ACTION GAP STATION
PALMDALE SUB.
SKE-1


66KV, 3Ø, 60HZ POWER FROM SCE
600A (3P-GANG SEPERATE) DISC. SW.)
600A BYPASS SW.
5000 MVA OCB
600A
TRANS. 3-PHASE, 60HZ
10/12.5MVA OA/FA
66KV-13.8/7.97 KV
Z=7.5 %
400A
1200A
1200 A, 13.8 KV 3Ø, 60HZ, 18 KA
1200A (TYP.)
TYPICAL SUBSTATION EQUIP. DETAILS. TOTAL FOUR (4) SUBSTATIONS REQUIRED AT THE FOLLOWING LOCATIONS,
• SAN FERNANDO
• SAND CANYON
• ACTION
• PALMDALE
2.5MW UNIT (TYP.)
RECTIFIER TRANSFORMER
CONVERTERS WITH
-RECTIFIER
-BRAKING CHOPPER
-INVERTER (TYP.)
DRIVE CONTROL
AR
2.5MW UNIT (TYP.)
OUTPUT TRANSFORMER
WITH VARIABLE VOLT. (0-7800V), 3-PHASE
VARIABLE FREQUENCY (0-213 HZ)
1200A, 3-POLE 8KV (TYP.)
OUTPUT FEED BACK SIGNAL FOR DRIVE CONTROL
3-PHASE FEEDER CABLES
AMPACITY 1500A/PHASE/SYSTEM
3-PHASE SYSTEM #1
3-PHASE SYSTEM #2
SYSTEM #1
SYSTEM #2
1200A VACUUM SWITCHING STATION (TYP.)
MOTOR SECTIONS (TYP.) ALONG THE GUIDEWAY
SAN FERNANDO TO PALMDALE SUPER SPEED GROUND TRANSPORTATION RAIL SYSTEM
ELECTRIFICATION
ONE-LINE DIAGRAM
ICF KAISER ENGINEERS
SKE-2
4-16-90

Appendix D

H.S.G.T. RAIL SYSTEM 05/10,1990
SAN FERNANDO TO PALMDALE Y.FAINSTEIN

SEGMENT DEFINITION

SEGMENT	DESCRIPTION	ROUTE LENGTH RF
HW-1	SAN FERNANDO TO SAND CANYON	69800
HW-2	SAND CANYON TO PALMDALE REGIONAL AIRPORT	163100
HW-SW	SYSTEMWIDE	
RR-1	SAME AS THE SEGMENT HW-1	69800
RR-2	SAND CANYON TO PALMDALE REGIONAL AIRPORT	158400
RR-SW	SYSTEMWIDE	
SH-1	SAN FERNANDO TO SAND CANYON	69650
SH-2	SAND CANYON TO PALMDALE REGIONAL AIRPORT	149100
SH-SW	SYSTEMWIDE	

H.S.G.T RAIL SYSTEM
SAN FERNANDO TO PALMDALE
ALTERNATIVE DEFINITION

05/08/90
Y.F.

NO.	DESCRIPTION	HW-1	HW-2	RR-1	RR-2	SH-1	SH-2	TOTAL
ALT I	HIGHWAY ALIGNMENT	69800	163100					232900
ALT II	RAIL ROAD ALIGNMENT			69800	158400			228200
ALT III	SUPER SPEED ALIGNMENT					69650	149100	218750

KAISER ENGINEERS
H.S.G.T. FEASIBILITY STUDY
JOB NO.90084-003(REV.#0)

