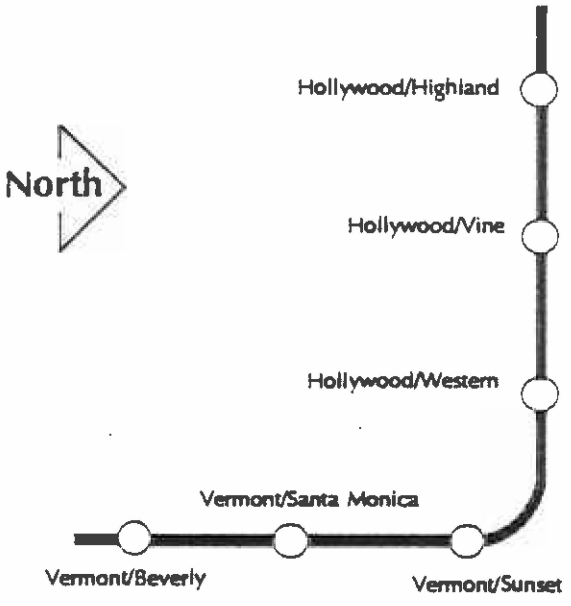
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

METRO RAIL PROJECT



VALUE ENGINEERING STUDY #3

STATIONS MOS II

September 1989

Prepared by:

FOSTER ENGINEERING, INC.
CVS, INC.

FOSTER ENGINEERING, INC.
ENGINEERING AND ARCHITECTURE
SAN FRANCISCO SACRAMENTO SAN DIEGO

October 13, 1989

Mr. J. E. Crawley
Southern California Rapid Transit District
425 South Main Street
Los Angeles, CA 90013

Subject: Value Engineering Study No. 3, MOS II Stations

Dear Mr. Crawley:

We are pleased to submit for your use five (5) copies of Value Engineering Study No. 3 on the District's Stations for MOS-II of the Metro Rail Project.

We would like to thank you and others at SCRTD and MRTC for their help and cooperation. Special thanks to Al Levy for his coordinating efforts, and to Doug Low for his helpful comments and input during the VE Study. We look forward to meeting with you at your convenience to discuss the results of our Value Engineering efforts.

Very truly yours,

FOSTER ENGINEERING, INC.

H. A. Foster
President

847 Howard Street, San Francisco, CA 94103 (415) 543-1193

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT

VALUE ENGINEERING STUDY #3
STATIONS MOS-II

CONTENTS

INTRODUCTION

During the course of the next several years it is the intent of the Southern California Rapid Transit District to construct a starter or initial heavy rail Metro Project which will provide a much needed alternative mode of transportation in a corridor that extends from the central business district in downtown Los Angeles to North Hollywood, a distance of approximately 17.3 miles.

Construction of the first Minimum Operating Segment (MOS-I) is well underway and plans are materializing to extend MOS-I from its current terminal at the Wilshire/Alvarado Station towards two branch lines, one on Vermont Avenue and west on Hollywood Boulevard to the intersection at Hollywood and Highland, and the other on Wilshire Boulevard terminating at Wilshire and Normandie.

SCRTD has retained Foster Engineering, Inc. of San Francisco and CVS, Inc. of Portland, Oregon to undertake Value Engineering Studies of a six mile segment of the proposed extension including six proposed stations, three of which are located on Vermont Avenue and three on Hollywood Boulevard.

The work will be presented to the District in three separate Value Engineering reports, namely:

Value Engineering Study #1	Design Criteria and Directives
Value Engineering Study #2	Line Structures
Value Engineering Study #3	Passenger Stations

This report summarizes findings of Value Engineering Study #3.

Scope of VE Study #3 - Passenger Stations

The scope of VE Study #3 is primarily concerned with the analysis of the function of the design of certain of the District's proposed passenger stations for MOS-II. The extent of the subject matter is shown in Exhibit A. The analysis is conducted in order to determine how the required function can be achieved at the lowest total cost consistent with defined levels of quality and performance.

For the purpose of this study, passenger stations are defined as those structures that permit access and egress for patrons to the District's rail transit system. The structures include 450 foot long platforms, mezzanines with stair and escalator systems, and entrances that connect the station mezzanines to the street.

Beyond the 450 foot platforms, passenger stations generally provide additional space at each structure level. This space has been defined as ancillary space and contains facilities for various systems including ventilation, train control, traction power, and so on. The entire structure containing platforms and ancillary space has been designated to be constructed by cut-and-cover methods.

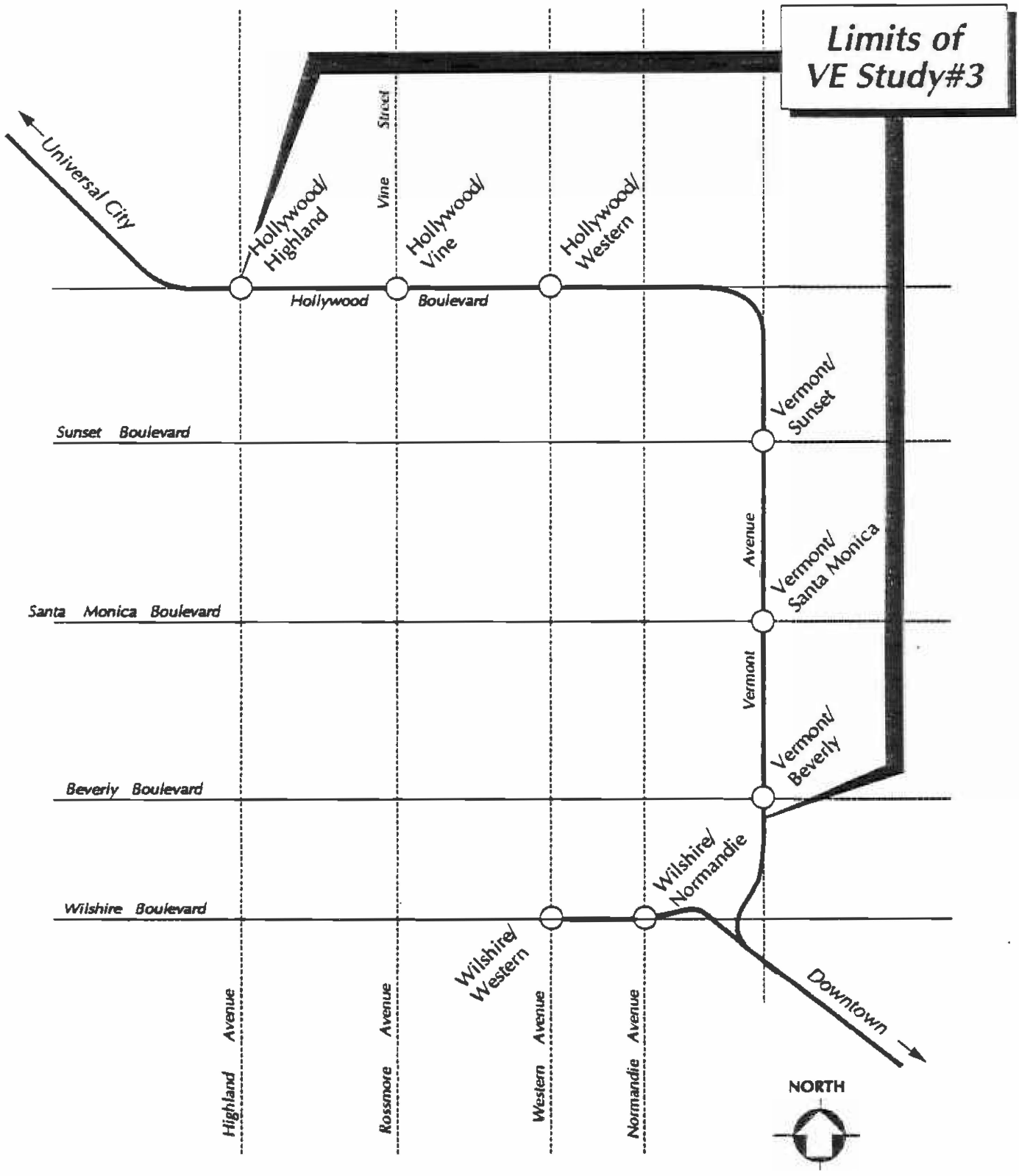


EXHIBIT A - STUDY SCOPE

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT
VALUE ENGINEERING STUDY #3 - STATIONS - MOS II

The following six transit stations are included in the scope of the study:

- Vermont/Beverly, plus crossover structure
- Vermont/Santa Monica
- Vermont/Sunset, plus crossover structure
- Hollywood/Western
- Hollywood/Vine, plus pocket track structure
- Hollywood/Highland

For reasons described in Value Engineering Study #2, VE proposals that are concerned with the narrowing of the tracks through crossover structures, are presented in this report because of the profound effect that the suggested modifications to the crossover structure have on the station design.

In the case of the Hollywood/Vine station, and the adjacent pocket track, the VE team considered that a careful re-evaluation of the District's operating plan should be undertaken with a view to relocating the pocket track structure to a point north of the Highland Station and that the pocket track and related work be constructed by tunneling methods in the Santa Monica mountains.

The team generally determined that such a move would be feasible and practical and could be accomplished without disrupting the District's plan for operating trains in an emergency. Consequently, a VE proposal was developed to deal with this matter even though the pocket track would actually be located beyond the present scope of work in the proposed design.

Personnel

The VE team for this study included the following key people. Additional personnel provided drafting and administrative support.

Harry A. Foster	(FEI)	Project Manager
Robert H. Mitchell	(CVS)	Team Leader
Johnson W. Yee	(FEI)	Recorder

***

Howard Grant	Architect	Transit Station Design
William E. Cullen	Architect	Transit Station Design
Wilmot McCutcheon	(FEI)	Rail Transit Specialist
Robert H. Miller	(FEI)	Electrical
Mervin S. Ash	(FEI)	Mechanical
Hery Litman-Cleper	(FEI)	Structural
Robert E. Willow	(FEI)	Civil/Trackwork

Resumes for these key personnel are contained in the Appendix

VE Methodology

Value Engineering methodology was described in some detail in VE Report #1.

For this phase of the work, the VE team applied the standard five phase job plan to the examination of the project data provided by SCRTD.

The team reviewed the District's directive drawings, reports, specifications, cost estimates and other documents and identified those elements with apparent high cost relative to the function performed.

These items were prioritized to establish those areas that seemed to yield the greatest potential for cost savings.

Once sufficient data and information had been reviewed to establish and understand the functions that needed to be achieved, the team applied the "Brainstorming" technique to develop alternatives for construction methods and materials which could achieve the same function for less cost without degrading quality or performance requirements.

Several ideas and concerns were discussed in considerable depth during this process and eighteen specific areas were identified for detailed analysis and consideration.

The results and details of the Value Engineering proposals that resulted from this process are contained later in this report.

Basis for Cost Comparison

Very preliminary cost estimates for the various construction elements of MOS-II were provided to the team by SCRTD.

The data provided was naturally very schematic because of the early state of the drawings and specifications for this work.

The team, nevertheless, used this information to develop simplified cost models for the various areas under consideration.

In addition, "bidding" information for specific construction contracts on MOS-I was provided to the team. The data was used to estimate typical unit prices for work elements that were not easily extracted from the "budget" type estimates available for MOS-II.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSION AND RECOMMENDATIONS

During the course of the VE study, the team reached the following major conclusions:

- The preparation of "DIRECTIVE" drawings delineating both the structural system and architectural treatment for the District's stations, and the use of these drawings by section architects and engineers, would not work in the District's interest. The major reason for this conclusion is that the procedure imposes severe constraints on the designer's imagination and creativity and as a result, full advantage of site specific potential cannot take place.

- Directive drawings and other design data reviewed by the team did not clearly define the District's policy with respect to the potential need to air-condition the stations. The decision is fundamental as it has a profound bearing on the cost of construction of any given station.

  The team felt that this aspect of the program needs to be carefully re-evaluated and defined more clearly so that once final design gets underway, designers will know the District's intent.

- The team felt very strongly that the concept currently shown on the District's preliminary plans for stations, concerning the distribution of the various ventilation systems to openings with gratings in the sidewalk should be changed. Apart from the major cost savings that can be achieved by terminating these shafts in the middle of the street directly over the stations, the team felt that the District's exposure to damage lawsuits resulting from injuries sustained from walking over sidewalk gratings would be greatly reduced.

  Furthermore, from a "public interest" standpoint, the team felt that removing these shafts from the sidewalk would greatly reduce damage to very popular tourist attractions and, of course, the Hollywood Walk of Fame.

- The team evaluated the potential merits of relocating the traction power substations from the present mezzanine level location to street level. In the case where these substations are located over crossover structures, construction of street level facilities would result in higher costs principally because of the right-of-way acquisition cost.

  In the case where the substation is located adjacent to station entrances, the potential for re-sale of the property or the viability of a joint development governs the final cost of the substation, i.e., if the property can be resold at purchase price or if the value of joint development equals the purchase price, then the subsurface design would be more cost effective.

Conversely, should re-sale or joint development not materialize, then a surface development would be more advantageous. Additional discussion of this issue is contained in the Appendix.

- The team concluded that because of the substantial cost savings that result from narrowing the cross-over structures adjacent to three passenger stations under consideration, the District should re-evaluate its position regarding the acceptance of side-platform stations. The team concluded, in fact, that in locations such as Vermont/Beverly, Vermont/Sunset and Hollywood/Vine, a side platform station configuration should be investigated.

- On general design issues, the team felt that because of the relatively good ground conditions, stations should be designed without any internal columns and with a simplified type of foundation. Mezzanines should be made "continuous" except that to the extent possible the portion directly over the platforms should be omitted to continue to create the "open-space" concept, however, headroom clearances should be reduced. The team felt that providing this type of mezzanine would greatly increase the potential for private entrances being added to the stations.

The team identified seventeen specific Value Engineering proposals (VEP's) summarized in Exhibit B:

The team recommends that the District implements VEP's 1, 2, 3, 4, 5, 6, 7, 8, 12, 13, 14 and 15.

VEP's 9 and 10 are concerned with making provisions for future air-conditioning systems. If information available to the District concerning the need for air-conditioning is firm and reliable, then the District may wish to drop the suggestion contained in the proposals. Should there be any doubt concerning this matter, then full implementation is recommended.

VEP's 16 and 17 are concerned with the controversial pocket track location at Hollywood and Vine. Of the two alternatives, the team felt that Alternative 17 would best serve the District's needs. Full advantage of relocating the pocket track to a rock tunnel location can be achieved, and operational flexibility maintained at Hollywood/Vine station operating as an interim terminal station. Side platforms for this station are recommended.

It is possible that further refinements of the District's operating plan in emergency or "dead car" conditions could lead to the potential of relocating the "present design" crossovers at Vermont/Beverly and Vermont/Sunset to Vermont/Santa Monica and Hollywood/Western with the elimination of the crossover at Hollywood/Vine. The team recommends further study.

SUMMARY OF VALUE ENGINEERING PROPOSALS (VEP's)

No.	Description	Remarks	Potential VE Savings
1	Station Depth This proposal suggests reducing headroom clearance in stations to 10'-0"	Has potential to reduce overall station depth by over 5'-0".	$ 4,150,000
2	Station Columns This proposal suggests eliminating interior station columns.	Introduces clear span concept with prestressed concrete long-span beams.	$ 3,995,000
3	Station Length This proposal reduces the length of the platform by 10'-0" but maintains program stop antenna length of 450'-0".	All doors on trains will open on to platform while 10'-0" of train at trailing end will stop beyond platform.	$ 2,622,000
4	Station Foundation This proposal is additive to VEP #2 and suggests utilization of eccentric strip footings instead of stiff mat.	Considerably less concrete and rebar needed and capitalizes on good bearing capacity of Puente formation.	$ 1,859,000
5	Emergency Vent Shaft (BRS Outlet) This proposal suggests locating BRS shaft in the middle of the street directly over tracks and providing system for collecting hazardous spills.	Deletes sidewalk vent shafts and extensive associated underground passages connecting to station.	$ 9,910,000
6	Emergency Vent Shaft (Noise Control) This proposal deletes requirement for attentuation of emergency fans by substituting an auxiliary vent system for methane detection. This proposal is additive to VEP #5.	Reduces considerably space requirements for emergency fans. Complies with noise control criteria.	$ 12,030,000

Continued Next Page

SUMMARY OF VALUE ENGINEERING PROPOSALS (VEP's)

No.	Description	Remarks	Potential VE Savings
7	Under Platform Exhaust (UPE) Outlets This proposal suggests locating UPE outlets in center of street in lieu of sidewalk placement. This proposal is additive to VEP's #5 & #6.	Delete sidewalk outlets.	$ 2,562,000
8	Smoke Exhaust System This proposal modifies present design for smoke exhaust.	Insures best possible ventilation for passenger and fire fighter safety.	$ 432,000
9	Station Ventilation (Provision For Future Air Conditioning) This proposal deletes underground spaces for future system chillers. Suggest installing chillers at surface with cooling tower when and if air conditioning is required.	Deletes air conditioning requirement from current program and suggests construction of facilities when and if required at surface. This proposal does not preclude provision of future air conditioning.	$ 10,314,000
10	Station Ventilation (Fresh Air Supply) This proposal suggests deleting sidewalk shafts and fans providing "fresh air" to the station because, as presented, system is not adequate and therefore not functional.	As presented, ventilation and fresh air supply is adequately provided by train piston action.	$ 7,706,000
11	Station Mezzanine Configuration This proposal suggests extending mezzanine throughout station and providing open space over platform center.	Has major structural advantages and provides access for future entrances throughout entire length of station.	$ 557,000

Continued Next Page

SUMMARY OF VALUE ENGINEERING PROPOSALS (VEP's)

No.	Description	Remarks	Potential VE Savings
12	Station Entrances This proposal suggests reducing size of major entrances and providing secondary entrance off sidewalk.	Right-of-way implications are complex but proposal is considered to add value to the stations. Cost of proposed alternate is comparable.	Not Quantified
13	Station Entrances This proposal suggests opening station entrances with approach concourses to atmosphere.	Will create open space feeling for station and create plaza entrance for each station.	$ 1,027,000
14	Emergency Exits This proposal suggests rearrangement of emergency exits and elimination of sidewalk appendages and hatches.	Reduces cut-and-cover construction and makes exiting safer and more accessible.	$ 3,509,000
15	Crossover/Station Width This proposal modifies crossover configuration at Vermont/Beverly and Vermont/Sunset by narrowing track to 13'-0" centers. Stations are side platform configuration.	Major reduction of cut-and-cover construction.	$ 13,833,000
16	Pocket Track At Hollywood/Vine Station This proposal substitutes two double crossovers for pocket track at Hollywood/Vine Station and introduces side platform configuration.	Substantial reduction in cut-and-cover construction. Disadvantage is that pocket track is maintained on main line.	$ 16,961,000

Continued Next Page

SUMMARY OF VALUE ENGINEERING PROPOSALS (VEP's)

No.	Description	Remarks	Potential VE Savings
17	Relocate Pocket Track This proposal is suggested as alternate to VEP #16. The proposal suggests modifying dwell time criteria for low use stations to 20 seconds, thereby permitting relocation of pocket track to point north of Highland Station. Crossovers are located at Vermont/Beverly and Hollywood/Western. Add double crossover at Hollywood/Vine for interim operations as terminal station with side platform configuration.	Eliminates controversy of pocket track construction at Hollywood/Vine. Pocket track constructed by tunneling method in rock within Santa Monica mountains under MOS-III. Offers operational flexibility of crossover for terminal switching purposes. Not recommended in favor of VEP #16.	$ 9,707,000*
		VE Study #3 Total	$ 91,467,000*

* (Does Not Include VEP # 17)

DESCRIPTIONS OF
VE PROPOSALS

VEP #1
STATION DEPTH

Value Engineering Proposal (VEP) No. 1

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM: STATION DEPTH

FUNCTION: Establish Clearance

CONCEPT BEFORE VE

Station depth [Top of Rail (T/R) to Roof]. In the present design, the depth of station is established by minimum clearances from floor to beam soffits. As presently configured, overall station depth is 38'-11" from roof to T/R.

Comparative Estimate per Station: $691,800

PROPOSED ALTERNATIVE CONCEPT

In the proposed design, minimum clearances from floor to local beam soffits are reduced and a minimum of 10'-0" clearance is established. This action will reduce the overall station depth 5'-2-1/2".

Advantages:

1. Raised T/R will reduce total excavation costs for station and adjacent cut-and-cover construction.

2. Reduced overall station depth will reduce volume of construction with effecting cost savings in finish and ventilation requirements.

Disadvantages:

1. Lower ceiling may adversely affect visual comfort and spaciousness.

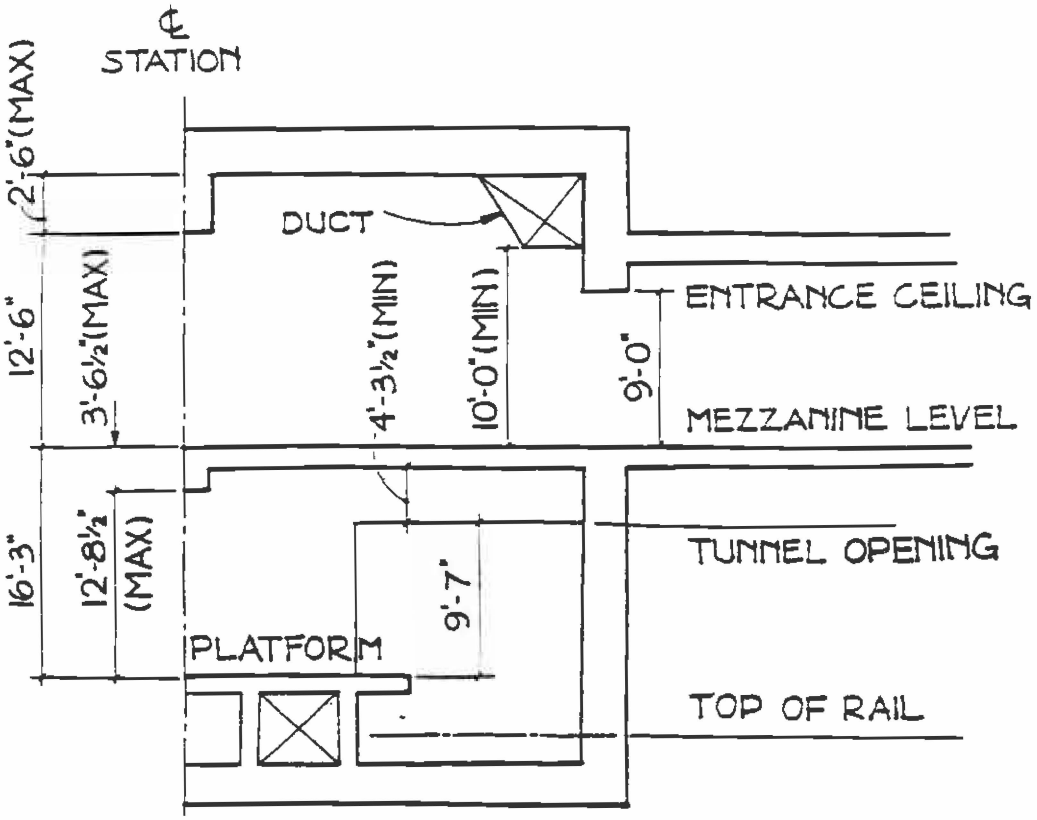
ESTIMATED COST x (6) = $4,151,000	ESTIMATED COST $ -0-
	EST GROSS SAVINGS $4,150,000
	EST IMPLEMENTATION COST $-0-
	EST NET INITIAL SAVINGS $4,150,000
	EST LIFE CYCLE SAVINGS $4,150,000

DESCRIPTION OF PRESENT DESIGN

As presently designed, typical station cross sections allow a total of 38'-11" from top of rail to top of structure. The mezzanine structural floor elevation is 19'- 8" above T/R and the dimension from mezzanine to roof slab provides an addi :ional height of 19'-0". These elevations are established with minimum platform and mezzanine to beam clearances of 12'-8-1/2" and 12'-0" respectively.

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



HALF SECTION

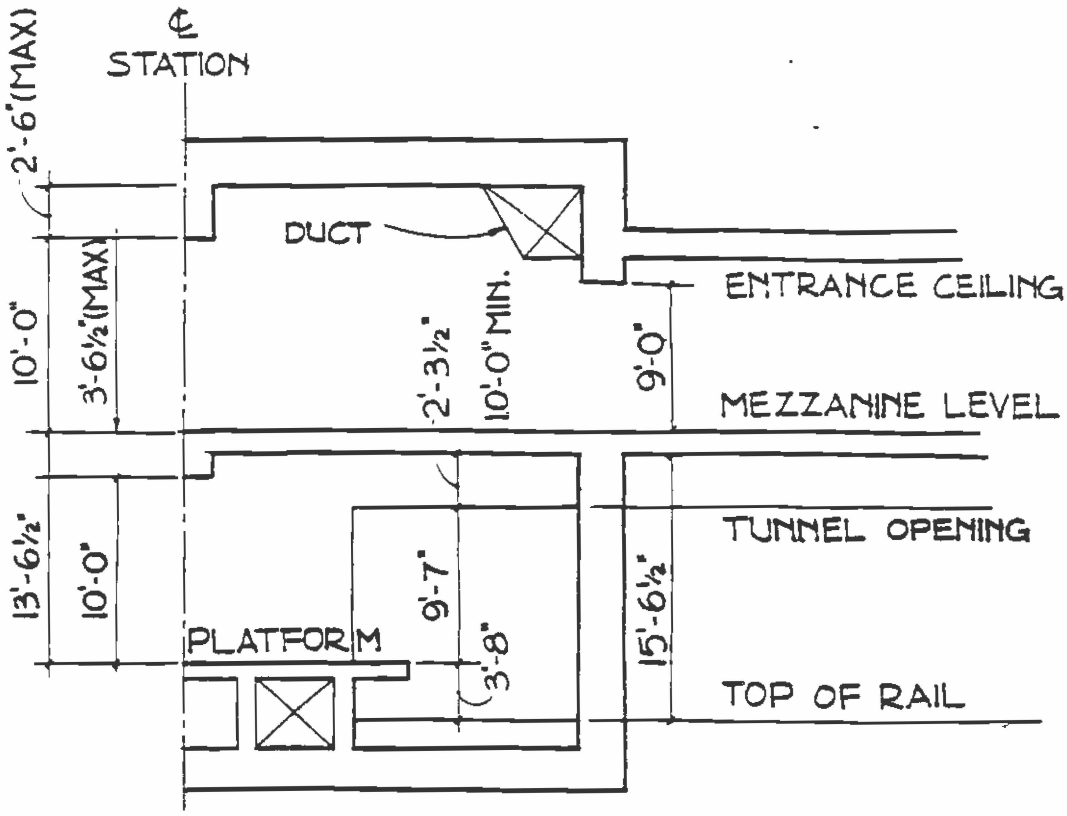
STATION DEPTH

DESCRIPTION OF PROPOSED DESIGN

For the proposed design, the present design configuration is maintained but clearances are reduced. Basic minimum headroom at either platform or mezzanine is reduced to 10'-0". There is no change in structural configuration and size; however, overall station depth is reduced by 5'-2-1/2".

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN



HALF SECTION

STATION DEPTH

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE
PAGE ____ OF ____

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
	Comparative Est. 5.2 Exc.	UNITS	NO. UNITS	UNIT COST	TOTAL	UNITS	NO. UNITS	UNIT COST	TOTAL
	Excavation								
	(5.2)(512)(560) ÷27 = 5533 cy.	CY	5533.	20	110660		-		
	Exc Support.								
	(2/5.2)/560 = 5824 sq ft.	SF	5824	80	465920		-		
	Conc to Walls.								
	2/12.2(5)(560) ÷27 = 518	C.Y	518.	220	113960		-		
	Membrane.								
	(2)(5.2)(560) = 582 sft	S.F.	582	2.20	1280.		-		
		MI			691.820.			0.	
					Diff	in	$691.820.		

Reference: ____

VEP #2
STATION COLUMNS

Value Engineering Proposal (VEP) No. 2

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM	FUNCTION
STATION COLUMN	Support Load

CONCEPT BEFORE VE

In the present design, a poured-in-place reinforced concrete roof is supported by a center row of reinforced concrete or structural steel columns.

Comparative Cost Base/STA
6 Stations x 6.976599 = $41,859,594

ESTIMATED COST $41,860,000

PROPOSED ALTERNATIVE CONCEPT

In the proposed design, precast prestressed clear span beams and a poured-in-place slab structure is used for the roof. No columns.

Advantages:

1. Speed in construction
2. Better architectural design
3. Narrower platform and station

Disadvantages:

None

Comparative Cost Base/STA
6 Stations x 6.310.744 = $37,864,644

ESTIMATED COST	$37,865,000
EST GROSS SAVINGS	$3,995,000
EST IMPLEMENTATION COST	$ 0
EST NET INITIAL SAVINGS	$3,995,000
EST LIFE CYCLE SAVINGS	$3,995,000

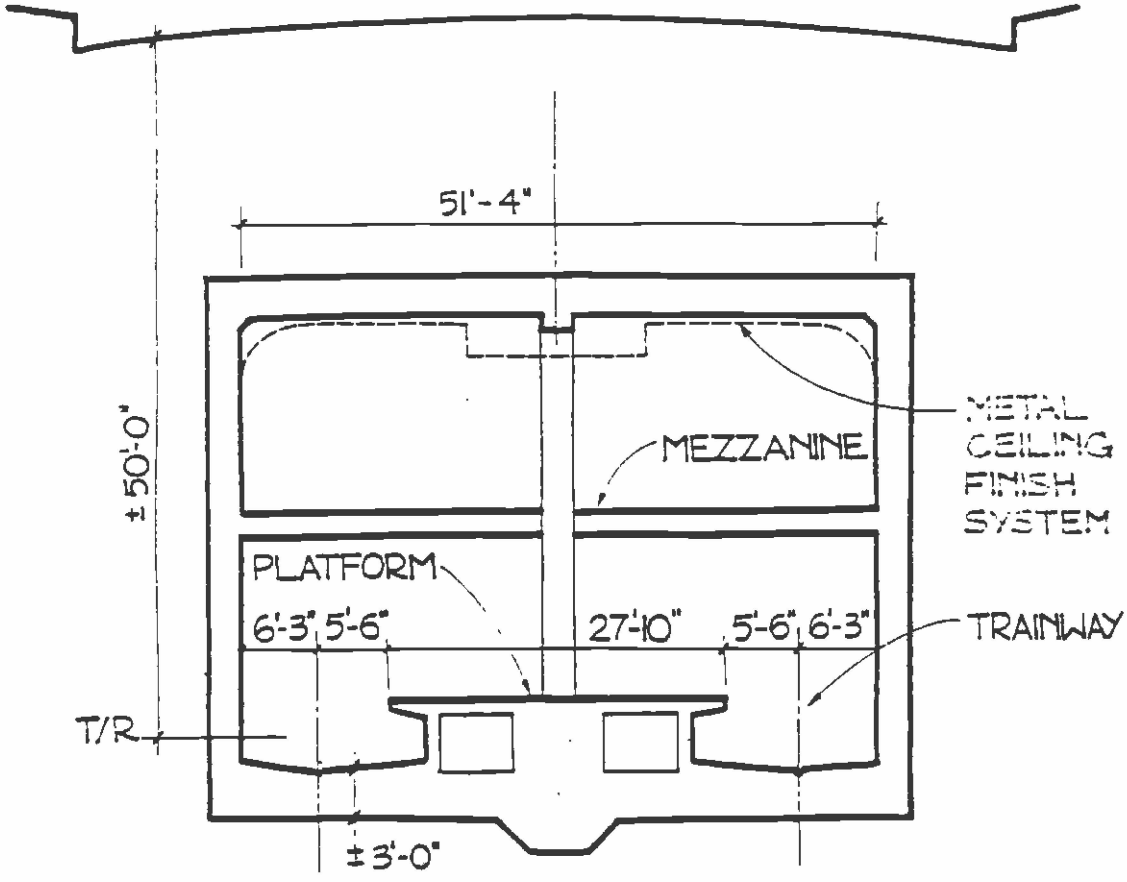
DESCRIPTION OF PRESENT DESIGN

The present design for typical subway stations constructed by cut-and-cover methods is generally shown on SCRTD directive drawings. The station roof structure is a poured-in-place two-way reinforced concrete slab supported generally by the longitudinal walls of the station structure and a center row of columns.

In approximate terms for MOS-II, the station roof carries a total load of about 2 kips per square foot. There does not appear to be any need for resistance to hydrostatic pressures as the existing water table appears to be below invert level.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



STATION COLUMNS

DESCRIPTION OF PROPOSED DESIGN

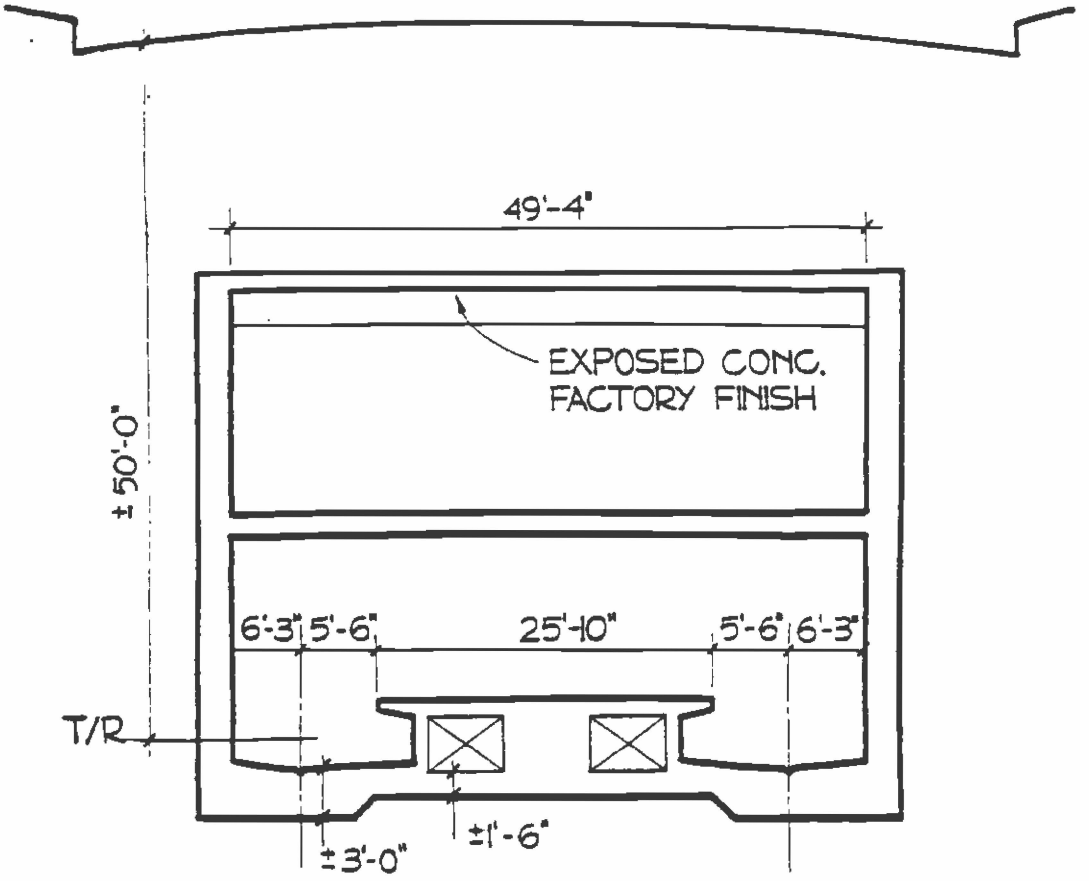
The proposed design maintains the basic functional aspects of the station but is based on a column free or clear span approach.

The use of prestressed concrete is included because of desirable properties which include great strength and watertightness.

The proposed design seeks to simplify the construction approach and shorten the duration of the work. Experience with precast concrete clear span structures confirms substantial time savings with resulting reduction of construction impact and overhead costs. Factory finished concrete surface is proposed for finish with insulating material between beam stems. The cost of the complex column finishing in stainless steel is eliminated.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN

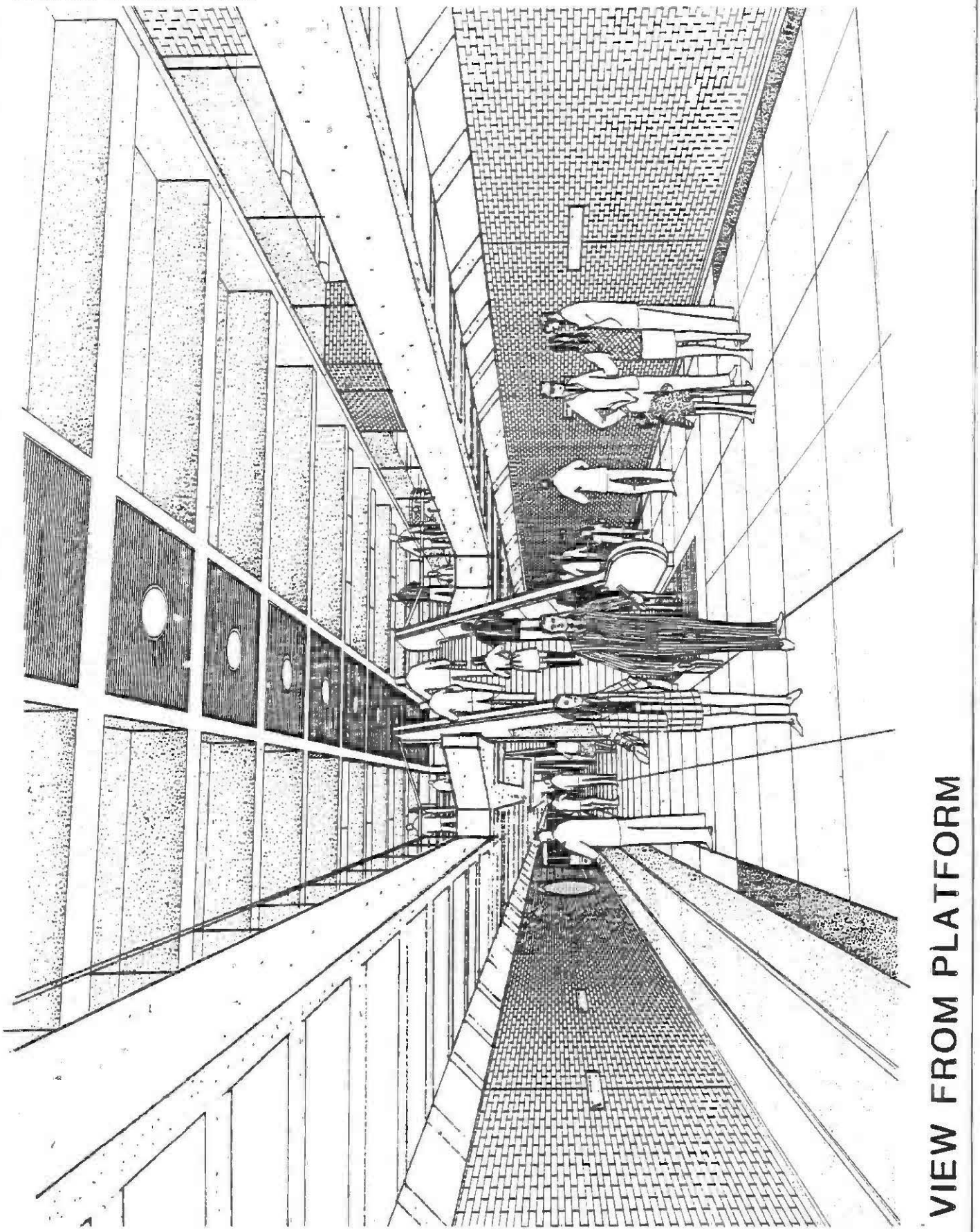


STATION COLUMNS

STUDY TITLE

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN



VIEW FROM PLATFORM

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE
PAGE ____ OF ____

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	TOTAL	UNITS	NO. UNITS	UNIT COST	TOTAL
	Station Excavation	CY	42750	20	855000	CY.	41085	20	821700
	Station Decking.	SY	2565	350	897750	SY	2465	350	862750
	Restration	SF	23085	150	3462750	SF	22185	150	3.327.750
	Conc Roof Slab	CY	1071	250	267750	CY	819	250	204750
	Conc Mezzanie Slab.	CY	1066	250	266500	CY.	1026	250	256500
	Conc Roof Beams	CY.	350	250	87500	CY	675	250	168.750
	Conc Mezz Beams.	-	-			CY	1025	250	256.250
	Conc Platform Slab.	CY	463	350	162050	CY	430	350	150.500
	Conc FDN Slab (*)	-	-	-		-	-	-	
	Conc to Cols	CY	146	600	87600	-	-		
	Membrane	SF	46170	2.20	101574		44370	2.20	97614
	Col FINISHES.	SF	5275	40	211000	-	-		
	ROOF SLAB FINISH. B/S.	SF	23085	25	577125	SF	16421.	10.	164210.
					6976559				6310.774

DIFF $665.825.

Reference:

-* Included in Sta. Sch. in VE Proposal

VEP #3
STATION LENGTH

Value Engineering Proposal (VEP) No. 3

DATE 9/15/89

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II VALUE ENGINEERING STUDY #3 - STATIONS**

ITEM	FUNCTION
STATION LENGTH	Permits boarding; aids bertning

CONCEPT BEFORE VE

Station platform length in the present six station designs is 450 feet, corresponding to the end-to-end dimension of a six car train. Automatic program stopping capability is provided for normal direction of traffic only. Program stop berths trains so that all doors on a six car train can be used for boarding and alighting. At mezzanine level, between 100 and 150 feet of open area is provided in each station design.

Space for ancillary equipment also occupies this level.

PROPOSED ALTERNATIVE CONCEPT

Reduce the station platform length by 10 feet but retain the program stop antenna length of 450 feet. Offset the antenna so its head end aligns with the head end wall of the station. This arrangement berths the train so all doors open on the new shorter platform but leaves 10 feet at the trailing end beyond the platform. The present design's berthing tolerance is retained.

At mezzanine level, 10 feet of open space can be closed up or 10 feet of excess ancillary space can be removed so that 10 feet of cut-and-cover construction at each station is replaced by tunneling.

Advantages:

1. Reduces station costs.

Disadvantages:

1. Minor change in station open appearance of closing open space is chosen.

ESTIMATED COST	$163,195,000	ESTIMATED COST	$ 160,573,000
		EST GROSS SAVINGS	$ 2,622,000
		EST IMPLEMENTATION COST	$ 100,000
		EST NET INITIAL SAVINGS	$ 2,522,000
		EST LIFE CYCLE SAVINGS	$ 2,522,000

DESCRIPTION OF PRESENT DESIGN

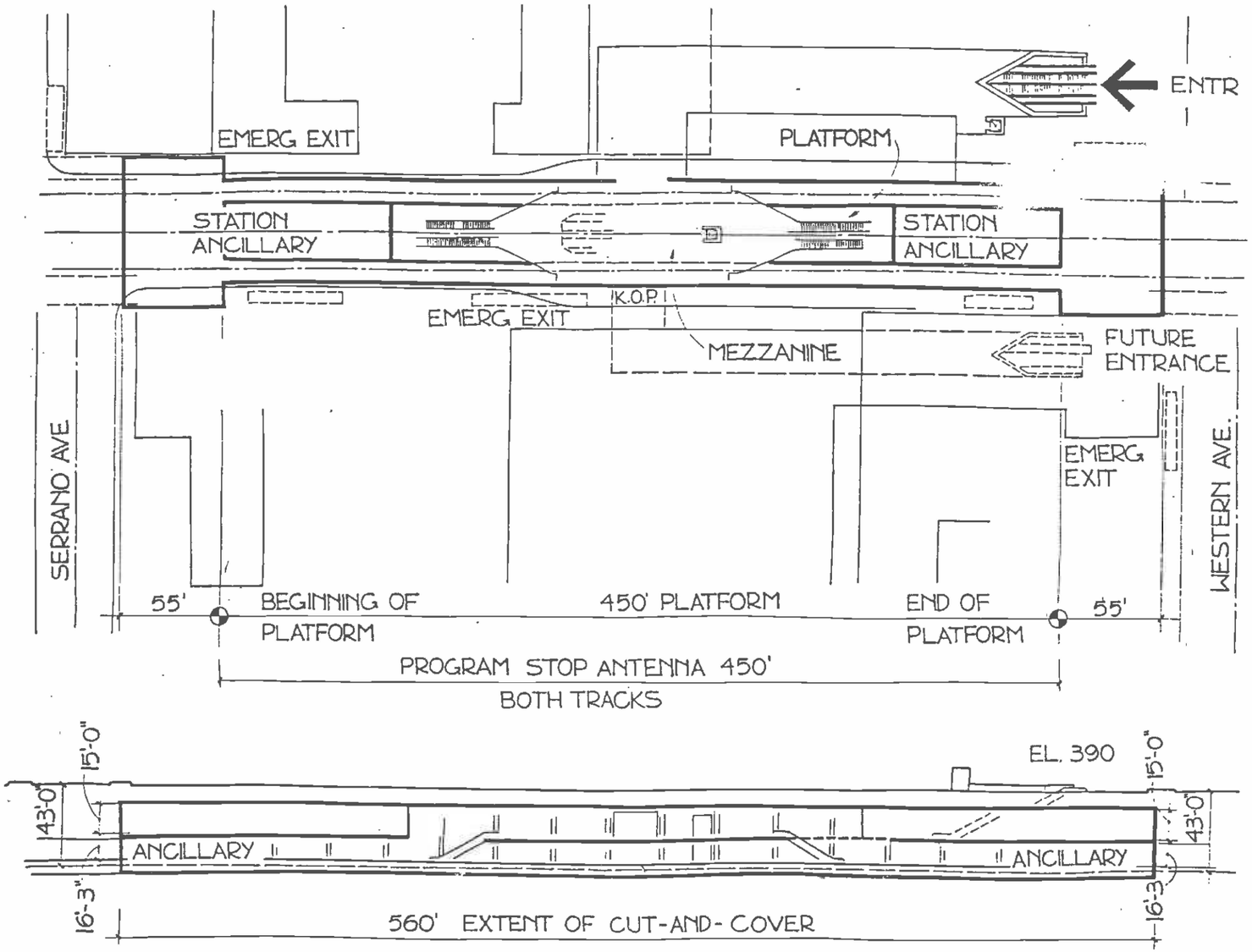
The station length of 450 feet corresponds to the length of a six car train, out to out. This length permits boarding and alighting of passengers through all car doors. The end cars have doors no closer than 15-1/2 feet from the ends of the platform if the train is exactly berthed in the station. The program stop antenna for both tracks is 450 feet long and centered on their respective platforms. The programmed stop function is to be provided for the normal direction of traffic only, per design criteria.