05/09/90 07:26:12

BY: Y. FAINSTEIN
ALL COSTS IN $1,000'S

ALTERNATIVE: ALT_1 - HIGHWAY ALIGNMENT

DESCRIPTION	UNIT	SEG.: HW 1 QTY	COST	SEG.: HW 2 QTY	COST	SEG.: HW SW QTY	COST	QTY	COST	QTY	COST	QTY	COST	QTY	COST	QTY	COST	QTY	COST	TOTALS QTY	COST
SYSTEM DATA																					
ROUTE LENGTH	RF	69800	0	163100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	232900	0
TRACK LENGTH	TF	139600	0	326200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	465800	0
NUMBER OF STATIONS	EA	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
CONSTRUCTION COSTS																					
SITE MODIFICATIONS -DEMOLITIONS	RF	69800	349	163100	816	0	0	0	0	0	0	0	0	0	0	0	0	0	0	232900	1165
-UTILITY RELOCATIONS	RF	69800	1396	163100	3262	0	0	0	0	0	0	0	0	0	0	0	0	0	0	232900	4658
-STRUCT. MODIFICATIONS	LS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUIDEWAY AERIAL -STD SPAN SNGL TRACK	LF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-STD SPAN DBL TRACK	RF	63100	220345	101600	354787	0	0	0	0	0	0	0	0	0	0	0	0	0	0	164700	575132
GUIDEWAY AT GRADE -AT GRADE OFF STREET	RF	0	0	28300	3566	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28300	3566
-AT GRADE - CUT ROCK	RF	5200	7124	21900	21812	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27100	28936
-AT GRADE-CUT RIPPABLE	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-AT GRADE - FILL	RF	0	0	5800	1352	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5800	1352
-RETAINED CUT/FILL	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUIDEWAY TUNNEL -DBL 18.5'DIA,BY TBM	RF	0	0	2000	20790	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000	20790
-DBL 22.5'DIA,BY TBM	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-TUNNEL-DRILL & BLAST	RF	1500	12000	3500	28000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5000	40000
STATIONS -AT GRADE	EA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-AERIAL	EA	2	10794	1	8224	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	19018
-PARKING LOT	LS	2	5260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5260
GUIDANCE RAIL & LONG - STATOR PACKS	TF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKWORK	TF	139600	31270	326200	66219	12550	1632	0	0	0	0	0	0	0	0	0	0	0	0	478350	99121
TRACKWORK SPECIAL	LS	1	1140	1	1440	1	834	0	0	0	0	0	0	0	0	0	0	0	0	3	3414
TRACTION POWER SUPPLY	TF	139600	34900	326200	81550	12550	2761	0	0	0	0	0	0	0	0	0	0	0	0	478350	119211
SIGNALING	TF	139600	13960	326200	32620	12550	4756	0	0	0	0	0	0	0	0	0	0	0	0	478350	51336
COMMUNICATIONS	TF	139600	6980	326200	16310	12550	628	0	0	0	0	0	0	0	0	0	0	0	0	478350	23918
FARE COLLECTION	STA	2	600	1	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	900
LANDSCAPING	LS	1	399	1	866	1	25	0	0	0	0	0	0	0	0	0	0	0	0	3	1290
YARDS & SHOPS	LS	0	0	0	0	1	22727	0	0	0	0	0	0	0	0	0	0	0	0	1	22727
VEHICLES	EA	0	0	0	0	49	98245	0	0	0	0	0	0	0	0	0	0	0	0	49	98245
Subtotal CONSTRUCTION COSTS :			$346517		$641914		$131608		$0		$0		$0		$0		$0		$0		$1120039
NON CONSTRUCTION COSTS																					
RIGHT OF WAY & AGREEMENTS	LS	0	0	0	0	1	32578	0	0	0	0	0	0	0	0	0	0	0	0	1	32578
ENGINEERING & MANAGEMENT 20%		0	69303	0	128383	0	26322	0	0	0	0	0	0	0	0	0	0	0	0	0	224008
Subtotal NON CONSTRUCTION COSTS :			$69303		$128383		$58900		$0		$0		$0		$0		$0		$0		$256586
CONTINGENCY																					
CONTINGENCY		0	103955	0	192574	0	47627	0	0	0	0	0	0	0	0	0	0	0	0	0	344156
ESCALATION																					
ESCALATION		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PROJECT RESERVE																					
PROJECT RESERVE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL :			$519775		$962871		$238135		$0		$0		$0		$0		$0		$0		$1720781

KAISER ENGINEERS
H.S.G.T. FEASIBILITY STUDY
JOB NO.90084-003(REV.#0)

05/09/90 07:26:32

BY: Y. FAINSTEIN
ALL COSTS IN $1,000'S

ALTERNATIVE: ALT_2 - RAIL ROAD ALIGNMENT

DESCRIPTION	UNIT	SEG.: HW_1 QTY	COST	SEG.: RR_2 QTY	COST	SEG.: RR_SW QTY	COST	QTY	COST	QTY	COST	QTY	COST	QTY	COST	QTY	COST	TOTALS QTY	COST
SYSTEM DATA																			
ROUTE LENGTH	RF	69800	0	158400	0	0	0	0	0	0	0	0	0	0	0	0	0	228200	0
TRACK LENGTH	TF	139600	0	316800	0	0	0	0	0	0	0	0	0	0	0	0	0	456400	0
NUMBER OF STATIONS	EA	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
CONSTRUCTION COSTS																			
SITE MODIFICATIONS-DEMOLITIONS	RF	69800	349	158400	792	0	0	0	0	0	0	0	0	0	0	0	0	228200	1141
-UTILITY RELOCATIONS	RF	69800	1396	158400	3168	0	0	0	0	0	0	0	0	0	0	0	0	228200	4564
-STRUCT. MODIFICATIONS	LS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUIDEWAY AERIAL -STD SPAN SNGL TRACK	LF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-STD SPAN DBL TRACK	RF	63100	220345	123000	429516	0	0	0	0	0	0	0	0	0	0	0	0	186100	649861
GUIDEWAY AT GRADE -AT GRADE OFF STREET	RF	0	0	7100	852	0	0	0	0	0	0	0	0	0	0	0	0	7100	852
-AT GRADE - CUT ROCK	RF	5200	7124	15900	17737	0	0	0	0	0	0	0	0	0	0	0	0	21100	24861
-AT GRADE-CUT RIPPABLE	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-AT GRADE - FILL	RF	0	0	5600	1243	0	0	0	0	0	0	0	0	0	0	0	0	5600	1243
-RETAINED CUT/FILL	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUIDEWAY TUNNEL -DBL 18.5'DIA,BY TBM	RF	0	0	2600	26072	0	0	0	0	0	0	0	0	0	0	0	0	2600	26072
-DBL 22.5'DIA,BY TBM	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-TUNNEL-DRILL & BLAST	RF	1500	12000	4200	33600	0	0	0	0	0	0	0	0	0	0	0	0	5700	45600
STATIONS -AT GRADE	EA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-AERIAL	EA	2	10794	1	8224	0	0	0	0	0	0	0	0	0	0	0	0	3	19018
-PARKING LOT	LS	2	5260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5260
GUIDANCE RAIL & LONG - STATOR PACKS	TF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKWORK	TF	139600	31270	316800	68429	12550	1632	0	0	0	0	0	0	0	0	0	0	468950	101331
TRACKWORK SPECIAL	LS	1	1140	1	1440	1	834	0	0	0	0	0	0	0	0	0	0	3	3414
TRACTION POWER SUPPLY	TF	139600	34900	316800	79200	12550	2761	0	0	0	0	0	0	0	0	0	0	468950	116861
SIGNALING	TF	139600	13960	316800	31680	12550	4756	0	0	0	0	0	0	0	0	0	0	468950	50396
COMMUNICATIONS	TF	139600	6980	316800	15840	12550	628	0	0	0	0	0	0	0	0	0	0	468950	23448
FARE COLLECTION	STA	2	600	1	300	0	0	0	0	0	0	0	0	0	0	0	0	3	900
LANDSCAPING	LS	1	399	1	866	1	25	0	0	0	0	0	0	0	0	0	0	3	1290
YARDS & SHOPS	LS	0	0	0	0	1	22727	0	0	0	0	0	0	0	0	0	0	1	22727
VEHICLES	EA	0	0	0	0	49	98245	0	0	0	0	0	0	0	0	0	0	49	98245
Subtotal CONSTRUCTION COSTS :			$346517		$718959		$131608		$0		$0		$0		$0		$0		$1197084
NON CONSTRUCTION COSTS																			
RIGHT OF WAY & AGREEMENTS	LS	0	0	0	0	1	31068	0	0	0	0	0	0	0	0	0	0	1	31068
ENGINEERING & MANAGEMENT 20%		0	69303	0	143792	0	26322	0	0	0	0	0	0	0	0	0	0	0	239417
Subtotal NON CONSTRUCTION COSTS :			$69303		$143792		$57390		$0		$0		$0		$0		$0		$270485
CONTINGENCY																			
CONTINGENCY		0	103955	0	215688	0	47250	0	0	0	0	0	0	0	0	0	0	0	366893
ESCALATION																			
ESCALATION		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PROJECT RESERVE																			
PROJECT RESERVE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL :			$519775		$1078439		$236248		$0		$0		$0		$0		$0		$1834462

KAISER ENGINEERS
H.S.G.T. FEASIBILITY STUDY
JOB NO.90084-003(REV.#0)