The programmed stop position may be expected to vary by 2 standard deviations of 9" each for routine train berthing. If the programmed stop function fails, the operator would have approximately 3/4 second of reaction time plus service brake rate application time to brake from 6 mph and stop the train to keep the doors within the platform space.

At mezzanine level between 100 and 150 feet of open space is provided in each station design. Space for ancillary equipment also occupies this level.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



STATION LENGTH

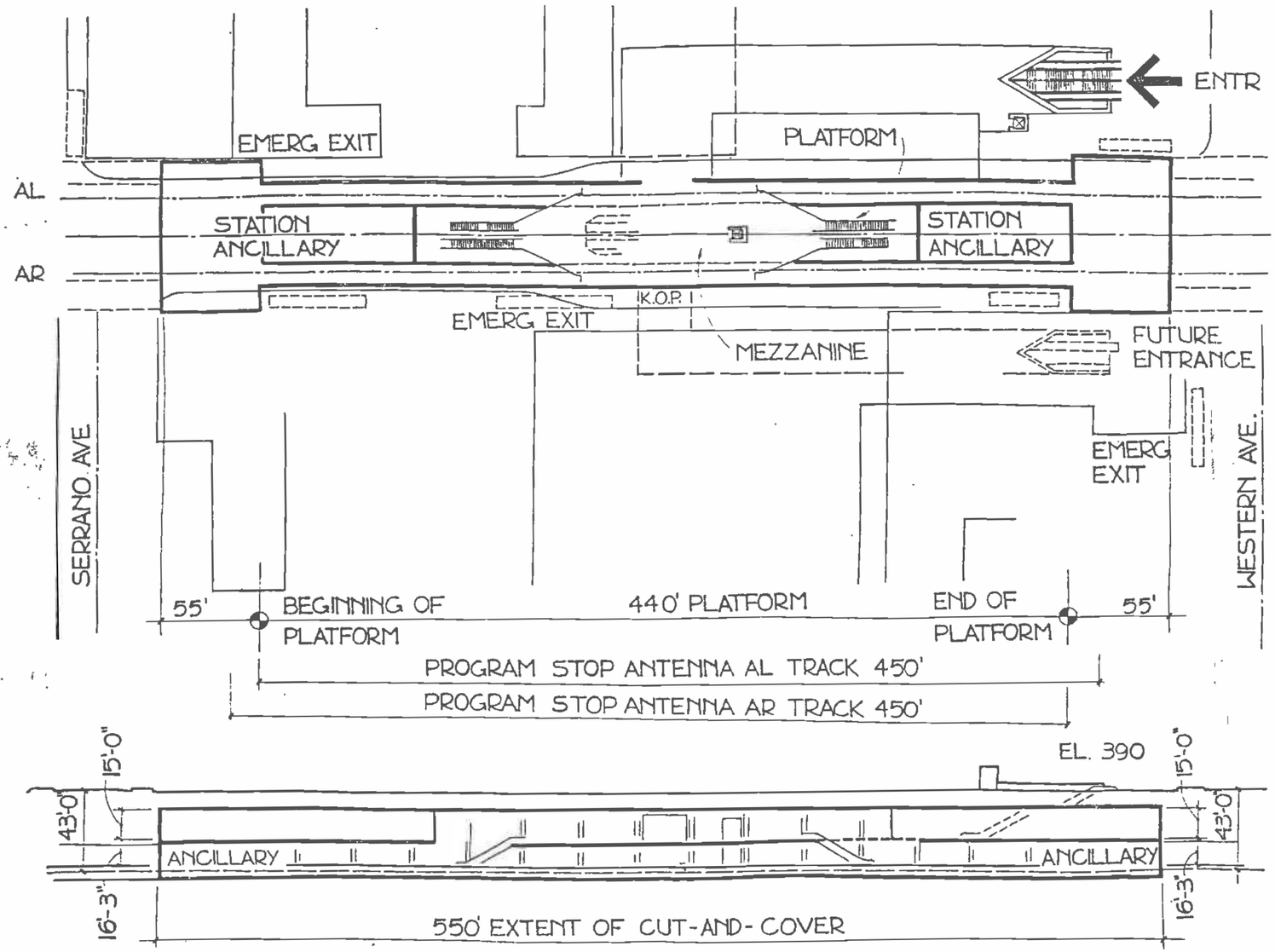
DESCRIPTION OF PROPOSED DESIGN

The station platform is reduced to 440 feet in length by shortening the overall station length from 560 feet to 550 feet (including space for ancillary facilities). Station entrances and vertical circulation elements remain unchanged. The program stop antennas for both tracks would be 450 feet in length and be aligned so the lead end of antenna aligns with the head end of the station platform for the normal direction of travel. With this positioning, the berthing tolerance remains the same as in the present design and passengers are allowed to board and alight from all doors. This new antenna arrangement is asymmetrical for normal and reverse traffic on one track but design criteria requires automatic stopping for the normal direction only. Hence, this asymmetry does not compromise the present design's operating flexibility.

At mezzanine level, 10 feet of open space can be closed up or 10 feet of excess ancillary space can be removed so that 10 feet of cut-and-cover station construction at each station are replaced by 10 feet of tunneling.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN



STATION LENGTH

PROJECT Metro Rail VE - Criteria & Standards
LOCATION Los Angeles, California
SYSTEM

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE 7/26/89
PAGE 1 OF 1

ITEM NO.	DESCRIPTION	SYSTEM BREAKDOWN QUANT	UNIT	UNIT COST				% OF TOTAL*	ITEM COST
	Station Platform Length								
	Present Design								
	6 Stations Complete	3360	LF	48570					$163,195,200
	Proposed Design								
	6 stations complete	3300	LF	48570					$160,281,000
	tunneling	60	RF	4860					291,600
	Total								$160,572,600

* Percentage based on total cost of _____ (Amount) for _____ (Scope)

VEP #4
STATION FOUNDATION

Value Engineering Proposal (VEP) No. 4

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM: STATION FOUNDATION

FUNCTION: Support Load

CONCEPT BEFORE VE	PROPOSED ALTERNATIVE CONCEPT
The present design consists of a stiff two-way raft type reinforced concrete foundation supporting wall and column loads.	The proposed design consists of eccentric continuous one-way footings with propping action provided by roof and base slab. Advantages 1. Less conc 2. Easier construction 3. Less rebar. Disadvantages: None
Base Cost: 6 Stations at $662,850 = $3,977,100	Base Cost: 6 Stations at $353,000 = $2,118,000
ESTIMATED COST $3,977,000	ESTIMATED COST $ 2,118,000
	EST GROSS SAVINGS $ 1,859,000
	EST IMPLEMENTATION COST $ 0
	EST NET INITIAL SAVINGS $ 1,859,000
	EST LIFE CYCLE SAVINGS $ 1,859,000

DESCRIPTION OF PRESENT DESIGN

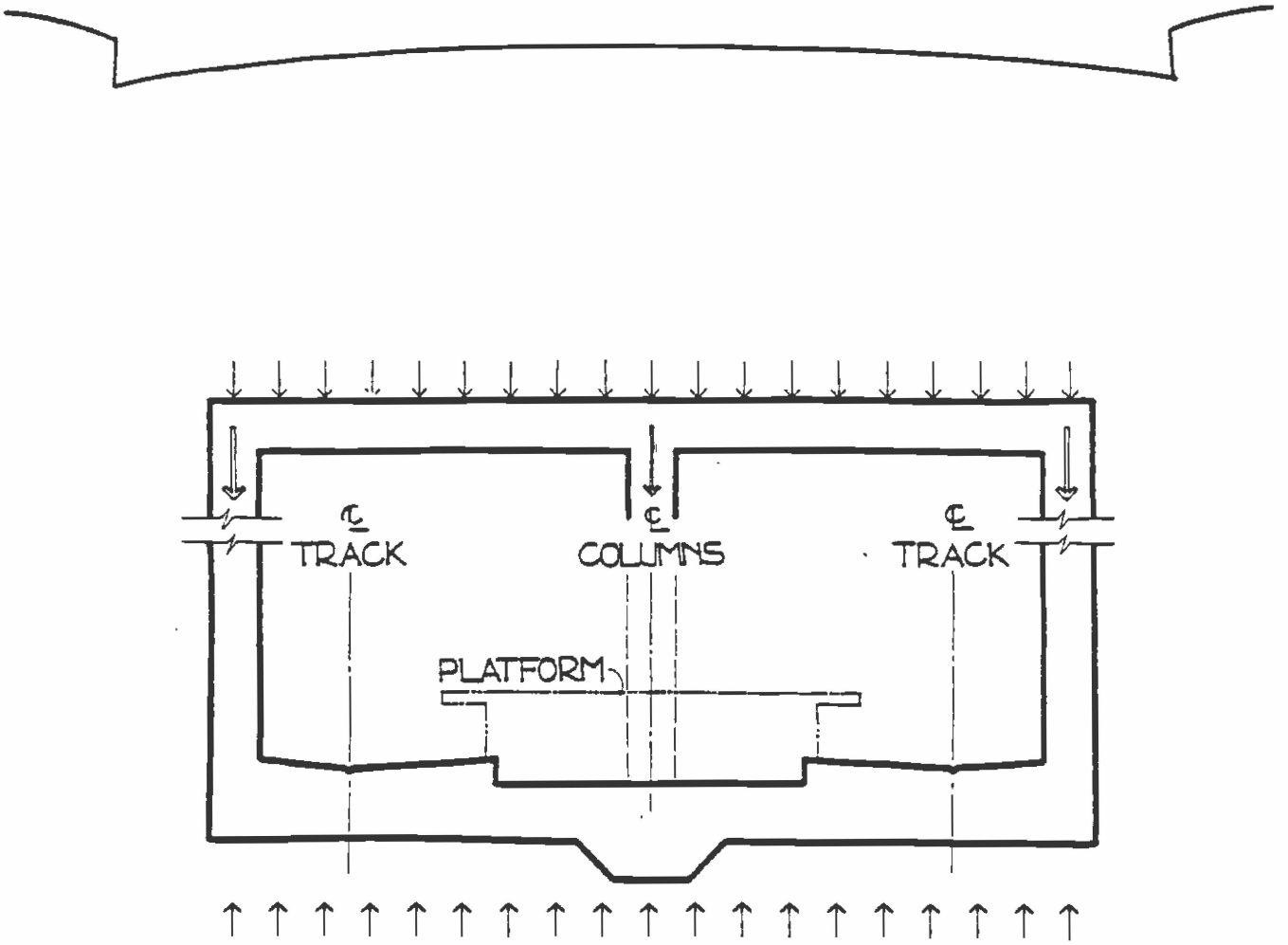
Present design consists of a stiff raft or mat type foundation. Loads from the structure are delivered to the mat as continuous line loads from the station walls and as concentrated loads from center columns. Distribution of the load to the foundation is generally assumed to be uniform based on the assumption that the raft or mat is stiff.

Variation in the uniformity arising from eccentricities and other unsymmetrical loading is generally neglected.

The raft has a two-way structural spanning action, i.e., transversely between the walls and longitudinally between the columns. Thickening of the raft along the center line of the station creates a spine beam which tends to stiffen the slab in the longitudinal direction. Average bearing pressure is about 3 ksf. Little or no provision for hydrostatic uplift is assumed for this section.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



STATION FOUNDATIONS

DESCRIPTION OF PROPOSED DESIGN

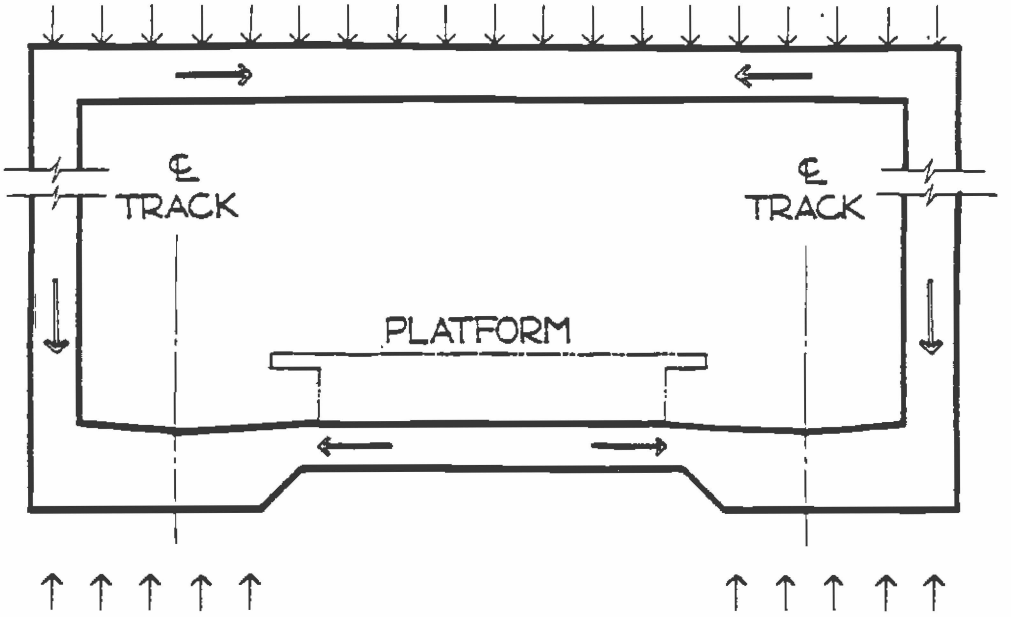
Proposed design is based on a clear span concept without columns but is also applicable to structures with internal columns. foundation design capitalizes on firm ground conditions in the Puente formation where allowable bearing pressures could exceed 8 ksf.

Proposed design consists of a stiff, propped cantilever concept. The station wall generally behaves as a propped cantilever.

Vertical wall loads of some 60 k per linear foot are distributed uniformally to a stiff eccentric footing 8'-0" wide. Equilibrium is provided by propping action of station roof and floor slab. Where internal columns are present, column loads are carried by column footings.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN



STATION FOUNDATIONS

PROJECT _____
LOCATION _____
SYSTEM _____

Cost Model

CLIENT _____
DATE _____
PAGE _____ of _____

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	TOTAL	UNITS	NO. UNITS	UNIT COST	TOTAL
	Conc to Foundation	c.y	2946	$150	441.900	c.y.	1620.	$150	243.000.
	Rebar	lb.	441.900	.50	220.950	lb.	220.000.	50.	110.000
					662.850				353000.
					Diff	for Station			= 309.850.
				For	6 Stations				= 1.859.000.

Reference: _____

VEP #5
BRS OUTLET

Value Engineering Proposal (VEP) No. 5

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II VALUE ENGINEERING STUDY #3 - STATIONS

ITEM	FUNCTION
EMERGENCY VENT SHAFT/BLAST RELIEF SHAFT (B.R.S.) OUTLETS	Channel Flow

CONCEPT BEFORE VE

Emergency ventilation shaft/blast relief shaft (B.R.S.) outlets channel the flow of air through long underground passageways connecting to the stations. The outlets occupy sidewalk space away from the station. This is in compliance with the fire and life safety criteria prohibiting these outlets in the streets. These criteria are aimed at prohibiting the intrusion of hazardous materials into the trainways.

Base Cost: $13,185,900

ESTIMATED COST $13,186,000

PROPOSED ALTERNATIVE CONCEPT

Emergency vent/blast relief shaft outlets channel air through grids located in the center of the street and through air passages offset horizontally from the outlet shaft. Intrusion of hazardous materials is prevented by the mid-street location and by a sump directly below the opening, large enough to catch, contain, and discharge any substances falling through the grid.

Advantages:

1. More effective and less costly outlet system.

2. Eliminates a public annoyance and nuisance.

3. Provides permanent access hatch for equipment installation.

Disadvantages:

1. Requires approval of fire and life safety and street officials.

Base Cost: $3,276,000

ESTIMATED COST	$3,276,000
EST GROSS SAVINGS	$9,910,000
EST IMPLEMENTATION COST	$-0-
EST NET INITIAL SAVINGS	$9,910,000
EST LIFE CYCLE SAVINGS	$9,910,000

DESCRIPTION OF PRESENT DESIGN

Emergency ventilation shafts used also as blast relief shafts for all six stations channel the flow of air (supply or exhaust) through vent outlets located in the sidewalks adjacent to the stations. There are two outlets at each end of the stations and these are located on opposite sides of the street. The size of the vent opening averages 6' x 80', with 20 foot wide by 10 to 12 foot high chambers leading from the station mezzanine to the sidewalk vents. The length of these leads ranges from about 10 feet to 220 feet.

These are SCRTD Metro Rail System Design Criteria apparently governing the location of these shafts:

1. "2.2.3.1.3 Ventilation shaft terminals at grade shall be located as follows:

A. Openings for blast relief shafts, and under platform and smoke exhaust shafts at grade shall be separated by a minimum horizontal distance of 40 feet from the closest station entrance, surface emergency stair doorways, unprotected outside air intake, or from each other" (Underlining supplied.)

2. "2.2.3.2 Underground Trainway Protection Against Hazardous Substance Intrusion

2.3.2.3.1 Vent or fan shafts utilized for ventilation of subway tunnels shall not terminate at grade on any vehicle roadway or parking lot.

2.3.2.3.2 Vent and fan shafts may terminate in the median strips of divided highways or on sidewalks designed to accept such shafts, or in open space areas, provided that their location at the level of the median strips, or sidewalk, or open space, is protected by a concrete curb. This curb shall be of sufficient elevation to exclude drainage into the shaft, but in no case shall the height be less than six inches."

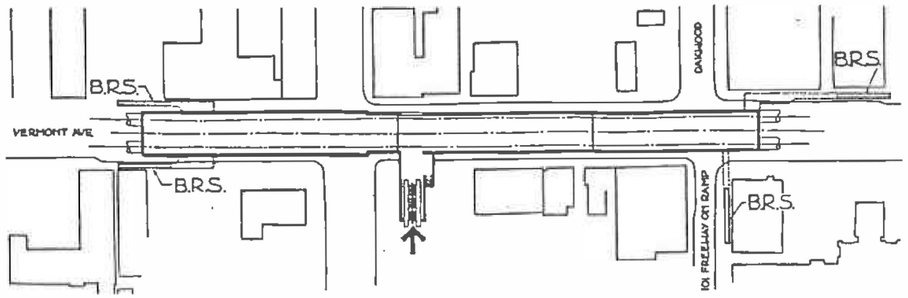
Because the pair of fans at one end of the station are to be operated one at a time or, if both at one time, only in parallel, there is no reason to separate shaft openings at the surface as called for in Section 2.2.3.1.3. The intake for the fans at the trainway level is common for both fans.

The objective of Section 2.3.2.3 is to prevent the intrusion of hazardous substance into the trackway or other vulnerable areas, but the restriction on terminating vent or fan shafts in the street is unnecessarily restrictive because the objective of the criteria can be met by the appropriate design of a street outlet and by cooperation of local authorities to prevent hazardous vehicle traffic over these vent openings.

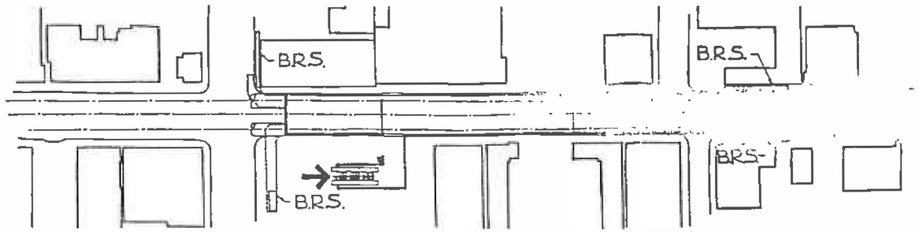
The result of these restrictive criteria is the design of long and very costly passageways terminating in widewalk outlets which are a definite public nuisance. The channeling of air through these long conduits and through outlets of unfavorable aspect ratio is not functionally optimal nor efficient.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

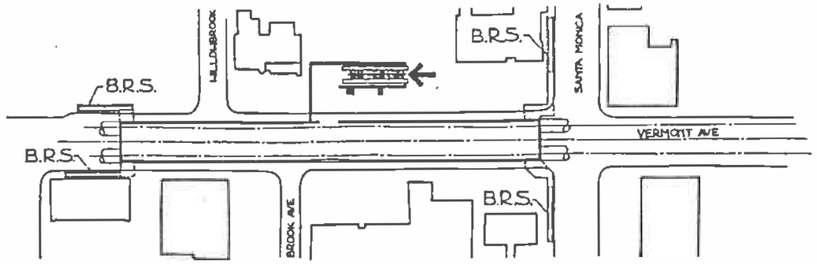
SKETCH OF PRESENT DESIGN



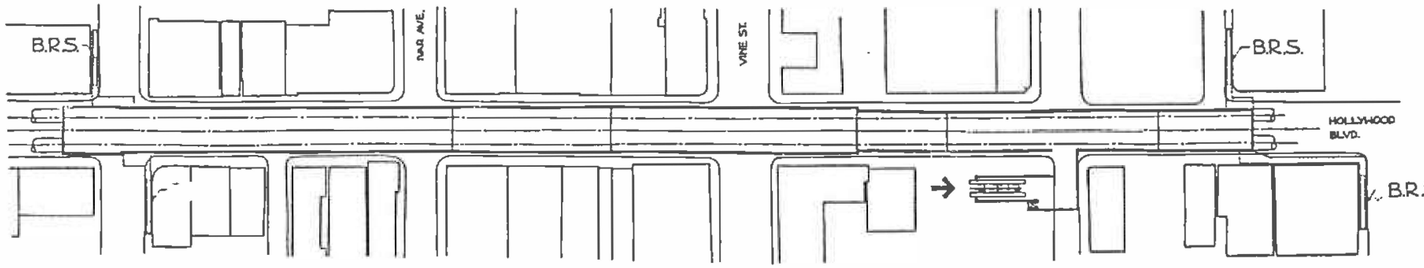
VERMONT / BEVERLY STATION
Not To Scale



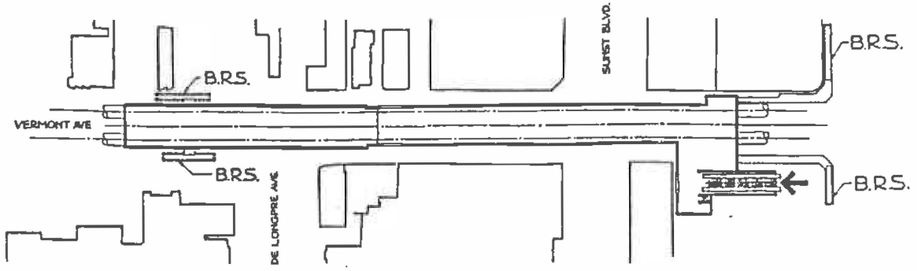
HOLLYWOOD / WESTERN STATION
Not To Scale



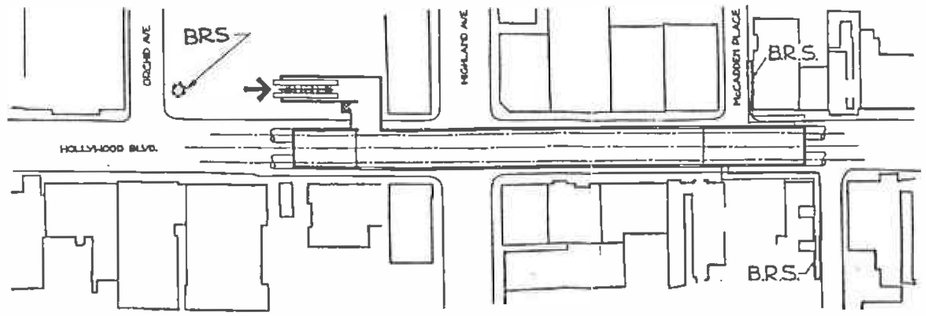
VERMONT / SANTA MONICA STATION
Not To Scale



HOLLYWOOD / VINE STATION
Not To Scale



VERMONT / SUNSET STATION
Not To Scale



HOLLYWOOD / HIGHLAND STATION
Not To Scale

EMERGENCY VENT SHAFT / BRS OUTLETS

DESCRIPTION OF PROPOSED DESIGN

Emergency Ventilation Shaft/Blast Relief Shaft (BRS) outlets channel the flow of air through grids 20 feet wide by 30 feet long each. The outlets are symmetrical about the centerline of the street so that substances falling on the street surfaces outside the grids flow away from the outlets. Substances falling through the grid area drop directly to a sump below having a capacity of 8,000 gallons or more.

The air passageways leading from the outlet shaft are offset horizontally from the outlet shaft itself to ensure that no material intrudes further into the stations and enters such vulnerable areas as the trackways or equipment rooms. The sump is sized to handle and discharge any hazardous material falling into the vertical shaft below the street grid.

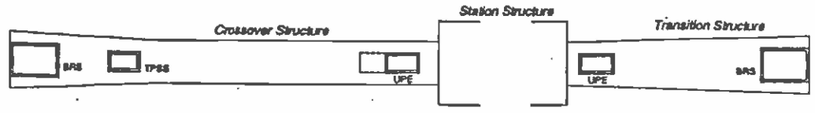
The proposed design will fulfill the protection requirement against hazardous substance intrusion into the underground trainways as intended by the criteria. Accidental spills on Vermont and Hollywood Boulevards could be prevented by either prohibiting hazardous vehicle traffic on these streets or by requiring that they travel on the sidewalk lane.

By having a shorter, straighter path leading to the outlet shaft and by having a more favorable aspect ratio, the proposed design will perform the function of channeling the flow of air more efficiently and at a lesser cost.

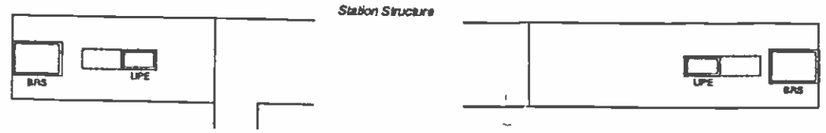
The placement of outlets would avoid crosswalks. Having permanent openings through the roof of the station facilities initial and future equipment installation.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

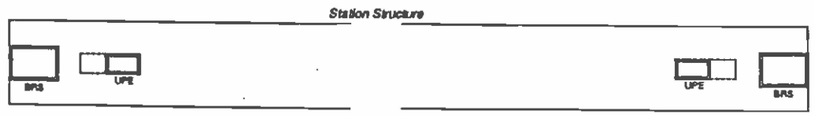
SKETCH OF PROPOSED DESIGN



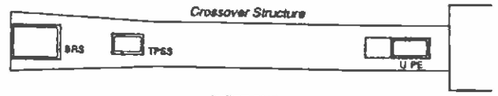
VERMONT / BEVERLY STATION NORTH



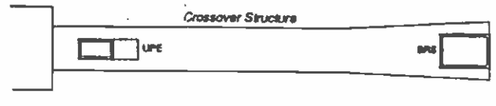
HOLLYWOOD / WESTERN STATION NORTH



VERMONT / SANTA MONICA STATION NORTH

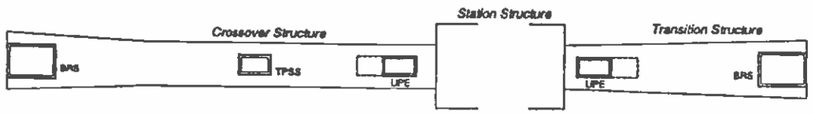


WEST END

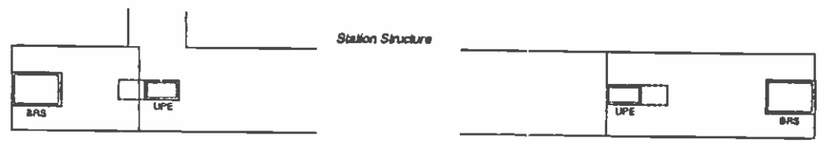


EAST END

HOLLYWOOD / VINE STATION NORTH



VERMONT / SUNSET STATION NORTH



HOLLYWOOD / HIGHLAND STATION NORTH

EMERGENCY VENT SHAFT / BRS OUTLETS

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE 9/13/89
PAGE 1 OF 1

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
	Emerg Vent/Blast Relief Shaft (BRS) outlets	UNITS	NO. UNITS	UNIT COST	TOTAL	UNITS	NO. UNITS	UNIT COST	TOTAL
1.	Vermont/Beverly Station	ft²	6240	455	3,839,200	ft²	1200	455	546,000
2.	Vermont/Santa Monica Station	ft²	4300	455	1,956,500	ft²	1200	455	546,000
3.	Vermont/Sunset Station	ft²	7932	455	3,609,060	ft²	1200	455	546,000
4.	Hollywood/western Station	ft²	5180	455	2,356,900	ft²	1200	455	546,000
5.	Hollywood/Vine Station	ft²	5328	455	2,424,240	ft²	1200	455	546,000
6.	Hollywood/Highland Station	ft²	5256	455	2,391,480	ft²	1200	455	546,000
			Total 13		185,900		Total 3,		276,000

Reference:

VEP #6
NOISE CONTROL

Value Engineering Proposal (VEP) No. 6

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM
EMERGENCY VENTILATION - NOISE CONTROL

FUNCTION
Controls Noise

CONCEPT BEFORE VE

To control noise generated by emergency fans, long attenuators and appurtences are installed at each end of the fans, affecting substantially the ancillary space required. Emergency fans are run nightly during non-revenue hours to control methane build-up. Operation of fans during these hours requires noise control measures.

PROPOSED ALTERNATIVE CONCEPT

To control noise generated by emergency fans, the fans are operated only in an emergency or in training and preparation for an emergency. Secondary or normal functions now performed by the emergency fans are performed by auxiliary ventilation systems in compliance with noise control criteria 2.3.5.1.

The attenuators in the present design are removed, and acoustical lining is installed.

Advantages:

1. Greatly reduces noise nuisance.

2. Reduces cost.

3. Provides greater fan pressures.

Disadvantages:

1. Noise will be greater in infrequent emergencies.

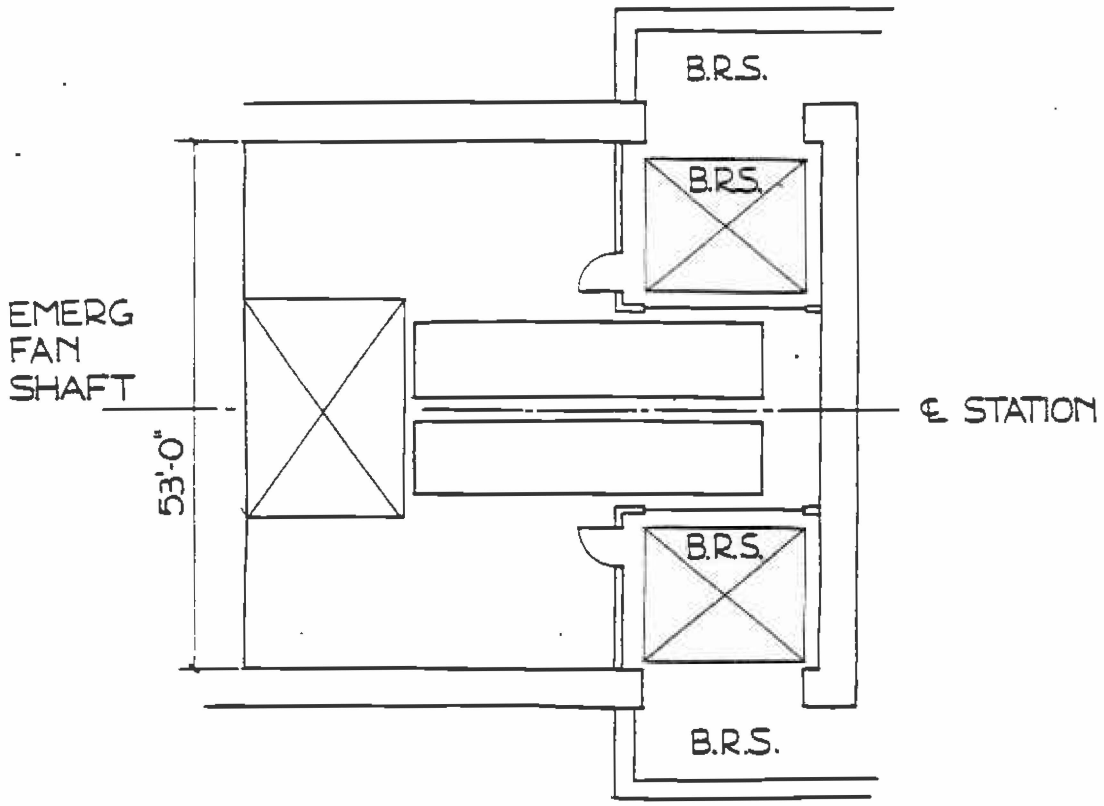
ESTIMATED COST	$25,918,000	ESTIMATED COST	$13,888,000
		EST GROSS SAVINGS	$12,030,000
		EST IMPLEMENTATION COST	$ -0-
		EST NET INITIAL SAVINGS	$12,030,000
		EST LIFE CYCLE SAVINGS	$12,688,000

DESCRIPTION OF PRESENT DESIGN

To control noise generated by emergency ventilation fans, attenuators are installed at each end of the fan. These attenuators reduce the noise near the source from about 125 dB to about 85 dB in the mid-frequency ranges. The overall length of a fan, transitions, and attenuators is approximately 40 feet. The dimensions of the ancillary space housing these fans is greatly affected by the sizes of the attenuators and appurtenances. The primary function of the emergency ventilation fans is to protect the underground areas from the smoke and heat due to fires. A secondary function is to monitor and control methane relief shafts for the 4 hour non-revenue hours. The extended nightly operation of these fans produces unwanted noise in the environment which necessitates noise control measures such as the addition of attenuators.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



PLAN

PRESENT DESIGN ALL STATIONS

EMERGENCY VENTILATION - NOISE CONTROL

DESCRIPTION OF PROPOSED DESIGN

To control noise generated by emergency ventilation fans, the fans are only operated in an emergency or in training and preparation for an emergency. Secondary or normal functions now assigned to the emergency ventilation system, such as methane monitoring and control and ventilation for rail grinding, will be provided by separate systems in compliance with Fire/Life Safety Criteria 2.3.5.1.

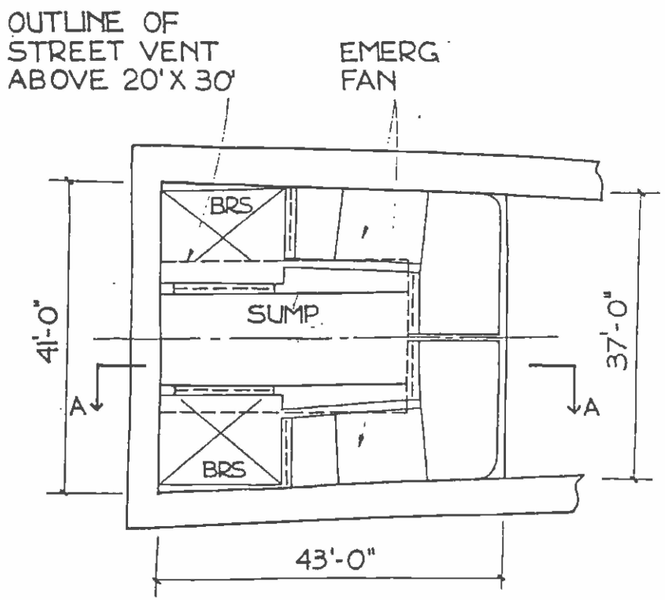
The methane monitoring and control function is performed by fans presently designated as "smoke exhaust" fans, approximately 37,500 cfm at 2.5" W.C. each. Two fans in the present area of the "smoke exhaust" fans conduct air from each tunnel past methane detectors/monitors at the blast relief openings from the trackway. Exhaust from the station is through the UPE outlets. With fan dampers and blast dampers closed, preliminary calculations show that each fan can draw at least 13,500 cfm from each tunnel. This quantity will create a velocity of about 60 feet minimum, sufficient to move gas accumulation. Sixteen fans total are installed in pairs at the following locations to take advantage of natural ventilation pressures and flows: Vermont/Beverly, south end; Vermont/Santa Monica, south end; Vermont/Sunset, south and north ends; Hollywood/Western, east and west ends; Hollywood/Vine, east end; Hollywood/Highland, east end. These fans are operated only when needed as indicated by the monitored levels, say when methane levels exceed 1/2% in the air stream.

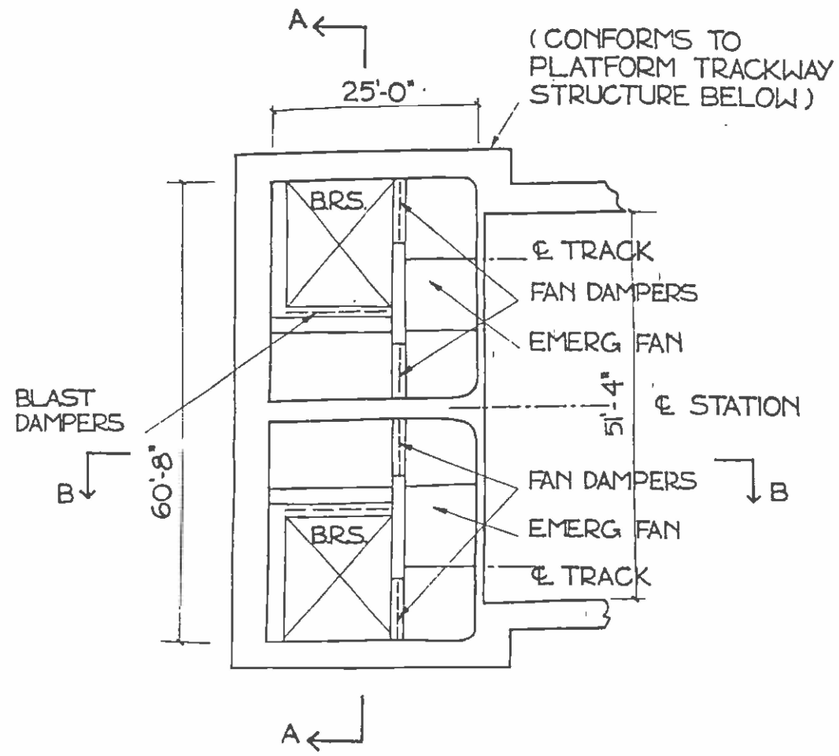
Since the emergency fans will, therefore, operate on a very infrequent basis, and the "smoke exhaust" fans do not emit such high noise levels, the community noise control function can be accomplished by removing the attenuators and appurtenances from the fans and installing acoustical lining in air passages instead. The fan length is thus reduced from 40 feet to 7.33 feet. This length reduction makes possible large savings in ancillary spaces as well as increases in the effectiveness of the fans.

Additionally, maintenance crews will be equipped with a track vehicle, a fan and diesel generator/motor, a portable tunnel stopper sized to fit tunnel cross sections, which can be unfolded to provide isolation of air flow, and portable flexible ducts. This track vehicle will be set up to exhaust air through the BRS grille from the trackway to augment the methane control fan as required.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN





PLAN AT 3 STATIONS

VERMONT/BEVERLY
VERMONT/SUNSET &
HOLLYWOOD/VINE

PLAN AT 3 STATIONS

VERMONT/SANTA MONICA
HOLLYWOOD/WESTERN &
HOLLYWOOD/HIGHLAND

EMERGENCY VENTILATION - NOISE CONTROL

Life Cycle Cost Analysis — annualized method

Project SCRTD - Stations — Life Cycle Period: 25 Years

System or Item: Ventura Tunnel in Down Time — Date: 9-14-89

	Emerg. Vent. Noise Control	ORIGINAL	ALT NO 1	ALT NO. 2
INITIAL COSTS	1. Base Cost			
	2. Interface Costs			
	a.			
	b.			
	3. Other Initial Costs			
	a.			
	b.			
	4. TOTAL INITIAL COST (IC)			
SALVAGE & REPLACEMENT COSTS	5. SINGLE EXPENDITURES @ ____ %			
	a. Year ____ PWF' ____ Amount PW			
	b. Year ____ PWF' ____ Amount PW			
	c. Year ____ PWF' ____ Amount PW			
	d. Year ____ PWF' ____ Amount PW			
	e. Salvage Yr ____ PWF' ____ Amount PW			
LIFE CYCLE COSTS (ANNUALIZED)	6. ANNUAL OWNING & OPERATING COSTS			
	a. Capital Recovery of Initial Cost			
	CRF for 25 Years @ ____ % = ____ x IC			
	b. Cap Rec of Repl Cost: CRF x PW			
	(1) Year ____			
	(2) Year ____			
	(3) Year ____			
	(4) Year ____			
	c. Cap Rec of Salvage Cost: CRF x PW ____			
	d. Annual Maintenance (Escalation Rate ____ %)			
	e. Annual Operations (Escalation Rate 0 %)	108,770	36,257	
	f. Other Annual Costs (Escalation Rate ____ %)			
	7. TOTAL ANNUAL COSTS	108,770	36,257	
	8. ANNUAL DIFFERENCE (AD)		72,513	
	9. LIFE CYCLE SAVINGS			
	(PWF 9.077) x AD		658,201	

The equipment is presently installed. However it is desired to operate it differently - the life cycle cost represents the operating costs.

8 eq 150,000 cfm fans operating 4 hrs/day
16 eq 37,500 cfm fans operating 4 hrs/day

150,000 cfm fans w/ 150 HP motor

$$\text{Cost/yr} = \frac{150\ HP \times .745\ KW/HP}{.90\ \text{eff}} \times \$0.075/KWh \times 4\ hr \times 8 \times 365$$

$$= \$108,770$$

37500 cfm fans w/ 25 HP motors

$$\text{Cost/yr} = \frac{25\ HP \times .745\ KW/HP}{.90\ \text{eff}} \times \$.075/KWh \times 4\ hr \times 8 \times 365$$

$$= \$36,257$$

Life Cycle
Cost of Operating 8 ea 150,000 cfm fans
4 hrs / day

vs. Operating 16 ea 37,500 cfm (Smoke Exh. fans) 4 hrs / day

Cost/yr $\frac{150\ HP \times .745\ KW}{.90\ eff} \times \frac{\$.075}{KWh} \times 4\ hr \times 8\ Fans$

$298/yr $300 × 365 days
$109,500

Cost/yr $\frac{25\ HP \times .745\ KW}{.90\ eff} \times \frac{\$.075}{KWh} \times 4\ hr \times 16\ Fans$

$99/yr. $100 × 365 days

$36,500

PROJECT SCRTD
LOCATION LA Metro
SYSTEM

Cost Model

CLIENT
DATE 9/15/89
PAGE 1 of 1

ITEM NO.	DESCRIPTION Emergency Ventilation - Noise Control	ORIGINAL DESIGN UNITS	NO. UNITS	UNIT COST	TOTAL	VE PROPOSED DESIGN UNITS	NO. UNITS	UNIT COST	TOTAL
1.	Station Ancillary								
	Space								
a.	Vermont/Beverly	sf	4600	946	4,351,600	sf	1677	946	1,586,442
b.	Vermont/Santa Monica	sf	5015	946	4,744,190	sf	3034	946	2,870,164
c.	Vermont/Sunset	sf	4600	946	4,351,600	sf	1677	946	1,586,442
d	Hollywood/Western	sf	5015	946	4,744,190	sf	3034	946	2,870,164
e.	Hollywood/Vine	sf	3266	946	3,089,636	sf	1677	946	1,586,442
f.	Hollywood/Highland	sf	4379	946	4,142,534	sf	3034	946	2,870,164
			Sub Total (1)		25,423,750	Sub-Tot.		(1) 13	369,818
2.	Attenuators	ea.	48	7,800	374,400		NONE		—
a.	Attenuator covers	ea	48	2,500	120,000		NONE		—
3.	Acoustic Lining	sf	0			sf	9600	30	288,000
			Sub Total (2)		494,400	Sub Tot		(2)	288,000
4.	37,500 cfm fans.	ea	0	—	—	ea.	17	10,000	170,000
5.	Maint. Veh. & Fan Equip.	ea.	0	—	—	ea	1	60,000	60,000
			Tot	25	918,150	Tot		13	887,818

Reference: _____

VEP #7
UPE OUTLETS

DESCRIPTION OF PRESENT DESIGN

Under Platform Exhaust Shafts (UPE) for all six stations channel the flow of exhaust air through vent outlets located in the sidewalks adjacent to the stations. There is one outlet for each end of a station, connected to the under platform exhaust fan discharge by a lengthy underground passage leading from the ancillary space at the station mezzanine level. The size of the sidewalk outlets are about 6 feet to 50 feet. The shafts also function to discharge the smoke exhaust fan in emergency situations, and also vent the battery rooms.

Restrictions on placing these outlets in the street come from the same regulations governing Emergency Ventilation Shaft/Blast Relief Shaft outlets as cited in the VEP on these shafts; namely 2.2.3.1.3 and 2.3.2.3 of the fire and life safety criteria. The result of these restrictive criteria is the design of long and very costly passageways terminating in sidewalk outlets which are a definite public nuisance. The channeling of air through these outlets of unfavorable aspect ratio is not functionally optimal nor efficient.

Value Engineering Proposal (VEP) No. 7

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM: UNDER PLATFORM EXHAUST (UPE) OUTLET

FUNCTION: Channel Flow

CONCEPT BEFORE VE

Under Platform Exhaust (UPE) outlets channel the flow of exhaust air through long underground passageways connecting to the stations. The outlets occupy sidewalk space away from the station. This is in compliance with the fire and life safety criteria prohibiting these outlets in the streets. These criteria are aimed at prohibiting the intrusion of hazardous materials into the trainways.

The UPE plenums also receive exhaust air from the smoke exhaust system in emergencies, and receives vent air from the battery rooms.

Base Cost: $4,564,550

ESTIMATED COST $4,555,000

PROPOSED ALTERNATIVE CONCEPT

Under Platform Exhaust (UPE) outlets channel exhaust air through grids located in the center of the street and through air passages offset horizontally from the outlet grid and shaft directly below it. Intrusion of hazardous materials is prevented by the street crown location and by a sump directly below he opening large enough to catch, contain, discharge any substances falling through the grid.

Advantages:

1. More effective and less costly outlet system.

2. Eliminates a public annoyance and nuisance.

3. Provides permanent access for equipment installation.

Disadvantages:

1. Requires approval of fire and life safety and street officials.

Base Cost: $1,992,900

ESTIMATED COST $ 1,993,000

EST GROSS SAVINGS $ 2,562,000

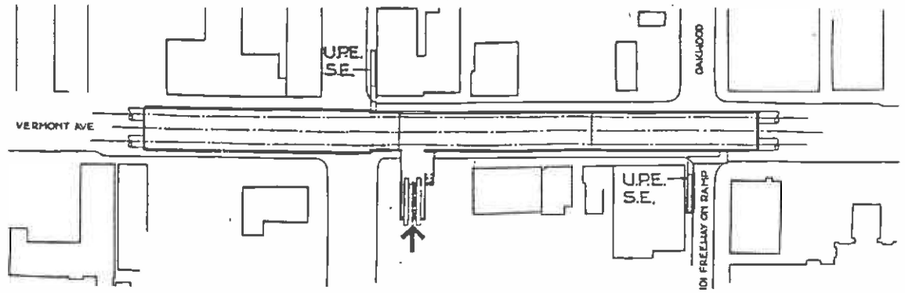
EST IMPLEMENTATION COST $ -0-

EST NET INITIAL SAVINGS $ 2,562,000

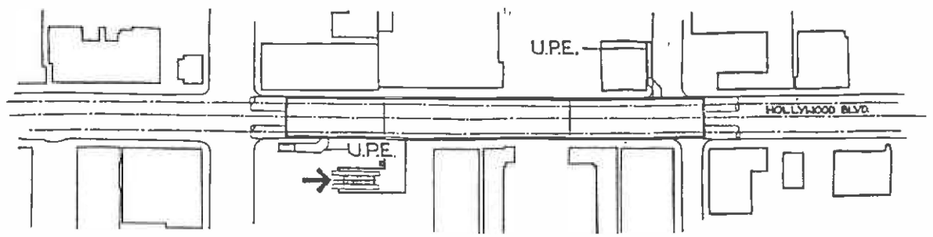
EST LIFE CYCLE SAVINGS $ 2,562,000

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

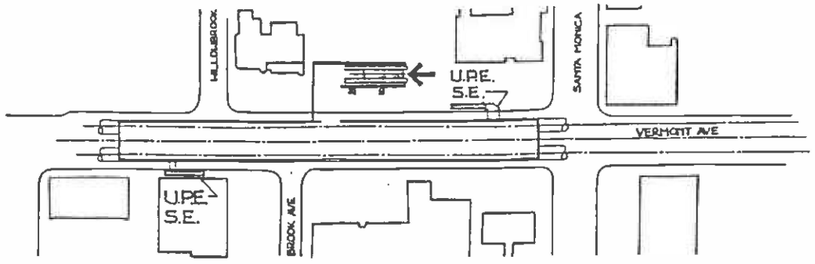
SKETCH OF PRESENT DESIGN

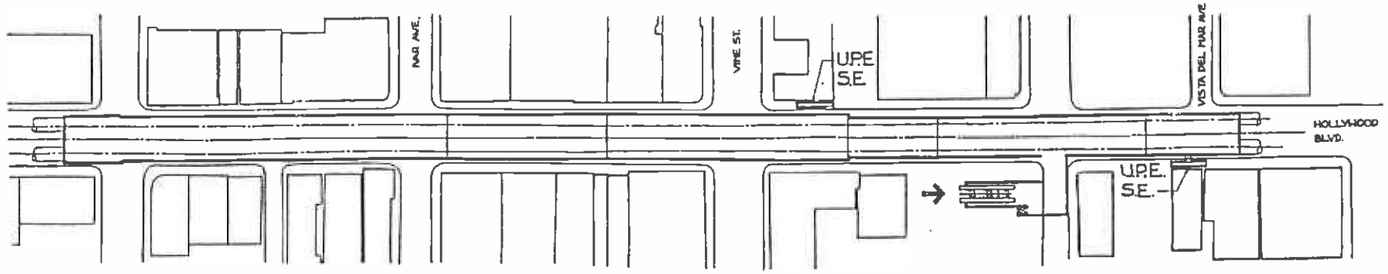


VERMONT / BEVERLY STATION
Not To Scale

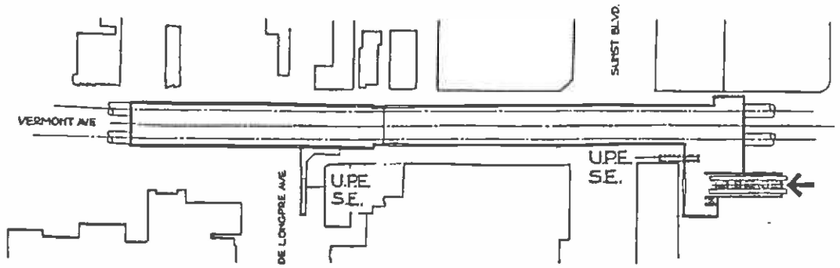


HOLLYWOOD / WESTERN STATION
Not To Scale



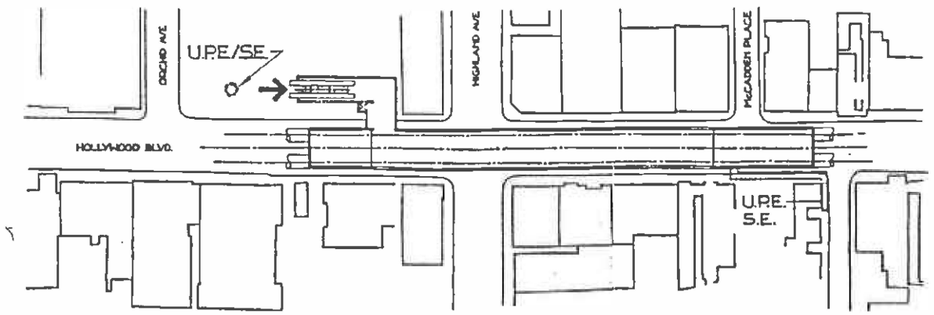


VERMONT / SANTA MONICA STATION
Not To Scale



VERMONT / SUNSET STATION
Not To Scale

HOLLYWOOD / VINE STATION
Not To Scale



HOLLYWOOD / HIGHLAND STATION
Not To Scale

UNDERPLATFORM EXHAUST

DESCRIPTION OF PROPOSED DESIGN

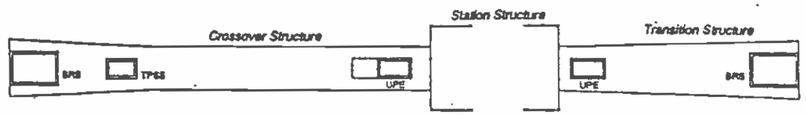
Under Platform Exhaust Outlets (UPE) channel the flow of air through grids 10' wide by 20' long. The outlets are symmetrical about the center line of the street, and situated beyond crosswalks. Substances falling on street surfaces outside the grids flow away from the outlets, while substances falling through the grid area drop directly to a sump below having a capacity of approximately 6,000 gallons. This sump is sized to handle and discharge any hazardous material dropping into the vertical shaft below the street grid. The air passageway leading from the outlet shaft is offset horizontally from the outlet shaft to preclude hazardous material intrusion into the equipment room and to obtain at least 40 feet clearance from other outlets such as the emergency vent shafts.

The proposed design will fulfill the protection requirement against hazardous intrusion into the subway as intended by the criteria. Accidental spills on Hollywood and Vermont could be prevented by prohibiting such traffic on these streets.

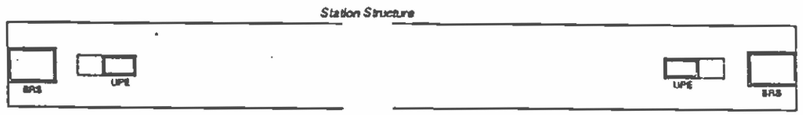
By having a shorter, straighter path leading to the outlet shaft and by having a more favorable aspect ratio for the outlet, the proposed design will perform the function of channeling the flow of air more efficiently and at less cost.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

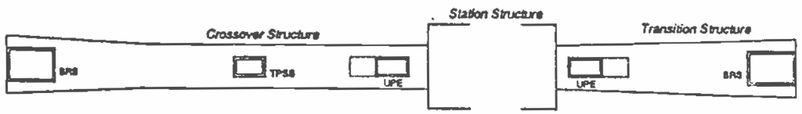
SKETCH OF PROPOSED DESIGN



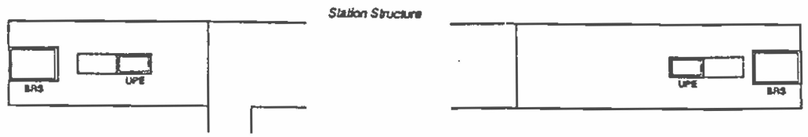
VERMONT / BEVERLY STATION NORTH



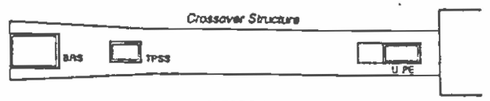
VERMONT / SANTA MONICA STATION NORTH



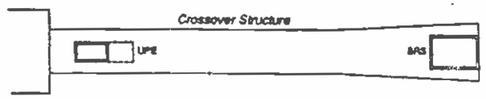
VERMONT / SUNSET STATION NORTH



HOLLYWOOD / WESTERN STATION NORTH

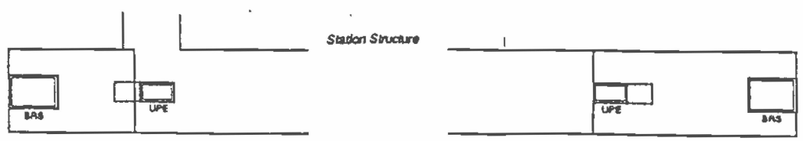


WEST END



EAST END

HOLLYWOOD / VINE STATION NORTH



HOLLYWOOD / HIGHLAND STATION NORTH

UNDERPLATFORM EXHAUST

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE
PAGE 1 OF 1

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
	Under Platform Exhaust (UPE) Outlet	UNITS	NO. UNITS	UNIT COST	TOTAL	UNITS	NO. UNITS	UNIT COST	TOTAL
1	Vermont/Beverly Station	ft^2	2120	455	964,600	ft^2	730	455	332,150
2	Vermont/Santa Monica Sta.	ft^2	1040	455	473,200	ft^2	730	455	332,150
3	Vermont/Sunset Station	ft^2	1430	455	650,650	ft^2	730	455	332,150
4	Hollywood/Western Station	ft^2	1920	455	873,600	ft^2	730	455	332,150
5	Hollywood/Vine Station	ft^2	820	455	373,100	ft^2	730	455	332,150
6	Hollywood/Highland Station	ft^2	2680	455	1,219,400	ft^2	730	455	332,150
	Totals			4,	551,550			1,	992,900
					1,650				

Reference: VESP Emergency Vent Shaft/Blast Relief Shaft

VEP #8
SMOKE EXHAUST SYSTEM

Value Engineering Proposal (VEP) No. 8

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM
SMOKE EXHAUST SYSTEM

FUNCTION
Remove Smoke

CONCEPT BEFORE VE

In emergencies, the station smoke exhaust system removes smoke from the fire/smoke source, almost always at the platform level, through ducts located at the roof corners of the mezzanine. Due to the partial vacuum created, this smoke is spread throughout the station and particularly into the patrons evacuating path and firefighters approach path. This system does not meet the fire/life safety criteria of 2.3.5.3.3 and 2.2.3.2.2.

PROPOSED ALTERNATIVE CONCEPT

In emergencies, smoke is removed by the emergency ventilation fans according to preplanned and preprogrammed routines tailored to the situation. The smoke exhaust path is the shortest possible and away from the paths of evacuating patrons. All points on the exiting paths are at higher air pressures than the pressure at the smoke source, and the air used to produce these pressures is free of gas and smoke. The proposed design meets fire/life safety criteria.

Advantages:

1. Ensures the best possible ventilation for patrons and firefighter safety.

2. Eliminates cost of unsafe system.

Disadvantages:

None

ESTIMATED COST	$430,000

ESTIMATED COST	$ -0-
EST GROSS SAVINGS	$ 432,000
EST IMPLEMENTATION COST	$ -0-
EST NET INITIAL SAVINGS	$ 432,000
EST LIFE CYCLE SAVINGS	$ lives

DESCRIPTION OF PRESENT DESIGN

In emergencies, the station smoke exhaust system removes smoke from the upper mezzanine areas through ducts located in the corners of the mezzanine roof. These ducts, approximately 25 ft^2 in cross-section, lead to exhaust fans, one in each end of the station, of 37,500 cfm capacity. The fans exhaust smoke to the surface through the underground platform exhaust shaft.

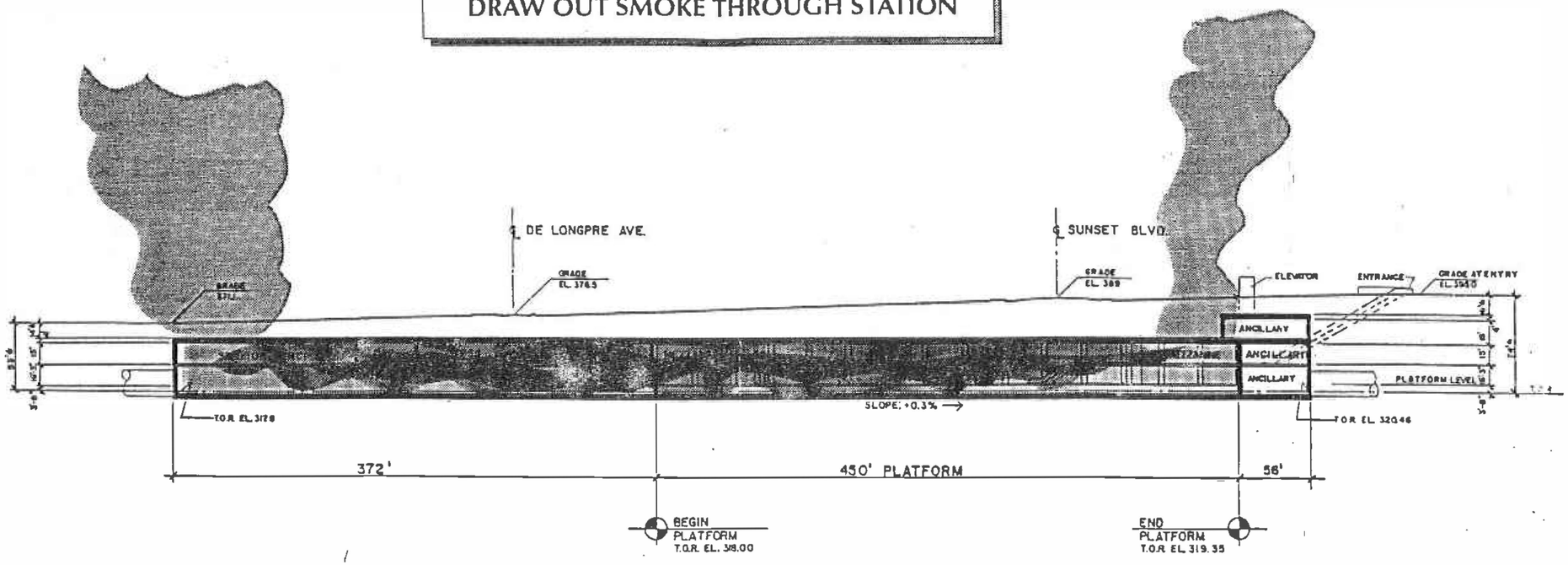
The smoke exhaust system removes smoke from the fire/smoke sources, usually occurring at platform level and due to the partial vacuum created in the mezzanine area, this smoke is spread throughout the station and particularly into the paths of evacuating patrons and firefighters approaching the source. This is in violation of Fire/Life Safety Criteria 2.3.5.3, particularly 2.3.5.3.3. Also, the system does not meet the requirements of 2.2.3.2.2:

"2.2.3.2.2 Emergency ventilation systems shall produce airflow rates so as to provide a stream of noncontaminated air to patrons in a path of egress."

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN

EXHAUST FANS AT TOP OF MEZZANINE DRAW OUT SMOKE THROUGH STATION



SMOKE EXHAUST SYSTEM

DESCRIPTION OF PROPOSED DESIGN

In emergencies, smoke is exhausted by the emergency ventilation fans over the shortest possible exhaust path and away from the paths of exiting patrons or approaching firefighters. All points on the exiting/approach paths are at higher air pressures than the pressure at the smoke source, and the air used to produce these pressures on the exiting paths is free of gas or smoke. Thus, a stream of noncontaminated air is provided to patrons in a path of egress, as required by Criteria 2.2.3.2.2.

The proper modes of emergency fan operation are previously calculated, developed, tested, and put into a computer at central operations for immediate and accurate recall in a particular emergency situation. Firefighters are thoroughly briefed on these fan routines.

In the present design, the smoke exhaust system appears to be detrimental to the needs of the station ventilation in an emergency.

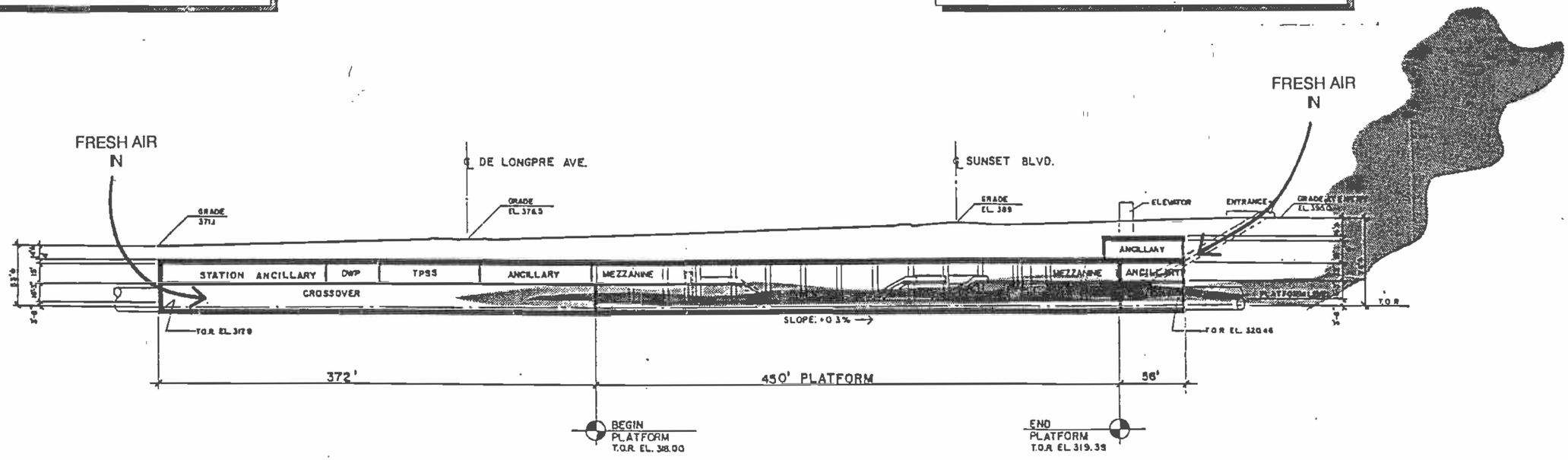
In the proposed design, the system is deleted.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN

EMERGENCY FAN AT THIS END
PUSHES SMOKE

EMERGENCY FAN AT THIS END
DRAWS OUT SMOKE



SMOKE EXHAUST SYSTEM

SITUATION

FIRE ON TRAIN AT STATION. PATRONS EXIT THROUGH MAIN CIRCULATION PATHS TO FREE AIR SPACE. FIREFIGHTERS APPROACH SMOKE WITH WIND AT THEIR BACKS. SMOKE IS EXHAUSTED THROUGH EMERGENCY VENTILATION FAN FOR TRACKWAY CONTAINING SMOKE. OTHER FAN AT THIS END OF STATION NOT OPERATING. BOTH FANS AT OTHER END TURNED ON IN SUPPLY MODE.

PROJECT _____
LOCATION _____
SYSTEM SMOKE EXHAUST

Cost Model

CLIENT SCRTD METRO RAIL
DATE 9/15/99
PAGE 1 of 2

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	TOTAL	UNITS	NO. UNITS	UNIT COST	TOTAL
	PER STATION COST	EA.	6	72,070	432,420	NONE			0
	OF SMOKE EXHAUST								
	SYSTEM (SEE P2)								

Reference: _____

PROJECT
LOCATION
SYSTEM SHOKE EXHAUST

Cost Model

CLIENT SCRTD METRO RAIL
DATE 9/15/89
PAGE 2 of 2

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN UNITS	NO. UNITS	UNIT COST	TOTAL	VE PROPOSED DESIGN UNITS	NO. UNITS	UNIT COST	TOTAL
1	Perforated Faced Alum Acoustic Panel	Sq Ft	3,780	$5	18,900	NONE			
2	Sidewall Registers Alum - 12"x30"	Eq	54	$105	5,670	NONE			
3	60"x60" Duct ≈ 200' @ 50#/Ft	LBS	10,000	3.45	34,500	NONE			
4	37,500 cfm @ 2.5" Vaingaxial Fan	1	eq	$10,000	10,000	NONE			
5	Silencer	1	eq	3,000	3,000	NONE			
					72,070				0

Reference: (1) est (2)(3)(5) Means (5) Mat'l Quote x 2.
(5)(3) size factor 16 x means cost.

VEP #9
FUT. AIR CONDITIONING

Value Engineering Proposal (VEP) No. 9

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM: STATION VENTILATION WITH PROVISION FOR FUTURE AIR CONDITIONING

FUNCTION: Cool Air

CONCEPT BEFORE VE

In the present design, the station ventilation system has provision for the future addition of air conditioning consisting of space in each of the air handling units for cooling coils and chiller rooms (from 1320 to 2500 sq. ft.) for installing chillers and pumps.

Remote cooling towers with piping to the chiller will also be required. These will be installed at street surface within acquired ROW once A/C system is implemented.

PROPOSED ALTERNATIVE CONCEPT

The proposed station ventilation system will be as the present, except the deletion of the chiller room. When air conditioning is added, secure above grade private property for cooling tower, chillers pumps and piping to the station. The piping in this case will be insulated.

Advantages:

1. Saves station space.
2. Reduces station cost.
3. Reduces pumping cost.

Disadvantages:

1. More pipe insulation.

ESTIMATED COST	$8,595,000

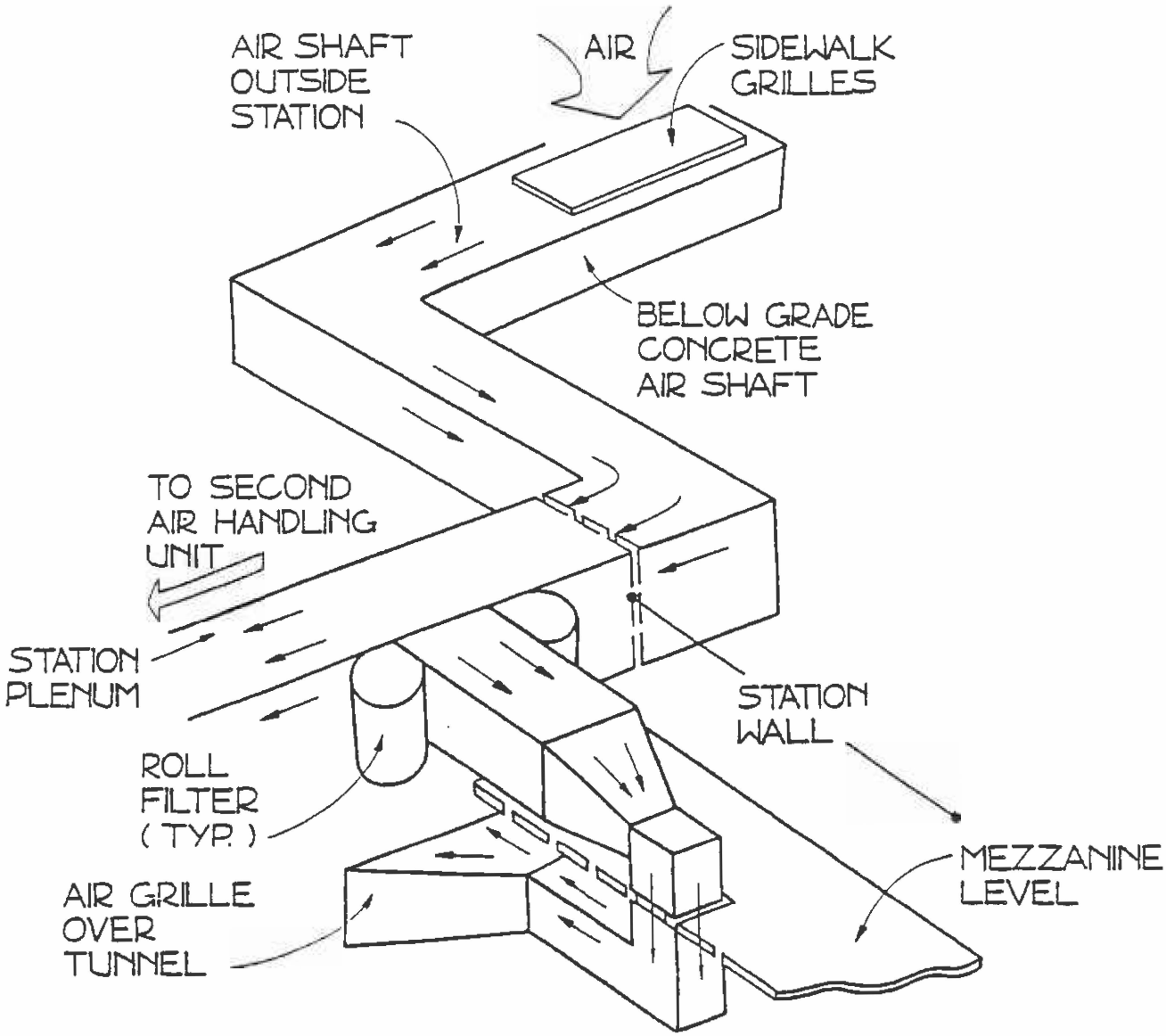
ESTIMATED COST	$ -0-
EST GROSS SAVINGS	$ 8,595,000
EST IMPLEMENTATION COST	$ -0-
EST NET INITIAL SAVINGS	$ 8,595,000
EST LIFE CYCLE SAVINGS	$ 8,595,000

DESCRIPTION OF PRESENT DESIGN

The present station ventilation system takes outside air (150,000 cfm) at ambient temperature and discharges onto the platform area via 4 grilles, each located over the tunnel entrances. This provides platform ventilation of about 20 air changes per hour in conjunction with the train piston effect. The system consists of outside air intakes and shafts, roll filters, air handling units with space for future cooling coils, ducting to the grills over the tunnel entrance and chiller room for the future installation of chillers, to provide air-conditioning (cooling). Chilled water will be pumped through the piping connecting the chillers with the cooling coils. To reject the heat from the chiller, a cooling tower pump and piping will be required. At present, it is planned to secure private property for the remote above grade cooling tower and piping at a future time when air-conditioning will be added.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



STATION VENTILATION

DESCRIPTION OF PROPOSED DESIGN

The proposed station ventilation system will be the same as the present except for the deletion of the chiller room. A space saving of from 1320 to 2500 square feet results depending upon the station.

The chiller pumps and cooling tower will be located on private property secured when air-conditioning will be added. A great amount of water flows between the chiller and cooling tower. As this distance will be reduced, there will be a saving in pumping cost. The chilled water between the chiller and cooling coils requires insulation thus the insulation cost will increase. However, installing the chiller package at a later date when needed could result in a compact layout and more savings. This proposal is practical and economical, as in either case only water is being transmitted.

In the case of the station at Sunset and Vermont, this saving will not be realized because of the specific location of the Chiller Room in the present design.

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN

STATION VENTILATION

PROJECT SCRTD
LOCATION STADIUM
SYSTEM Station Vent w/ Exhaust A/C

Cost Model

CLIENT SCRTD
DATE 9-14-89
PAGE ____ of ____

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN UNITS	ORIGINAL DESIGN NO. UNITS	ORIGINAL DESIGN UNIT COST	ORIGINAL DESIGN TOTAL	VE PROPOSED DESIGN UNITS	VE PROPOSED DESIGN NO. UNITS	VE PROPOSED DESIGN UNIT COST	VE PROPOSED DESIGN TOTAL
1	Space for Chiller Room								
	1320 + 2500 SF / 2								
	= 1910 SF/station		9550		8.595.000				
5	(6) station x 1910 SF = (Do not include Pavement/subst..	SF	11460	$900	10,314,000		1		
					8.595.000				
	Total				10,314,000				zero

Reference: _____

69

VEP #10
FRESH AIR SUPPLY

Value Engineering Proposal (VEP) No. 10

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM	FUNCTION
STATION VENTILATION	Provides Air

CONCEPT BEFORE VE

The station is provided with a ventilation system that takes air in through sidewalk grills, conveys it through concrete air shafts to a plenum in the station then through rool filters to air handling units with provisions for future air conditioning cooling coils, down ducting to grills over the tunnel entrance at the end of each station platform. It appears that ventilating air reaches only a portion of the platform at each end of the station.

PROPOSED ALTERNATIVE CONCEPT

Delete the station ventilation system and rely on the piston effect of the trains to ventilate the platform area and station.

Advantages:

1. Saves cost.

2. Saves operational expense

ESTIMATED COST 7,706,000	ESTIMATED COST $ -0-
	EST GROSS SAVINGS $7,706,000
	EST IMPLEMENTATION COST $-0-
	EST NET INITIAL SAVINGS $7,706,000
	EST LIFE CYCLE SAVINGS $14,713,000

DESCRIPTION OF PRESENT DESIGN

In the present design, the station ventilation system draws outside air through large sidewalk grilles, conveys the air along long concrete air shafts to the station air plenums, then through roll filters, air handling units (fans), sheet metal ducting with acoustical lining to supply air grilles over the tunnel entrances at the end of each station platform. Each station is equipped with two air supplies and plenums, one at each end of the station. Each plenum supplies two air handling units (fans with space for future cooling coils to be added when air-conditioning is installed) and supply ducting for the grilles over the tunnel entrances.

It would appear that this system is being installed now to make provision for future air-conditioning and to provide for present ventilation of the platform. 150,000 cfm of air is distributed through the 4 grilles.

The platform is 450 foot long with 2 grilles at each end. With the Design Criteria air discharge velocity of 1000 feet per minute, the air throw would be from 30 to 80 feet, leaving 290 to 390 feet of the platform without ventilation, which would indicate that the present design has no effective ventilating function.

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN

PRESENT DESIGN
PROVIDES SPACE IN
STATION FOR FUTURE
AIR CONDITIONING
EQUIPMENT

AIR CONDITIONING

DESCRIPTION OF PROPOSED DESIGN

In the proposed design, station ventilation is accomplished by the piston action of the trains passing through the tunnels.

In this case, the equipment and various shafts needed to distribute "fresh" air from the sidewalk level are redundant and deleted. Space for the future installation of fans in the station is provided but equipment is not installed.

If and when station air-conditioning becomes a reality, alternative ways of providing the required air supply can be installed. In the meantime, there does not appear to be sufficient justification for the special provision.

STUDY TITLE

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN

AIR CONDITIONING

Life Cycle Cost Analysis — annualized method

Project SCRTD STATIONS — Life Cycle Period: 25 Years

System or Item: STATION VENTILATION — Date: 9-15-89

		ORIGINAL	ALT NO 1	ALT NO. 2
INITIAL COSTS	1. Base Cost	7,706,000	zero	
	2. Ir terface Costs			
	a.			
	b.			
	3. Other Initial Costs			
	a.			
	b.			
	4. TOTAL INITIAL COST (IC)	7,706,000	zero	
SALVAGE & REPLACEMENT COSTS	5. SINGLE EXPENDITURES @ ____ %			
	a. Year ____ PWF' ____ Amount PW			
	b. Year ____ PWF' ____ Amount PW			
	c. Year ____ PWF' ____ Amount PW			
	d. Year ____ PWF' ____ Amount PW			
	e. Salvage Yr ____ PWF' ____ Amount PW			
LIFE CYCLE COSTS (ANNUALIZED)	6. ANNUAL OWNING & OPERATING COSTS			
	a. Capital Recovery of Initial Cost			
	CRF for 25 Years @ 10 % = .11017 x IC	848,970		
	b. Cap Rec of Repl Cost: CRF x PW			
	(1) Year ____			
	(2) Year ____			
	(3) Year ____			
	(4) Year ____			
	c. Cap Rec of Salvage Cost: CRF x PW ____			
	d. Annual Maintenance (Escalation Rate ____ %)			
	e. Annual Operations (Escalation Rate 0 %)	771,920		
	f. Other Annual Costs (Escalation Rate ____ %)			
	7. TOTAL ANNUAL COSTS	1,620,890	zero	
	8. ANNUAL DIFFERENCE (AD)		1,620,890	
	9. LIFE CYCLE SAVINGS (PWF 9.077) x AD		14,712,800	

(Use as many sheets as necessary.)

PROJECT SCRTD
LOCATION STATIONS
SYSTEM STATION VENTILATION

Cost Model
Per Station

CLIENT
DATE
PAGE ____ of ____

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN UNITS	ORIGINAL DESIGN NO. UNITS	ORIGINAL DESIGN UNIT COST	ORIGINAL DESIGN TOTAL	VE PROPOSED DESIGN UNITS	VE PROPOSED DESIGN NO. UNITS	VE PROPOSED DESIGN UNIT COST	VE PROPOSED DESIGN TOTAL
1	Sidewall Register								
	15'x3' Al	ea.	4	900	3600				
2.	Sheet Metal								
	Ducting	lbs	11,491	$3.58	41,138				
3.	Duct Linning	SF	4,320	5.46	23,590				
4.	Air Handling								
	Unit 37,500 cfm	ea	4	25,125	100,500				
5.	Roof filter	ea	4	5,000	20,000				
6	Interior								
	Air Shafts								
	or Plenum	SF	192	900	172,800				
7	Outside Air								
	Shafts (Ave)	SF	2028	455	922,740				
	Total				1,284,368				zero
	Six Stations				7,706,000				zero

Reference: _____

FOSTER ENGINEERING, INC.
ENGINEERING AND ARCHITECTURE
SAN FRANCISCO SACRAMENTO SAN DIEGO

COMPUTATION SHEET

Page 1 of 3
Job No. 453-A01
Made by [signature]
Date 9-14-89
Checked by
Date

Subject SCRTD STATION VE
STATION VENTILATION

1. Sidewall Register 15'x3'
   Means 87 157-580-2560
   36"x36" \$ 275
   LA = 1.137
   For 89 = 1.1 use
   1.25 mult

   $\frac{15\times3}{3\times3} = 5$

   5'6 x 275 x 1.25 = \$903 use 900

2. Duct work Lined
   Say 72"x 36" x 60' each
   = 1080 SF Ducting use 16ga.
   @ 2.66#/sf.
   Wt = 4 x 1080 x 2.66 = 11,491#
   Means 157-640-0580
   2.86/# x 1.25 = \$3.58/#

3. DuctLiner
   Means 155-650-3710
   1½" No finish \$4.37/SF x 1.25 = 5.46

4. AHU 37,500
   Means 33,500 cfm \$20,100, use because no chilled water coil.
   \$20,100 x 1.25 = \$25,125

5. Rool Filter ~\$5,000 use

6. Interior Concrete Air Shafts

Use $900/SF

Shaft 4'x24' = 96 SF/shaft

2 shafts 192 SF

7. Outside Concrete Air Shafts

Use $455/SF

		SF
~~8'x 56'~~	8'x 170'	1360
~~8'x 50'~~	8'x 100'	800
~~8'x 30'~~	8'x 110'	880
~~8'x 35'~~	8'x 116'	928
~~8'x 38'~~	8'x 70'	560
~~8'x 35'~~	8'x 60'	480
~~8'x 110'~~	8'x 65'	520
	10'x 70'	700
	8'x 109'	872
	12'x 100'	1200
	8'x 150'	1200
	8'x 80'	640
		10,140
	AVE SF/STA	2028

$$HP = \frac{37{,}500 \times 2.5''}{6365 \times .70 \text{ eff}} = 21.04$$

Use 25 HP motor

$$\text{Cost/fan/yr} = \frac{25\ HP \times .745\ kw/HP \times \$.075/kwh \times 20\ hr/day \times 365\ days}{.90 \text{ eff}}$$

$$= \$11{,}330 \text{ /fan/yr.}$$

4 fans/station & 6 stations

Annual Power Cost = $271,920

VEP #11
MEZZANINE CONFIG.

Value Engineering Proposal (VEP) No. 11

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM: STATION MEZZANINE CONFIGURATION

FUNCTION: Distributes Patrons

CONCEPT BEFORE VE	PROPOSED ALTERNATIVE CONCEPT
Mezzanines provided at major entrances only and in some stations where double end loading is planned, at locations where future entrances will be constructed. Mezzanines are isolated and do not have direct contact with ancillary spaces except in the case where end loading of the station is specified. For 6 Stations	In the proposed design, the mezzanines are generally continuous throughout the station except that substantial areas occurring directly over the platforms are omitted recreating the "open design" feature expressed in the present design. Advantages: 1. Major structural advantage. 2. Flexibility for private connections 3. Connects all mezzanine areas Disadvantages: None For 6 Stations
ESTIMATED COST $2,567,000	ESTIMATED COST $2,010,000
	EST GROSS SAVINGS $ 557,000
	EST IMPLEMENTATION COST $ -0-
	EST NET INITIAL SAVINGS $ 557,000
	EST LIFE CYCLE SAVINGS $ 557,000

DESCRIPTION OF PRESENT DESIGN

For the purpose of this proposal, the mezzanine is considered to be that level of the station occurring between the street level and the platform. Each station has additional space provided at this level for ancillary functions. These areas are not considered to be a part of this VEP.

In the present design, three mezzanine configurations are used.

1. End loaded at Hollywood/Western

2. Center loaded at Vermont/Beverly, Vermont/Santa Monica and Hollywood/Vine.

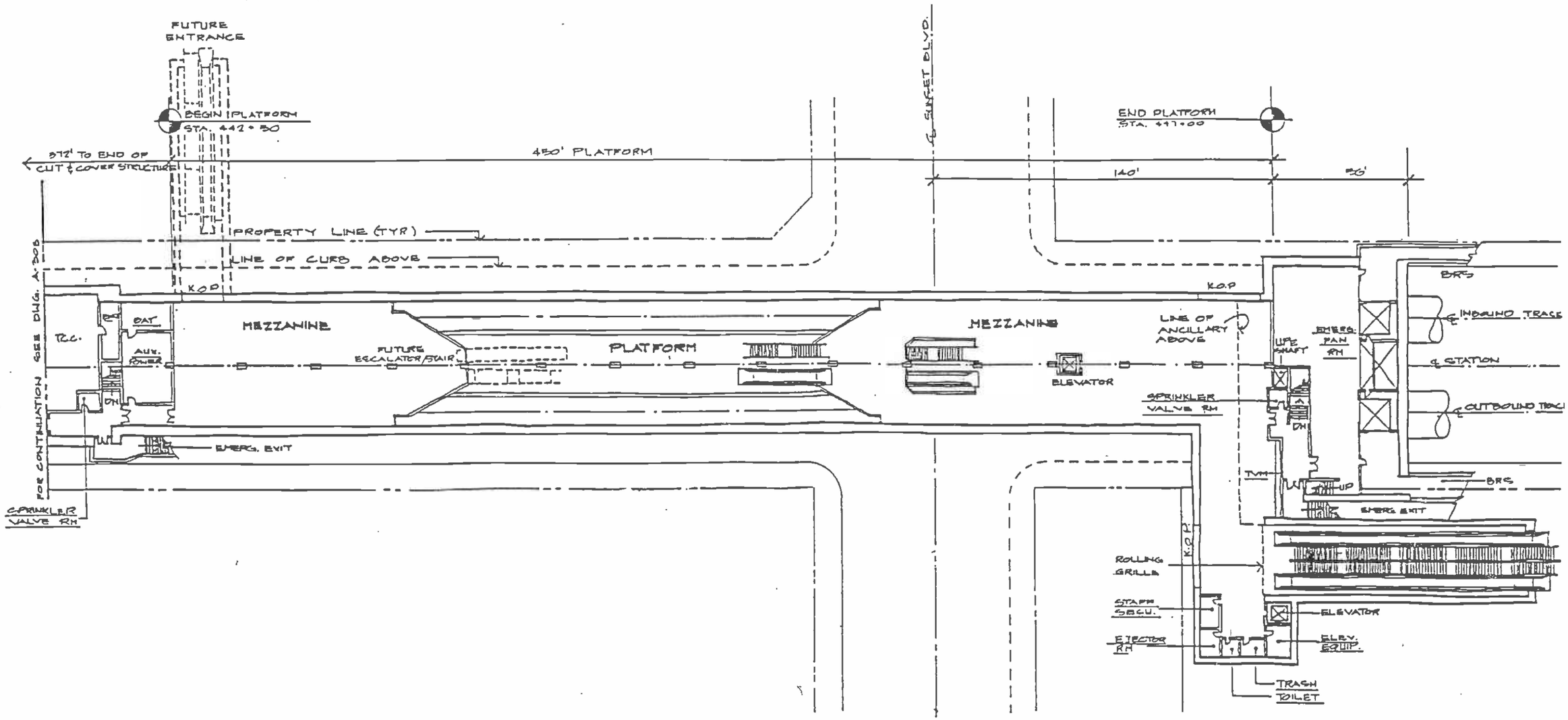
3. Double end loaded at Vermont/sunset and Hollywood/Highland

Generally, mezzanines are provided only at passenger distribution points, otherwise the station is open from platform level to roof.

Each station mezzanine is served by a single major entrance. Currently, the design of stations with double end loading mezzanines have one mezzanine which is not connected to the street. The assumption is that entrances constructed at a future date will utilize these mezzanines. Patron access to station can only be made at designated mezzanine. No intermediate access between mezzanine is possible from either sidewalk entrances or future "private" entrances.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



PRESENT DESIGN – DOUBLE END LOADED

STATION MEZZANINE CONFIGURATION

DESCRIPTION OF PROPOSED DESIGN

In the proposed design, the mezzanine is made generally continuous at mezzanine level except that throughout the station wherever possible, that portion of the mezzanine occurring directly over the platform is deleted, resulting in clear headroom from platform to roof but only directly over the platform. The mezzanine would extend over the trainways.