05/09/90 07:43:13

BY: Y. FAINSTEIN
ALL COSTS IN $1,000'S

ALTERNATIVE: ALT_3 - SUPER SPEED ALIGNMENT

DESCRIPTION	UNIT	SEG.: SH_1 QTY	COST	SEG.: SH_2 QTY	COST	SEG.: SH_SW QTY	COST	QTY	COST	QTY	COST	QTY	COST	QTY	COST	QTY	COST	QTY	COST	TOTALS QTY	COST
SYSTEM DATA																					
ROUTE LENGTH	RF	69650	0	149100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	218750	0
TRACK LENGTH	TF	139300	0	298200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	437500	0
NUMBER OF STATIONS	EA	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
CONSTRUCTION COSTS																					
SITE MODIFICATIONS-DEMOLITIONS	RF	69650	348	149100	746	0	0	0	0	0	0	0	0	0	0	0	0	0	0	218750	1094
-UTILITY RELOCATIONS	RF	69650	697	149100	1491	0	0	0	0	0	0	0	0	0	0	0	0	0	0	218750	2188
-STRUCT. MODIFICATIONS	LS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUIDEWAY AERIAL -STD SPAN SNGL TRACK	LF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-STD SPAN DBL TRACK	RF	44750	136344	81700	248924	0	0	0	0	0	0	0	0	0	0	0	0	0	0	126450	385268
GUIDEWAY AT GRADE -AT GRADE OFF STREET	RF	0	0	0	0	5660	2219	0	0	0	0	0	0	0	0	0	0	0	0	5660	2219
-AT GRADE - CUT ROCK	RF	7700	16047	4600	8559	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12300	24606
-AT GRADE-CUT RIPPABLE	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-AT GRADE - FILL	RF	0	0	4600	9196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4600	9196
-RETAINED CUT/FILL	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUIDEWAY TUNNEL -DBL 18.5'DIA,BY TBM	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-DBL 22.5'DIA,BY TBM	RF	17200	204336	58200	691416	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75400	895752
-TUNNEL-DRILL & BLAST	RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STATIONS -AT GRADE	EA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-AERIAL	EA	2	10794	1	8224	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	19018
-PARKING LOT	LS	2	5260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5260
GUIDANCE RAIL & LONG - STATOR PACKS	TF	139600	35040	298200	74848	5660	1421	0	0	0	0	0	0	0	0	0	0	0	0	443460	111309
TRACKWORK	TF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKWORK SPECIAL	LS	1	1440	1	1440	1	2736	0	0	0	0	0	0	0	0	0	0	0	0	3	5616
TRACTION POWER SUPPLY	TF	139300	34825	298200	74550	5660	1415	0	0	0	0	0	0	0	0	0	0	0	0	443160	110790
SIGNALING	TF	139300	16716	298200	35784	5660	4177	0	0	0	0	0	0	0	0	0	0	0	0	443160	56677
COMMUNICATIONS	TF	139300	8358	298200	17892	5660	340	0	0	0	0	0	0	0	0	0	0	0	0	443160	26590
FARE COLLECTION	STA	2	600	1	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	900
LANDSCAPING	LS	1	439	1	952	1	25	0	0	0	0	0	0	0	0	0	0	0	0	3	1416
YARDS & SHOPS	LS	0	0	0	0	1	22220	0	0	0	0	0	0	0	0	0	0	0	0	1	22220
VEHICLES	EA	0	0	0	0	42	171360	0	0	0	0	0	0	0	0	0	0	0	0	42	171360
Subtotal CONSTRUCTION COSTS :			$471244		$1174322		$205913		$0		$0		$0		$0		$0		$0		$1851479
NON CONSTRUCTION COSTS																					
RIGHT OF WAY & AGREEMENTS	LS	0	0	0	0	1	19154	0	0	0	0	0	0	0	0	0	0	0	0	1	19154
ENGINEERING & MANAGEMENT 17%		0	80111	0	199635	0	35005	0	0	0	0	0	0	0	0	0	0	0	0	0	314751
Subtotal NON CONSTRUCTION COSTS :			$80111		$199635		$54159		$0		$0		$0		$0		$0		$0		$333905
CONTINGENCY																					
CONTINGENCY		0	137839	0	343489	0	65018	0	0	0	0	0	0	0	0	0	0	0	0	0	546346
ESCALATION																					
ESCALATION		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PROJECT RESERVE																					
PROJECT RESERVE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL :			$689194		$1717446		$325090		$0		$0		$0		$0		$0		$0		$2731730

SEGMENT: HW_1 - SAN FERNANDO TO SAND CANYON

DESCRIPTION		UNIT	QTY	UNIT COST	FACTOR	TOTAL ($000)
SYSTEM DATA						
ROUTE LENGTH		RF	69800.0		1.00	
TRACK LENGTH		TF	139600.0		1.00	
NUMBER OF STATIONS		EA	2.0		1.00	
CONSTRUCTION COSTS						
SITE MODIFICATIONS	-DEMOLITIONS	RF	69800.0	5	1.00	349
	-UTILITY RELOCATIONS	RF	69800.0	20	1.00	1396
	-STRUCT. MODIFICATIONS	LS			1.00	
GUIDEWAY AERIAL	-STD SPAN SNGL TRACK	LF			1.00	
	-STD SPAN DBL TRACK	RF	63100.0	2910	1.20	220345
GUIDEWAY AT GRADE	-AT GRADE OFF STREET	RF			1.00	
	-AT GRADE - CUT ROCK	RF	5200.0	1631	0.84	7124
	-AT GRADE-CUT RIPPABLE	RF			1.00	
	-AT GRADE - FILL	RF			1.00	
	-RETAINED CUT/FILL	RF			1.00	
GUIDEWAY TUNNEL	-DBL 18.5'DIA,BY TBM	RF			1.00	
	-DBL 22.5'DIA,BY TBM	RF			1.00	
	-TUNNEL-DRILL & BLAST	RF	1500.0	8000	1.00	12000
STATIONS	-AT GRADE	EA			1.00	
	-AERIAL	EA	2.0	5140000	1.05	10794
	-PARKING LOT	LS	2.0	2630100	1.00	5260
TRACKWORK		TF	139600.0	224	1.00	31270
TRACKWORK SPECIAL		LS	1.0	1140000	1.00	1140
TRACTION POWER SUPPLY		TF	139600.0	250	1.00	34900
SIGNALING		TF	139600.0	100	1.00	13960
COMMUNICATIONS		TF	139600.0	50	1.00	6980
FARE COLLECTION		STA	2.0	300000	1.00	600
LANDSCAPING		LS	1.0	399000	1.00	399
YARDS & SHOPS		LS			1.00	
VEHICLES		EA			1.00	
Subtotal CONSTRUCTION COSTS :						$346517
NON CONSTRUCTION COSTS						
RIGHT OF WAY & AGREEMENTS		LS			1.00	
ENGINEERING & MANAGEMENT 20%					1.00	69303
Subtotal NON CONSTRUCTION COSTS :						$69303
CONTINGENCY						
CONTINGENCY					1.00	103955
ESCALATION						
ESCALATION					1.00	
PROJECT RESERVE						
PROJECT RESERVE					1.00	
TOTAL:						$519775

SEGMENT: HW_2 - SAND CANYON TO PALMDALE STA.