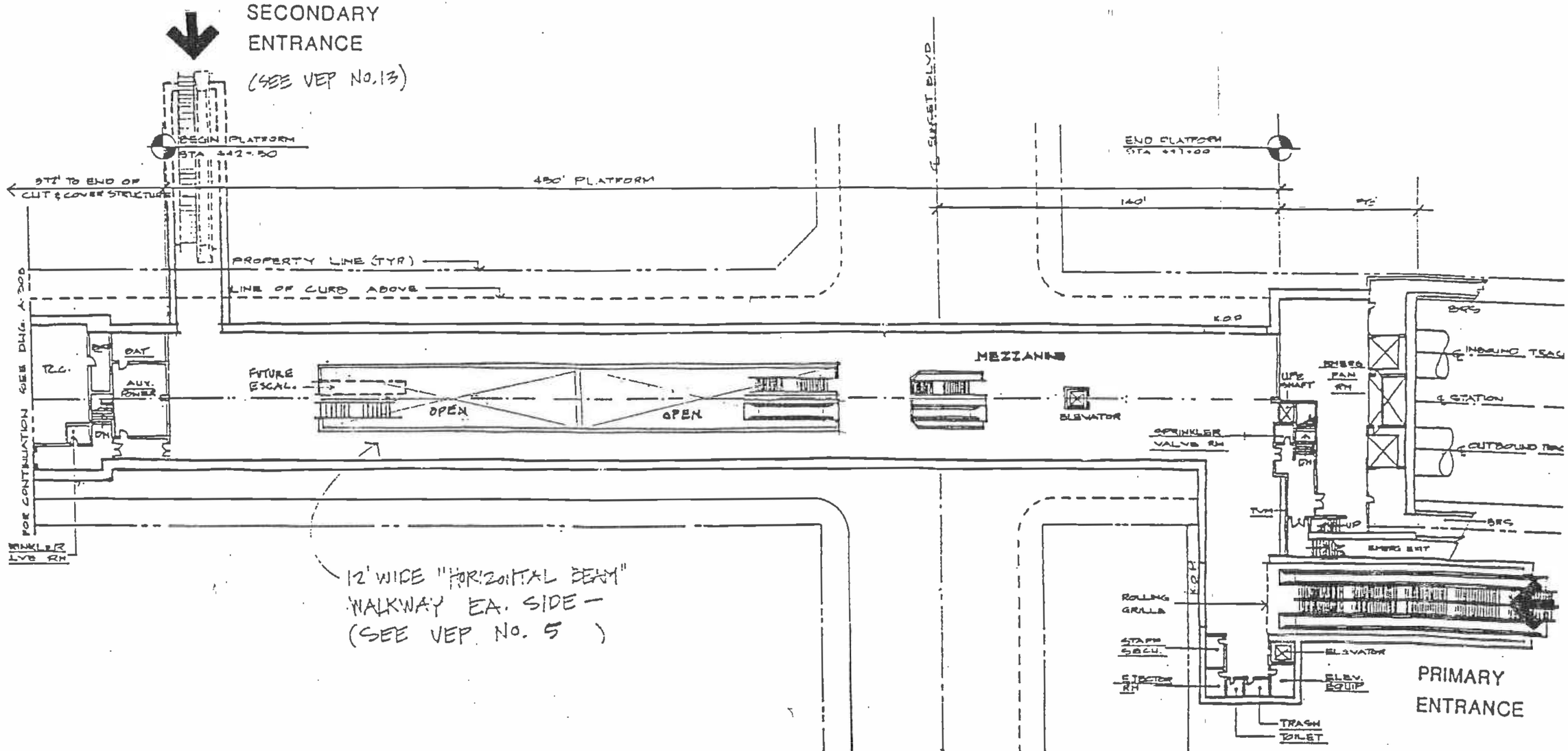
Mezzanine configurations for the six station are as follows:

Vermont/Beverly	-	Center Mezzanine
Vermont/Santa Monica	-	Center Mezzanine
Vermont/Sunset	-	Double End Loaded Mezzanine
Hollywood/Western	-	Single End Loaded Mezzanine
Hollywood/Vine	-	Center Mezzanine
Hollywood/Highland	-	Double End Loaded Mezzanine

The proposed design provides substantial structural advantage and continuous access to public mezzanine or free areas allowing flexibility for placement of secondary entrances and extensive private property connection to the station. Access ancillary space is provided from the main entrance and double end loaded station mezzanines are connected.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN



STATION MEZZANINE CONFIGURATION

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM Station Mezz and Concourse

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE
PAGE 4 OF

ITEM NO.	VEP # 12 DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	TOTAL	UNITS	NO. UNITS	UNIT COST	TOTAL
	Floor finish	-	-	-	-	SF	27152	15	407340.
	Wall finish					SF	32880	20	657600
	Ceiling finish					SF	27152	25	678900
	Cantilever Systems Supports				67000.				
	Structural Walls	~~C.Y~~	10.000	250*	2500000				
	Mezz Slabs.					C.Y	1333	250	333000.
		Mat			2567.000				2.009840

Reference:
+ includes rebar + labor.

VEP #12
ENTRANCES (Addl.)

Value Engineering Proposal (VEP) No. 12

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM	FUNCTION
STATION ENTRANCES	Access Station

CONCEPT BEFORE VE

A single entrance is provided for each station from an off-street land parcel to be acquired by the District. The entrances typically extend via a 40-foot long walkway appendage from the station mezzanine to a bank of two (2) escalators and a 12-foot wide stairway that surfaces off-street.

PROPOSED ALTERNATIVE CONCEPT

Reduce size of main entrance and compact configuration to minimize intrusion into parcel take. Add a secondary entrance in lieu of emergency exit appendage on the opposite side of the street within sidewalk area as much as practicable. Opportunities do exist for off-street placement of these secondary entrances within vacant portions of lot frontages in the station vicinities.

Trade-offs in construction cost and permanent right-of-way cost not quantified but anticipated to result in comparable costs. Substantial improvement in cost benefit anticipated.

Advantages:
1. Improved patron access.
2. Enhanced station environment.
3. Improved potential for optimal right-of-way development.
   3.1 Better joint development potential of primary entrance parcel.
   3.2 Better potential for relinquishment of right-of-way remnants.
4. More effective use of transit funds.

Disadvantages:
1. Possible additional right-of-way acquisitions.
2. Possible sidewalk encroachments.

ESTIMATED COST	ESTIMATED COST	$_____
	EST GROSS SAVINGS	$ Not Quantified
	EST IMPLEMENTATION COST	$_____
	EST NET INITIAL SAVINGS	$_____
	EST LIFE CYCLE SAVINGS	$_____

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

DESCRIPTION OF PRESENT DESIGN

The present design provides each station with a single major entrance typically consisting of two (2) escalators, one (1) 12-foot wide stair and one (1) elevator. These entrances are located off-street within a land parcel acquired from private landowners. The general configuration of these entrances is L-shaped except at Vermont/Beverly Station where the entrances orient directly into the station mezzanine. The station mezzanine is generally extended 40 feet to the edge of nearest escalator and a total distance of 75 feet to the edge of farthest escalator, for a total structure extension of 42 feet width by 75 feet length. This space between the entrance and the mezzanine is used to accommodate staff security rooms, staff toilets, custodial and trash rooms, and miscellaneous equipment rooms. A narrow strip of this space accommodates ticket vending machines, maps and telephones.

In addition, an emergency exit appendage is provided (often in combination with platform exit stairs) to the sidewalk, ending in a sidewalk hatch. The Vermont/Santa Monica and Hollywood/Western stations include a platform level structure adjacent to the main entrance to house Traction Power Sub Station (TPSS) functions. The Hollywood/Highland station includes Department of Water & Power (DWP), TPSS, miscellaneous equipment rooms, exhaust shafts within the parcel acquired in conjunction with the entrance. All six stations have been provided with knock-out panels to permit future addition of a second entrance by a private developer.

Each entrance is configured to permanently occupy an average space of 60 feet by 120 feet or 7,200 square feet (s.f.), excluding access spaces, within an adjacent land parcel to be acquired. Including patron circulation and access spaces, the entrances would entirely occupy each land parcel affected. Present design real estate property acquisitions are as follows:

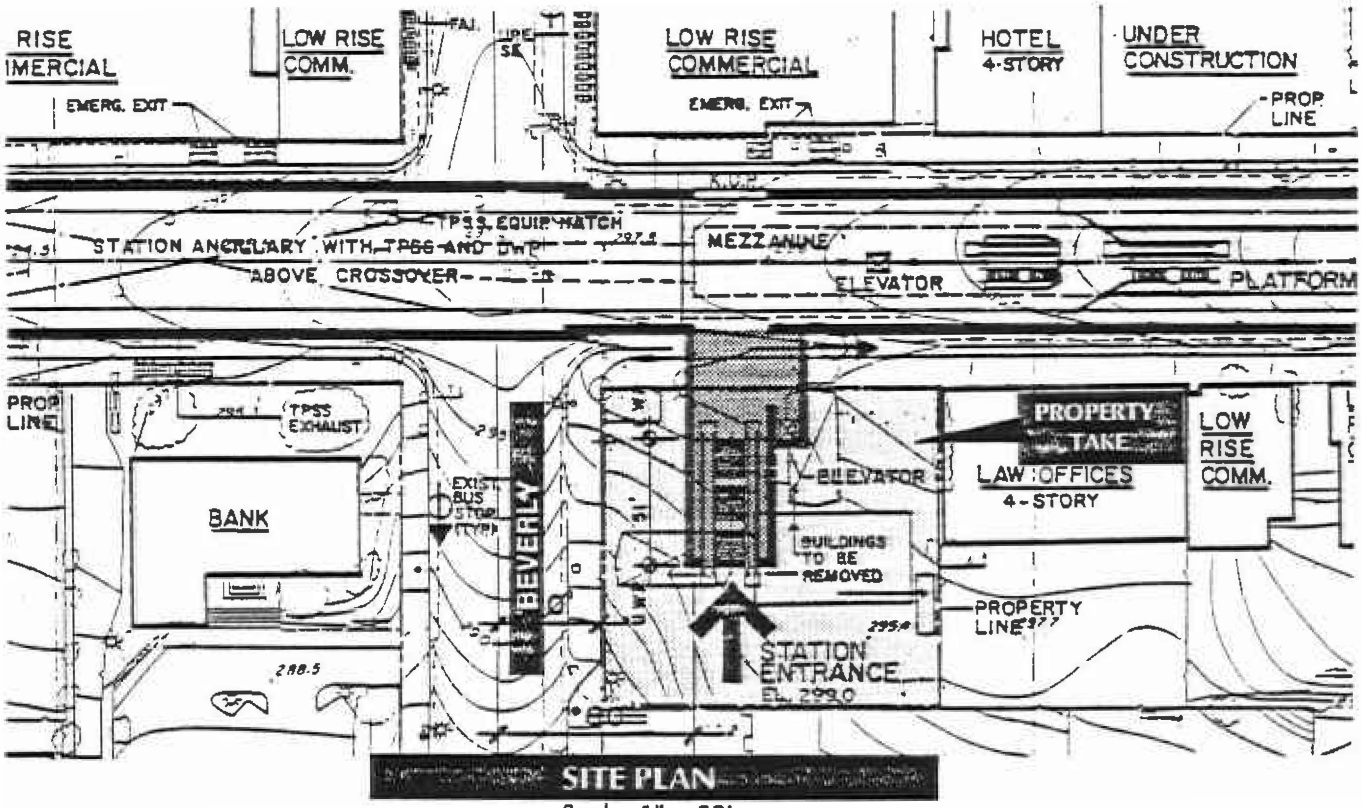
Station	Location	Area
Vermont/Beverly	Northeast Corner Intersection	16,900 s.f.
Vermont/Santa Monica	Midblock South of Intersection	21,960 s.f.
Vermont/Sunset	Midblock 210' South of Intersection	26,000 s.f.
Hollywood/Western	Southeast Corner of Intersection	37,800 s.f.
Hollywood/Vine*	Southwest Corner of Hollywood/Argyle One Block East of Intersection	87,400 s.f.
Hollywood/Highland	Portion Northeast Corner at Hollywood/Orchid, Midblock Location	59,300 s.f.

*Site to be developed as bus terminal in conjunction with station development.

STUDY TITLE

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



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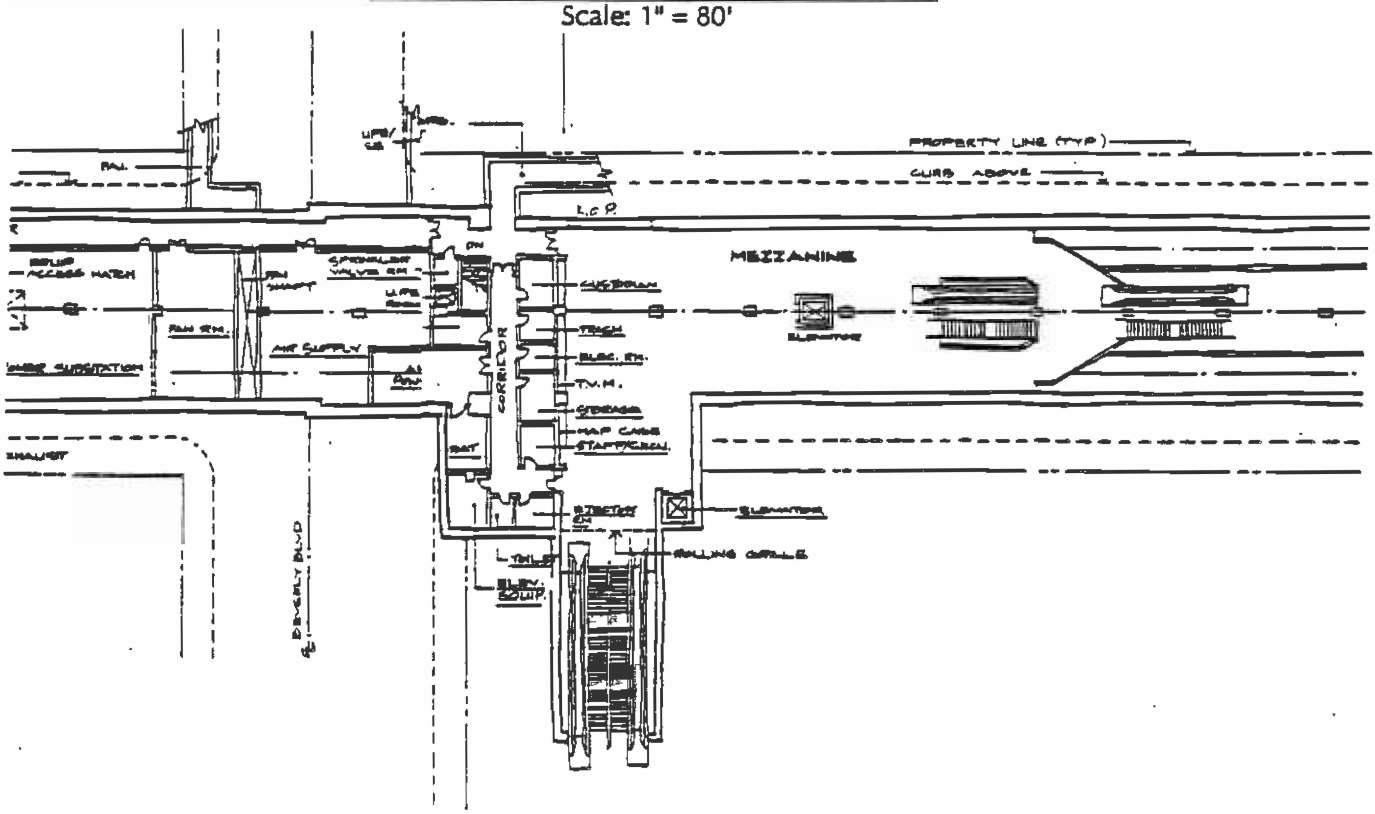


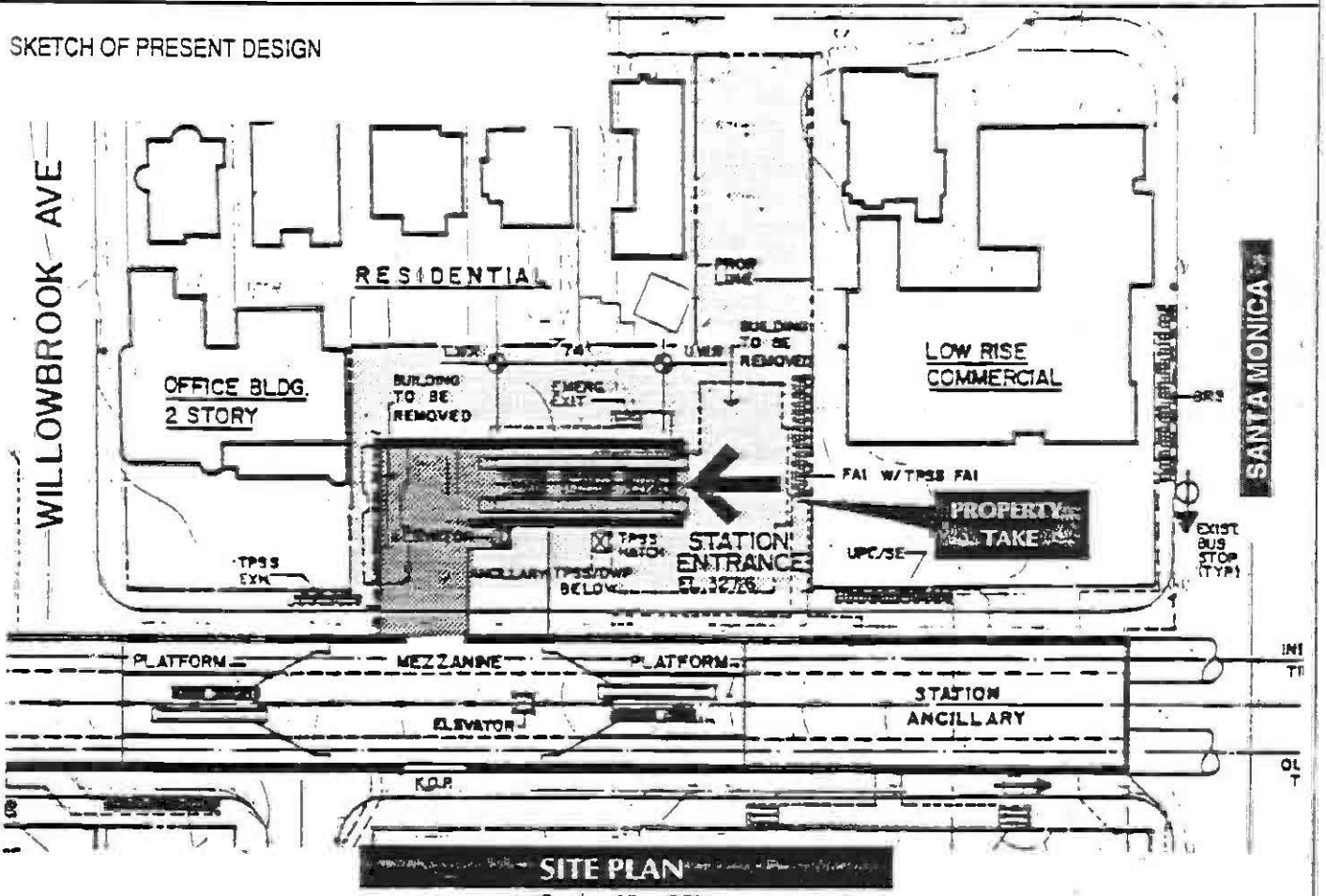
VERMONT / BEVERLY STATION

Not To Scale

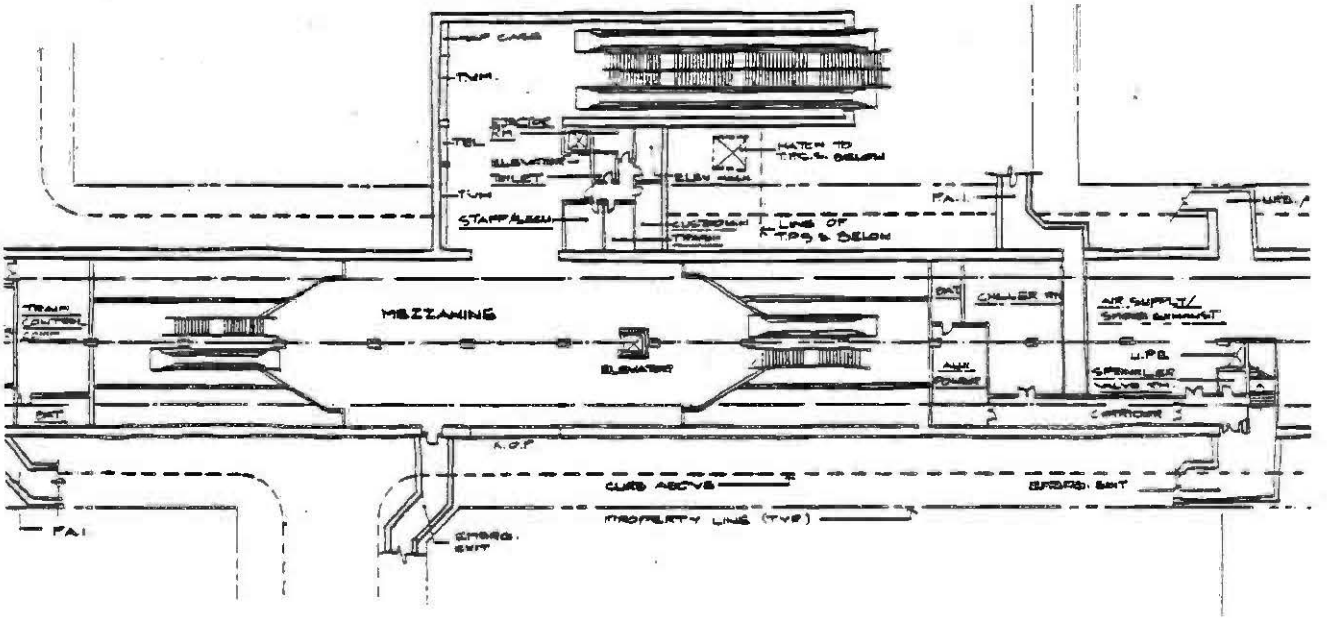
NORTH

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



SITE PLAN
Scale: 1" = 80'

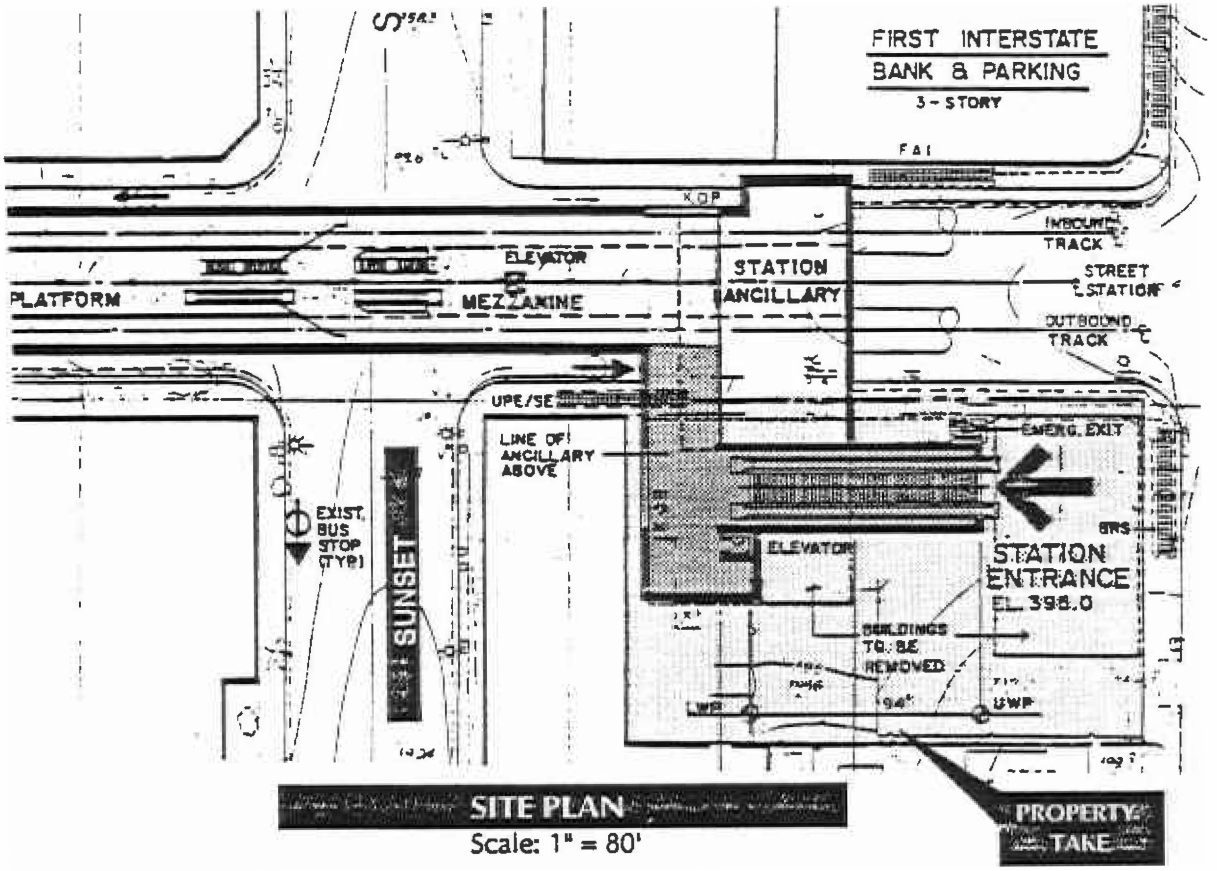


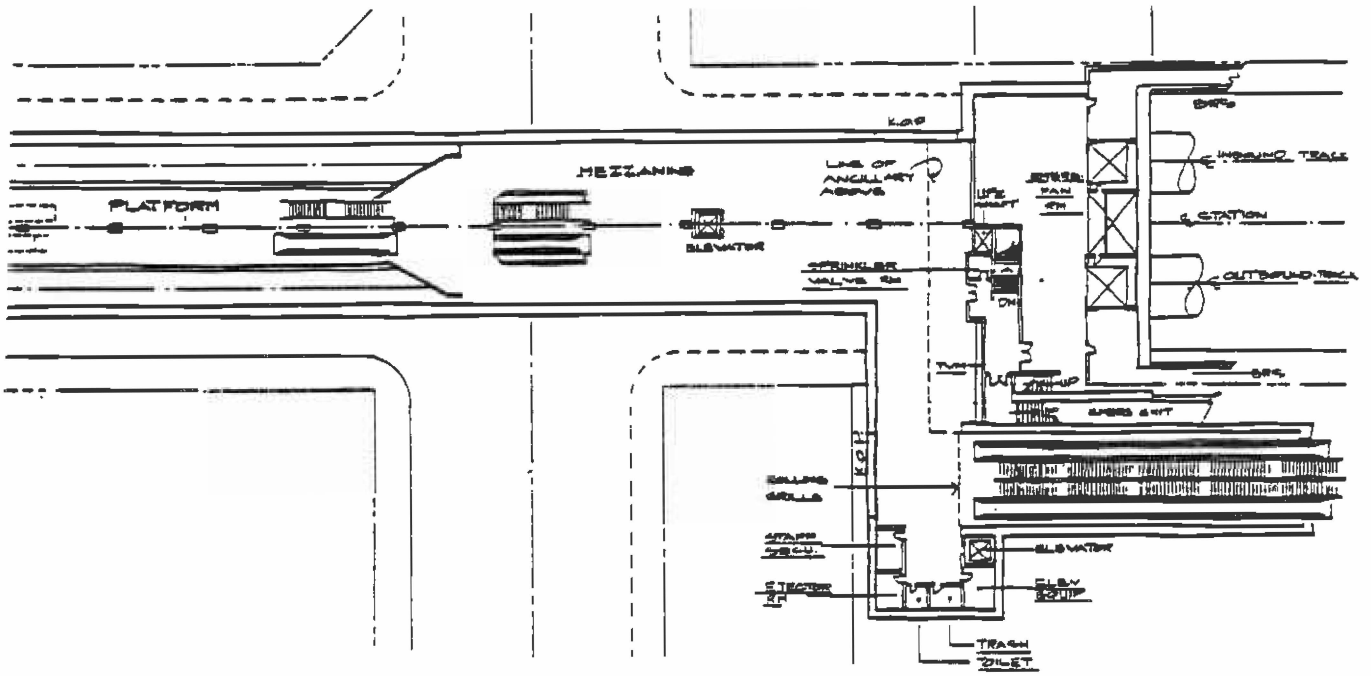
VERMONT / SANTA MONICA STATION
Not To Scale
NORTH

STUDY TITLE

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

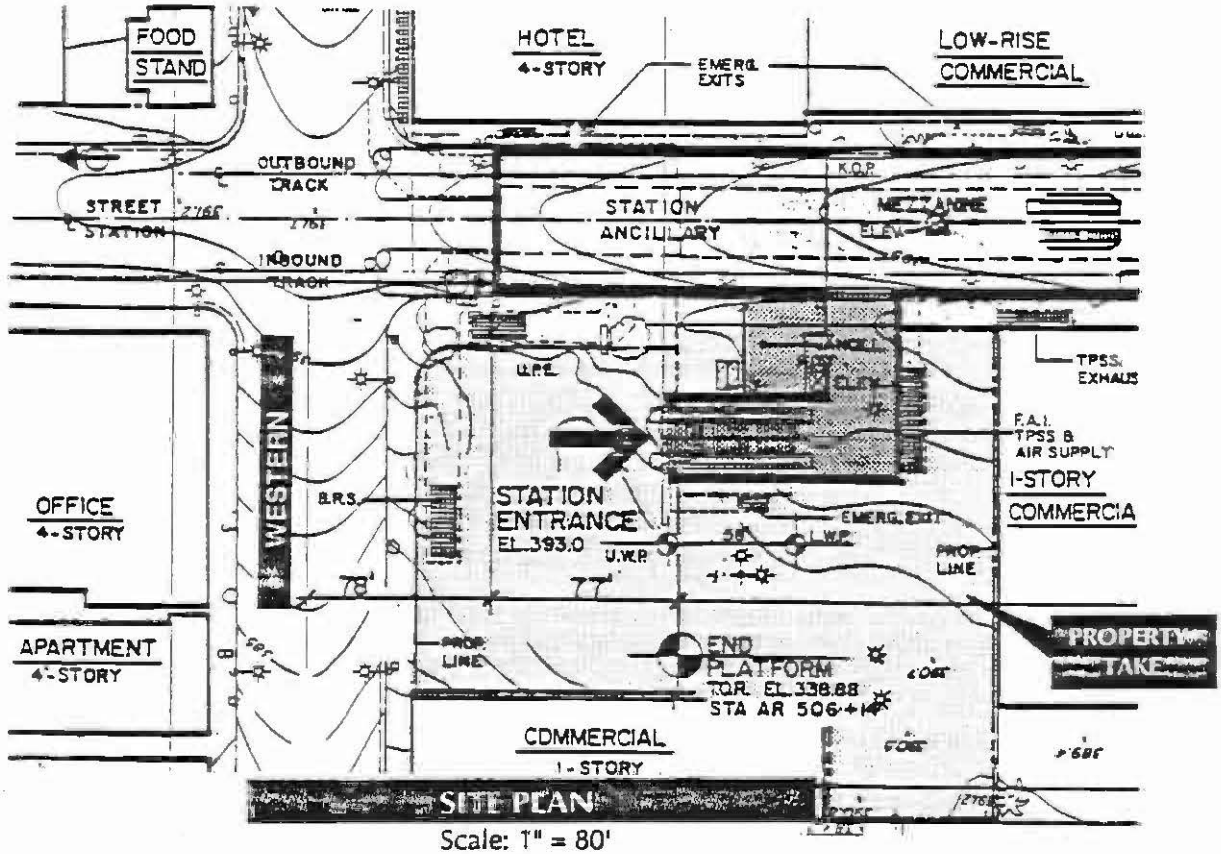
SKETCH OF PRESENT DESIGN





STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



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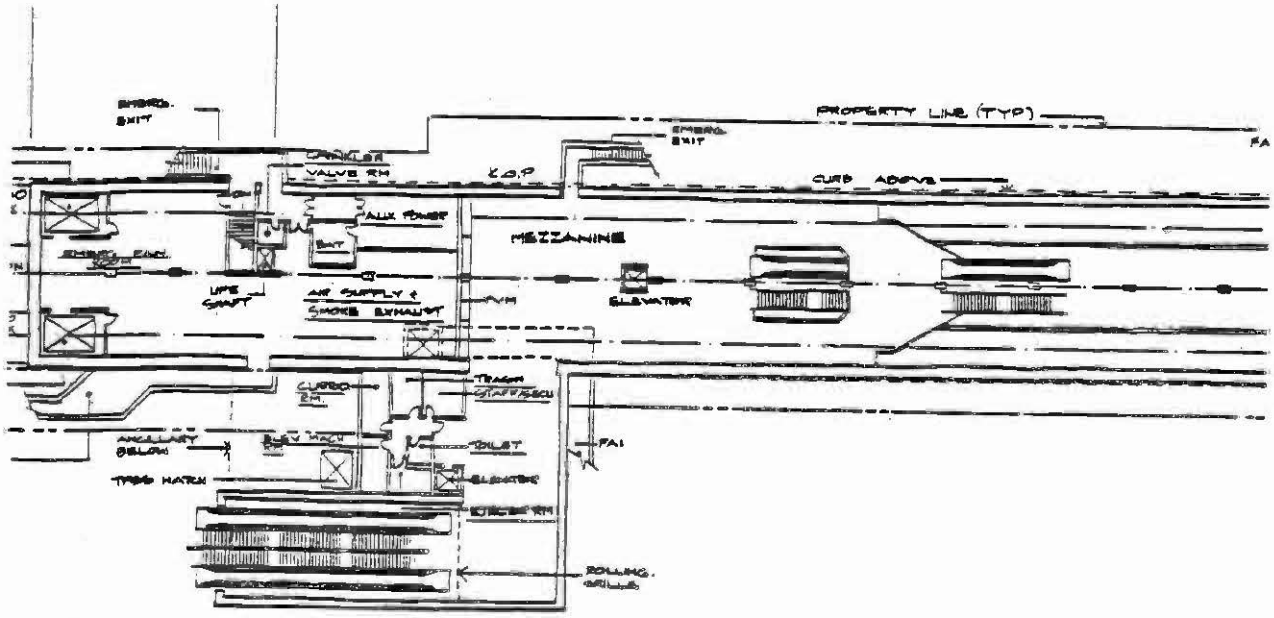


HOLLYWOOD / WESTERN STATION

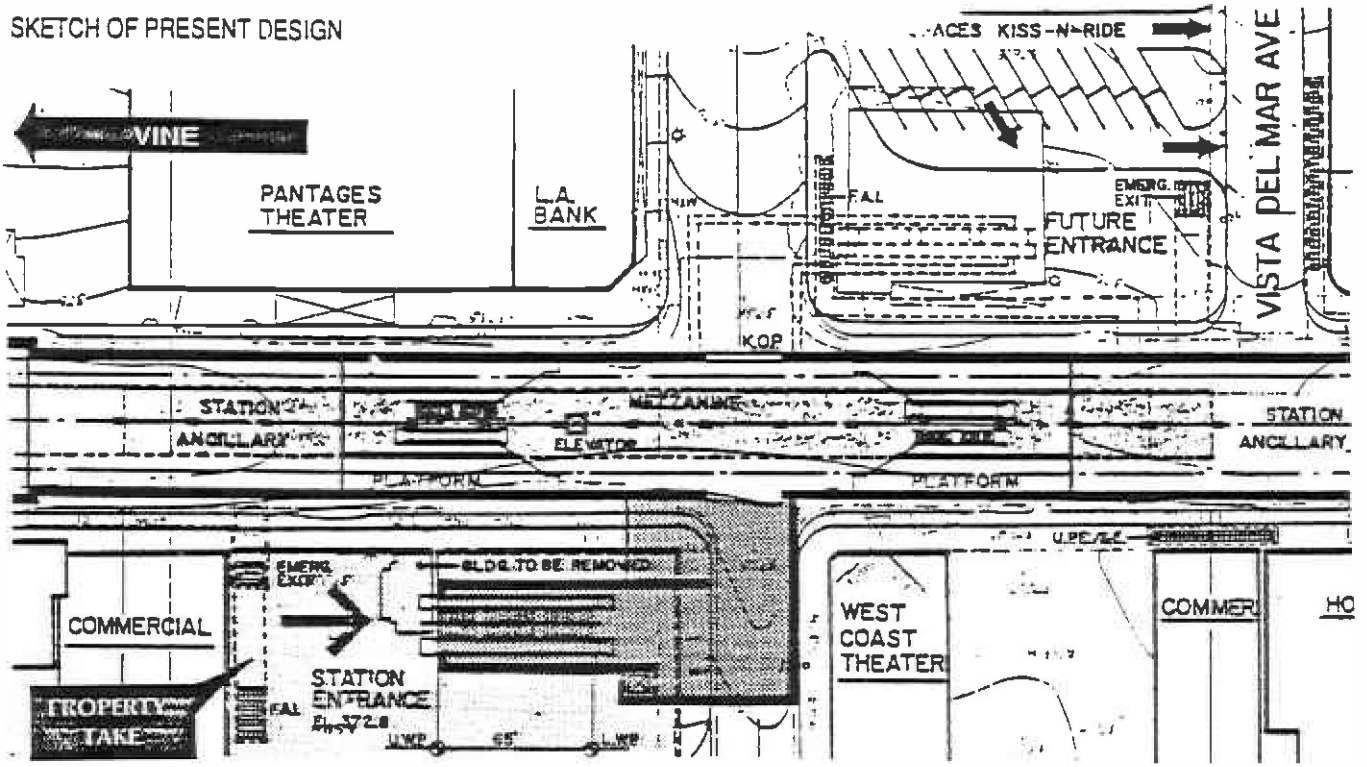
Not To Scale

NORTH

STUDY TITLE

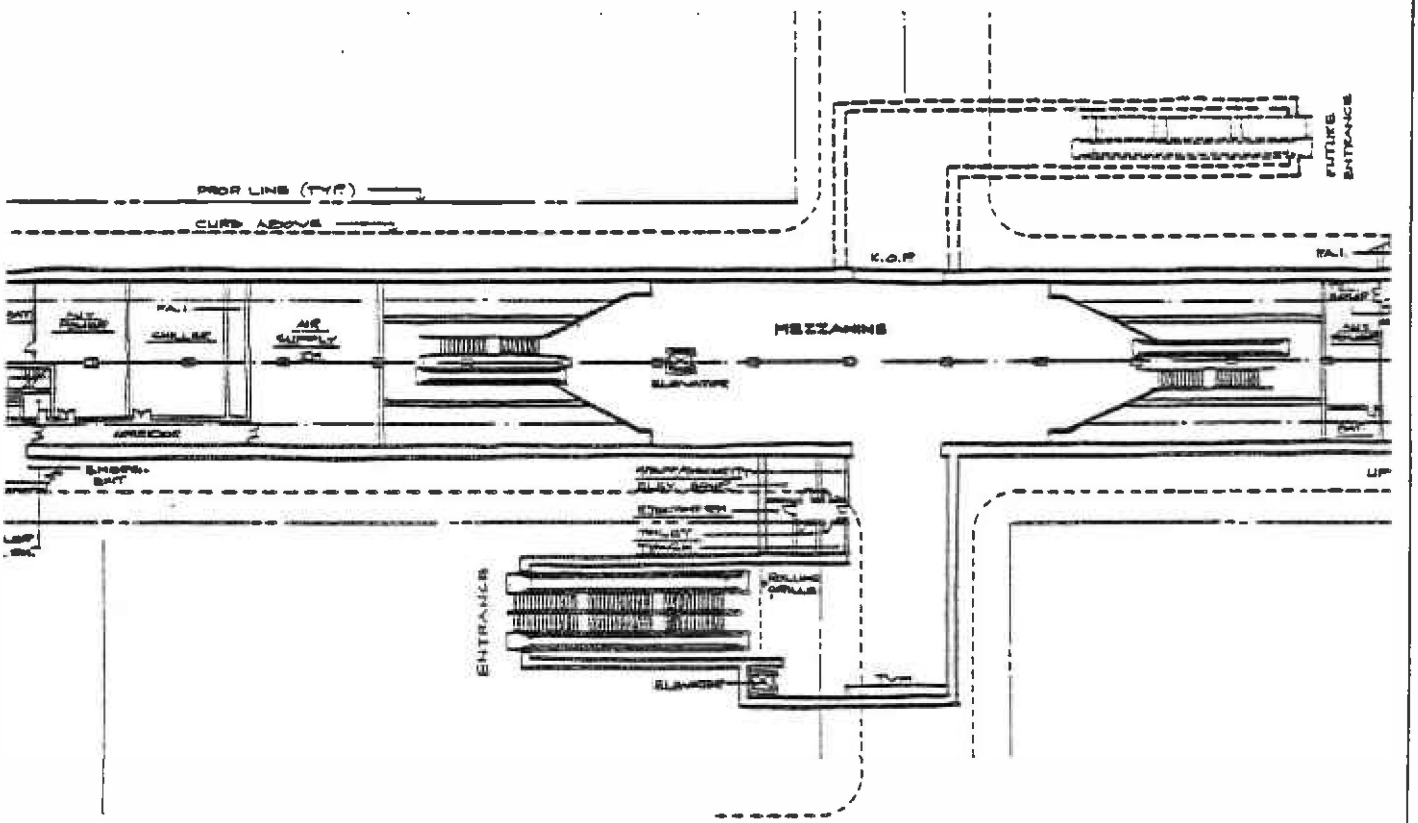
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



SITE PLAN

Scale: 1" = 80'



HOLLYWOOD / VINE STATION

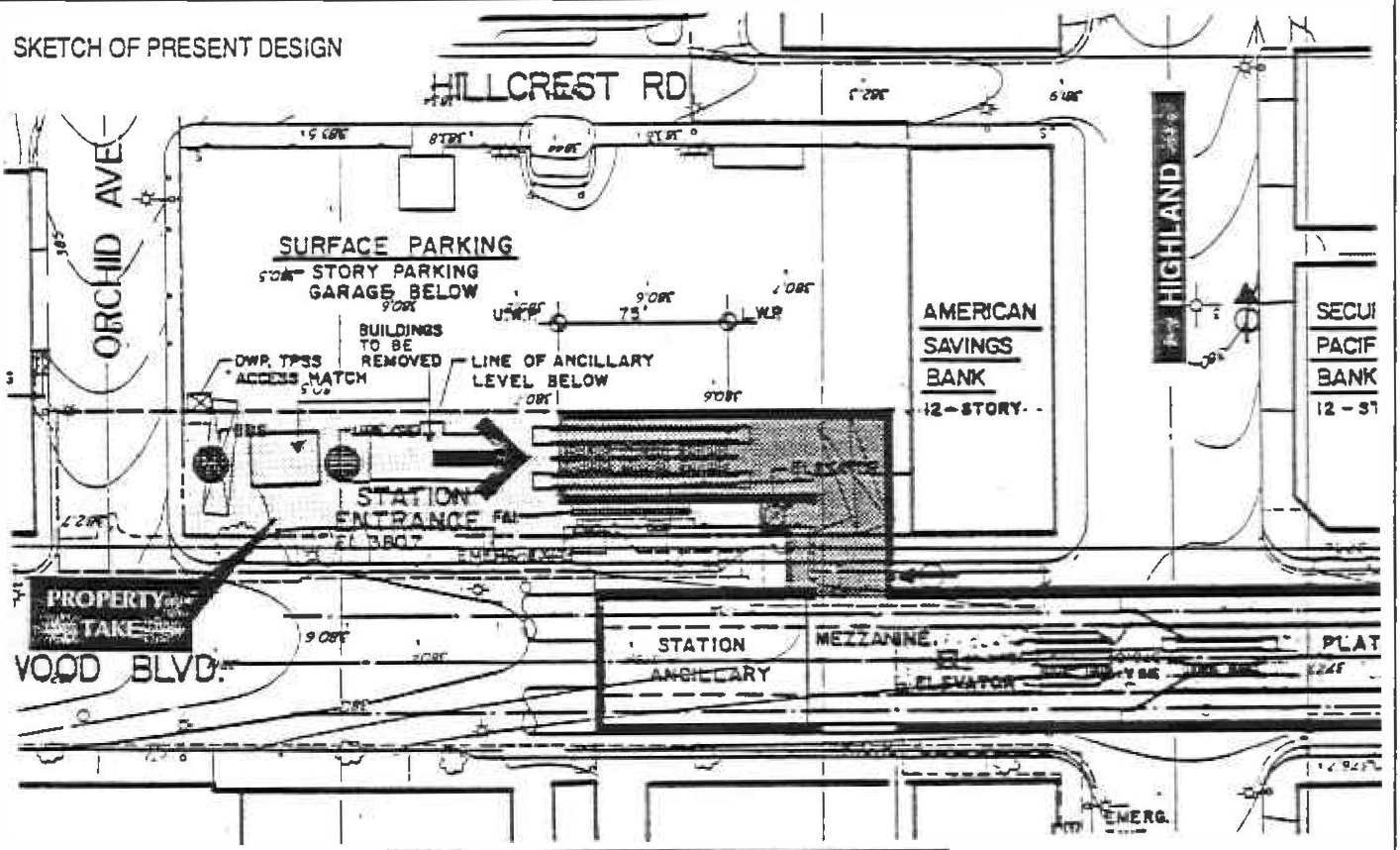
Not To Scale

NORTH

STUDY TITLE

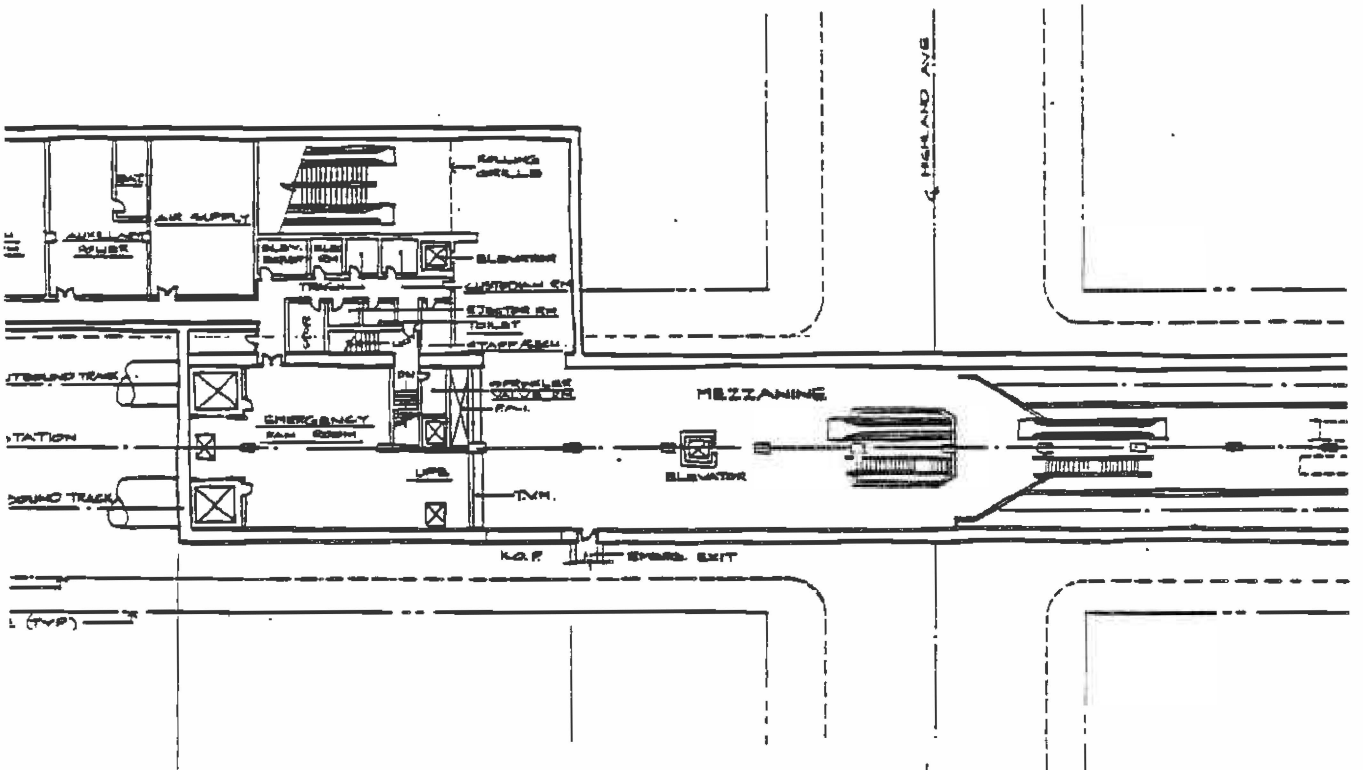
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



SITE PLAN

Scale: 1" = 80'



HOLLYWOOD / HIGHLAND STATION

Not To Scale

NORTH

DESCRIPTION OF PROPOSED DESIGN

The VE team considered that the present design stations require a large right-of-way and construction investment of approximately $25 million for the station alone. To be truly effective, the system should be designed to provide a level of service which provides maximum convenience to the patrons and the adjacent neighborhood, thereby providing an opportunity for maximized utilization and optimum cost-effectiveness. We note that other transit systems have concluded that this level of service is best accomplished by providing as many entrances as possible. For instance, urban stations in the BART system with similar patronage loads have no fewer than two entrances. The VE team notes that the provision of knock-outs for future entrance addition by private development is a risky concept that may not occur at all. In the meantime, the station level of service is not considered to be optimum.

The VE team then examined the real estate implications of the station configuration and note that the entrances appear to physically occupy less than one-quarter of the property being taken but the entrance configurations are such that each entire parcel is utilized. Specifically, the entrances intrude deeply into the affected properties. These configurations severely limit the joint development potential and excess property and remnant disposal potential of the parcels being taken.

Therefore, the VE team proposes that reducing the size of the main entrance and adding a secondary entrance on the opposite side of each street will achieve the same function and will provide more value at a comparable cost. These secondary entrances would be provided in lieu of the present design emergency exit appendages. The VE team notes that for those stations with a lower level TPSS/DWP structure below the entrance, these spaces could be reconfigured to fit within the reduced entrance envelope. The station entrances would be fitted to utilize maximum public right-of-way and minimum permanent right-of-way takes. The objective of the station entrance final design should be to provide maximum patron attraction, optimized joint development opportunity and optimized remnant parcel disposition.

ADVANTAGES:

1. Improved Patron Access

1.1 Serves the neighborhood more effectively by tapping both sides of the street.

1.2 Reduces conflict between patrons and vehicular traffic by eliminating need to cross the street.

1.3 Provides a safer, more effective emergency exit than a passage/sidewalk hatch solution. There is concern that sidewalk hatches could lead to panic and serious injury in an emergency.

DESCRIPTION OF PROPOSED DESIGN

2. Enhanced Station Environment

2.1 Cross ventilation is provided for the mezzanine, reducing the need for forced air exhaust.

2.2 Natural daylight is increased at mezzanine level, resulting in a more pleasant atmosphere.

3. Improved Potential for Optimal Right-of-Way Development

3.1 Better joint development potential of primary entrance parcel.

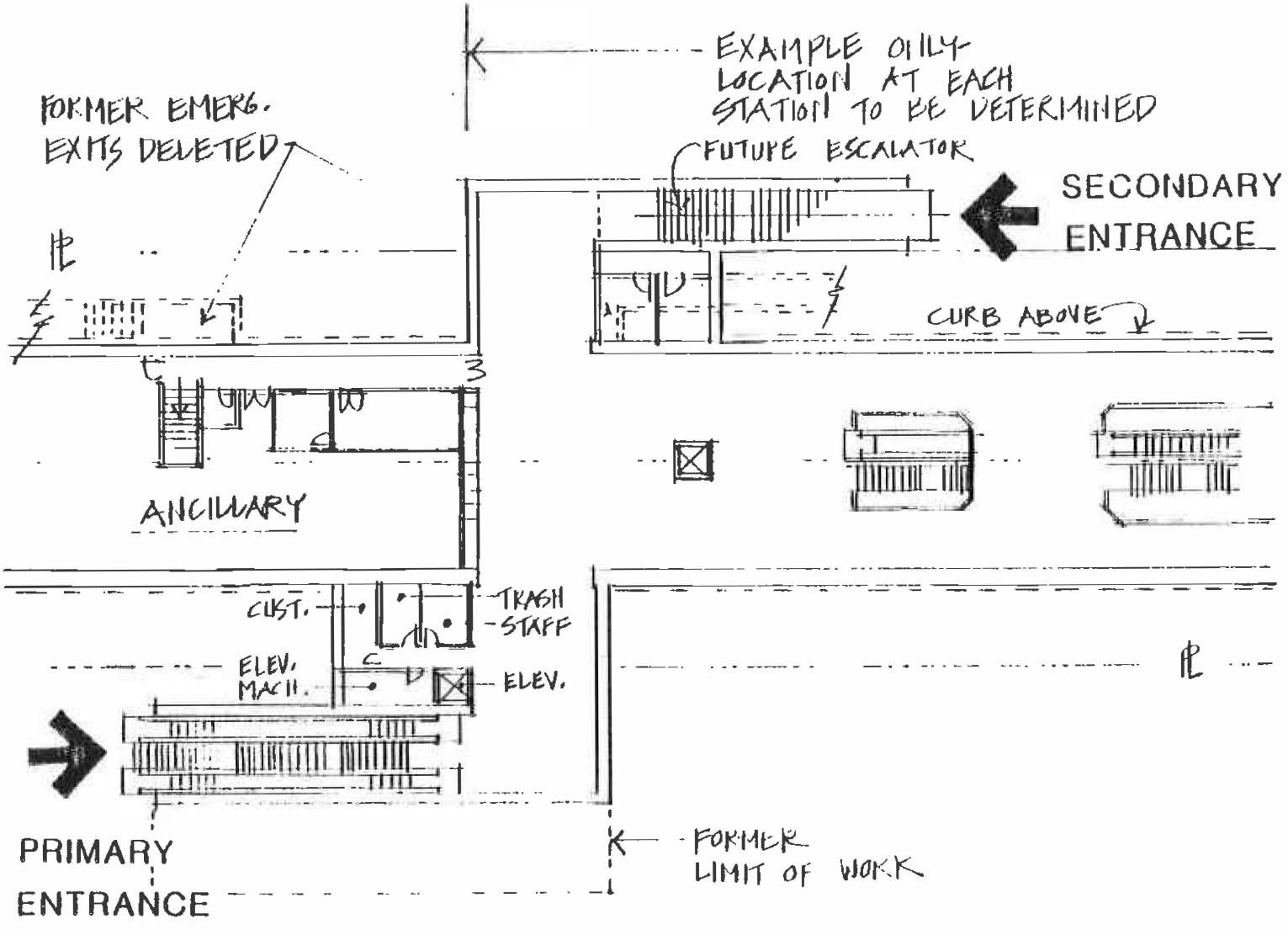
3.2 Better potential for relinquishment of Right of Way Remnants.

4. Utilizes dollars for usable structures which serve the patrons daily instead of "dormant" structure which come into use only in event of emergency: More effective use of limited transit funds.

DISADVANTAGES

1. Possible additional right-of-way acquisitions.

2. Possible sidewalk encroachments.



MEZZANINE LEVEL PLAN

SKETCH OF PROPOSED DESIGN

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

VEP #13
ENTRANCES (Open Plaza)

Value Engineering Proposal (VEP) No. 13

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM
STATION ENTRANCES

FUNCTION
Permits Access

CONCEPT BEFORE VE

The present design typically for each of the six stations under construction consists of a single major entrance consisting of a set of stairs and escalators and a passageway connecting to the station mezzanine. Ancillary space is provided in certain cases adjacent to the station entrance.

The entire structure is underground with a minimum opening at street level to provide clearance for patrons using escalators and stairs.

$301,200 per Station = $1,807,200 for 6

ESTIMATED COST $1,807,200

PROPOSED ALTERNATIVE CONCEPT

The proposed design maintains the general entrance layout, stairs and escalators but the proposal suggests constructing an entrance that is open to the atmosphere. Ancillary space is relocated to provide a plaza type entrance with appropriate landscaping and identity.

Advantages:

1. Reduces cost
2. More natural light
3. Better ventilation
4. Dramatic entrance

Disadvantages:

1. Less weather protection
2. Loss of street level space.

$130,000 per Station = $780,000 for 6

ESTIMATED COST	$ 780,000
EST GROSS SAVINGS	$ 1,027,000
EST IMPLEMENTATION COST	$ -0-
EST NET INITIAL SAVINGS	$ 1,027,000
EST LIFE CYCLE SAVINGS	$ 1,027,000

DESCRIPTION OF PRESENT DESIGN

In the present design, each station is provided with a single major entrance connected to the station by an entrance passageway. The passageway has a roof structure similar to the station with approximately 13 feet of earth backfill on top. Only the upper 23 feet of the stairs/escalator are open to the street above.

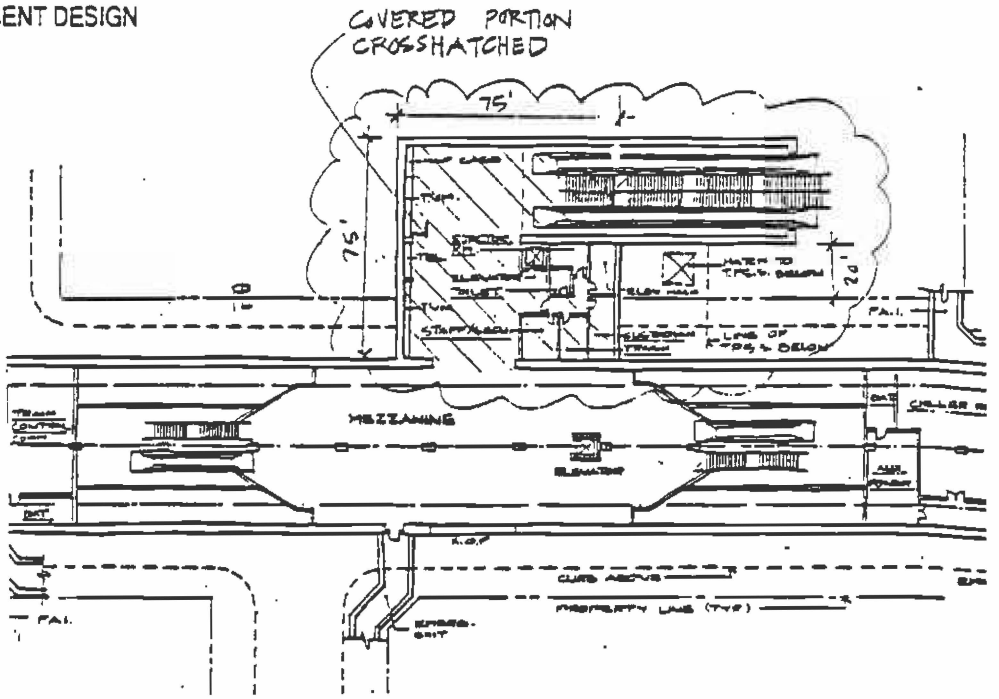
The stairs/escalator are typically located 20 feet from the property line, resulting in a 40-foot-deep space between them and the station wall. This area is used to house ancillary spaces (staff, custodian, trash, elevator, ejector rooms).

The passageway is approximately 75 feet wide at Vermont/Santa Monica (used here as an example). The public portion is approximately 35 feet wide, and the opening through the station and the opening through the station wall is less than 30 feet wide. At Vermont/Santa Monica a TPSS space is built below the entrance, a portion of which is backfilled at mezzanine level.

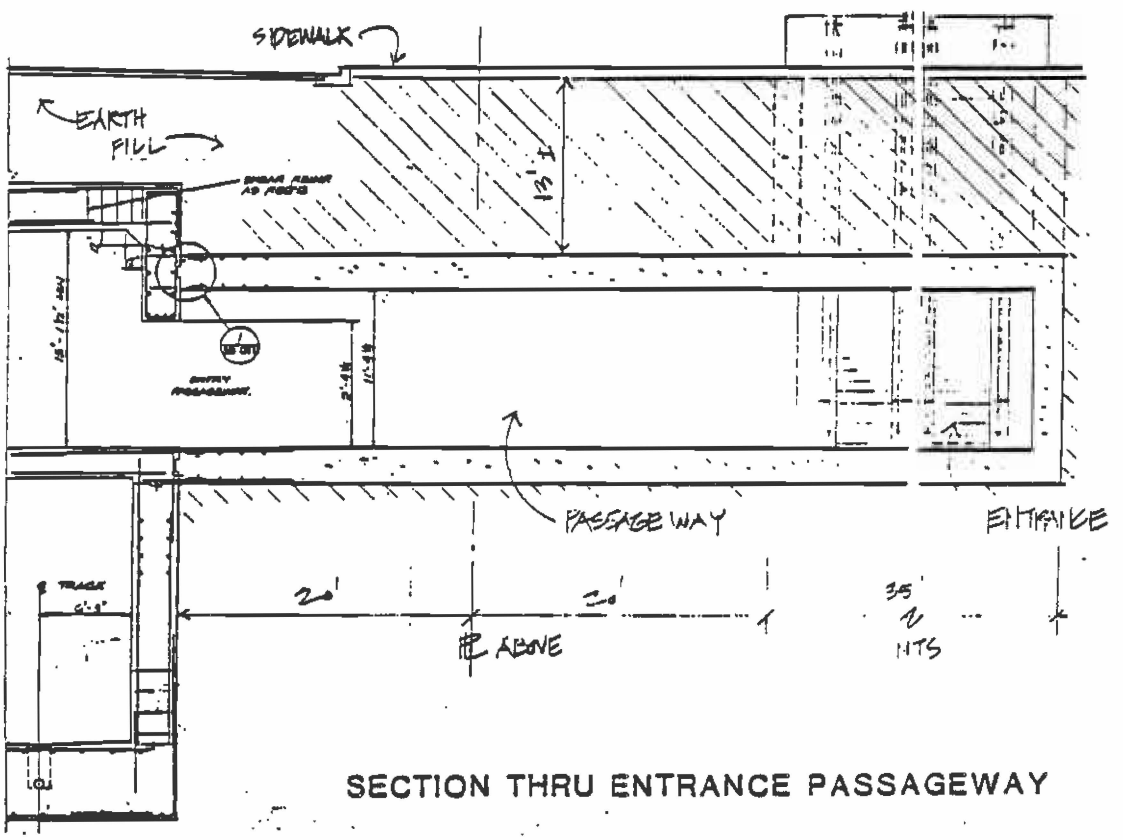
STUDY TITLE

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



PRESENT ENTRANCE PLAN (Vermont/Santa Monica)



SECTION THRU ENTRANCE PASSAGEWAY

OPEN UP STATION ENTRANCES

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

DESCRIPTION OF PROPOSED DESIGN

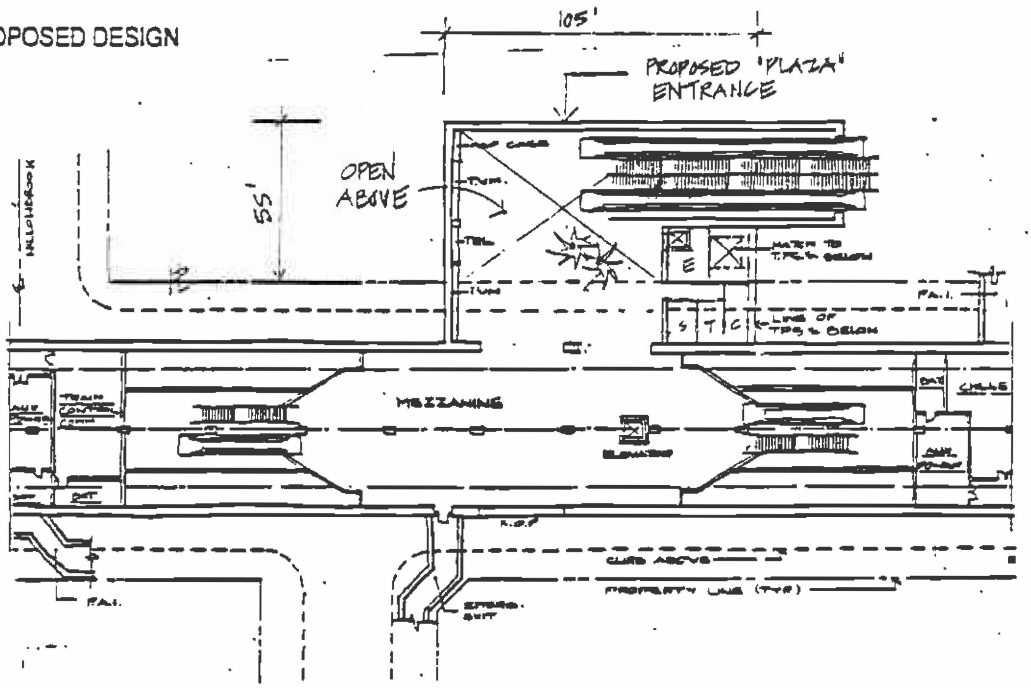
The proposed design removes the structural roof and earth backfill over the entrance passageway from the property line to the entrance wall. The ancillary spaces are shifted to open the entrance to the maximum extent possible (two 30-foot bays at Vermont/Santa Monica). The roof over the ancillary spaces could be at an intermediate level with planting on top, to permit a plaza opening at street level approximately 55 feet by 105 feet. Successful example of this approach are Hallidie and Oakland City Center plaza entrances on the BART system.

Apart from the structural and construction advantages that the deletion of the roof structures would create, the major benefit of such a proposal would be to bring more natural light to the entrance and to physically bring the open air into the station. The dramatic plaza type entrance that would result is compatible with the Southern California climate and would serve as a positive identification for any given station.

Future joint development potential is not affected. In fact, it may provide more attractive to potential developers to develop property within, over or adjacent to such a plaza.

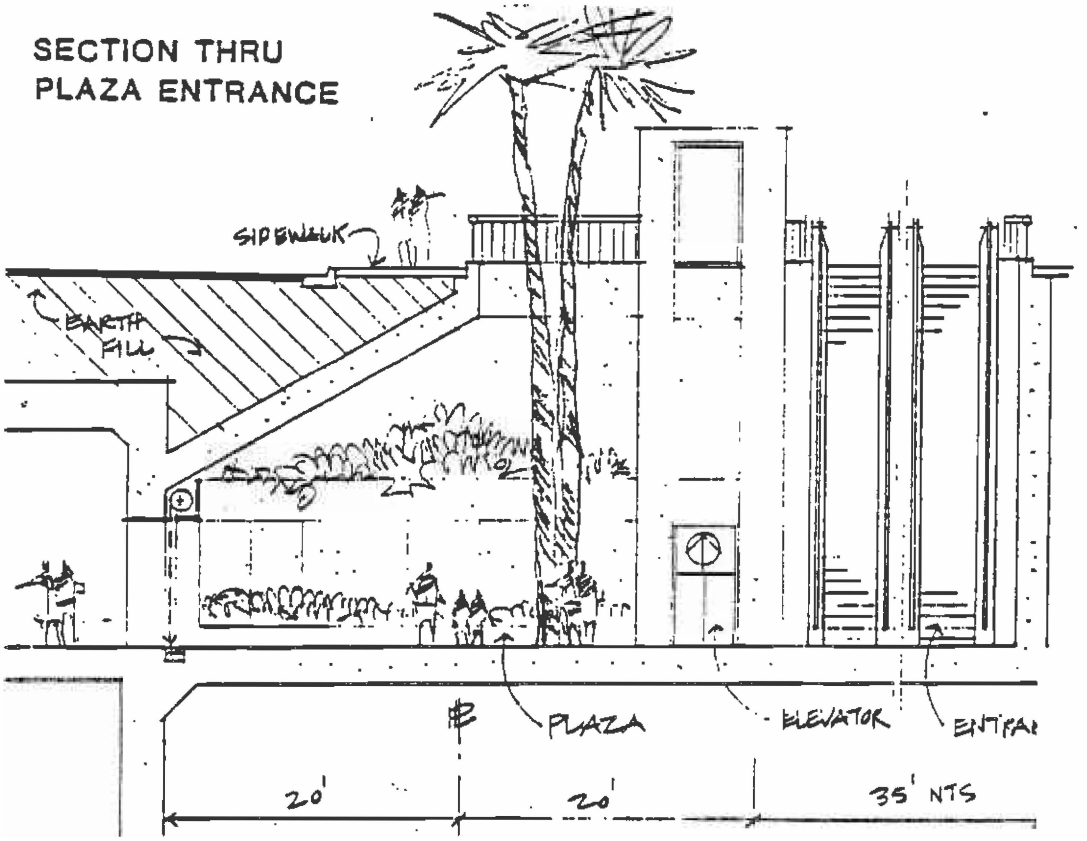
STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN



PROPOSED ENTRANCE (Vermont/Santa Monica)

SECTION THRU PLAZA ENTRANCE



OPEN UP STATION ENTRANCES

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM STATION ENTRANCES.

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE
PAGE ____ OF ____

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	TOTAL	UNITS	NO. UNITS	UNIT COST	TOTAL
	Cone Roof Structure	SF	4125	$40	165000				-0-
	Earth Backfill	CY	2000	$12	24000				-0-
	Waterproofing	SF	4125	2.20	9075				-0-
	Additional Retaining Walls	LS			-0-	LS.			50.000
	Arch. Finishes.	SF	4125	25	103125	JF	1200	25	30.000
	Landscaping	LS			-0-	LS			30.000
	Misc Weather protection	LS.			-0-	LS			20.000
				$	301200			$	130.000
						Diff.	=	$	171.200
								$	1.027.200
								for	Six Stations

Reference: _____

VEP #14
EMERGENCY EXITS

Value Engineering Proposal (VEP) No. 14

DATE 9/15/89

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II VALUE ENGINEERING STUDY #3 - STATIONS**

ITEM	FUNCTION
EMERGENCY EXITS	Permits Egress

CONCEPT BEFORE VE

In the present design, the emergency exit stairways are located beyond the end of the 450' platform. The stairs are connected to sidewalk level hatches* through various passageways and stairs.

PROPOSED ALTERNATIVE CONCEPT

For the proposed design, the exiting concept is not changed.* However, the stairs are relocated so that they occur within the 450' platforms

*The VE team felt that the concept of exiting through shafts connected to sidewalk hatches had many disadvantages and should be re-evaluated.

Advantages:

1. Less cut-and-cover construction.

2. Less cost.

Disadvantages:

None

ESTIMATED COST	$3,509,000	ESTIMATED COST	$ -0-
		EST GROSS SAVINGS	$ 3,509,000
		EST IMPLEMENTATION COST	$
		EST NET INITIAL SAVINGS	$ 3,509,000
		EST LIFE CYCLE SAVINGS	$ 3,509,000

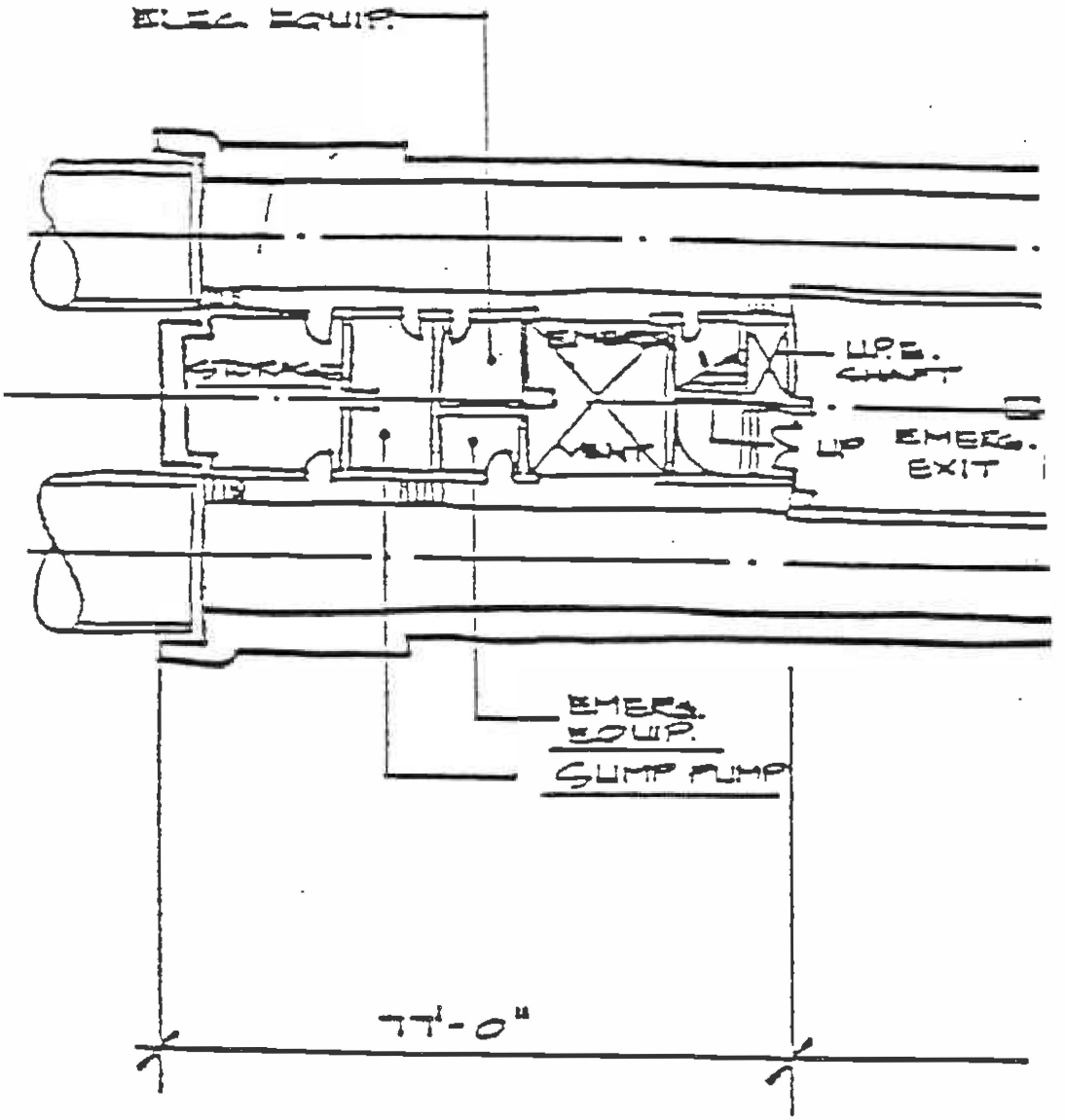
DESCRIPTION OF PRESENT DESIGN

Emergency exits are provided for ancillary spaces and at each end of the platform. Typically these exits are housed in appendage structures which surface at sidewalk level via hatches. Emergency exiting from the ends of the platform requires a 66-inch wide exit stair.

Platform exit stairs occur beyond the end of the 450 foot platform, and are flanked by custodian/electrical rooms and a UPE shaft. At end loaded and double end loaded mezzanine stations, however, the present single entrance design has been estimated to accommodate exiting from the mezzanine only. Consequently, platform exits have been provided with their own separate appendage emergency exit structures consisting of passageways and shafts terminating at sidewalk level exit hatches.

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



EMERGENCY EXITS

DESCRIPTION OF PROPOSED DESIGN

In the proposed design, the exit stairs are located within the limit of the 450' platform.

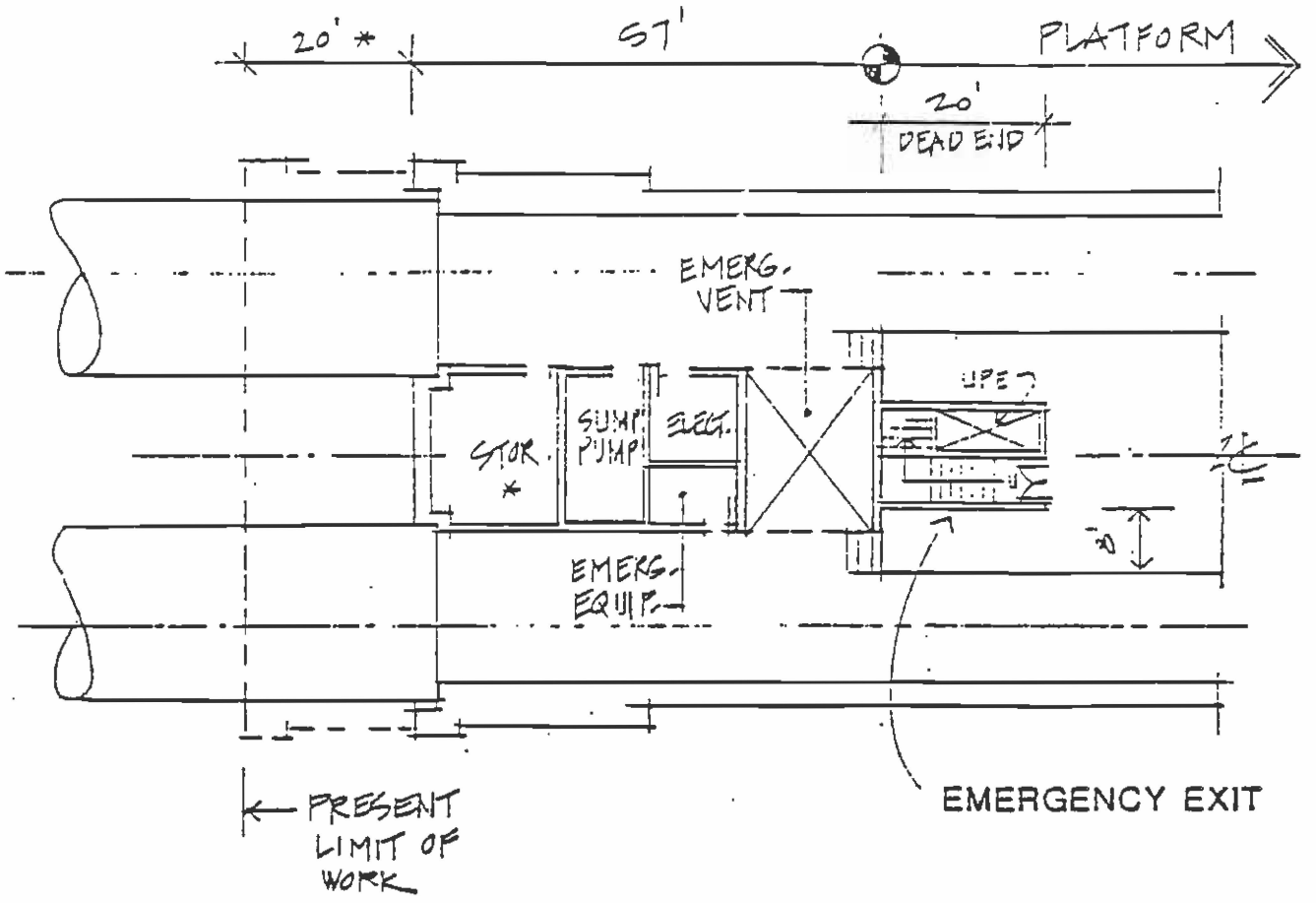
The platform has been sized to accommodate a stair and an escalator side-by-side, with adequate clearance on each side to the platform edge (8 feet). Consequently, the end exit stair could be moved into the platform envelope and still provide adequate patron access to vehicles. The space beneath the stairs could be utilized for custodian or storage function if separated by 1 hour-rated construction. The assumed limit of intrusion into the platform is 20 feet in accordance with UBC.

As a stand-alone proposal, the net effect of this concept would be to reduce the overall length of the cut-and-cover construction by some 20'-0" at each end of the structure for a total reduction of 40 linear feet.

Such an exit as described would be more visually apparent to users but would occupy the central portion of the platform at station ends.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN



* DIM. MAY BE LARGER IF ANCILLARY SPACES @ MEZZ. LEVEL ARE REDUCED MORE THAN 20'. SEE VEP NO. 6

PLATFORM LEVEL PLAN (opposite end similar)

EMERGENCY EXITS

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE
PAGE ____ OF ____

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	TOTAL	UNITS	NO. UNITS	UNIT COST	TOTAL
	Reduce c/c construction (Ancillary)	SF	240	323	77520				
	Increase cost of Tunnelly.	LF	40	4760	190400				
	NET			$ 584000	for Station.				
	OR			3.504.000	for Six Stations.				

Reference:

		ft^2	$Cost*
Vermont/Beverly	- Stations	12,360	5,364,240
	- Sidewalks	5,300	1,134,200
	- Crossover	27,440	5,872,160
		45,100	12,370,600
Vermont/Santa Monica	- Stations	21,880	9,495,920
	- Sidewalks	12,040	2,576,560
		30,920	12,072,480
Vermont/Sunset	- Stations	9,800	4,253,200
	- Sidewalks	9,000	1,926,000
	- Crossover	32,800	7,019,200
		51,600	13,198,400
Hollywood/Western	- Stations	21,568	9,360,512
	- Sidewalks	14,200	3,038,800
		29,988	12,399,312
Hollywood/Vine	- Stations	20,160	8,749,440
	- Sidewalks	7,400	1,583,600
	- Tailtrack	21,616	4,625,824
		49,176	14,958,864
Hollywood/Highland	- Stations	23,296	10,110,464
	- Sidewalks	6,440	1,378,166
		29,736	11,488,620
	TOTALS	236,520	76,488,240

Station cost 434/ft^2
Sidewalks and crossovers 214/ft^2 ft^2 $323/$ft^2$

ALLOCATION OF AUXILIARY SPACE

Emergency fans	4,320	
Station and UPE	2,230	Station 1,500
T/C and _____	950	
Battery	400	
Chiller	1,461	
TPSS & DWP	3,000	

12,361 x 2 = 24,800

Sidewalks $\frac{54,400}{237,000}$ = 23%

VEP #15
XOVER/STATION WIDTH

Value Engineering Proposal (VEP) No. 15

DATE 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM: ANCILLARY SPACE - PRESENT ALLOCATIONS
CROSSOVER STATION WIDTH

FUNCTION: Change Track

CONCEPT BEFORE VE

Space is created at the south end of Vermont/Beverly and Vermont/Sunset by cut-and-cover construction to pass vehicles from one track to another. Tracks are spaced 38.83' apart for ground stability in tunnels and for center platform station configurations. By virtue of this construction, a large amount of space at mezzanine level is available for ancillary functions

PROPOSED ALTERNATIVE CONCEPT

Space for changing track is narrowed in the crossover area by having 13' track centerlines, transitioning from the wider tunnel spacing. Vermont/Beverly and Vermont/Sunset are changed to side platform loading stations.

Ancillary space is reduced to be comparable to that at other stations.

Advantages:

1. Substantial construction savings
2. Reduces surface disruption
3. Reduces construction time

Disadvantages:

1. Patron inconvenience when changing directions for boarding

ESTIMATED COST	$121,297,000	ESTIMATED COST	$ 107,464,000
		EST GROSS SAVINGS	$ 13,833,000
		EST IMPLEMENTATION COST	$ -0-
		EST NET INITIAL SAVINGS	$ 13,833,000
		EST LIFE CYCLE SAVINGS	$ 13,833,000

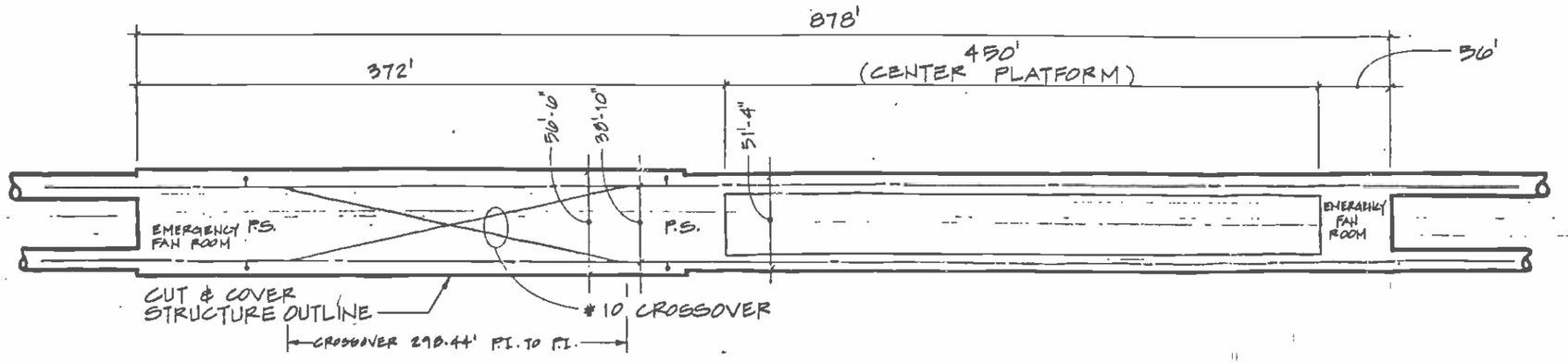
DESCRIPTION OF PRESENT DESIGN

The cut-and-cover structures at the south end of the Vermont/Beverly and Vermont/Sunset stations are designed at the trackway level to create a space to allow transit vehicles to pass from one track to the other in subway. Because of cut-and-cover construction about 370 feet long and because of track spacing of 38.83' CL for the main line tracks in the crossover area, a generally large space is also created at the mezzanine level (amounting to about 20,000 square feet per station) for ancillary functions. Some of the ancillary space at the mezzanine level, which at other stations would occupy the station box, has been absorbed int he crossover box amount. Ancillary functions within the crossover box at mezzanine level are: emergency fans, DWP, TPSS with fan room, FAI shaft, air supply and UPE, auxiliary power and battery rooms. The space allocations, having been created as a by-product of the crossover box, are quite generous.

The station configurations are both center platform, 28 feet wide, with a single end mezzanine area for Vermont/Beverly and a double end mezzanine for Vermont/Sunset station. The center platform is easier to use by patrons since there is no directional split going to separate platforms. The number of vertical circulation elements is reduced. The inside width of the station box is approximately 51 feet.

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



CROSSOVERS / STATION WIDTH

DESCRIPTION OF PROPOSED DESIGN

The crossover function at the south end of Vermont/Beverly and Vermont/Sunset stations is accommodated in the cut-and-cover structure reduced to about 31 feet in width (versus 53' wide in the present design). The length of the crossover box is about 380' slightly more than the length in the present design, but with an option to allow tunneling in the 100 foot reach connecting to the tunnels. The reduction in width is made possible by narrowing the tracks approaching the crossover area from 38.3' CL to 13' CL. The space available for ancillary functions is about 13,000 ft^2. This amount of space is more comparable to that provided at other stations.

The crossover function is the same as the present design and unneeded space is saved with less costly construction of a narrow box.

Because of the track narrowing to 13' CL, both stations become side platform stations, with Vermont/Beverly having a 10 foot wide platform (plus vertical circulation width on the midsections) and Vermont/Sunset having a 12 foot wide platform. A transition structure of about 120 feet to the wide track spacing is provided at the north end of each station, with the same tunneling alternative available for the last 100 feet. Mezzanine configurations are similar to the present design with vertical circulation elements corresponding to that provided for the center platform designs.

Although somewhat inconveniencing patrons when they have to change platforms, the advantages to the proposed design lie in its substantial savings in construction costs, reduced surface disruption and reduced construction time.

DESCRIPTION OF PROPOSED DESIGN (Continued)

Supplemental Notes - Tunnel Spacing

For several reasons, and especially when considering reduction in the lengths of cut-and-cover structures, it is desirable to consider the conditions in which tunnels can be allowed to approach each other closely.

It is generally considered that tunnels separated by two tunnel diameters do not interact with each other at all except in heavily squeezing or extremely weak soils. In compact granular soils, a separation of one tunnel diameter is sufficient. In soils of the type in which the L.A. Metro is being constructed, experience indicates that a separation of as little as five (5) feet can be achieved quite readily given careful construction. In fact, the Lower Market Street BART tunnels in San Francisco approached the offshore caisson in Bay mud with only a five-foot pillar between bores.

The potential for problems arises chiefly from the increased risk of loss of ground from the pillar between tunnels. This is especially the case when lenses or pockets of completely non-cohesive soil are present. The visible effects affecting the construction zone are surface settlement, distortion and lateral movement of the tunnel first constructed and control problems in driving the second shield. Since, in general, no significant construction problems should be encountered for tunnels separated by more than five feet, given adequate controls on the level of workmanship, there is little to be said about this condition. Surface settlement will generally be greater than for tunnels more widely separated in the same type of soil, but the amount of such settlement is governed more by the soil type and condition than by the level of workmanship in ground control. The amount of settlement should not be sufficient to give rise to problems, short of actual loss of ground, and this is always true whatever the tunnel separation.

As the tunnels close even further, the potential for development of unstable ground increases because the second tunnel is being driven in soil which has been disturbed by passage of the first tunnel and which has higher intergranular stress than before. In addition, the mechanical action of shoving the shield and excavating within it has a greater chance of peeling off the soil remaining in the pillar and thereby creating voids.

It becomes clear that the possibility of successful execution of the work would be increased if the soil in the pillar could be stabilized and even strengthened. It is therefore proposed that borehole investigations be carried out at the locations of all narrow pillars to determine what type of consolidation would be appropriate. This may be any of the following: (1) Injection of cement, silicate or other grout from the street surface or from the completed tunnel; (2) hydrofracting (cleavage) using high pressure cement grout: or (3) jet grouting in overlapping columns from the surface. Other methods may also be available.

The chances that the work will be completed successfully will be enhanced if the rate of closure of the tunnels is maximized so that pillar widths narrower than normal are limited in extent.