DESCRIPTION		UNIT	QTY	UNIT COST	FACTOR	TOTAL ($000)
SYSTEM DATA						
ROUTE LENGTH		RF	163100.0		1.00	
TRACK LENGTH		TF	326200.0		1.00	
NUMBER OF STATIONS		EA	1.0		1.00	
CONSTRUCTION COSTS						
SITE MODIFICATIONS	-DEMOLITIONS	RF	163100.0	5	1.00	816
	-UTILITY RELOCATIONS	RF	163100.0	20	1.00	3262
	-STRUCT. MODIFICATIONS	LS			1.00	
GUIDEWAY AERIAL	-STD SPAN SNGL TRACK	LF			1.00	
	-STD SPAN DBL TRACK	RF	101600.0	2910	1.20	354787
GUIDEWAY AT GRADE	-AT GRADE OFF STREET	RF	28300.0	120	1.05	3566
	-AT GRADE - CUT ROCK	RF	21900.0	1328	0.75	21812
	-AT GRADE-CUT RIPPABLE	RF			1.00	
	-AT GRADE - FILL	RF	5800.0	222	1.05	1352
	-RETAINED CUT/FILL	RF			1.00	
GUIDEWAY TUNNEL	-DBL 18.5'DIA,BY TBM	RF	2000.0	9900	1.05	20790
	-DBL 22.5'DIA,BY TBM	RF			1.00	
	-TUNNEL-DRILL & BLAST	RF	3500.0	8000	1.00	28000
STATIONS	-AT GRADE	EA			1.00	
	-AERIAL	EA	1.0	5140000	1.60	8224
	-PARKING LOT	LS			1.00	
TRACKWORK		TF	326200.0	203	1.00	66219
TRACKWORK SPECIAL		LS	1.0	1440000	1.00	1440
TRACTION POWER SUPPLY		TF	326200.0	250	1.00	81550
SIGNALING		TF	326200.0	100	1.00	32620
COMMUNICATIONS		TF	326200.0	50	1.00	16310
FARE COLLECTION		STA	1.0	300000	1.00	300
LANDSCAPING		LS	1.0	865500	1.00	866
YARDS & SHOPS		LS			1.00	
VEHICLES		EA			1.00	
Subtotal CONSTRUCTION COSTS :						$641914
NON CONSTRUCTION COSTS						
RIGHT OF WAY & AGREEMENTS		LS			1.00	
ENGINEERING & MANAGEMENT 20%					1.00	128383
Subtotal NON CONSTRUCTION COSTS :						$128383
CONTINGENCY						
CONTINGENCY					1.00	192574
					1.00	
ESCALATION						
ESCALATION					1.00	
PROJECT RESERVE						
PROJECT RESERVE					1.00	
TOTAL:						$962871

SEGMENT: HW_SW - SYSTEMWIDE

DESCRIPTION		UNIT	QTY	UNIT COST	FACTOR	TOTAL ($000)
SYSTEM DATA						
ROUTE LENGTH		RF			1.00	
TRACK LENGTH		TF			1.00	
NUMBER OF STATIONS		EA			1.00	
CONSTRUCTION COSTS						
SITE MODIFICATIONS	-DEMOLITIONS	RF			1.00	
	-UTILITY RELOCATIONS	RF			1.00	
	-STRUCT. MODIFICATIONS	LS			1.00	
GUIDEWAY AERIAL	-STD SPAN SNGL TRACK	LF			1.00	
	-STD SPAN DBL TRACK	RF			1.00	
GUIDEWAY AT GRADE	-AT GRADE OFF STREET	RF			1.00	
	-AT GRADE - CUT ROCK	RF			1.00	
	-AT GRADE-CUT RIPPABLE	RF			1.00	
	-AT GRADE - FILL	RF			1.00	
	-RETAINED CUT/FILL	RF			1.00	
GUIDEWAY TUNNEL	-DBL 18.5'DIA,BY TBM	RF			1.00	
	-DBL 22.5'DIA,BY TBM	RF			1.00	
	-TUNNEL-DRILL & BLAST	RF			1.00	
STATIONS	-AT GRADE	EA			1.00	
	-AERIAL	EA			1.00	
	-PARKING LOT	LS			1.00	
TRACKWORK		TF	12550.0	130	1.00	1632
TRACKWORK SPECIAL		LS	1.0	834000	1.00	834
TRACTION POWER SUPPLY		TF	12550.0	220	1.00	2761
SIGNALING		TF	12550.0	379	1.00	4756
COMMUNICATIONS		TF	12550.0	50	1.00	628
FARE COLLECTION		STA			1.00	
LANDSCAPING		LS	1.0	25000	1.00	25
YARDS & SHOPS		LS	1.0	22727000	1.00	22727
VEHICLES		EA	49.0	2005000	1.00	98245
Subtotal CONSTRUCTION COSTS :						$131608
NON CONSTRUCTION COSTS						
RIGHT OF WAY & AGREEMENTS		LS	1.0	32578100	1.00	32578
ENGINEERING & MANAGEMENT 20%					1.00	26322
Subtotal NON CONSTRUCTION COSTS :						$58900
CONTINGENCY						
CONTINGENCY					1.00	47627
ESCALATION						
ESCALATION					1.00	
PROJECT RESERVE						
PROJECT RESERVE					1.00	
TOTAL:						$238135