(Continued Overleaf)

DESCRIPTION OF PROPOSED DESIGN (Continued)

Supplemental Notes - Tunnel Spacing (Continued)

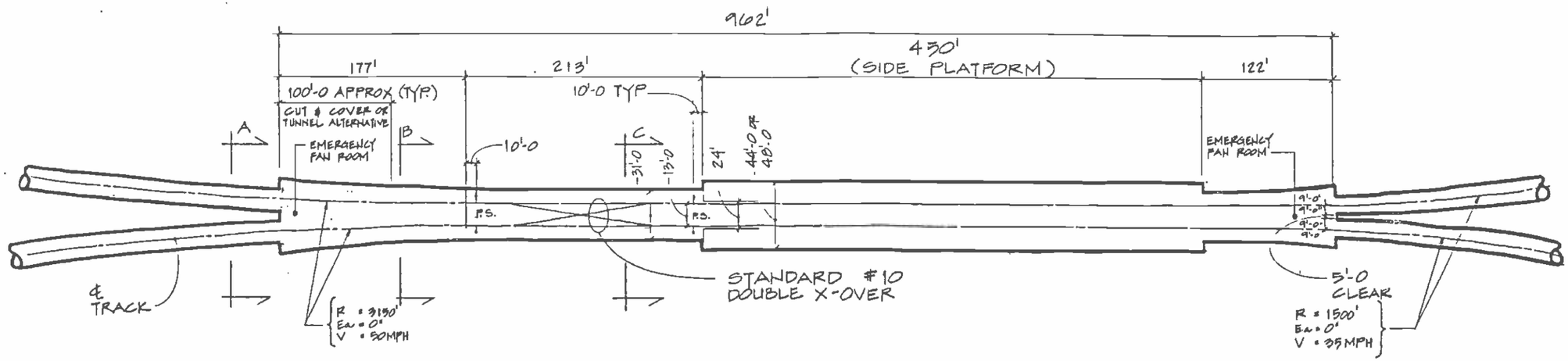
The tendency of the tunnel to distort and to move in the direcrtion of the second can be limited by installing vertical braces and horizontal ties (rod or cable with a turnbuckle) at the location of each vertical brace. This method has been totally successful elsewhere.

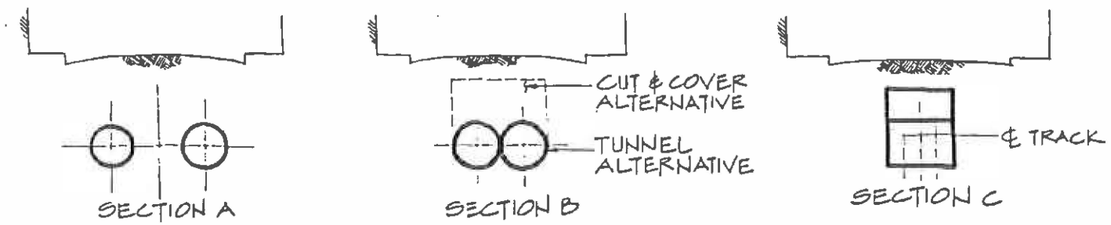
Given the approach discussed above, the second shield can be driven to the point where it touches the outside of the first tunnel, if this is required. As a practical matter, it is proposed that minimum tunnel separation be one (1) foot.

An alternative approach to specifying alignments resulting in pillar widths of less than five feet would be to allow the Contractor a free choice of tunnel or cut-and-cover construction in the affected reach, so as to ensure that the Contractor not be forced to strain his capability and that the actual lower cost alternative will be offered.

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN





CROSSOVERS / STATION WIDTH

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM Cross over/Station Width

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE 9/12/89
PAGE 1 OF 3

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	(1000's) TOTAL	UNITS	NO. UNITS	UNIT COST	(1000's) TOTAL
	SUMMARY								
	Vermont/Beverly - page 2	-	-	-	$56,793	-	-	-	$49,025
	Vermont/Sunset - page 3	-	-	-	64,504				58,439
	Total				$121,297				$107,464

Reference: _____

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM Cross overs/Station Width

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE 9/12/89
PAGE 2 OF 3

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	($1000's) TOTAL	UNITS	NO. UNITS	UNIT COST	($1000's) TOTAL
B241	Wilshire/Vt to Vt/Beverly Tunnel	RF	4080	$4,760	$19,421	RF	4018	$4,760	$19,126
	Station - Vermont/Beverly	LF	560	$48,570	27,199	SF	④ 19,800	① 946	18,731
	Station, mezzanine only	-	-	-	-	SF	⑤ 5,760	② 631	3,635
	Xover	LF	340	25,700	8,736	SF	⑥ 17,367	③ 303	5,262
	Facilities Subtotals		4980		$55,356				$46,754
B710	Escalators	Ea	4	236,000	944	Ea	6	236,000	1,416
B710	Elevators	Ea	2	131,000	262	Ea	3	131,000	393
B760	Signs & Graphics	Sta	1	231,200	231	Sta	2	231,200	462
	Page Totals				$56,793				$49,025

① □ft Price = ($48,570/LF) ÷ 51.33 FT WIDE = $946/SF.

② □ft Price = ($946/SF) x 2/3 DEPTH = $631/SF.

③ □ft Price = ($25,700/LF) ÷ 56.5 FT WIDE = $455/SF. x 2/3 = $303/SF.

④ 44 x 450 12x240 (TYP)

450'

⑥ 177 218 41 31 12,975 □f

122 31 41 4392 □f

Reference:

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM Cross overs/Station Width

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE 9/12/89
PAGE 3 OF 3

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	($1000's) TOTAL	UNITS	NO. UNITS	UNIT COST	($1000's) TOTAL
B261	Vt/Sunset to Hollywood/Western Tunnel	RF	5700	$4,760	$27,132	RF	5638	$4,760	$26,837
	Station - Vermont/Sunset	LF	560	$48,570	27,199	SF	④ 21,600	① 946	20,434
	Station, mezzanine only	-	-	-	-	SF	⑤ 5,760	② 631	3,635
	Xover	LF	340	25,700	8,736	SF	⑥ 17,367	③ 303	5,262
	Facilities Subtotals		6600		$63,067				$56,168
B710	Escalators	Ea	4	236,000	944	Ea	6	236,000	1,416
B710	Elevators	Ea	2	131,000	262	Ea	3	131,000	393
B760	Signs & Graphics	Sta	1	231,200	231	Sta	2	231,200	462
	Page Totals				$64,504				$58,439
	① □ft Price = ($48,570/LF) ÷ 51.33 FT WIDE = $946/SF.								
	② □ft Price = ($946/SF) x 2/3 DEPTH = $631/SF.								
	③ □ft Price = ($25,700/LF) ÷ 56.5 FT WIDE = $455/SF. x 2/3 = $303/SF.								
	④ 48×450, 12×100 (TYP), 12×140 (TYP) ⑤ 450' ⑥ 177 213 +1 31 12,975 □f; 122 31 +1 4392 □f								

Reference:

VEP #16
POCKET TRACK AT STA

Value Engineering Proposal (VEP) No. 16

DATE 9/15/89

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II VALUE ENGINEERING STUDY #3 - STATIONS**

ITEM
POCKET TRACK IN STATION

FUNCTION
Recover Failures
See text for others

CONCEPT BEFORE VE

West of Hollywood/Vine station, the present design provides one combination double crossover/bidirectional pocket track to permit transit operations to recover from equipment failures and other disruptions. This facility is housed in a long cut-and-cover structure approximately 57 feet wide. By virtue of this construction, 65,000 square feet of space is created above the trackway, of which 31,000 square feet is allocated to adjacent station ancillary functions.

PROPOSED ALTERNATIVE CONCEPT

This proposal eliminates the separate pocket track structure by relocating its functions to within the adjacent Hollywood/Vine station. A double crossover is provided at each end of the station to form pockets at the berthed train position. The station is changed from center platform to side platform to permit closer track spacing and thereby minimize cut-and-cover structure length. Width is also reduced.

The proposed concept creates 26,000 square feet of space above the trackway.

Advantages:

1. Substantially less surface disruption.
2. Enhances terminal operation.
3. Reduces construction time.

Disadvantages:

1. Requires infrequent single tracking over one station length.
2. Requires passengers be directed between platforms occasionally

ESTIMATED COST $79,862,000	ESTIMATED COST $62,901,00
	EST GROSS SAVINGS $16,961,000
	EST IMPLEMENTATION COST $-0-
	EST NET INITIAL SAVINGS $16,961,000
	EST LIFE CYCLE SAVINGS $16,961,000

DESCRIPTION OF PRESENT DESIGN

Function Description

The schematic track plan presently targeted for design proposed combination double crossover, bidirectional pocket track located west of Hollywood/Vine station. This facility used in conjunction with crossovers located at other stations will provide the following functions:

1. Failure recovery, i.e., restoring service after mainline incidents such as train breakdowns, single track operation or short turns to recover schedule.

2. Local/express operations, i.e., turnback of outbound local trains.

3. Maintenance vehicle staging.

Facilities Description

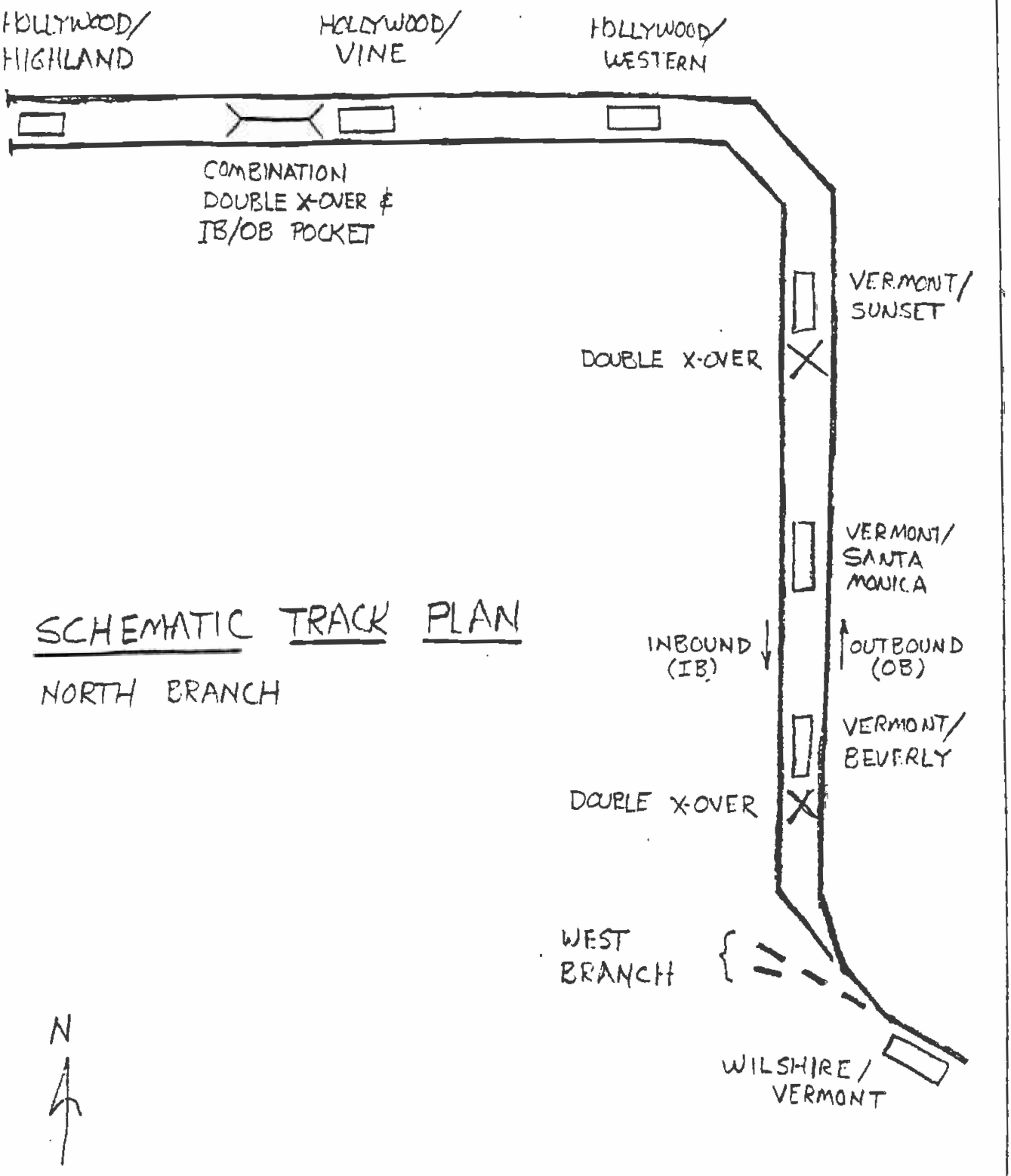
This functional description is taken from the Hollywood area pocket track study dated June 1989.

The present design for the pocket track structure at Hollywood/Vine consists of a standard three-track arrangement at approximately 20'-0" centers using two equilateral and four lateral turnouts. The special trackwork is contained in a reinforced concrete structure approximate 1,100 feet long constructed by cut-and-cover methods. The inside of the structure is 56-1/2 feet.

Above the trackwork, approximately 65,000 square feet of space is created at the mezzanine level of the adjacent station. About 31,000 square feet is allocated for ancillary functions. Some of the ancillary space at the mezzanine level, which at other stations occupies the station box, has been absorbed at Hollywood/Vine in the pocket track box. Ancillary functions within the pocket track box at mezzanine level are: emergency fans, DWP, TPSS with fan room, FAI shaft, air supply and UPE auxiliary power and battery room. The total space having been created as a by-product of the pocket track box exceeds required amounts. The adjacent Hollywood/Vine station configuration is center platform, 28 feet wide, with a double end mezzanine. The center platform is convenient for patrons since there is no directional split required to arrive at separate platforms. The number of vertical circulation elements is minimum. The inside width of the station box is approximately 51 feet.

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN

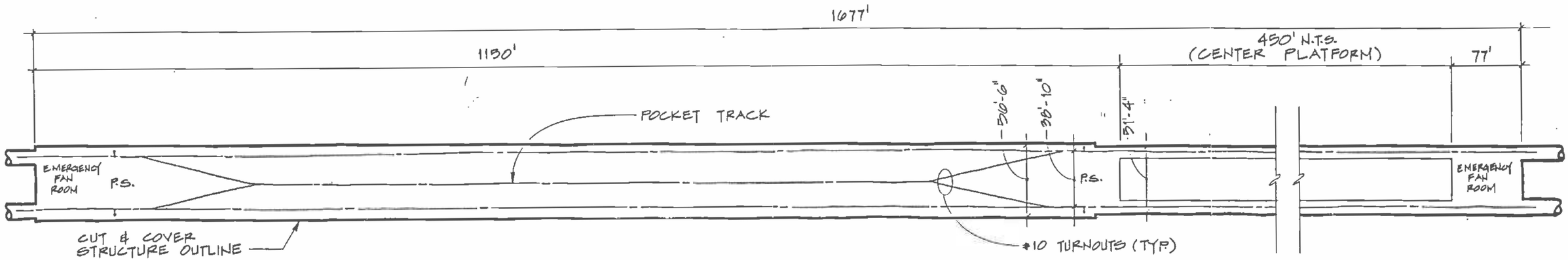


SCHEMATIC TRACK PLAN

NORTH BRANCH

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



POCKET TRACK IN STATION

DESCRIPTION OF PROPOSED DESIGN

This proposal relocates the present design's Hollywood/Vine combination double crossover/bidirectional pocket track to fall within the Hollywood/Vine station structure. A double crossover is provided at each end of the station. The pocket locations coincide with the berthed train positions at Hollywood/Vine. This arrangement eliminates the present design's separate pocket track structure west of Hollywood/Vine.

In order to avoid major extension of the station structure, the Hollywood/Vine station is designed with side platform arrangements to permit close centerline-to centerline track spacing.

Functional Description

All the same functions of the present design are retained except for maintenance vehicle staging which the VE team's analysis shows cannot be provided by the present design. If maintenance vehicles are stored, they will be stored for time intervals between "graveyard" work shifts. This requires that maintenance vehicles occupy the pocket track during revenue rush hours in order to be "staged" for the next work period. During these rush hours, single track headways will be doubled because the crossover function of the pocket track is obstructed. Practical operations personnel will never permit such uses to interfere with failure recovery capability except for dire maintenance emergencies. Consequently, the team concluded that maintenance vehicle staging is not being provided by the present design.

The failure recovery function is enhanced by the proposed design because the crossover function remains useable which the pocket is occupied. Identical single tracking headways can be achieved by the proposal as well as unscheduled short turn capability. The proposed design, however, requires bidirectional traffic to operate through the remaining station platform while the pocket track is occupied by failed equipment. The effect on revenue service headways will be imperceptible because of the short time required to transit the short bidirectional track segment. Whenever the pocket track is occupied, passengers will need to be directed to the remaining operational platform either by announcement or signs.

The terminal operation function could be enhanced by the proposed design because two turnback locations can be provided in lieu of one location in the present design. If the second location is desired, minor additional train control costs will be incurred.

A local/express operation function cited in the present design is being contemplated for future inclusion. The present pocket track and crossover spacing is too wide to permit express trains to overtake local trains without obstructing oncoming traffic headways. Consequently, transit operators generally find it infeasible to run combined local and express service on double track with conventional crossover spacing. The proposed design provides short run-around tracks within station limits which could be found by future work to materially improve the chances of operating a local/express service.

DESCRIPTION OF PROPOSED DESIGN (Continued)

Facilities Description

The double crossovers forming the pockets within the Hollywood/Vine station platform are accommodated in a cut-and-cover structure about 31 feet in width at each end of the station. The length of each crossover box is about 390 feet. The resulting overall length of station and crossover boxes is dramatically reduced from that of the present design, especially if the option to allow tunneling in the 100 foot reach adjacent to the tunnel end is permitted. In addition, a reduction in width is made possible by narrowing the tracks approaching the crossover area from 38.3' CL to 13' CL. The space available for ancillary functions is about 26,000 ft^2. This amount of space is more comparable to that required at this station.

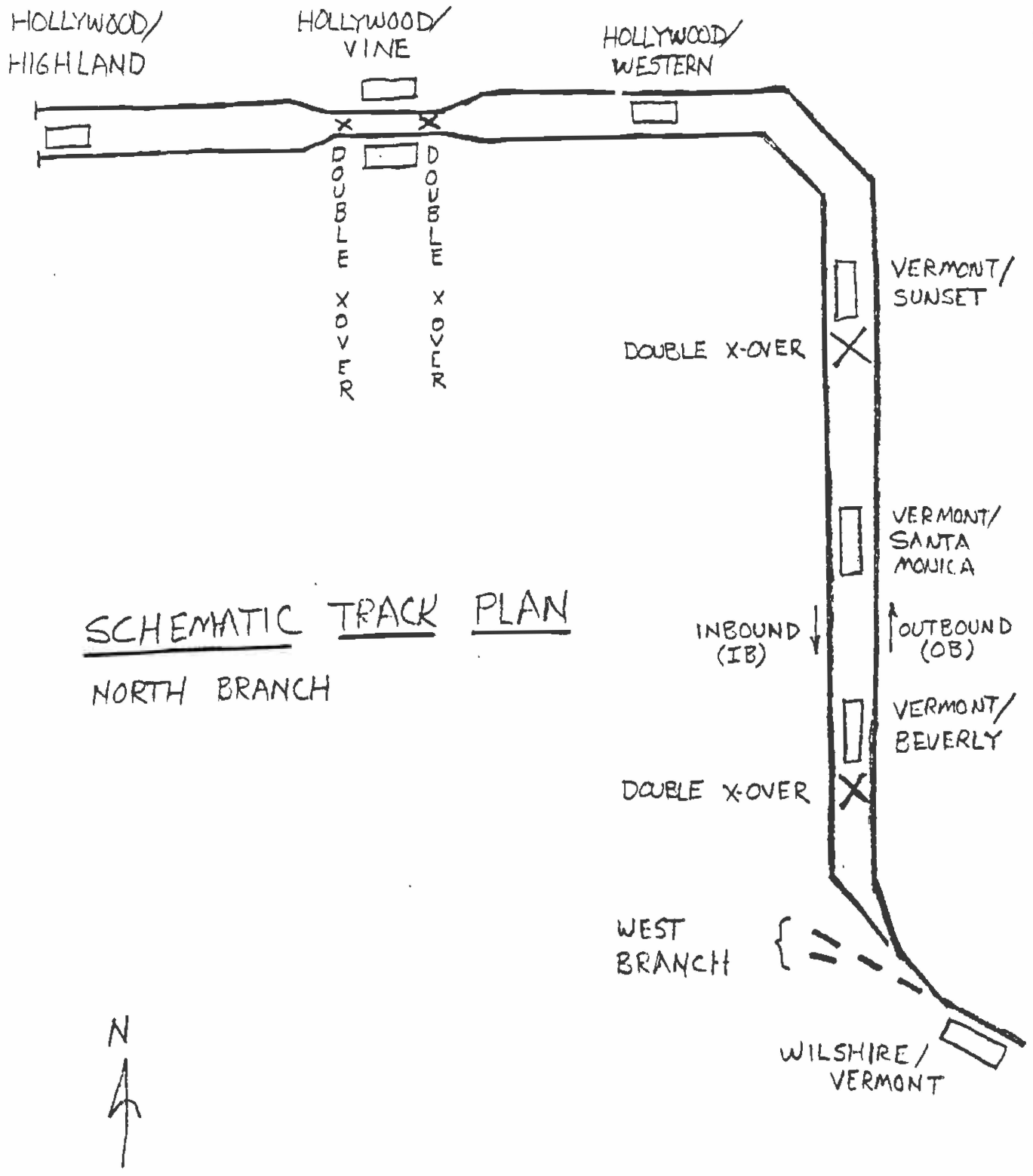
The pocket track crossover function remains comparable to that of the present design and unneeded space is saved with less costly construction for a narrow box.

Because of the track narrowing to 13' CL, the Hollywood/Vine station becomes a side platform station having 15 foot wide platforms through the vertical circulation areas at mid-station platform and 12 foot wide platform elsewhere. Mezzanine configurations are similar to the present design, with vertical circulation elements corresponding to that provided for the center platform designs.

Although somewhat inconveniencing patrons when they have to change platforms, the advantages of the proposed design lie in its substantial savings in construction cost, reduced surface disruption and reduced construction time.

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN

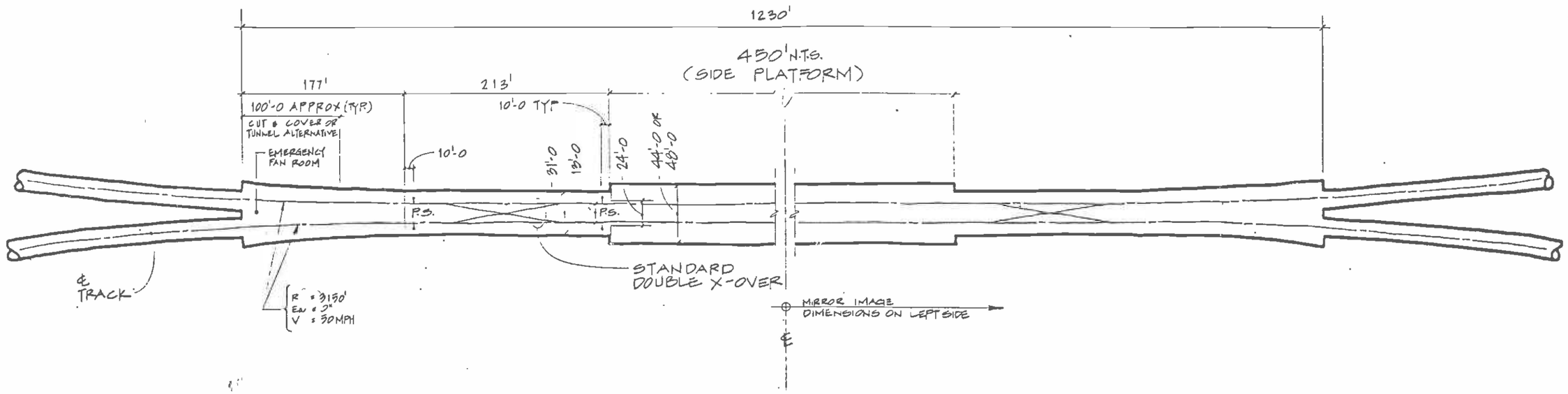


SCHEMATIC TRACK PLAN

NORTH BRANCH

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN



POCKET TRACK IN STATION

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM Pocket Track in Station

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE 9/13/89
PAGE 1 OF 3

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	TOTAL	UNITS	NO. UNITS	UNIT COST	TOTAL
	SUMMARY								
	Facilities Subtotal	-	-	-	$76,290	-	-	-	$58,046
	Systems - Wayside Subtotal	-	-	-	2,135				2,584
	Systems - Stations Subtotal	-	-	-	1,437				2,271
					$79,862				$62,901

Reference: _____

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM Pocket Track in Station

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE 9/13/89
PAGE 2 OF 3

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	($1000's) TOTAL	UNITS	NO. UNITS	UNIT COST	($1000's) TOTAL
B281	Hollywood/Western to Highland								
	Tunnel	RF	4860	$4760	$23,134	RF	5200	$4760	$24,752
	Station - Hollywood Vine	LF	560	48,570	27,199	SF	④ 23,040	① 946	21,796
	Station, mezzanine only	-	-	-	-	SF	⑤ 5,760	② 631	3,635
	X-over	LF	-	-	-	SF	⑥ 25,950	③ 303	7,863
	Pocket Track	LF	1010	25,700	25,957	-	-	-	-
	Facilities Subtotals		6430		$76,290				$58,046
	① □ft Price = ($48,570/LF) ÷ 51.33 FT WIDE = $946/SF								
	② □ft Price = ($946/SF) × 2/3 DEPTH = $631/SF.								
	③ □ft Price = ($25,700/LF) ÷ 56.5 FT WIDE = $455/SF × 2/3 = $303/SF								
	④ 54×240, 12×240 (TYP) ⑤, 48×105 (TYP), 150' Platform								
	⑥ 41, 177, 213, 31 — 12,975 □f; 31, 213, 177, 41 — 12,975 □f								

Reference: _____

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM Pocket Track in Station

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE 9/13/80
PAGE 3 OF 3

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	(1000's) TOTAL	UNITS	NO. UNITS	UNIT COST	(1000's) TOTAL
B610	Trackwork Procure / Install								
	Yard Track	RF	7500	$205	$1,538	RF	7000	$205	$1,435
	Turnouts	Ea	6	55	330	Ea	8	100	800
	Diamond X-ings	Ea	-	-	-	Ea	2	50	100
E612	Contact Rail Procure	TF	7500	28.32	212	TF	7000	28.32	198
B615	Prot. Cover Bd. Procure	TF	7500	7.27	55	TF	7000	7.27	51
	Systems - Wayside Subtotals				$2,135				$2,584
B710	Escalators	Ea	4	236,000	944	Ea	6	236,000	1,416
B710	Elevators	Ea	2	131,000	262	Ea	3	131,000	393
B760	Signs & Graphics	Sta	1	231,200	231	Sta	2	231,200	462
	Systems - Stations Subtotals				$1,437				$2,271

Reference: _____

VEP #17
RELOC. POCKET TRACK

Value Engineering Proposal (VEP) No. 17

DATE 9/15/89

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

ITEM
RELOCATE POCKET TRACK & ADD CROSSOVER

FUNCTION
Recover Failures
See Text for Others

CONCEPT BEFORE VE

West of Hollywood/Vine station, the present design provides one combination double crossover/bidirectional pocket track to permit transit operations to recover from equipment failures and other disruptions. This facility is housed in a long cut-and-cover structure approximately 57 feet wide. By virtue of this construction, 65,000 square feet of space is created above the trackway, of which 31,000 square feet is allocated to adjacent station ancillary functions.

PROPOSED ALTERNATIVE CONCEPT

This proposal relocates the pocket track function and its separate structure to a point within the Santa Monica mountains. A double crossover is provided at the west end of Hollywood/Vine station. The station is changed from center platform to side platform to permit closer track spacing and therby minimize cut-and-cover structure length. Width is also reduced.

The proposed concept creates 17,000 square feet of space above the trackway. This space is consistent with that required for crossover stations.

Advantages:

1. Substantially less surface disruption.
2. Enhances failure recovery.
3. Permits maintenance vehicle staging.
4. Reduces construction time.

Disadvantages:

1. Requires Revenue Service stop to pick up failed equipment train operator.
2. Requires passengers to be directed between platforms occasionally

ESTIMATED COST	$81,041,000

ESTIMATED COST	$ 71,334,000
EST GROSS SAVINGS	$ 9,707,000
EST IMPLEMENTATION COST	$ -0-
EST NET INITIAL SAVINGS	$ 9,707,000
EST LIFE CYCLE SAVINGS	$ 9,707,000

DESCRIPTION OF PRESENT DESIGN

Functional Description

The schematic track plan presently targeted for design proposes a combination double crossover, bidirectional pocket track west of Hollywood/Vine station. This facility, used in conjunction with crossovers located at other stations, will provide the following functions:

1. Failure recovery, i.e., restoring service after mainline incidents such as train breakdowns, single track operation or short turns to recover schedule.

2. Local/express operations, i.e., turnback of outbound local trains.

3. Maintenance vehicle staging.

This functional description is taken from the Hollywood area pocket track study dated June 1989.

Facilities Desription

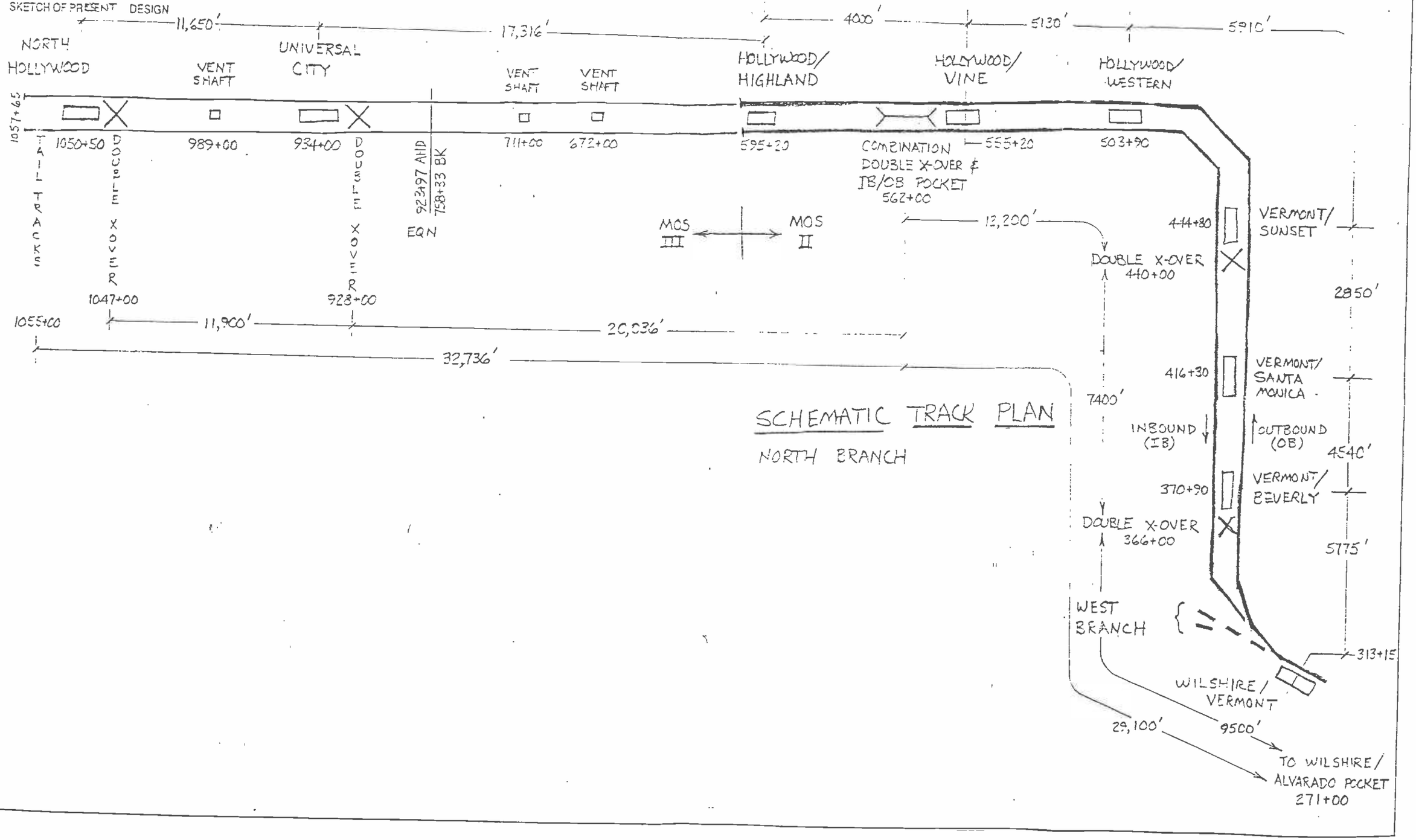
The present design for the pocket track structure at Hollywood/Vine consists of a standard three-track arrangement at approximately 20'-0" centers using two equilateral and four lateral turnouts. The special trackwork is contained in a reinforced concrete structure approximate 1,100 feet long constructed by cut-and-cover methods. The inside of the structure is 56-1/2 feet.

Above the trackwork, approximately 65,000 square feet of space is created at the mezzanine level of the adjacent station. About 31,000 square feet is allocated for ancillary functions. Some of the ancillary space at the mezzanine level, which at other stations occupies the station box, has been absorbed at Hollywood/Vine in the pocket track box. Ancillary functions within the pocket track box at mezzanine level are: emergency fans, DWP, TPSS with fan room, FAI shaft, air supply and UPE auxiliary power and battery room. The total space having been created as a by-product of the pocket track box exceeds required amounts.

The adjacent Hollywood/Vine station configuration is center platform, 28 feet wide, with a double end mezzanine. The center platform is convenient for patrons since there is no directional split required to arrive at separate platforms. The number of vertical circulation elements is minimum. The inside width of the station box is approximately 51 feet.

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PRESENT DESIGN



SCHEMATIC TRACK PLAN

NORTH BRANCH

DESCRIPTION OF PROPOSED DESIGN

This proposal relocates the Hollywood/Vine combination double crossover/-bidirectional pocket track to a point approximately 4800 feet west and north of Hollywood/Highland station. A double crossover is provided at the west end of Hollywood/Vine station. This arrangement changes the present design's cut-and-cover pocket track structure into a tunneled structure in the granite formation of the Santa Monica mountains

In order to minimize the length of the station/crossover structure, the Hollywood/Vine station is designed with side platform arrangements to permit close centerline-to-centerline track spacing.

Functional Description

All the stated functions of the present design are possible with this arrangement including maintenance vehicle staging.

The failure recovery function is enhanced by the proposed design because the crossover function remains useable while the pocket is occupied. Identical single tracking headways can be achieved by the proposal as well as unscheduled short turn capability. The terminal operation function and the future local/express operation function are identical to the present design.

Because the proposed pocket track location is nearly a mile from the nearest station, a small operator's boarding platform would permit the failed equipment operator to board the next Revenue Service train. The BART heavy rail system and Sacramento Light Rail System both routinely stop revenue trains outside stations to pick-up dead-heading operators.

The proposal postpones construction of the pocket track from the MOS-II segment to the MOS-III segment. During the MOS-II operation, storage pockets will be located on the tunneled main line between Hollywood/Vine and Hollywood/Highland stations.

Facilities Description

In its new location, the pocket track will be constructed by hard rock tunneling methods. The additional track can be accommodated by either enlarging the double track tunnel planned for the main line or by constructing a parallel single tunnel with mined transition sections to accommodate the special trackwork.

The double crossovers at Hollywood/Vine station is accommodated in a cut-and-cover structure about 31 feet in width at the west end of the station. The length of the crossover box is about 390 feet. On the east end, a transition structure of 120 feet would bring the track centerlines to a point where tunnel outside diameters have 5 feet clearance.

The resulting overall length of station, crossover and transition boxes is dramatically reduced from that of the present design, especially if the option to allow tunneling in the 100 foot reach adjacent to the tunnel end is

DESCRIPTION OF PROPOSED DESIGN

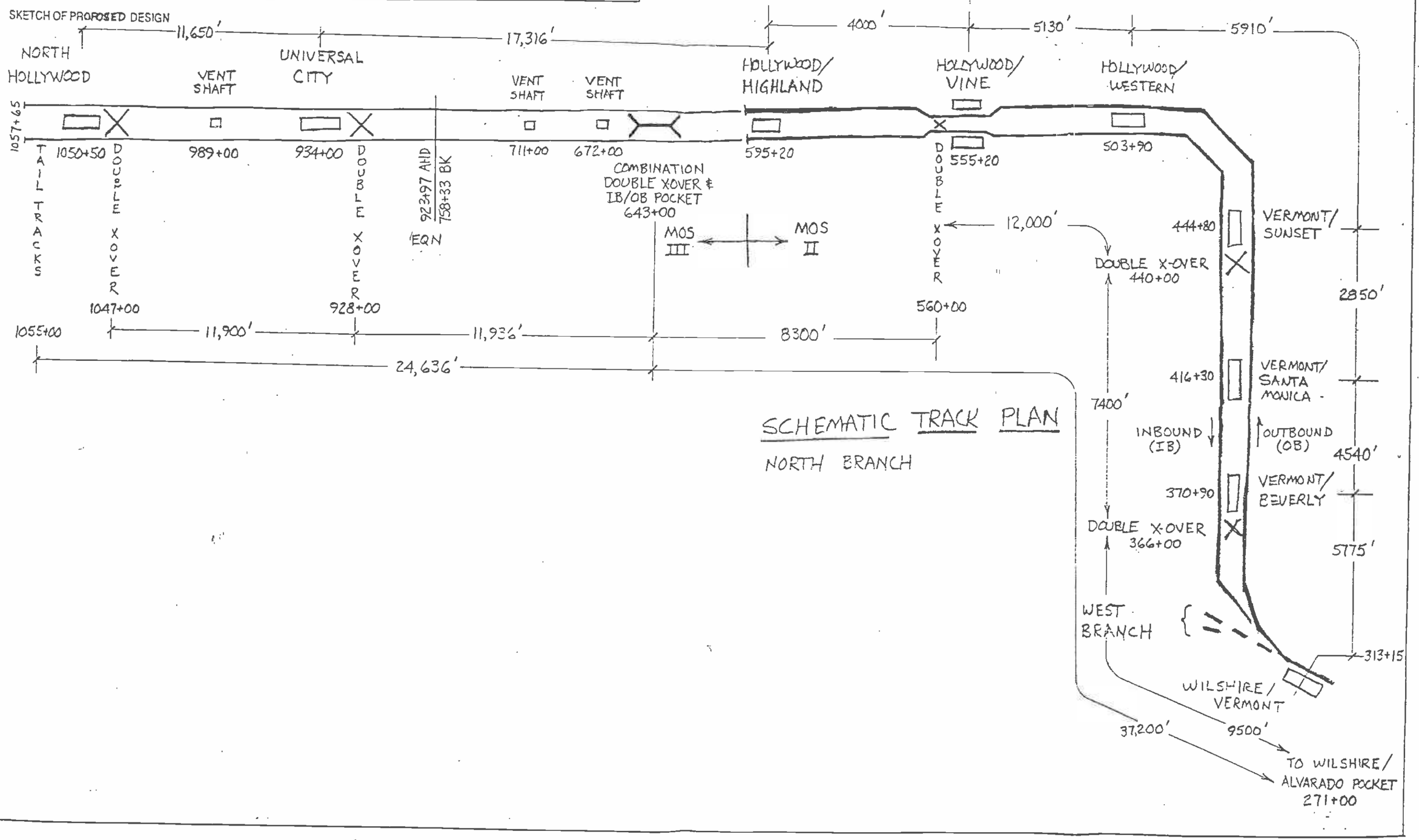
permitted. In addition, a reduction in width is made possible by narrowing the tracks approaching the crossover area from 38.3' CL to 13' CL. The space available for ancillary functions is about 17,000 ft^2. This amount of space is comparable to that required for the crossover functions proposed for this station.

Because the track spacing narrows to 13', the Hollywood/Vine station becomes a side platform station having 15 foot wide platforms through the vertical circulation areas at mid-station and 12 foot wide platforms elsewhere. Mezzanine configurations are similar to the present design, with vertical circulation elements corresponding to that provided for the center platform designs.

The pocket track/crossover functions are comparable to or better than that of the present design and unneeded space is saved with less costly construction for a narrow box. Although somewnat inconveniencing patrons when they have to change platforms, the advantages of the proposed design lie in its substantial savings in construction cost, reduced surface disruption and reduced construction time. The savings estimated is the combined total for MOS-II and MOS-III changes. The reduction in MOS-II construction scope is almost $20 million; the increase in MOS-III scope is just under $10 million.

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN



SCHEMATIC TRACK PLAN

NORTH BRANCH

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM Relocate Pocket Track. & Add X-over

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE 9/13/89
PAGE 1 OF 4

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
		UNITS	NO. UNITS	UNIT COST	TOTAL	UNITS	NO. UNITS	UNIT COST	TOTAL
	SUMMARY								
MOS II	Facilities Subtotals	-	-	-	$76,290	-	-	-	$56,721
MOS II	Systems - Wayside Subtotals	-	-	-	3,314	-	-	-	2,712
MOS II	Systems - Stations Subtotals	-	-	-	1,437	-	-	-	2,271
	MOS II TOTALS				$81,041				$61,704
MOS III	Facilities Subtotals				-0-				8,000
MOS III	Systems Subtotals				-0-				1,630
	MOS III TOTALS				$ -0-				$ 9,630
	PROJECT TOTALS				$81,041				$71,334

Reference: _____

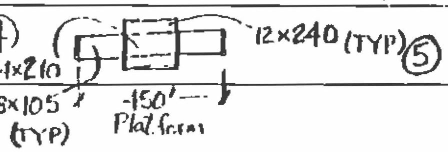
PROJECT Metro Rail VE #3 - Stations	**Value Engineering Study**	CLIENT SCRTD
LOCATION Los Angeles, California	**Cost Model**	DATE 9/13/89
SYSTEM Relocate Pocket Track & Add X-over		PAGE 2 OF 4

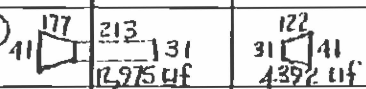
ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
	MOS II	UNITS	NO. UNITS	UNIT COST	(1000's) TOTAL	UNITS	NO. UNITS	UNIT COST	(1000's) TOTAL
B281	Hollywood/Western to Highland								
	Tunnel	RF	4860	$4760	$23,134	RF	5468	$4760	$26,028
	Station - Hollywood Vine	LF	560	48,570	27,199	SF	④ 23,040	① 946	21,796
	Station, mezzanine only	–	–	–	–	SF	⑤ 5,760	② 631	3,635
	X-over	LF	–	–	–	SF	⑥ 17,367	③ 303	5,262
	Pocket Track	LF	1010	25,700	25,957	–	–	–	–
	Facilities Subtotals		6430		$76,290				$56,721

① □ft Price = ($18,570/LF) ÷ 51.33 FT WIDE = $946/SF

② □ft Price = ($946/SF) × 2/3 DEPTH = $631/SF

③ □ft Price = ($25,700/LF) ÷ 56.5 FT WIDE = $455/SF × 2/3 = $303/SF

④ 

⑥ 

Reference:

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM Relocate Pocket Track & Add X-over

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE 9/13/89
PAGE 3 OF 4

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
	MOS II.	UNITS	NO. UNITS	UNIT COST	(1000's) TOTAL	UNITS	NO. UNITS	UNIT COST	(1000's) TOTAL
B610	Trackwork Procure / Install								
	Yard Track	RF	7500	$205	$1,538	RF	7000	$205	$1,435
	Turnouts	Ea	6	100	600	Ea	4	100	400
	Diamond X-ings	Ea	-	-	-	Ea	1	50	50
B612	Contact Rail Procure	TF	7500	28.32	212	TF	7000	28.32	198
B615	Prot.. Cover Bd. Procure	TF	7500	7.27	55	TF	7000	7.27	51
B620	Automatic Train Control T/C Room & Two Interlockings	Ea	1	908,500	909	Ea	-	-	-
	T/C Room and Diamond	Ea	-	-	-	Ea	1	578,250	578
	Systems-Wayside Subtotals				$3,314				$2,712
B710	Elevators	Ea	2	131,000	262	Ea	3	131,000	393
B710	Escalators	Ea	4	236,000	944	Ea	6	236,000	1,416
B760	Signs & Graphics	Sta	1	231,200	231	Sta	2	231,200	462
	Systems-Stations Subtotals				$1,137				$2,271

Reference: _____

PROJECT Metro Rail VE #3 - Stations
LOCATION Los Angeles, California
SYSTEM Relocate Pocket Track & Add X-over

Value Engineering Study
Cost Model

CLIENT SCRTD
DATE 9/13/89
PAGE 4 OF 4

ITEM NO.	DESCRIPTION	ORIGINAL DESIGN				VE PROPOSED DESIGN			
	MOS III	UNITS	NO. UNITS	UNIT COST	(1000's) TOTAL	UNITS	NO. UNITS	UNIT COST	(1,000's) TOTAL
	Pocket Track Tunnel (Hard Rock)	-	-	-	-	LF	1000	4000	$4,000
	Connections to Line Tunnels(" ")	-	-	-	-	LS	-	-	4,000
	Facilities Subtotals				-0-				$8,000
	T/C Room & Two Interlockings	-	-	-	-	Ea	1	908,500	909
	Yard Track	-	-	-	-	RF	500	205	103
	Turnouts	-	-	-	-	Ea	6	100	600
	Contact Rail	-	-	-	-	TF	500	28.32	14
	Prot. Cover Bd.	-	-	-	-	TF	500	7.27	4
	Systems Subtotals				-0-				$1,630

Reference: _____

APPENDICES

APPENDIX A - Resumes

H. A. FOSTER

PRESIDENT/STRUCTURAL ENGINEER, FOSTER ENGINEERING, INC.