KAISER ENGINEERS
H.S.G.T. FEASIBILITY STUDY

05/09/90 07:12:14

SEGMENT: RR_2 - SAND CANYON TO PALMDALE STA.

DESCRIPTION		UNIT	QTY	UNIT COST	FACTOR	TOTAL ($000)
SYSTEM DATA						
ROUTE LENGTH		RF	158400.0		1.00	
TRACK LENGTH		TF	316800.0		1.00	
NUMBER OF STATIONS		EA	1.0		1.00	
CONSTRUCTION COSTS						
SITE MODIFICATIONS	-DEMOLITIONS	RF	158400.0	5	1.00	792
	-UTILITY RELOCATIONS	RF	158400.0	20	1.00	3168
	-STRUCT. MODIFICATIONS	LS			1.00	
GUIDEWAY AERIAL	-STD SPAN SNGL TRACK	LF			1.00	
	-STD SPAN DBL TRACK	RF	123000.0	2910	1.20	429516
GUIDEWAY AT GRADE	-AT GRADE OFF STREET	RF	7100.0	120	1.00	852
	-AT GRADE - CUT ROCK	RF	15900.0	1328	0.84	17737
	-AT GRADE-CUT RIPPABLE	RF			1.00	
	-AT GRADE - FILL	RF	5600.0	222	1.00	1243
	-RETAINED CUT/FILL	RF			1.00	
GUIDEWAY TUNNEL	-DBL 18.5'DIA,BY TBM	RF	2600.0	9550	1.05	26072
	-DBL 22.5'DIA,BY TBM	RF			1.00	
	-TUNNEL-DRILL & BLAST	RF	4200.0	8000	1.00	33600
STATIONS	-AT GRADE	EA			1.00	
	-AERIAL	EA	1.0	5140000	1.60	8224
	-PARKING LOT	LS			1.00	
TRACKWORK		TF	316800.0	216	1.00	68429
TRACKWORK SPECIAL		LS	1.0	1440000	1.00	1440
TRACTION POWER SUPPLY		TF	316800.0	250	1.00	79200
SIGNALING		TF	316800.0	100	1.00	31680
COMMUNICATIONS		TF	316800.0	50	1.00	15840
FARE COLLECTION		STA	1.0	300000	1.00	300
LANDSCAPING		LS	1.0	865500	1.00	866
YARDS & SHOPS		LS			1.00	
VEHICLES		EA			1.00	
Subtotal CONSTRUCTION COSTS :						$718959
NON CONSTRUCTION COSTS						
RIGHT OF WAY & AGREEMENTS		LS			1.00	
ENGINEERING & MANAGEMENT 20%					1.00	143792
Subtotal NON CONSTRUCTION COSTS :						$143792
CONTINGENCY						
CONTINGENCY					1.00	215688
ESCALATION						
ESCALATION					1.00	
PROJECT RESERVE						
PROJECT RESERVE					1.00	
TOTAL:						$1078439