EDUCATION

B. S., Civil Engineering, Bristol University, England, 1954

REGISTRATIONS

Structural and Civil Engineer, California CE 16634; SE 1649
General Engineering Contractor's License, Class. A, #428000

CAPABILITIES

Over 25 years of experience in the planning, design, preparation of contract documents and construction management of public and private work. Strong background in all aspects of project development, including project management, structural design, mechanical/electrical systems and facilities, construction engineering and management, and preparation of contract specifications and estimates of construction cost.

Specific expertise includes design and construction planning of large civil engineering projects related to both light and heavy rail systems, highway and bridge construction projects and major maintenance facilities for rail vehicles and buses for Bay Area Rapid Transit District, San Francisco Municipal Railway (MUNI), Sacramento Regional Transit District, Niagara Frontier Transportation Authority LRRT project, AC Transit, Golden Gate Bridge Highway and Transportation District and others. Strong background in construction management and administration; was resident engineer for several years on major civil works constructed in downtown San Francisco. Considerable experience with military projects and capability in preparation of contract documents from standpoint of constructibility, value engineering and construction claim mitigation. Substantial experience dealing with construction contractors, negotiating change orders and conducting final acceptance inspections.

EXPERIENCE RECORD

Foster Engineering, Inc.
Since the inception of FEI in 1972, Mr. Foster has had responsible charge of all administrative and technical operations. He is a working principal and plays an active role in the development of project design and implementation. He has responsibility for contractual relations with the client; maintains a constant review of the project's progress; adjusts manpower schedules to project requirements, and contributes to and reviews the technical approach to each work program.

Major assignments include:

- Project Principal on FEI's work for AC Transit and Golden Gate Bridge, Highway and Transportation District on the design of major bus maintenance and storage facilities totaling some $25,000,000 of construction.

- Principal-in-Charge of the firm's work for the Sacramento Regional Transit District. The work involved major responsibilities in systems integration and design review for construction of an 18-mile light rail system in Sacramento, construction management planning and scheduling of all planned construction and management procurement activities, and development of operating plans and maintenance procedures. The total construction cost was over $150,000,000.

- Project Manager for the firm's Value Engineering work for Southern California Rapid Transit District and Western Division Engineering Command - U. S. Navy.

- Project Manager on reconstruction of 3-1/2 miles of light rail trackwork and electrification facilities for San Francisco MUNI M-Line, including staging of construction on congested city areas in order to keep light rail service fully operational during construction and minimize impact on pedestrian and vehicular traffic flows.

- Project Manager on the firm's work on BART'S KE-Line project involving construction of 4800 linear feet of revenue track, multispan precast, prestressed concrete bridge structures, electrification facilities and train control systems.

- Principal-in-Charge of the firm's work for the Niagara Frontier Transportation authority for the design and preparation of contract plans and specifications for Humboldt Station and a section of line structures for Buffalo's LRRT system (low bid of $21,500,000 in April. 1981).

- Project Manager on the firm's work on construction planning and design of a major extension to San Francisco MUNI Metro in downtown San Francisco. Work involved major subsurface utility relocation planning and design, alternatives analysis and comparative cost estimating, and design of major underground structures for LRT trainways and other facilities.

- Resident Engineer and Construction Manager on BART's Embarcadero Station project for 3-1/2 years, in charge of technical administration, inspection of all work, processing and reviewing of all vendor and contractor submittals, monitoring financial status of the project and negotiating change orders.

- Project Manager on design and preparation of contract plans and on monitoring of multicontract addition to BART's downtown Oakland subway project. Work included major civil and structural works for utility relocation, grading, trackwork, bridges, electrification and train control. All work carried out maintaining revenue service through the construction zone fully operational.

PREVIOUS EXPERIENCE

With Parsons, Brinckerhoff, Quade & Douglas for ten years. Was design project manager on multicontract $125,000,000 highway and bridge project in Hawaii and Project Manager on many heavy rail transit projects totaling over $200 million in San Francisco, Boston, and Sao Paulo, Brazil.

With W. S. Atkins & Partners in Toronto, Canada for five years. Was project engineer on major sections of Toronto heavy rail system.

Value Engineers

CONSULTING
VALUE
SPECIALISTS
INC.

821 N.W. Flanders,
Portland, Oregon 97209
(503) 223-2876

RESUMÉ

ROBERT H. MITCHELL, CVS

Bob Mitchell is President of Consulting Value Specialists, Inc. and has been at the forefront of value engineering in the construction industry since 1964. He established the VE program in the North Pacific Division of the Corps of Engineers and served for more than ten years as Value Engineering Officer in that organization. During that period, over $40 million were saved by applying VE methods to major government construction projects. He also served as an instructor on the staff of the Chief of Engineers, and conducted Value Engineering workshops and seminars throughout the United States and in Europe. He established the Value Engineering instruction program in the Oregon State System of Higher Education, Division of Continuing Education, at Portland State University, and regularly conducts VE classes at this institution, and at the University of California, Berkeley.

He is registered by the Society of American Value Engineers as a Certified Value Specialist (LIFE) and is an active member, past president of the Portland Chapter, past Northwest Regional V.P., National Board of Directors of SAVE, and was elected to the position of FELLOW in 1984. In 1973 he founded Consulting Value Specialists, Inc. as a full-service Value Engineering organization specializing in design, construction, and industrial applications.

EDUCATION:	University of Washington and Glendale City College Major: Business Administration Minor: Engineering and Technology	1938-1941
	Air Force University	1952
	Industrial College of the Armed Forces	1963
PROFESSIONAL EXPERIENCE:	CONSULTING VALUE SPECIALISTS, INC. Portland, Oregon President	1973-Present
	NORTH PACIFIC DIVISION CORPS OF ENGINEERS	
	Various Assignments	1941-1964
	Value Engineering Officer	1964-1973
	U.S. AIR FORCE	
	Active Duty (Pilot)	1942-1945
	Reserve Status (Pilot-Commander) Colonel	1945-1973

PROFESSIONAL CERTIFICATION: Certified Value Specialist, as administered by the Society of American Value Engineers

ASSOCIATIONS:
Society of American Military Engineers
Society of American Value Engineers
American Management Association
Air Force Association
Multnomah Athletic Club, Portland, Oregon

PUBLICATIONS:
"Value Engineering in Design & Construction," 1965 (Paper, NW Constructor)

"Value Engineering in Construction," 1967 (Co-author)

"Value Engineering for the Construction Industry," 1974 (Co-author)

"Value Engineering in Design and Construction," 1981 (Co-author)

JOHNSON W. YEE

SENIOR CIVIL ENGINEER, FOSTER ENGINEERING, INC.

EDUCATION

B. S., Civil Engineering, with Honors, University of California, Berkeley, 1978
M. S., Transportation Engineering, University of California, Berkeley, 1979

REGISTRATION

Civil Engineer, California CE 35706

CAPABILITIES

Extensive background in a broad range of civil engineering and design projects with specific experience in site development studies and engineering, highway and street improvements, airport taxiway and runway improvements, utilities systems, transmission pipelines, light rail route engineering and trackwork, field surveying and investigations, right-of-way engineering and title documentation, traffic and transportation studies, environmental studies and alternatives analyses and systems analyses. Experienced in preparation of contract bid documents and construction cost estimates, development of project budgets and cost control techniques, coordination of engineering disciplines with construction contractors and design compliance with military standards.

EXPERIENCE RECORD

Foster Engineering, Inc.

Project Engineer responsible for $9 million site improvement and utilities systems reconstruction for the U. S. Navy at the San Diego Naval Hospital, and for a $10 million combined tank and light infantry training range for the U. S. Army Corps of Engineers.

Civil and Pipeline Engineer responsible for design of 8 miles of welded steel natural gas transmission pipeline in urban street right-of-way for the Pacific Gas & Electric Company in San Mateo County, and for the reconstruction of natural gas distribution systems for the U. S. Navy at the Oakland Army Base and at the Department of Defense Housing Facility in Novato, California.

Civil Engineer responsible for site and utilities improvements such as site and building demolition; removal of hazardous materials; grading and drainage systems; underground secondary containment for hazardous material tanks and distribution pipelines; natural gas, domestic and fire water, sanitary and industrial waste utility systems; yard and street pavements; and perimeter sound walls for the Emeryville and Richmond bus maintenance facility projects for AC Transit.

Civil Engineer responsible for topographic and utility surveys and basemapping on the firm's site development projects. Recent experience includes field

surveying support for the construction of the Bay Area Rapid Transit District (BART) Daly City Turnback and Yard project.

Transportation Engineer participating in the development of computer-aided train simulation and operating plan analysis for the Sacramento Regional Transit District's 18-mile Light Rail project.

PREVIOUS EXPERIENCE

Civil Engineer responsible for site development and utilities engineering and contract document preparation for residential, commercial, industrial and public works projects. Participated in field investigations, traffic and environmental impact studies, and conceptual alignment development for street, highway, rail transit, and combined sewerage facilities. Reviewed and coordinated construction contracts on multi-phased heavy construction projects. Concept development of route alignment and grade separations for light rail transit systems.

Designed and prepared contract documents for access apron and taxiway improvements at the Oakland Airport for the Port of Oakland.

Designed and prepared contract documents for 5 miles of plastic and welded steel water transmission and distribution pipelines in urban street right-of-way for the East Bay Municipal Utilities District (EBMUD) in Alameda and Contra Costa Counties.

Designed and prepared contract documents for site and utilities improvements for enlisted personnel barracks at Fort Ord and the Presidio of San Francisco for the U. S. Army Corps of Engineers; site and utilities improvements for the Central Maintenance Facility and Hayward Training Center projects for AC Transit; onshore site and utilities improvements for the San Francisco Redevelopment Agency's South Beach Marina project; access trackwork for the Metro Center Addition project for the San Francisco Municipal Railway.

TERENCE G. McCUSKER
TUNNEL CONSULTANT
423 SHARON BUILDING
55 NEW MONTGOMERY ST.
SAN FRANCISCO, CA 94105
TEL: (415) 777-5670

EDUCATION:

B.Sc.(Eng.) (With honors) 1950 - London University

AWARD:

Construction Achievement Award - ASCE, New York Metropolitan Section, 1975

PROFESSIONAL ACTIVITIES:

International Soc. for Soil Mechanics and Foundation Engineering:
Member

Panelist	-	Soft Ground Tunneling Session, Fifth Pan-American Conference on Soil Mechanics and Foundation Engineering, Buenos Aires, 1975

International Society for Rock Mechanics:
Member

International Tunneling Association:

U.S. Representative	-	Working Group 'Research' - 1978/84
Vice-Animateur	-	Working Group 'Research' - 1982/84
Co-Reporter	-	Preparation and presentation of data for reports on Soft Ground Tunneling and TBM Tunneling in Hard Rock

U.S./Sweden Technical Cooperation:
Appointed member of U.S. delegation for workshop in Stockholm on TBM vs. Drill and Blast Tunneling in Swedish Conditions, 1976

U.S. National Committee on Tunneling Technology:

Member	-	1978/81
Chairman	-	Subcommittee on Research Needs - 1978/84
Member	-	Joint Committee on Rock Failure Mechanisms in Underground Openings

U.S. National Committee on Rock Mechanics:

Panelist	-	Conference on Under-Ocean Tunneling

American Society of Civil Engineers:

Member

Member	-	Tunnel and Underground Construction Committee, 1975/85
Chairman	-	Tunnel and Underground Construction Committee, 1979/82
Panelist, Lecturer	-	AEG/ASCE Symposium on Geotechnical Engineering and the Law, 1976
Member	-	Organizing and Steering Committees for Conference on Risk and Liability Sharing, 1978/79
Keynote Speaker	-	Soft Ground Tunnel Session, Conference on Geotechnical Design and Construction, 1981
Panelist	-	Geotech III, 1984

Transportation Research Board:

Member	-	Committee on Tunnels and Underground Structures 1978-1988

Underground Technology Research Council:

Member	-	Organizing Committee for Symposium on Tunnel Lining Design
Keynote Speaker		Symposium on Development and Use of Deep Underground Space, 1980
Panelist	-	Workshop on Materials Handling, 1979
Member	-	Committee on Research Needs
Member	-	Committee on Oil Recovery Using Underground Drilling Platforms

Engineering Foundation:

Panelist	-	Shotcrete Conference, St. Anton, Austria, 1978
Session Chairman	-	Shotcrete Conference, Paipa, Colombia, 1982
Invited Attendee	-	Workshop on the Use of Underground Space, 1973 and Conference on Subsurface Exploration for Underground Excavation and Heavy Construction, 1974

Rapid Excavation and Tunneling Conference:

Chairman	-	Excavation Methods Section, 1976
Chairman	-	Soft Ground Tunneling Section, 1983

Universities:

Seminars on tunneling topics at Cornell and U.C. Berkeley
Lectures at University of Wisconsin Extension Courses
Lectures on Tunnel Lining Design and Materials Handling at course on Tunneling sponsored by University of Colorado/Burec

REGISTERED:

Professional Engineer, California, No. 15,272 Civil

EXPERIENCE:

Private Practice as Tunnel Consultant,	1978 to date
Perini Corporation, Tunnel Division Manager,	1967/78
Parsons Brinckerhoff Quade & Douglas, Senior Engineer,	1964/67
Foundation of Canada Engineering Co. (FENCO), Resident Engineer,	1963/64
W.S. Atkins & Associates (Now Hatch Associates), Senior Engineer,	1962/63
Robert McAlpine Ltd., Senior Construction Engineer,	1959/62
Mott, Hay & Anderson, Senior Engineer,	1951/59
John Laing & Sons, Ltd., Concrete Quality Control Engineer,	1950/51

CNA CONSULTING ENGINEERS

Charles R. Nelson & Associates, Inc.
2800 University Avenue S.E.
Minneapolis, MN 55414
(612) 379-8805

CHARLES R. NELSON
UNDERGROUND CONSTRUCTION CONSULTANT

EDUCATION:

Ph.D.	Massachusetts Institute of Technology
M.S.C.E.	Massachusetts Institute of Technology
B.S.C.E.	University of North Dakota

PROFESSIONAL ACTIVITIES:

Member - American Society of Civil Engineers
Member - ASCE Tunneling and Underground Construction Committee
Member and Past President - Minnesota Geotechnical Society
Member - Society of Professional Engineers

REGISTERED:

Professional Civil Engineer, State of Minnesota, #11301

EXPERIENCE:

CNA Consulting Engineers, Minneapolis, Principal Engineer.
Responsibilities include project planning, conceptualization, design, analysis and review of the firm's engineering projects. Business management and operations are handled by another corporate officer with business education and experience. The type of projects range from tunnel and cavern design, existing facilities evaluation and repair, applied mechanics investigations, geotechnical evaluations and reports, to complete civil engineering services for planning, conceptual design, preliminary design, final design and construction project administration.

University of Minnesota, Dept. of Civil and Mineral Engineering, Faculty Member.
Faculty member of Civil and Mineral Engineering Department teaching construction materials, tunneling and underground construction and conducting research. Directed major research projects in design, excavation, support and lining of underground openings in sedimentary rock formations. These projects developed new design methods, construction techniques and field verification of system response now in use.

Massachusetts Institute of Technology, Staff.
The design, construction and testing of buried reinforced concrete arches subject to a range of static and dynamic loads and development of design methods based on limit analysis. Development of analysis methods and their experimental verification for prediction of thermally and mechanically induced stresses and rock fracture. Refinements of these design methods and numerical approaches are currently being used for underground structures design and rock mechanics related problems.

CNA CONSULTING ENGINEERS

Charles R. Nelson & Associates, Inc.
2800 University Avenue S.E.
Minneapolis, MN 55414
(612) 379-8805

FIRM BACKGROUND DATA

CNA is located in a 2000 SF office centrally located in the Twin Cities, with seven graduate engineers, four of which are registered Professional Engineers, two technicians and two office staff offering professional engineering services to the construction and mining industry in the area of civil, structural, geotechnical, geostructural, and construction engineering. Most, but not all, of the company projects are constructed in the ground. A sample of these projects includes sewers by open cut and tunnel methods, steam, telephone and electrical passageways, transit routes at grade, in open cut and by tunneling, transit stations above and below ground, underground space for activities such as a laboratory, industrial and office use, hydropower dams, mines and foundation design for dynamic loadings.

CNA very often works in teams with other engineering firms and provides the specialized skills needed for the project in an efficient manner based on a wide experience and academic base. Such relationships have developed an unusual depth in the areas of practice.

CNA staff have degrees in Civil, Mining and Geological Engineering and are registered in Civil, Mining and Geology disciplines. Training and experience range from hydraulics, blasting, construction materials, transportation, structures and geology as well as geotechnical engineering. This base permits effective interaction with design teams for a variety of projects.

COMPUTER-ASSISTED DESIGN AND DRAFTING

CNA personnel use computers as tools to enhance the design and engineering services provided by the firm. Principal areas of use are (1) storage, analysis, and presentation of geotechnical data, (2) design studies for evaluation of construction alternatives, (3) storage and evaluation of field data collected during construction, and (4) traditional CADD, where an engineer uses a computer work station to design structures and produce construction drawings.

Geotechnical data analysis in site investigation programs is a natural application of computers, due to the complexity of the data, and the need to present the data in graphical form. Data integrity is enhanced because fewer data transfers are required and errors are more easily identified and corrected. CNA commonly integrates computer-produced geotechnical data with construction drawings, so the engineer and later contractors have the data available for decision making. By having geotechnical data computerized and presented graphically, the design engineer can quickly and accurately judge overall site conditions, and identify trends and localized poor conditions. Geostatistical methods are used where warranted to evaluate the confidence which should be placed in anomalous conditions, and identify areas where additional site investigation is required.

In the area of design studies, CNA conducts stability analysis of soil and rock slopes, and deep cuts. The computer allows the engineer to study a wider range of conditions and alternatives than can be done by hand calculations. The programs also aid in the design of retaining structures. Dewatering analysis is also conducted by computer, to judge the effectiveness of the well layout and evaluate the influence of regional groundwater flow characteristics. Stress and displacement analysis of near-surface and deep structures is also conducted by the finite element and boundary element methods. A typical application of finite element modeling is tunnel liner/rock interaction for a pressurized sewer tunnel. Finally, many small computer programs are written and used to conduct repetitive calculations typically done during the design phase of a project.

Analysis of field data is another common use of computer-assisted graphics at CNA. A recent application was three-dimensional perspective plotting of surveying data from a large cavern. The graphical output was used to identify areas where the cavern walls encroached on the structure planned for the cavern.

CNA uses AUTOCAD for most phases of a project including geotechnical information, display, quantity takeoff, geometric design and positioning of components as well as production of final plans. All computer work is conducted on five IBM compatible microcomputers teamed with Hewlett Packard pen plotters and a LaserJet printer. Plans and specifications can be provided to the owner, contractor and other members of the engineering team on paper and IBM 360K diskettes.

WILMOT R. MCCUTCHEN

SUBWAY PASSENGER STATION DESIGN SPECIALIST

EDUCATION

M.S., Engineer of Mines, Colorado School of Mines, 1948
B.S., U. S. Military Academy, 1939

REGISTRATION

Civil Engineer, California, No. 17248
Civil Engineer, Virginia, No. 1247

CAPABILITIES

Mr. McCutchen has hands-on experience in the major planning, design, construction and start-up operations of advanced rapid transit systems.

EXPERIENCE

Until May 1981, Mr. McCutchen was Manager of Design and Construction in the Department of Design and Construction of the San Francisco Bay Area Rapid Transit District (BART). He was in charge of engineering planning and design activities for the stations, tracks, and structures of the 75-mile system since March 1966.

Prior to joining BART in 1966, Mr. McCutchen served as District Engineer for the Far East District of the Corps of Engineers, as a Colonel in the U. S. Army, and as Executive Officer of the Sacramento District during the period when several large flood control dams were under design or initial construction in the Central Valley, California.

Mr. McCutchen is past Vice Chairman and Chairman of the American Public Transit Association's (APTA) Committee on Ways and Structures. He has also served as a member of the Advisory Board of the APTA on Noise Vibration, the Advisory Board of the APTA on Subway Ventilation and Environmental Control, and the Committee on Intermodal Transfer Facilities of the Transportation Research Board, National Research Council. He has authored several technical papers on the design and construction of BART facilities.

Mr. McCutchen's papers on transit and on mining technology include:

1. "The Behavior of Rocks and Rock Masses in Relation to Military Geology", Quarterly of the Colorado School of Mines, v44, n 1, Jan. 1949.

2. "A Treatment of Self Gravitational strains in the Earth", Transactions American Geophysical Union, v38, n 1, Feb. 1957.

3. "Passenger Design Standards for Bay Area Rapid Transit Stations", Proceedings, American Society of Civil Engineers Inter-disciplinary Conference on "The Man-Transportation Interface", Washington, D.C., 1972.

4. "Ventilation Considerations for the BART Trans-Bay Tube", Proceedings of the ASHRAE Annual Meeting Symposium on Ventilation Aspects of Hostile Environments, Louisville, KT, 1973.

5. "BART Scale Model Sand Bumper Arrestor Tests", Proceedings of the Inter-Society Conference on Transportation, American Society of Mechanical Engineers, Denver, CO, with H. E. Krachman, 1973.

6. "Air Pressure Transients in Subways", Proceedings of the Third Los Angeles Council of Engineers and Scientists Symposium "Transpo LA", Los Angeles, CA, with A. G. Behring, 1974.

7. "Tunnel Ventilation", Proceedings of the American Transit Association Rail Transit Conference, San Francisco, CA, 1974.

8. "BART's Experience with Design and Use of Concrete Ties", Proceedings of the Portland Cement Association Workshop on Concrete Ties, Lincolnwood, IL, 1977.

9. "BART Stations, A Reappraisal", Proceedings of the National Conference on Transit Station Design, University of Virginia, at Washington, D.C., 1980.

10. "Some Elements of a Theory for In-Situ Stress", International Journal of Rock Mechanics and Mining Sciences, v19, Aug. 1982.

ROBERT H. MILLER

VICE PRESIDENT, FOSTER ENGINEERING, INC.

EDUCATION

B. S., Electrical Engineering, 1966
SAVE, Value Engineering Workshop, 1987

REGISTRATION

Registered Electrical Engineer, California 1980, EE 10675

CAPABILITIES

Mr. Miller is in responsible charge of all electrical and mechanical engineering operations at FEI. He is a seasoned electrical engineer and designer. Mr. Miller has had considerable industrial and commercial electrical engineering experience, including rehabilitation and upgrading of existing electrical distribution systems. Experienced in system sizing, layout, fault duty and lighting design. Has prepared life cycle cost studies and operating/capital cost trade-off analysis for electrical systems. Has diagnosed complex computer-based supervisory control subsystem interface problems as well as power conversion and distribution equipment failures.

EXPERIENCE RECORD

Foster Engineering, Inc.
Recent experience includes the following:

- Systems Integration Project Manager for BART's $150 million Daly city extension. In responsible charge for coordinating start-up activities in preparation for revenue service.
- Project Engineer responsible for electrical work on bus storage and equipment maintenance facilities for AC Transit at Emeryville and Richmond, California.
- Project Electrical Engineer on the firm's project for the conversion of Building 26, Naval Hospital, in San Diego.
- Project Electrical Engineer on projects for the U. S. Navy involving the design and construction of a Vehicle Test Center and Recruit Depot in San Diego.
- Project Electrical Engineer for the rehabilitation of a vehicle storage and equipment maintenance facility at San Rafael, California for the Golden Gate Bridge, Highway and Transportation District.
- Project Manager on several VE studies for the U. S. Navy.

- Project Electrical Engineer on the development of plans, specifications and cost estimates for major rehabilitation of vehicle maintenance and storage facilities for the San Diego Transit Corporation.

Additionally, he was involved in the conceptual planning and development of construction documents and cost estimates for a Multi-Purpose Range Complex at Fort Hunter-Liggett for the Army Corps of Engineers.

He was responsible for system design review, coordination, and operating plan for the Sacramento Regional Transit District's LRT system. In this role, he was responsible for the review and coordination of documents for several multi-disciplinary contract documents, and for the development of a system operating plan for the proposed 18 miles of light rail transit. Mr. Miller was also responsible for the development of an integrated test plan for Sacramento's 18-mile system which was carried out prior to start up.

MERVIN S. ASH

SENIOR MECHANICAL ENGINEER, FOSTER ENGINEERING, INC.

EDUCATION

B. S., Mechanical Engineering, University of California at Berkeley, 1950

REGISTRATION

Mechanical Engineer, California No. M121081
Mechanical Engineer, Oregon, No. 7895

CAPABILITIES

Mr. Ash has been engaged in mechanical engineering since 1950, as consulting engineer or engineering-contractor. Projects include hydroelectric and water resources development, power plant design, machine and equipment design, material handling systems, HVAC, plumbing and drainage systems for buildings and hospitals. Specific recent experience on the design of bus maintenance facilities, and the development of functional drawings and equipment lists.

EXPERIENCE RECORD

Foster Engineering, Inc., San Francisco, California
Senior Mechanical Engineer for the firm's work on a $9 million project at the Naval Hospital in San Diego involving major site development and utilities reconstruction and for several open-end mechanical/electrical contracts with the Navy.

Senior Mechanical Engineer and functional designer on the firm's multi-contract rehabilitation development of the San Rafael 250-bus facility for the Golden Gate Bridge District, and project manager on the firm's contracts with the U. S. Postal Service.

Chief Mechanical Engineer responsible for all mechanical engineering design and contract documents on vehicle maintenance facility projects for San Diego Transit Corporation, Sonoma County, and the U. S. Navy.

Team member and mechanical.engineer on several VE projects for the U. S. Navy.

Chief Mechanical Engineer for the firm's work on major bus maintenance facilities at Emeryville and Richmond for AC Transit, in charge of preparation of function plans for the system, equipment procurement, and general systems design.

Project Engineer responsible for mechanical design review on the firm's work with Sacramento Regional Transit District on the development of 18 miles of light rail transit and maintenance facilities for light rail vehicles (LRV).

PREVIOUS EXPERIENCE

Has designed and prepared contract documents for heavy mechanical equipment, HVAC, and plumbing systems, pump and piping installations and odor control systems for sewage treatment plants.

Designed energy recovery systems using sludge gas engine generators with heat recovery for heating and cogeneration peak shaving, and participated in energy studies. Developed an HVAC system using a cooling tower as economizer for an underground computer center addition.

Responsible for a variety of mechanical equipment designs and material handling systems involving preliminary and final design, specifications, prototype testing, operations manuals, construction review and inspection and energy studies. Specific projects included: energy study on a large industrial building; design of accumulator for the 1000 psi water cooling system at the High Enthalpy Facility at NASA, Ames Research Center, energy study for utilizing sewage sludge gas for plant heating, cooling, and power generation (cogeneration peak shaving); computer-assisted energy studies and HVAC designs; pump station design and studies for small hydroelectric power plants.

Responsible for machinery and mechanical design for the Miller-Sweeney Highway Bridge, Fruitvale, County of Alameda.

HERY LITMAN-CLEPER

STRUCTURAL DESIGN ENGINEER, FOSTER ENGINEERING, INC.

EDUCATION

M. S., Structural Engineering, Institute of Civil Engineering, Bucharest, Romania

REGISTRATION

Civil Engineering, California No. C039725
Structural Engineering, Romania

CAPABILITIES

Strong capabilities in structural design of industrial and commercial buildings including foundations, structural steel and reinforced concrete bridges. Substantial background using state-of-the-art methods for dynamic and static design of structures to resist seismic forces. Substantial knowledge of soil structure interaction design and soil mechanics. In-depth knowledge of building codes and requirements for the design of structural steel, reinforced concrete and prestressed concrete.

EXPERIENCE RECORD

Foster Engineering, Inc., San Francisco, California
Structural Design Engineer on firm's work on the following projects:

- City of San Francisco Central Pump Station rehabilitation to withstand seismic forces based on current codes for essential facilities.
- Design review of grade separation structures for the Sacramento Light Rail Project.
- Structural design of steel framing and foundations for heavy duty maintenance building and other smaller buildings at San Rafael Bus Maintenance Facility.
- Structural design of structural steel and concrete buildings at AC Transit District's Emeryville Bus Maintenance Facility.
- Project Structural Design Engineer on major bus facility for AC Transit in Richmond. Major work in post-tensioned concrete structures.
- Structural design of reinforced concrete structures for intake structure, tunnel, and spillway section for Moccasin Hydroelectric Project for Utilities Engineering Bureau of the City of San Francisco.

PREVIOUS EXPERIENCE

With Earl & Wright and Bechtel, was engaged in complex structural design of industrial and off-shore facilities and highway and railroad bridges using computerized design techniques. Prior to coming to the United States, in Romania, he designed and participated in preparation of contract plans and specifications for long span prestressed precast concrete bridges.

ROBERT E. WILLOW

CIVIL ENGINEER

EDUCATION

B.S., Civil Engineering, 1957
M.S., Transportation Engineering, 1970

REGISTRATION

Professional Civil Engineer, California 14570

EXPERIENCE RECORD

Mr. Willow has over twenty-five years of experience in all aspects of civil engineering, planning, design and construction management. He has been a member of multi-disciplinary teams preparing feasibility and preliminary engineering reports on numerous private and public works projects. He has had experience in preparation of plans and specifications for the design of highways, irrigation projects, subdivisions, and water, sewage and utility systems. In addition, he has a strong background in the construction supervision of highway, railroad and municipal works including:

- Resident Engineer - State of Arizona, Interstate Interchange
- Resident Engineer - City of Pittsburg, Railroad Overpass and Underpass
- Resident Engineer - TAMS, 128 Mile Roads and Bridges, Malawi, Africa
- Structures Inspector - ATSF, 120 Mile Railroad Relocation, Arizona
- Pile Driving Inspector - State of Arizona, Interstate Interchange

Major projects at FEI include the following:

- Senior Civil Engineer and Project Manager on the firm's work for the Department of the Navy, Western Division, and Project Engineer on the firm's civil engineering work at the Marine Corps Base at Camp Pendleton. Responsible for client liaison and preparation of contract documents for various civil engineering and site development projects.
- Project Engineer responsible for underground utility mapping and facility design on the firm's work for Pacific Bell.
- Project Manager in charge of field investigation and inspection of 60 miles of railroad at the Sierra Army Depot, Herlong, California. Responsible for the preparation of base maps and construction contract documents for the rehabilitation of the Depot's entire rail system.

- Project Engineer on FEI's contract with the Utilities Engineering Bureau (City and County of San Francisco) for the design and construction of the Moccasin bypass tunnel.

- Project Manager on FEI's contract with Mare Island Naval Shipyard, responsible for preparation of contract documents for P-Crane dockside track replacement.

Previously, Mr. Willow served as senior partner for several engineering firms in Arizona, as well as serving as civil and transportation engineer for firms including Parsons, Brinckerhoff, Quade & Douglas, Tippet, Abbot, McCarthy & Stratton, De Leuw, Cather & Company, the Arizona Department of Transportation, and Santa Fe Railway.

WILLIAM E. CULLEN, AIA

PRINCIPAL, WILLIAM E. CULLEN, AIA & ASSOCIATES

EDUCATION

Bachelor of Architecture / 1967 / Architecture
Diploma D'Architecture / 1965 / Architecture

PROFESSIONAL REGISTRATION

Architect, California, 1968

EXPERIENCE

William Cullen, principal of William E. Cullen, AIA, and Associates, has thirty years' experience in the field of architecture and was first registered in 1965. Prior to opening the office of WEC & A, Mr. Cullen served three years as Senior Architect with the engineering consultants to BART before entering private practice. As an associate of Tallie B. Maule, AIA, and Associates, Mr. Cullen continued his work with the public client as Project Architect for the Embarcadero BART Station and MUNI's West Portal Station. Since opening his private practice, Mr. Cullen has continued to serve as consultant in the field of transportation. His most recent experience in this area has been as Chief Architect for a portion of the Singapore Transit System with Parsons, Brinckerhoff, Quade and Douglass. In addition to his consulting services in the area of transportation, Mr. Cullen's practice has dealt extensively in remodeling, restoration and compatible additions to existing structures both residential and commercial.

Work in the area of restoration of historic buildings has included:

- Purchase and restored the original Andrew Carnegie Public Library of Mill Valley, built in 1906.
- Negotiated the purchase of San Francisco's historic Audiffred Building, One Mission Street (at the Embarcadero), assembling the development team, and was Architect of record for the restoration and development of this historic structure.
- Served for ten years as a member of the Board of Henry Ohlhoff House and acted as consultant in numerous projects to restore their historically significant Victorian built in 1889.
- Detailed and supervised the restoration of a turn-of-the-century stained glass window at Saint Paul's Episcopal church of San Rafael.

Mr. Cullen is a member of the National Trust for Historic Preservation and was a founding member of the Environmental Design Foundation of Northern California (formerly the Architectural Foundation of Northern California), dedicated to the improvement and preservation of the built environment. WEC & A now works exclusively with CADD for all survey, design and contract documents, enhancing greatly the final accuracy of all work. This method of presentation will be used to co-ordinate all disciplines.

HOWARD GRANT, AIA

PRINCIPAL, REID & TARICS ASSOCIATES

EDUCATION

B. A. / 1963 / Architecture

PROFESSIONAL REGISTRATION

Architect, California and Hawaii

EXPERIENCE

Mr. Grant is a licensed architect in the states of California and Hawaii. He began his career as a member of the conceptual design team for the Bay Area Rapid Transit District, and joined RTA in 1965 to ultimately head the design team for five rapid transit stations and MUNI Metro.

His most recent experience has been the programming and design of the Advanced Materials Laboratory and the Advanced Light Source facility at Lawrence Berkeley Laboratory.

Mr. Grant was the project architect and design principal for the following projects:

- BART/MUNI Metro Subway Stations, Civic Center, Van Ness, Church, Castro, West Portal, San Francisco Underground Line, San Francisco, California.
- Advanced Materials Laboratory, Lawrence Berkeley Laboratory, 80,000 square feet.
- Advanced Light Source, Lawrence Berkeley Laboratory, 80,000 square feet.
- Mendocino College Gymnasium, Mendocino Lake Community College District, Ukiah, California.
- Advanced Isotope-Separation Facility, Lawrence Livermore National Laboratory, 60,000 square-foot office building, 80,000 square-foot laser laboratory.
- Physical Fitness Complex, U. S. Army - Presidio of Monterey, 84,000 square feet.
- Santa Ana Elementary School #10, Santa Ana Unified School District, Santa Ana, California.
- Auditorium (450 seats with fly gallery), McAteer High School, San Francisco Unified School District.
- Class of '54 Gate, UC Berkeley, Berkeley, California.

- Advanced-Generation Cockpit, Research Facility, NASA, Moffett Field, California.
- F-18 Aircraft Trainer Facility (2 phases), U. S. Navy, NAS Lemoore, California.
- Headquarters (3 buildings), California Air National Guard, Moffett Field, California.

APPENDIX B - VE Workbook

Southern California Rapid Transit District Metro Rail Project
Value Engineering Study #3 - Stations - MOS-II

Value Engineering Workbook

Title: Value Engineering Study #3
Stations - MOS II

Date: 9/15/89

VALUE ENGINEERING WORKBOOK

VALUE ENGINEERING WORKBOOK

VALUE STUDY NO: 3 DATE: 9/15/89

STUDY TITLE: SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT - VALUE ENGINEERING STUDY #3
STATIONS - MOS II

TEAM

NAME	DISCIPLINE		TELEPHONE NO.
R. H. Mitchell	Team Leader	L	(503) 223-2876
M. S. Ash	Mechanical		(415) 543-1193
W. Cullen	Architectural		(415) 381-2443
H. A. Foster	Structural		(415) 543-1193
H. Grant	Architectural		(415) 546-7170
R. H. Miller	Electrical		(415) 543-1193
W. R. McCutcheon	Subway Construction		(415) 254-1197
J. W. Yee	Civil	R	(415) 543-1193

L - TEAM LEADER
R - RECORDER

Phase I Information

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

PRESENT DESIGN COST MODEL

FACILITIES BREAKDOWN		
TUNNEL	$112,435,000	
REARRANGEMENT OF UTILITIES	$ 7,500,000	
STATION UTILITY WORK	$ 17,250,000	
STATION	$194,127,000	
STATION SITE RESTORATION	$ 5,000,000	
FACILITIES		**$336,312,000**
SYSTEMS		**$168,013,000**
DESIGN		**$ 51,128,000**
CONSTRUCTION MANAGEMENT		**$ 25,211,000**
CONTINGENCY, 12%		**$ 60,519,000**
TOTAL COST		**$641,183,000**

Notes:

1. Total cost excludes right-of-way, District administration, insurance and special consultant costs.
2. Systems cost is based on MOS-2 total cost. Design and Construction Management costs and contingency percentage are based on SCRTD supplied figures.

A. Design documents consisting of the Standard Directive Plans, Standard Specifications and Design Criteria were available to the VE Team for review prior to the Formal Study. The document list is as follows:

1. SCRTD Metro Rail System Design Criteria & Standards, Revision 1 dated 5/85:
   - 1.1. Volume I — Systemwide (Contract Drawings, Fire/Life Safety, System Safety, Security, System Assurance)
   - 1.2. Volume II — Civil/Structural
   - 1.3. Volume III — Stations
   - 1.4. Volume IV — Mechanical/Electrical
   - 1.5. Volume V — Subsystems.

2. SCRTD Metro Rail Project - Structural Standard and Directive Drawings, Various Revision Dates.

3. SCRTD Metro Rail Project - Architectural Standard Drawings, Various Revision Dates.

4. SCRTD Metro Rail Project - Electrical Standard and Directive Drawings, Various Revision Dates.

5. SCRTD Metro Rail Project - At-Grade Standard and Directive Drawings, Various Revision Dates.

6. SCRTD Metro Rail Project - Baseline Specifications:
   - 6.1. General Conditions
   - 6.2. Division 1
   - 6.3. Technical Guide Specification Sections 2 through 16.

7. SCRTD Metro Rail Project - Wilshire/Alvarado Line - Construction Contract No. A-171, dated September 1986 (Conformed Copy) and SCRTD Metro Rail Project - 7th/Flower Station - Construction Contract No. A-167, Advertised November 1988 and Awarded March 1989 (Conformed Copy).

8. SCRTD Metro Rail project - Bid Form for Wilshire/Alvarado Line - Contract A171 - Addendum No. 2, dated 11/11/86.

9. Final Supplemental Environmental Impact Statement, July 1989.

10. Dynamic and Static Outline of Breda Car Body Outline

11. Metro Rail Project Contract Change/Claim Status - Executive Summary Report (As of 03/31/89).

12. Metro Rail Cost Estimate - Phase II, MOS-2, dated March 17, 1989, and Metro Rail Cost Estimate - Phase II, MOS-3, dated March 22, 1989.

13. Tunnel Maintenance and Rerailment Study, dated April 30, 1984.

14. Design Drawings for Six Stations and Line Segments, Task 1.A Phase II Part A, dated June 30, 1989, and Design Report for Six Stations and Line Segments, dated June 1989.

B. The VE Team had initially considered the stations as part of Value Engineering Study #1, completed on 28 July 1989, and reported initial findings therein. The VE Team reconvened at 1:30 pm on 7 September 1989 at the offices of Southern California Rapid Transit District (SCRTD), Los Angeles, CA, for the Briefing and Discussion with the Design Architects & Engineers. Personnel attending were:

* Robert H. Mitchell, CVS	Consulting Value Specialists	(Value Engineering Team Leader)
* Harry A. Foster	Foster Engineering, Inc.	(Structural)
* Howard Grant	Reid & Tarics Associates	(Architect)
* Wilmot R. McCutheon	Foster Engineering, Inc.	(Station Construction)
* Robert H. Miller	Foster Engineering, Inc.	(Electrical)
* Johnson W. Yee	Foster Engineering, Inc.	(Civil and Utilities)
John Bilich	RTD	
Jeff Christiansen	RTD	
Jim Crawley	RTD	
Al Levy	RTD	
Douglas Low	RTD	
Sam Louis	RTD	
M. Merrick	RTD	
Joel Sandburg	RTD	
Hal Storey	RTD	
Nadeem Tahir	RTD	
Ramesh Thackanar	RTD	
Al Amador	MRTC	
William Armento	MRTC	
Jim Ball	MRTC	
Jim Monsees	MRTC	
K. N. Murthy	MRTC	
Jim Sowell	LACTC	

* (Denotes VE Team Members)

C. The Briefing was presented by RTD and MRTC representatives. This was followed by a Question and Answer Period by all Team Members. Items of interest presented and discussed were:

1. Jim Ball initiated the A/E Briefing. Made reference to newly issued Architectural Design Report and Drawings identified above as Reference 14. General discussion of NEPA process. Discussed in-progress status of preliminary design aspects relating to Parts A and B.

2. All Stations. Identified pertinent design features. Mezzanine configuration and station entrance location per District Directive. Climbing grade provided through stations. Discussion of entrance provision philosophy. Single entrance provided with other entrance opportunities based on potential joint-development cost sharing formulae.

3. Status of VE Study Direction. The VE Team was directed to examine Reference 18 design status as the scope of this VE Study.

4. Discussed possible substitution of Vermont/Melrose Station location in lieu of the present design Vermont/Beverly and Vermont/Santa Monica locations. Information only. VE Team directed to disregard this alternative.

5. General discussion of off-street entrances. The reason that no sidewalk entrances were considered was due to narrowness of sidewalks and limited expansion capability. Street traveled way widths were considered by City to be critical due to peak hour auto traffic flow requirements.

6. Joint development philosophy was discussed. Station entrances presently suit anticipated patronage. District will work with Developers when projects come "on-line" at station vicinities to achieve maximized attractiveness. RTD has adopted a Joint Development Policy which is in effect.

7. Station general arrangement and finishes were outlined by Doug Low. Basic station design discussion. Emergency exits are required per Fire-Life Safety and sizes are based on loading calculations. Mezzanine discussion. Waterproofing not considered because of HDPE outer liner. Finishes are durable materials. Tiebacks and temporary ground support is contractor responsibility; District has not entered into easement negotiations with adjacent landowners. Fare collection is to be initially "honor" with station mezzanines designed to permit future installation of fare collection equipment at the option of the District. Column supports were discussed. Escalators were discussed with an option by District to relax requirements at low-patronage stations. Station platform widths were discussed; 22' wide platform is possible. Platform lengths were discussed; 20' reduction is possible. Room sizing in Ancillary Areas was discussed at length. Station ventilation fan configurations, attenuation and ducting items were discussed.

8. Method of Construction was discussed. Decking must follow maintenance of traffic requirements. Minimum lane situation is 3 lanes with 2 lanes in each peak direction. Tiebacks versus Soldier Piles versus Waiers and Struts as excavation support was

discussed.

9. General discussion of various other issues. Station location shifts may be examined. Utility impacts are defined in Reference 18. Exit requirements must be based on capacity. V-Shape entrances are expendable if cost savings accrue. Plaza-type entrances are possible if cost advantage. Ceiling heights are nominal but an "open" environment is desirable.

D. Briefing was concluded at 3:30 pm and the District and A/E Representatives were thanked for their attendance. The VE Team returned to San Francisco to complete the Information Phase Work.

E. The VE Team reconvened on 11 September 1989 at Foster Engineering Inc. offices in San Francisco. The Team was joined by Mr. Douglas Low of SCRTD, Mr. Bill Cullen, Architect, and Mr. Mervin S. Ash, Mechanical Engineer, who participated as members of the VE team. The team was also assisted by Mr. Robert E. Willow, Civil Engineer, and Mr. Hery Litman-Cleper, Civil/Structural Engineer.

Mr. Mitchell briefly outlined the value engineering process for the benefit of all present.

In light of prior consideration of potential VE subjects during VE Studies #1 and #2 and review of additional material received at the Briefing, the team further developed the list of items to consider for speculation, analysis and ultimate development. These items are:

1. Station Ventilation Systems.
   - 1.1. Station Supply Air. Propose fresh air intake off street by tower.
     - 1.1.1. Modify Blast System to Ventilate Station. General discussion of concept.
   - 1.2. Ductwork. Present design does not have ducts and therefore is not functional. Propose distribution.
   - 1.3. Emergency System. Improve efficiency and reduce cost. Discussed Underplatform Exhaust (UPE) system. General discussion of BRS locations and function.
     - 1.3.1. Gas Monitoring and Control System. Emergency Fans are presently used for gas clearance. Eliminate gas control function from these fans. Objective is to eliminate noise nuisance.
     - 1.3.2. Noise Control. Look at using tunnels as noise attenuation devices.
   - 1.4. Smoke Exhaust System. Ducts in upper corner of station. Objective is to eliminate. Find alternate system to remove smoke from mezzanine.
   - 1.5. Air Conditioning Provision. Examine need. Possible use of swamp coolers.
   - 1.6. Ventilation Shafts. Blast relief shafts (BRS) should be placed in street. Sumps can be designed to accommodate prevention of fuel spillage onto trackways.

General Note: Suspect headroom in stations being provided to accommodate future ventilation ducts, etc. Perhaps modification of station configuration by "opening up" to atmosphere can eliminate need for complex ventilation system.