KAISER ENGINEERS
H.S.G.T. FEASIBILITY STUDY

05/09/90 07:12:49

SEGMENT: RR_SW - SYSTEMWIDE

DESCRIPTION		UNIT	QTY	UNIT COST	FACTOR	TOTAL ($000)
SYSTEM DATA						
ROUTE LENGTH		RF			1.00	
TRACK LENGTH		TF			1.00	
NUMBER OF STATIONS		EA			1.00	
CONSTRUCTION COSTS						
SITE MODIFICATIONS	-DEMOLITIONS	RF			1.00	
	-UTILITY RELOCATIONS	RF			1.00	
	-STRUCT. MODIFICATIONS	LS			1.00	
GUIDEWAY AERIAL	-STD SPAN SNGL TRACK	LF			1.00	
	-STD SPAN DBL TRACK	RF			1.00	
GUIDEWAY AT GRADE	-AT GRADE OFF STREET	RF			1.00	
	-AT GRADE - CUT ROCK	RF			1.00	
	-AT GRADE-CUT RIPPABLE	RF			1.00	
	-AT GRADE - FILL	RF			1.00	
	-RETAINED CUT/FILL	RF			1.00	
GUIDEWAY TUNNEL	-DBL 18.5'DIA,BY TBM	RF			1.00	
	-DBL 22.5'DIA,BY TBM	RF			1.00	
	-TUNNEL-DRILL & BLAST	RF			1.00	
STATIONS	-AT GRADE	EA			1.00	
	-AERIAL	EA			1.00	
	-PARKING LOT	LS			1.00	
TRACKWORK		TF	12550.0	130	1.00	1632
TRACKWORK SPECIAL		LS	1.0	834000	1.00	834
TRACTION POWER SUPPLY		TF	12550.0	220	1.00	2761
SIGNALING		TF	12550.0	379	1.00	4756
COMMUNICATIONS		TF	12550.0	50	1.00	628
FARE COLLECTION		STA			1.00	
LANDSCAPING		LS	1.0	25000	1.00	25
YARDS & SHOPS		LS	1.0	22727000	1.00	22727
VEHICLES		EA	49.0	2005000	1.00	98245
Subtotal CONSTRUCTION COSTS :						$131608
NON CONSTRUCTION COSTS						
RIGHT OF WAY & AGREEMENTS		LS	1.0	31068400	1.00	31068
ENGINEERING & MANAGEMENT 20%					1.00	26322
Subtotal NON CONSTRUCTION COSTS :						$57390
CONTINGENCY						
CONTINGENCY					1.00	47250
ESCALATION						
ESCALATION					1.00	
PROJECT RESERVE						
PROJECT RESERVE					1.00	
TOTAL:						$236248

KAISER ENGINEERS
H.S.G.T. FEASIBILITY STUDY

05/09/90 07:39:22

SEGMENT: SH_1 - SAN FERNANDO TO SAND CANYON

DESCRIPTION		UNIT	QTY	UNIT COST	FACTOR	TOTAL ($000)
SYSTEM DATA						
ROUTE LENGTH		RF	69650.0		1.00	
TRACK LENGTH		TF	139300.0		1.00	
NUMBER OF STATIONS		EA	2.0		1.00	
CONSTRUCTION COSTS						
SITE MODIFICATIONS	-DEMOLITIONS	RF	69650.0	5	1.00	348
	-UTILITY RELOCATIONS	RF	69650.0	10	1.00	697
	-STRUCT. MODIFICATIONS	LS			1.00	
GUIDEWAY AERIAL	-STD SPAN SNGL TRACK	LF			1.00	
	-STD SPAN DBL TRACK	RF	44750.0	2539	1.20	136344
GUIDEWAY AT GRADE	-AT GRADE OFF STREET	RF			1.00	
	-AT GRADE - CUT ROCK	RF	7700.0	2481	0.84	16047
	-AT GRADE-CUT RIPPABLE	RF			1.00	
	-AT GRADE - FILL	RF			1.00	
	-RETAINED CUT/FILL	RF			1.00	
GUIDEWAY TUNNEL	-DBL 18.5'DIA,BY TBM	RF			1.00	
	-DBL 22.5'DIA,BY TBM	RF	17200.0	10800	1.10	204336
	-TUNNEL-DRILL & BLAST	RF			1.00	
STATIONS	-AT GRADE	EA			1.00	
	-AERIAL	EA	2.0	5140000	1.05	10794
	-PARKING LOT	LS	2.0	2630100	1.00	5260
GUIDANCE RAIL & LONG - STATOR PACKS		TF	139600.0	251	1.00	35040
TRACKWORK SPECIAL		LS	1.0	1440000	1.00	1440
TRACTION POWER SUPPLY		TF	139300.0	250	1.00	34825
SIGNALING		TF	139300.0	120	1.00	16716
COMMUNICATIONS		TF	139300.0	60	1.00	8358
FARE COLLECTION		STA	2.0	300000	1.00	600
LANDSCAPING		LS	1.0	399000	1.10	439
YARDS & SHOPS		LS			1.00	
VEHICLES		EA			1.00	
Subtotal CONSTRUCTION COSTS :						$471244
NON CONSTRUCTION COSTS						
RIGHT OF WAY & AGREEMENTS		LS			1.00	
ENGINEERING & MANAGEMENT 17%					1.00	80111
Subtotal NON CONSTRUCTION COSTS :						$80111
CONTINGENCY						
CONTINGENCY					1.00	137839
ESCALATION						
ESCALATION					1.00	
PROJECT RESERVE						
PROJECT RESERVE					1.00	
TOTAL:						$689194

KAISER ENGINEERS
H.S.G.T. FEASIBILITY STUDY

05/09/90 07:39:49

SEGMENT: SH_2 - SAND CANYON TO PALMDALE

DESCRIPTION		UNIT	QTY	UNIT COST	FACTOR	TOTAL ($000)
SYSTEM DATA						
ROUTE LENGTH		RF	149100.0		1.00	
TRACK LENGTH		TF	298200.0		1.00	
NUMBER OF STATIONS		EA	1.0		1.00	
CONSTRUCTION COSTS						
SITE MODIFICATIONS	-DEMOLITIONS	RF	149100.0	5	1.00	746
	-UTILITY RELOCATIONS	RF	149100.0	10	1.00	1491
	-STRUCT. MODIFICATIONS	LS			1.00	
GUIDEWAY AERIAL	-STD SPAN SNGL TRACK	LF			1.00	
	-STD SPAN DBL TRACK	RF	81700.0	2539	1.20	248924
GUIDEWAY AT GRADE	-AT GRADE OFF STREET	RF		120	1.05	
	-AT GRADE - CUT ROCK	RF	4600.0	2481	0.75	8559
	-AT GRADE-CUT RIPPABLE	RF			1.00	
	-AT GRADE - FILL	RF	4600.0	1904	1.05	9196
	-RETAINED CUT/FILL	RF			1.00	
GUIDEWAY TUNNEL	-DBL 18.5'DIA,BY TBM	RF			1.00	
	-DBL 22.5'DIA,BY TBM	RF	58200.0	10800	1.10	691416
	-TUNNEL-DRILL & BLAST	RF			1.00	
STATIONS	-AT GRADE	EA			1.00	
	-AERIAL	EA	1.0	5140000	1.60	8224
	-PARKING LOT	LS			1.00	
GUIDANCE RAIL & LONG - STATOR PACKS		TF	298200.0	251	1.00	74848
TRACKWORK SPECIAL		LS	1.0	1440000	1.00	1440
TRACTION POWER SUPPLY		TF	298200.0	250	1.00	74550
SIGNALING		TF	298200.0	120	1.00	35784
COMMUNICATIONS		TF	298200.0	60	1.00	17892
FARE COLLECTION		STA	1.0	300000	1.00	300
LANDSCAPING		LS	1.0	865500	1.10	952
YARDS & SHOPS		LS			1.00	
VEHICLES		EA			1.00	
Subtotal CONSTRUCTION COSTS :						$1174322
NON CONSTRUCTION COSTS						
RIGHT OF WAY & AGREEMENTS		LS			1.00	
ENGINEERING & MANAGEMENT 17%					1.00	199635
Subtotal NON CONSTRUCTION COSTS :						$199635
CONTINGENCY						
CONTINGENCY					1.00	343489
					1.00	
ESCALATION						
ESCALATION					1.00	
PROJECT RESERVE						
PROJECT RESERVE					1.00	
TOTAL:						$1717446

SEGMENT: SH_SW - SYSTEMWIDE

DESCRIPTION		UNIT	QTY	UNIT COST	FACTOR	TOTAL ($000)
SYSTEM DATA						
ROUTE LENGTH		RF			1.00	
TRACK LENGTH		TF			1.00	
NUMBER OF STATIONS		EA			1.00	
CONSTRUCTION COSTS						
SITE MODIFICATIONS	-DEMOLITIONS	RF			1.00	
	-UTILITY RELOCATIONS	RF			1.00	
	-STRUCT. MODIFICATIONS	LS			1.00	
GUIDEWAY AERIAL	-STD SPAN SNGL TRACK	LF			1.00	
	-STD SPAN DBL TRACK	RF			1.00	
GUIDEWAY AT GRADE	-AT GRADE OFF STREET	RF	5660.0	392	1.00	2219
	-AT GRADE - CUT ROCK	RF			1.00	
	-AT GRADE-CUT RIPPABLE	RF			1.00	
	-AT GRADE - FILL	RF			1.00	
	-RETAINED CUT/FILL	RF			1.00	
GUIDEWAY TUNNEL	-DBL 18.5'DIA,BY TBM	RF			1.00	
	-DBL 22.5'DIA,BY TBM	RF			1.00	
	-TUNNEL-DRILL & BLAST	RF			1.00	
STATIONS	-AT GRADE	EA			1.00	
	-AERIAL	EA			1.00	
	-PARKING LOT	LS			1.00	
GUIDANCE RAIL & LONG - STATOR PACKS		TF	5660.0	251	1.00	1421
TRACKWORK SPECIAL		LS	1.0	2736000	1.00	2736
TRACTION POWER SUPPLY		TF	5660.0	250	1.00	1415
SIGNALING		TF	5660.0	738	1.00	4177
COMMUNICATIONS		TF	5660.0	60	1.00	340
FARE COLLECTION		STA			1.00	
LANDSCAPING		LS	1.0	25000	1.00	25
YARDS & SHOPS		LS	1.0	20200000	1.10	22220
VEHICLES		EA	42.0	4080000	1.00	171360
Subtotal CONSTRUCTION COSTS :						$205913
NON CONSTRUCTION COSTS						
RIGHT OF WAY & AGREEMENTS		LS	1.0	19153500	1.00	19154
ENGINEERING & MANAGEMENT 17%					1.00	35005
Subtotal NON CONSTRUCTION COSTS :						$54159
CONTINGENCY						
CONTINGENCY					1.00	65018
ESCALATION						
ESCALATION					1.00	
PROJECT RESERVE						
PROJECT RESERVE					1.00	
TOTAL:						$325090