2. Station Headroom.
   2.1. Platform to Mezzanine.
   2.2. Mezzanine to Roof.
3. Platform Width.
4. Platform Length.
5. Ancillary Spaces. Question size and volumes. Look at compression and relocation. Examine space intrusions into station areas.
   5.1. Location and Size.
6. Foundations.
7. Columns. Look at elimination and replacement with alternate structural system.
8. Method of Construction. General discussion of direction.
   8.1. Tunneled Stations.
9. Station Depth.
   9.1. Raise Profile.
   9.2. Undertrack Platform Connection. Side platform situation applications only.
10. Emergency Exits.
11. Station Entrances.
    11.1. Consider joint development potential.
    11.2. Examine openness.
    11.3. Parking Strip Location.
12. Station Mezzanines. Present directive drawings permit either end-loaded or center-loaded configurations; dependent on location of entrances. This may not be proper approach. Adjust locations to suit lower-cost or more cost-efficient situation. General discussion of optimal configuration. Additional discussion of "honor fare" system. Examine openness.
    12.1. Alternate Configurations.
    12.2. Elimination potential.
13. Station Location. Look at fine-tuning.
14. Blast Relief Shafts. Additional discussion. See Item 1 notes.
15. Swamp Coolers. Present design presumes cooling tower with refer equipment in station spaces. Evaporator coolers will eliminate need for equipment space within stations. Discussed disadvantages. Discussed effect of increased humidity over time and solution by indirect system. See Item 1 notes.
16. Off-street Ancillary Spaces.
17. Utilities. Examine utility constraints and relocation plans.
18. Joint Development. General discussion. Application as separate subject not apparently clear.
19. Highland Pocket Track. Look at relocation to Runyon Canyon versus Vine Street.
20. Side Platforms. Revisit side versus center at crossovers. General discussion.
21. Electrical. No obvious things. Wilshire-Alvarado package contains 1/3 electrical drawings; question is why?

The ideas were categorized by cost savings potential and by common subject matter. An attempt was made at consolidating and summarizing the ideas as follows:

1. Station Depth
2. Station Width
3. Station Length
4. Foundations
5. Columns
6. Emergency Ventilation System
7. Exhaust Shaft
8. Smoke Exhaust System
9. Air Conditioning System
10. Station Ventilation
11. Utility Relocation
12. Mezzanine Configuration
13. Station Entrance
14. Emergency Exits
15. Station Location
16. Relocate Pocket Track
17. Side Platform Station vs. Center Platform at X-Over Stations.
18. DWP Provision.

Consultation Record

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

INFORMATION CONTACT (Name, Title, Company)	TELEPHONE NO. and Area Code	MAJOR POINTS OF DATA RECEIVED
Ray Chan, Chief Mech. Engr BART	(415) 464-6685	BART has made only ~~rough~~ ~~measurements~~ of Q split between tunnels & stations, but he estimates Emerg. Fans would split about half-and-half station & tunnels with no trains in either. Has a paper on acoustic lining he will send.

Phase II Speculation

A. The items developed during the Information Phase were categorized into broad categories and "brainstormed".

B. Functional and creative analysis of the category items resulted in the following:

B.1. (Space for) Station Air Conditioning

Function(s):	Present - Allocate Space Future - Cool Station
Alternatives:	Retain Present Design of Allocating Space For Chillers. Eliminate Equipment Space and Design Station Not To Preclude Future Air Conditioning Provision. Evaporative Cooling System (Reduce Equipment Space).

B.2. Station Ventilation - Supply Air & Ductwork

Function(s):	Present - Change Air, Increase Comfort (Initial Consideration) No Function Finding After Final Consideration Future - Support (Future) Air Conditioning
Alternates:	Retain Present Design. Eliminate.

B.3. Noise Attenuator (Emergency Ventilation)

Function(s):	Control Noise
Alternates:	Retain Present Design. Alternate Muffling Design. Do Not Use Emergency Fans Except In Emergencies.

B.4. Station Ventilation - UPE Exhaust Shaft

Function(s):	Channels Airflow
Alternates:	Retain Present Design. Alternate Shaft Layouts, Minimized Length.

B.5. Station Ventilation - Blast Relief Shaft

Function(s):	Channels Airflow
Alternates:	Retain Present Design. Alternate Shaft Layouts, Minimized Length.

B.6. Station Ventilation - Smoke Exhaust System

Function(s):	Remove Smoke Remove Methane (Secondary)

	Alternates:	Retain Present Design. Eliminate Modify To Supply System Change Location To Eliminate Intrusion Into Station Volume
B.7.	Ancillary Space	
	Function(s):	Houses Equipment
	Alternates:	Retain Present Design. Reduce To Functional Requirements.
B.8.	Platform Length	
	Function(s):	Accesses Train
	Alternates:	Retain Present Design Which Encloses Entire Train Length. Reduce To Functional Requirements By Permitting End Overhangs.
B.9.	Station Mezzanine Configuration	
	Function(s):	Collects Fares Distributes Passengers
	Alternates:	Retain Present Design. Other Configurations That Would Maximize Entrance Opportunities and Patron Distribution.
B.10.	Emergency Exits	
	Function(s):	Evacuates Patrons
	Alternates:	Retain Present Design. Minimize Separate Exits. Reconfigure Exits At Platform Ends.
B.11.	Station Entrances	
	Function(s):	Accesses Stations Permits Flow
	Alternates:	Retain Present Design. Reconfigure To Achieve Minimal Permanent Right-Of-Way Impact, Maximized Capacity For Emergency Exiting, and Maximized Attractiveness.
B.12.	Platform Width	
	Function(s):	Accommodates Capacity
	Alternates:	Retain Present Design. Reduce To Accommodate Projected Passenger Loading.

B.13. Mezzanine To Roof Clearance
Function(s): Establish Clearance

Alternates: Retain Present Design.
Reduce To Accommodate True Clearance Requirements.

B.14. Platform To Mezzanine Clearance
Function(s): Establish Clearance

Alternates: Retain Present Design.
Reduce To Accommodate True Clearance Requirements.

B.15. Station Depth (Raise Profile)
Function(s): Accommodates Function

Alternates: Retain Present Design.
Modify To Achieve Minimized Excavation And Achieve Avoidance of Alignment Obstructions.

B.16. Station Mezzanine - Undertrack Platform Connections
Function(s): Accommodates Capacity

Alternates: Retain Present Design.
Provide Alternate Connection Between Platforms Underneath Trackway (For Side Platform Station Configurations Only).

B.17. Cut & Cover Method Stations
Function(s): Constructs Station
Disrupts Traffic (Unwanted)

Alternates: Retain Present Design.
Mine Station.
Invert Station Construction.

B.18. Foundations
Function(s): Supports Load

Alternates: Retain Present Design.
Strip Foundation System.

B.19. Station Columns
Function(s): Supports Load

Alternates: Retain Present Design.
Clear Span Design.

B.20. Utility Relocations

Function(s):	Clear Space
Alternates:	Retain Present Design. Avoid Utility Interferences. Modify Relocation Designs.

B.21. Station Location

Function(s):	Optimize Access Minimize Conflicts
Alternates:	Retain Present Design. Modify Station Locations.

B.22. Runyon Canyon Pocket Track

Function(s):	Store Train
Alternates:	Retain Present Design. Relocate Pocket Track To Location Specified. Relocate Pocket Track To Another Location.

B.23. Side Platform versus Center Platform At X-Over Stations

Function(s):	Access Train
Alternates:	Retain Present Design. Side Platform Configuration.

B.24. DWP Provision

Function(s):	Enclose Equipment.
Alternates:	Retain Present Design. Minimize To Functional Requirements.

C. This Phase was concluded and the VE Team proceeded to the Analysis Phase.

Phase III Analysis

A. The results of this phase are presented in the individual Value Engineering Proposals (VEP's) in the basic report. Each VEP compares advantages and disadvantages and analyzes in depth costs of present design and VE proposed design.

B. During the course of this phase, consideration was made of the following items.

B.1. Pocket track. Examined alternates: (1) relocation to Runyon Canyon, (2) tail tracks at MOS-II terminus beyond Highland, (3) operational constraints posed by elimination and modification schemes. The VE Team decided that two proposals will be prepared on the pocket track; (A) a single crossover at Hollywood/Vine and (B) a double crossover at Hollywood/Vine.

B.2. Hollywood/Vine Station. Discussed joint development potential and impact on design elements. Determined that 15' minimum width is necessary at maximum loading condition.

B.3. Hollywood/Sunset Station. Determined that 12' minimum platform width is necessary to accommodate anticipated passenger loads.

B.4. Platform Length. Discussed impact of berthing tolerance. Reviewed thought process.

B.5. DWP Provision. Considered as part of Station Configuration/Ancillary Space VE subject.

B.6. All VE Study items were subjected to intense scrutiny and the subjects were discussed among the VE Team members to fully understand the present design and then each item was developed to expose cost savings potential of alternate concepts.

Phase IV Development

DEVELOPMENT NOTES

Following the Information and Speculation phases of the VE process, the team analyzed and developed further all ideas considered worthy of pursuit. Some of these ideas were developed only sufficiently to show that there was no particular advantage or saving. Other ideas were carried through to completion when they showed a good potential for improvement in function and/or cost savings.

Ideas which were explored but dropped were:

1. Runyon Canyon Pocket Track Location. Not likely from an environmental feasibility standpoint. Look at in-rock location within Santa Monica Mountains.
2. Utility Relocations. Examined concept design and determined that present station construction design dictates the utility relocation scheme.
3. Side Platform Station Vs. Center Platform At X-Over Stations. Equivalent cost.

The other ideas were characterized into the following broad categories and each category was subjected to detailed analysis.

1. Station Physical Characteristics.
   - 1.1. Station Depth
   - 1.2. Station Columns
   - 1.3. Station Length
   - 1.4. Station Foundation
2. Station Ventilation Components.
   - 2.1. Emergency Vent Shaft (BRS Outlets)
   - 2.2. Emergency Vent Shaft (Noise Control)
   - 2.3. Underplatform Exhaust (UPE) Outlets
   - 2.4. Smoke Exhaust System
   - 2.5. Station Ventilation (Provision For Future Air Conditioning)
3. Station Mezzanines, Entrances and Emergency Exits.
   - 3.1. Station Mezzanine Configuration
   - 3.2. Station Entrances (Modify Primary Entrance & Provide Secondary Entrance(s))
   - 3.3. Station Entrances (Open Plazas)
   - 3.4. Emergency Exits
   - 3.5. Crossover/Station Width
4. Crossovers and Pocket Tracks.
   - 4.1. Pocket Track at Hollywood/Vine Station
   - 4.2. Relocate Pocket Track
   - 4.3. Relocate Pocket Track & Add Crossover

These categories were developed into specific Value Engineering Proposals (VEP's) reported in the Main Body of the Report.

Phase V Presentation

DEVELOPMENT NOTES

PRESENTATION, PHASE V

The presentation of study results was made at SCRTD offices in Los Angeles, California on 18 September 1989. Present were Messrs. R. H. Mitchell, H. A. Foster, W. R. McCutheon, H. Grant, R. H. Miller, and J. W. Yee comprising the VE Team; SCRTD and MRTC representatives.

The VE Team presented its findings and recommended value engineering proposals that would result in total estimated savings of $94.8 Million, order of magnitude amounts. This total was revised to $91.4 Million after further evaluation by the VE Team.

Introduction by R. H. Mitchell. Technical presentation was conducted by H. A. Foster. Brief recap of VE Study #2, with respect to overlap of certain VEP's originally presented therein to the Station VE analysis. Specific identification of VEP's 7 and 8, regarding crossovers, and recapitulation within VE Study #3 as incorporated VEP's.

VE Proposal Briefings

1. Station Depth
2. Station Columns
3. Station Length
4. Station Foundation

5. Emergency Vent Shaft (BRS Outlets)
6. Emergency Vent Shaft (Noise Control)
7. Underplatform Exhaust (UPE) Outlets
8. Smoke Exhaust System
9. Station Ventilation (Provision For Future Air Conditioning)
10. Station Ventilation (Fresh Air Supply)

11. Station Mezzanine Configuration
12. Station Entrances (Modify Primary Entrance & Provide Secondary Entrance(s))
13. Station Entrances (Open Plazas)
14. Emergency Exits
15. Crossover/Station Width

16. Pocket Track at Hollywood/Vine Station
17. Relocate Pocket Track
18. Relocate Pocket Track & Add Crossover

Short Question and Answer Period.

Closed Presentation.

Special Note: Subsequent to the Presentation, VEP's 17 & 18 were combined into a single VEP.

APPENDIX C - Design Review Comments

Station Finishes

The six MOS II stations have not been developed to preliminary design with regard to detailed finishes (Stage II). The finish element represents a substantial cost for the RTD System Budget based on our review of the 7th/Flower Station (Dual Station) low bid of $18,646,000.

While this bid may have been on the high side, considering the limited bid interest and the separate contract for Stage II work, it could indicate a very substantial level of cost for the six stations within MOS-II. Considering that this may be inflated by approximately 30 percent with actual competitive bids in the $8 Million to $10 Million range or some $50 Million to $60 Million for the six station total, a very substantial share of the station construction cost is contained in the station finishes.

Details were not available in the MOS-II package for the station finishes. However, a review of the 7th/Flower Station details indicates that a VE Study should be made at an early design stage of Station Finishes when preliminary plans and estimates are available. It is possible that a 30% ± saving could result from these studies.

The review of the 7th/Flower Station plans indicate substantial cost implications due to detailed requirements such as column treatment, stainless steel inserts for hangers, architectural ceiling design and details, platform and mezzanine floors, etc., that tend to be very costly over intended functional requirements. In some cases, future station areasare constructed to near finished condition yet are intended to remain inactive until some future need is determined.

Neither the required details nor time were available for the VE Study Team to provide specific study VEP's on finishes at this stage of design development so these elements were not examined during this VE Study. The VE Team recommends, however, that an examination of each station design at the conclusion of preliminary engineering be conducted in order to optimize the functional design of the system.

Station Comfort

The VE Team noted that comfort facilities (restrooms) have not been provided for public use at the Stations. A limited facility is provided solely for staff use.

The VE Team questions this as a serious omission that could develop into a substantial public and political objection with the station concepts. A great deal of attention has been directed toward architectural enhancement of stations that offer a pleasing and useful appearance to the public. This effort should be extended to accommodate users' basic needs in order to enlist their assistance in maintaining the stations' pleasant environment. Drinking fountains should also be considered as an enhancement to the stations' function at very little cost.

Methane Control

The profile from Vermont/Sunset to Hollywood/Western contains two reverse vertical curves which give rise to two potential methane collection pockets. The profiles should always slope to an eventual opening.

Hollywood/Highland Station Development

The VE Team has learned from L.A. Weekly of the following potential development projects in the vicinity of the Hollywood/Highland Station:

1. "Around Mann's Chinese Theater." two 20 story "Hollywood Exposition" towers. total 1.1 million square feet (Developer: The Melvin Simon Co. and the John Jerde Partnership).

2. One block west of Mann's Theater. "The Galaxy." Theater and Retail Center (Developer: Kornwasser and Friedman).

3. At Hollywood/Highland Intersection. 1.4 million square foot Office Project (Developer: Robert Bass).

Hollywood City Councilman Mike Woo is reportedly involved in these projects.

What is the impact on the present Hollywood/Highland Station design and construction plans of any of these development projects?

APPENDIX D - Composite Station Configurations

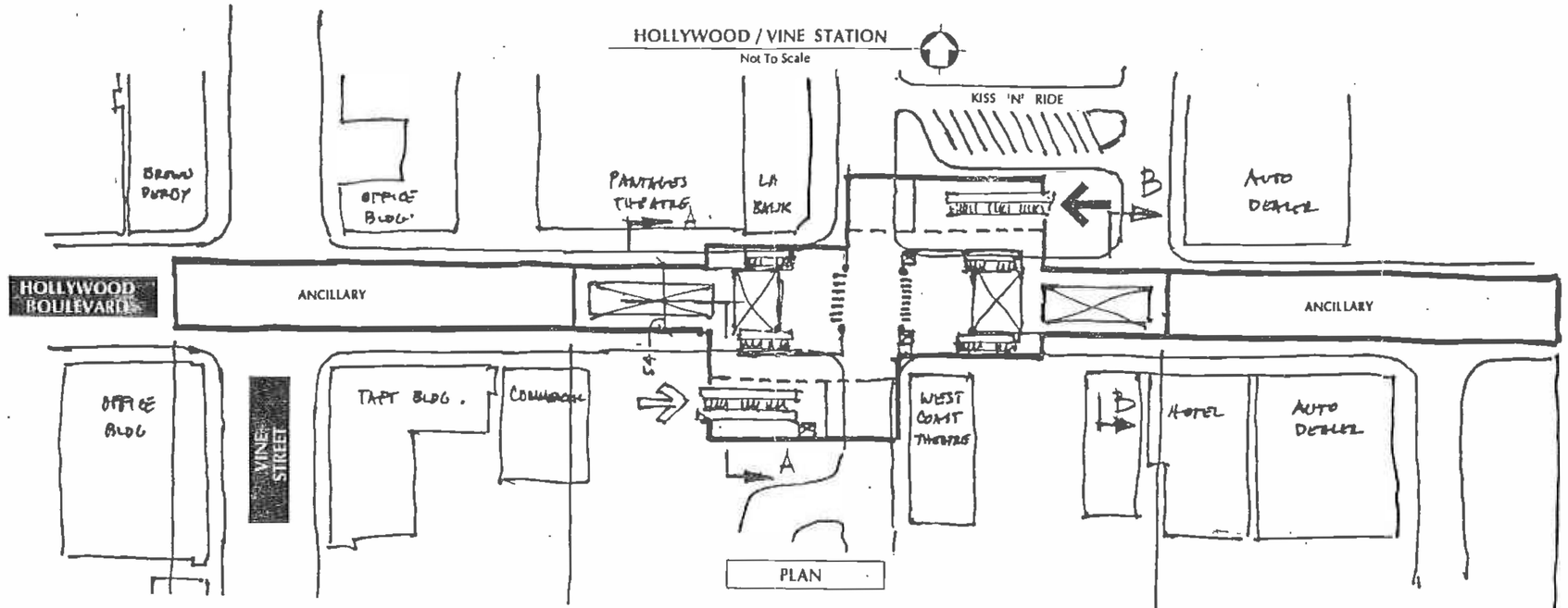
Composite Station Configurations

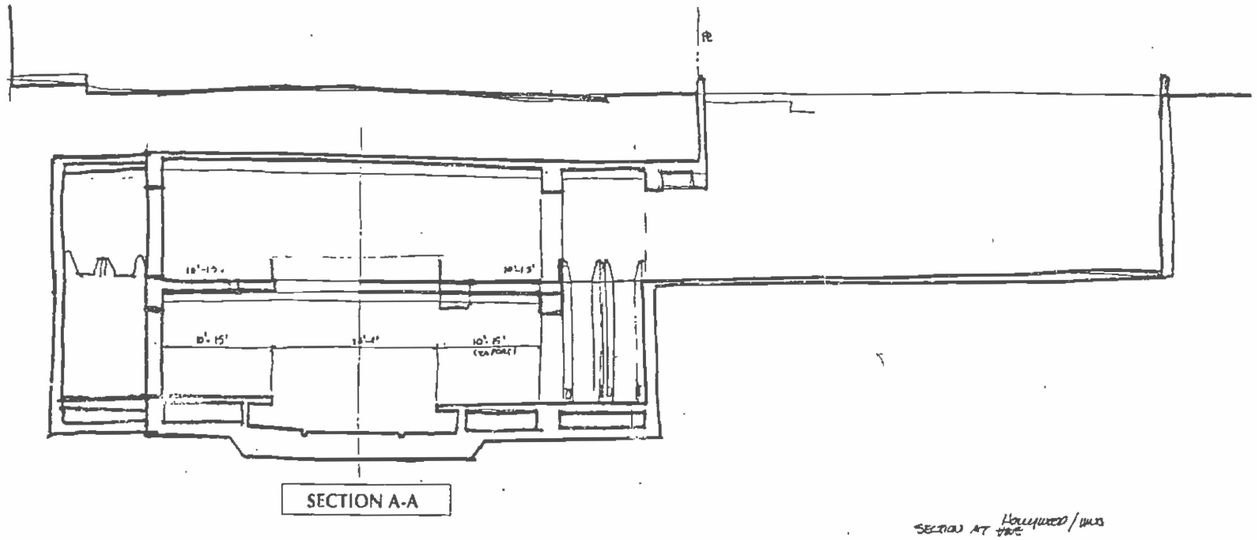
The following station configurations have been prepared to assist the readerto achieve a general overall appreciation of the station appearances after incorporation of the various Value Engineering Proposal concepts detailed in the course of this study effort and reported in depth within the main body of this Report.

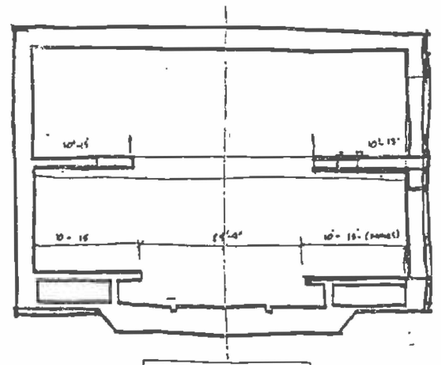
Due to the time limitations of the VE Study period, the configurations presented herein are schematic and representative. Additional design development and analysis is required to fully develop workable project designs. The VE Team hopes that these concepts help stimulate the reader's appreciation of the possibilities offered by incorporation of the VE Study results.

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN





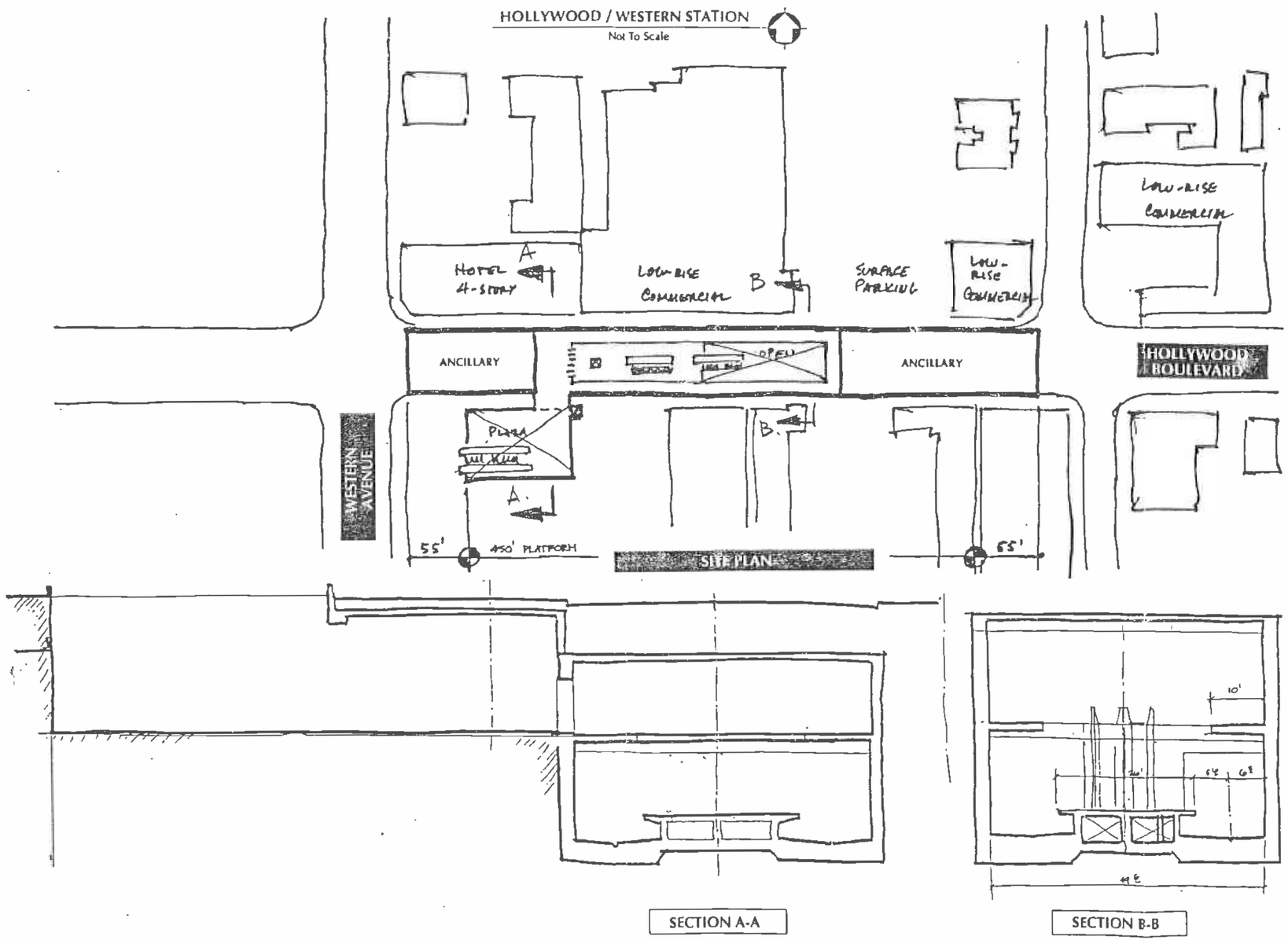


SECTION AT Hollywood/Vine

STATION CONFIGURATION

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

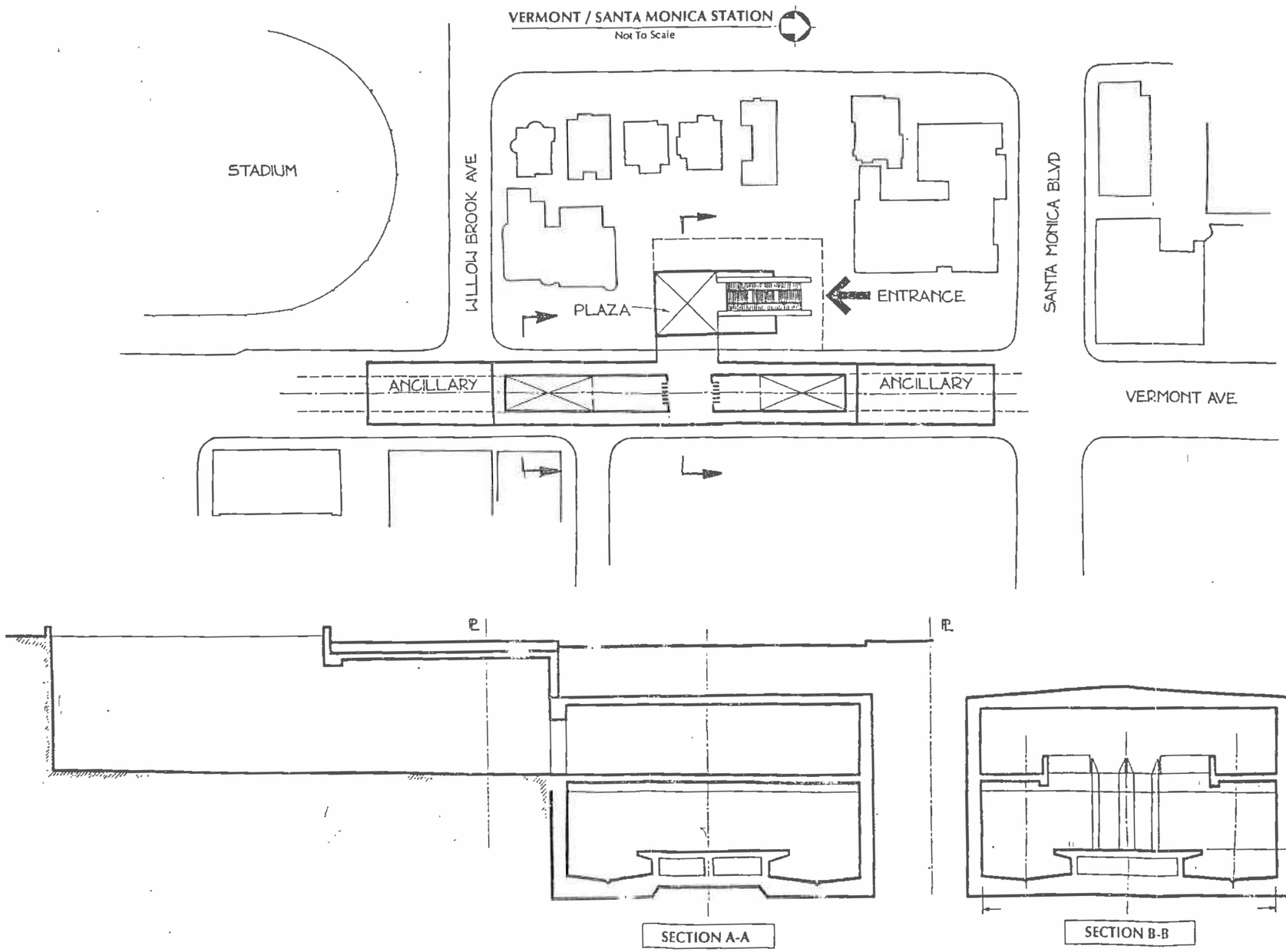
SKETCH OF PROPOSED DESIGN



STATION CONFIGURATION

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
VALUE ENGINEERING STUDY #3 - STATIONS

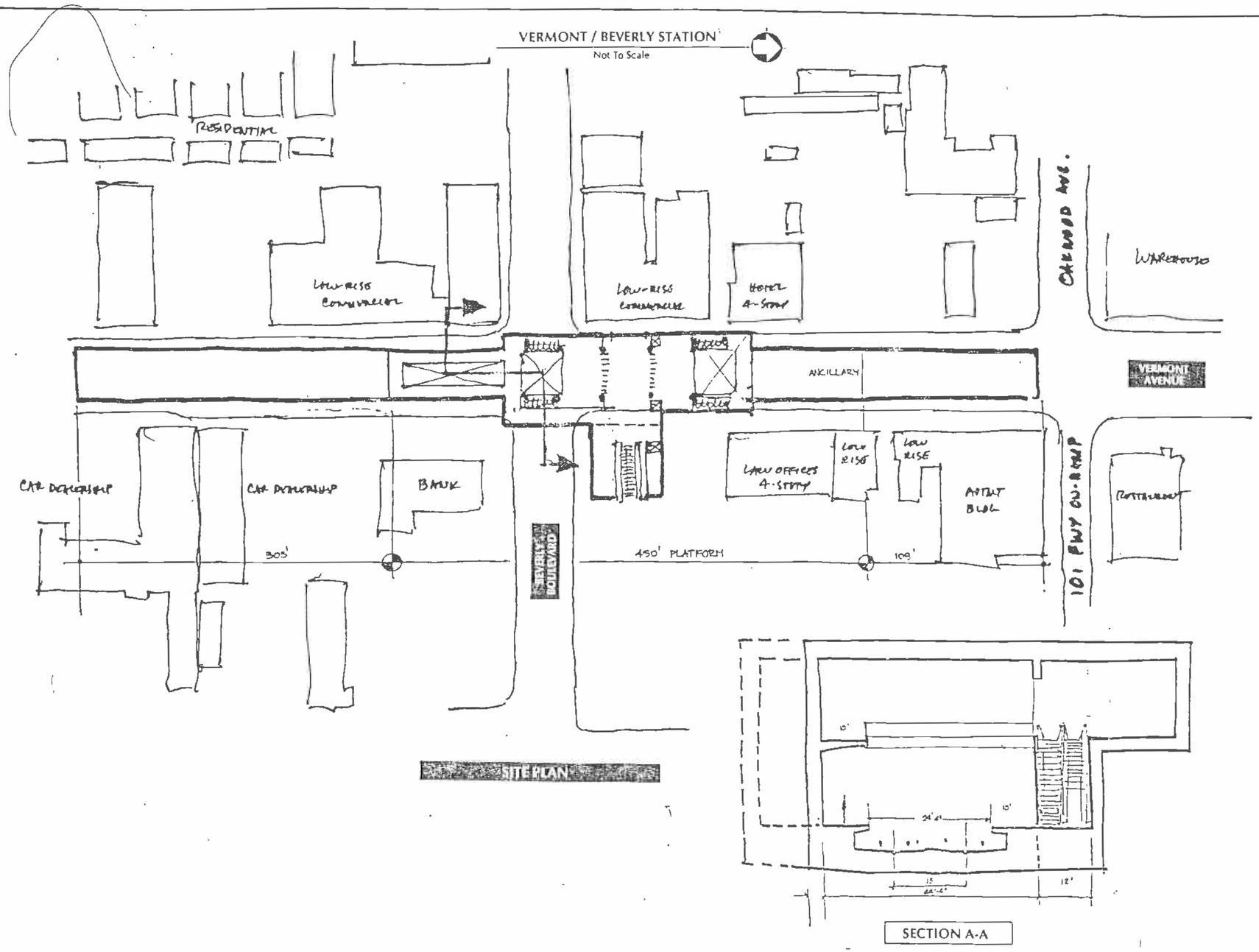
SKETCH OF PROPOSED DESIGN



STATION CONFIGURATION

STUDY TITLE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN

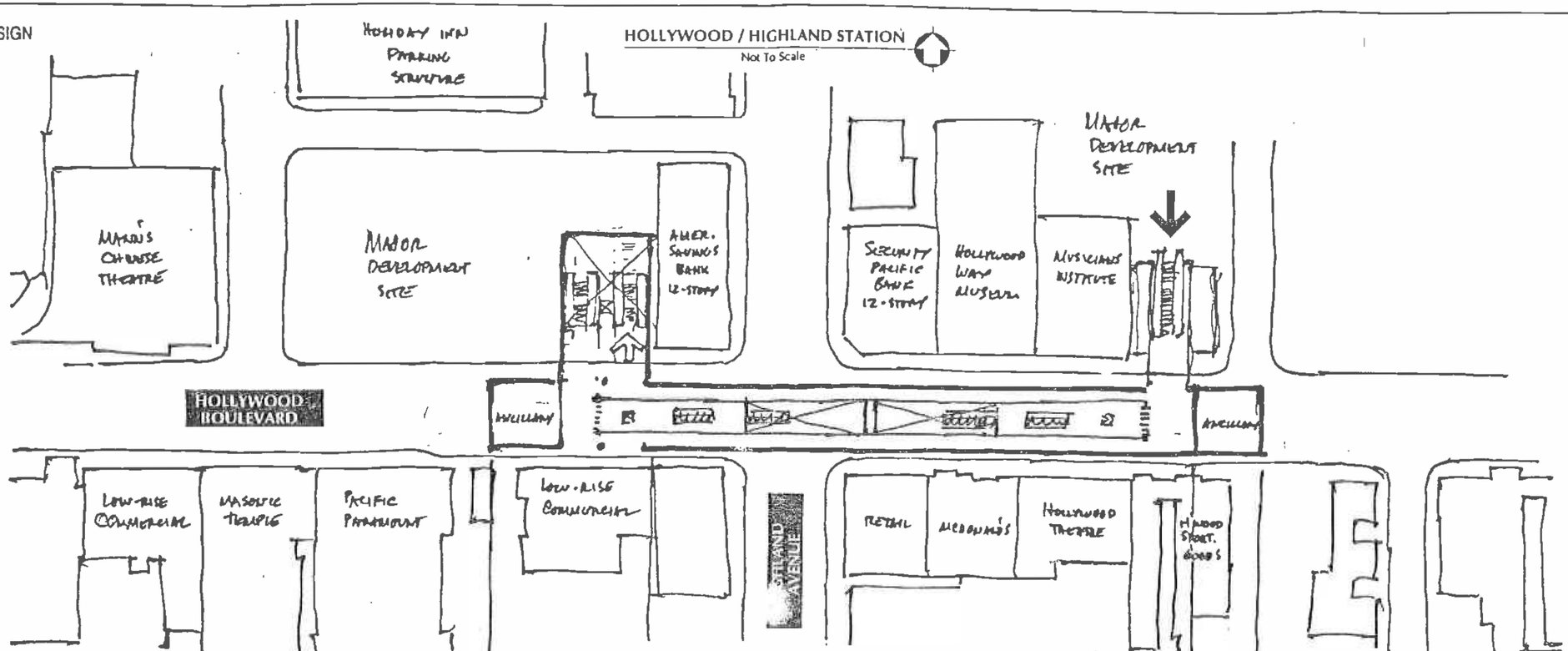


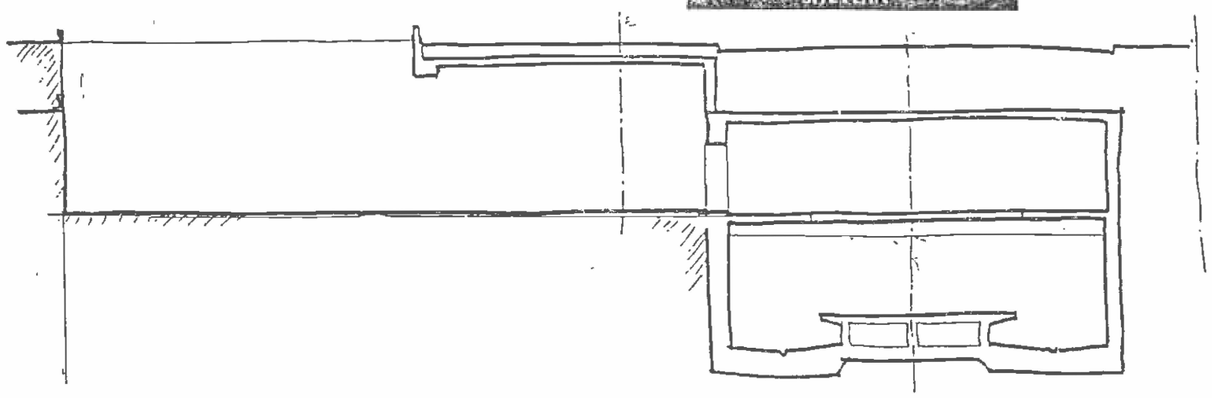
STATION CONFIGURATION

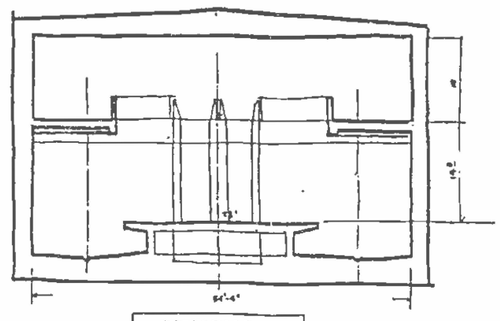
STUDY TITLE

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II
VALUE ENGINEERING STUDY #3 - STATIONS

SKETCH OF PROPOSED DESIGN







STATION CONFIGURATION

STUDY TITLE **SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT METRO RAIL PROJECT - MOS-II**
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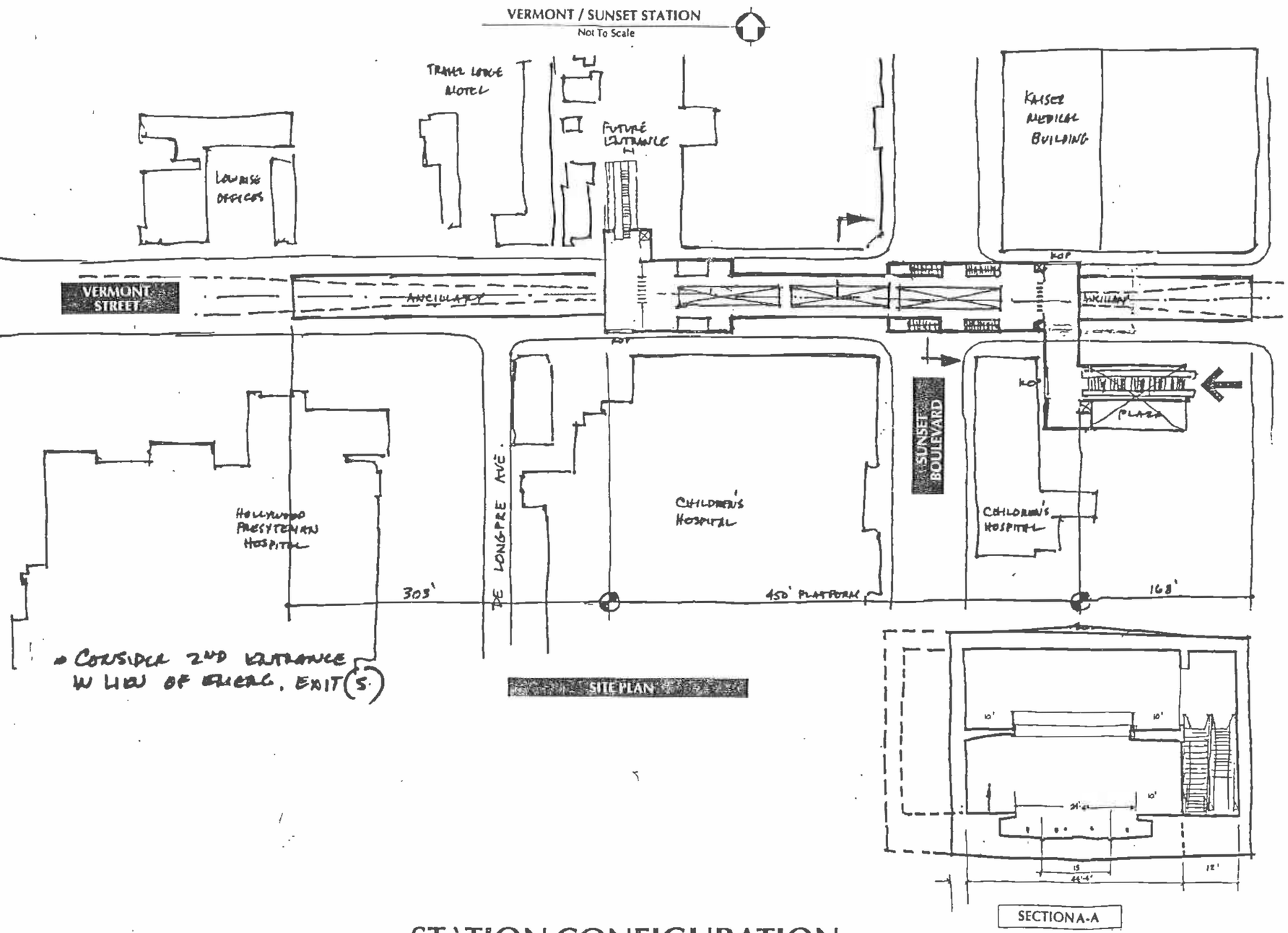

STATION CONFIGURATION

APPENDIX E -
Notes on Traction Power Substation Location

APPENDIX E

NOTES ON LOCATION OF TRACTION POWER SUBSTATIONS

Present Design

Present Design consists of a six traction power substations, one located at each passenger station. Indoor equipment consisting of transformers rectifiers, AC and DC switchgear, is planned for installation.

At three of the stations, the equipment is located in space directly over crossover facilities that occur adjacent to the station, within public right-of-way.

At the other stations, the equipment is located in spaces that require right-of-way acquisition adjacent to passenger station entrances. Future joint development or re-sale of the right of way takes is planned after construction is completed.

Proposed Design

In the proposed design for these stations where equipment is adjacent to the station entrances, the space required for the substation equipment is located at street level. This would necessitate the use of outdoor equipment or surface level structure. Private right-of-way acquisition is needed with limited possibilities for re-sale and joint development. There would be no costs savings in such a case.

For those other passenger stations where substation equipment is located over crossovers, no change is recommended.

Discussion

In developing ideas for the possible relocation of substation facilities to surface location, the team determined that in the case where space is provided over crossover structures to house equipment, deleting this space would not result in any cost savings because the cost of backfilling and heavier resultant structure would be greater than the cost of providing the empty space.

Relocation of these facilities to the surface and to private right of way would therefore result in additional costs associated with the property take and the facilities that would have to constructed thereon. Consequently, the VE Team determined that there would be no cost advantage associated with relocating these particular substations. A cost penalty in excess of $100 per square foot of surface facility space would result.

In the case of those substations which in the present design are located adjacent to entrances, relocating the facilities to street level is not recommended for the following reasons.

- The cost of constructing the underground facilities at mezzanine level are estimated as follows:

Excavation and support	$ 50/sq. ft.
Backfill	$ 20/sq. ft.
Structure/Improvements	$ 35/sq. ft.
Mechanical/Electrical	$ 35/sq. ft.
Total	$150/sq. ft.

- The cost of right-of-way for this facility in the present design is offset by the potential for re-sale or for joint development use. Therefore, the net or total cost for such a facility would be of the order of $150/sq. ft.

- If the same facility is located and developed at surface level, equipment would have to be outdoor type and would cost some 10% more or the equivalent of about $30 to $35 per square foot based on a total equipment cost of about $1,000,000. The cost of improvements around the facility for visual screening, landscaping, etc. is estimated to be about $25 per square foot. The cost of the real estate take would be about $100 per square foot.

In summary, the total cost for street level construction would be about $155 to $160 per square foot. Therefore, there does not appear to be any cost saving for these station locations as well.

It should be noted if right of way costs exceed $100/sq ft., then cost penalties for a surface scheme are increasing. On the other hand if re-sale or joint development of air rights over the subsurface installation do materialize then of course the net cost of the underground facility increases to about $250 per square foot which make a surface installation more attractive.

In summary, it appears that the issue concerning joint development of property adjacent to entrances would be the driving force in the decision to relocate traction power substations to the street level.