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RTD

Alan F. Pegg
General Manager

March 22, 1989

TO: Board of Directors

FROM: Alan F. Pegg

SUBJECT: Metro Rail Project Schedule Status Report

RECOMMENDATION

It is my recommendation that the Board of Directors: a) adopt a revised schedule for the Metro Rail Project which shows a Revenue Operations Date (ROD) of September 1993; and b) authorize the General Manager to submit this revision to the Urban Mass Transportation Administration (UMTA) for its approval, in accordance with Section 4(b) of the Full Funding Contract.

ALTERNATIVES CONSIDERED

The alternative is to not adopt a revised schedule. Maintenance of a ROD of January 1993 does not appear feasible. Not adopting this recommendation could lead to an increase to the Project budget for additional contractor costs for acceleration, as well as delay claims, when milestones are not completed as scheduled.

IMPACT ON BUDGET AND DISTRICT OBJECTIVES

Acceptance of this recommendation has no impact on the UMTA-approved Metro Rail Project budget of $1,249,900,000. The cost of this recommendation will reduce the Project contingency. There is no impact to the District objectives.

BACKGROUND

Over the past year considerable progress has been made on Metro Rail construction. The number of contracts underway has more than doubled, from 10 to 27. Work with a value of $178 million has been completed. MOS-1 is now 28% complete versus 5% at the beginning of 1988. We have resolved some major uncertainties which existed a year ago, such as site access dates, the scope of work of railroad facilities reconstruction at Union Station, and utility relocation at the 5th/Hill Station.

The completion of several key elements of work, such as tunneling excavation in the various soil formations and successful tunneling under major buildings without significant settlement, has caused us to reassess production rates. Analysis of actual performance in these key elements of

work has resulted in adjustments to the schedule and implementation of action plans to mitigate delays.

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There also have been schedule delays due to unforeseen conditions. These delays have accumulated to the point where retention of the current ROD of January 1993 is not feasible. An evaluation of these impacts has resulted in the preparation of revised forecasts to determine the projected delay to ROD and this recommendation to the Board.

SCHEDULE HISTORY SINCE JANUARY 1988

A. Revision 6 of the Metro Rail Project Schedule, January 14, 1988

On January 14, 1988, the RTD Board of Directors approved Revision 6 to the Metro Rail Project Schedule. This change delayed ROD 8 months, from April 1992 to January 1993, as a result of disruptions which occurred since the Full Funding contract was signed on August 27, 1986. These disruptions are listed below:

- o Redesign requirements of the realignment due to the discovery of hazardous material.
- o LAUPT/Amtrak reconstruction resulting from the realignment.
- o Water treatment and dewatering requirements.
- o Protracted contract bid and award cycles.
- o Interstate Commerce Commission decisions which delayed agreements with the railroads.

The status of individual contracts as of January 1988 is summarized as follows:

- o Contract **A135** (Union Station, Stage I). This contract was on the critical path with a projected Notice To Proceed (NTP) of May 2, 1988. This date was later than the originally scheduled NTP date of February 13, 1987, due to the realignment at Union Station.
- o Contract **A141** (Line Section, Union Station to 5th/Hill Civic Center Station, Stage I). This contract had only two weeks float before impacting the Project critical path. Soldier pile installation and excavation had begun at the station. Tunneling was delayed due to lack of site access at Union Station. The Union Station site access date was then revised from mid-May 1987 to May 2, 1988.
- o Contract **A146** (Line Section, 5th/Hill Station to 7th/Flower Station). No tunneling work had begun on this contract, and the **A146** contractor was preparing to lower the shield.
- o Contract **A145** (5th/Hill Station, Stage I). Activities on this contract consisted primarily of advance utility relocation and vault removal. The **A145** contractor was experiencing delays due to the discovery of uncharted tanks, foundations, and hazardous material. It was recognized that these delays were going to affect the contract completion date. Revision 6 of the project schedule included an allowance for this delay.

- Contract **A165** (7th/Flower Station Stage I). This contract had just received NTP on January 5, 1988. This date was later than the originally scheduled NTP date of June 8, 1987, due to requirements for UMTA approval for award to other than the low bidder.

- Contract **A171** (Line Section, 7th/Flower to Wilshire/Alvarado). No tunneling work had begun on this contract; the contractor was testing the muck hauling equipment.

- Contract **A175** (Wilshire/Alvarado Station, Stage I). The contractor was in the initial phase of installing soldier piles. Production rates were unknown at this time.

In summary, construction was in its very early stages on the major contracts, and there existed considerable uncertainty as to Union Station site access dates, tunneling production rates, and unpredictable underground obstructions, contamination, and soil conditions.

B. Revisions 6A (March 25, 1988) and 6B (June 24, 1988) of the Metro Rail Project Schedule

Several minor adjustments were made in the schedule to mitigate delays. The overall impacts were not major.

C. Revision 6C of the Metro Rail Project Schedule, September 30, 1988 (See MOS-1 Contract Schedule History - Summary, Attachment No. 1)

By September 1988, the major uncertainties in site access had been resolved, tunneling work was underway on Contract **A171**, and a tunnel test section had been completed by the **A146** contractor. However, other issues had arisen, and major adjustments had to be made to the schedule to maintain the ROD. The results of these adjustments reduced most of the float in the schedule, and work began to overlap to the point where limited crew availability and work sequencing constraints became a concern.

Several problems relating to individual contracts occurred during the 9 months from January 1988 to September 1988, which necessitated major adjustments to the MOS-1 schedule, as follows:

- Contract **A141.** The contractor received limited site access at Union Station in July 1988, more than 2 months after the Revision 6 date. Full access was not received until September 6, 1988, nearly 15 months after the contractual date and 4 months after the Revision 6 date. This full access finally allowed construction of the tunnel access shaft to begin.

  In order to mitigate the impact of delayed site access, extensive studies were performed on the most cost-effective alternatives for accelerating Contract **A141** work, and an Action Plan was developed and implemented to mitigate the impact by 6 to 8 months. This contract was on the critical path of the Project.

- Contract **A146.** After mining the test section, the contractor refused to continue work because of a dispute on building settlement criteria. Intensive efforts were made to resolve this disagreement, and Revision 6C of the Project schedule reflected a scheduled return to work in early December 1988, with the first tunnel run to be excavated by the end of February 1989. This did not affect ROD; three months of float remained for this contract.

- Contract **A145**. The contractor continued to experience additional delays in the first half of 1988 resulting from differing site conditions affecting utility and vault relocation and drilling of soldier pile holes. The most significant cause of delay was the discovery of four uncharted underground tanks which had to be removed. The contractor also encountered contaminated soil. Six months of delay, attributed to differing conditions, resulted in a change order granting a 174-day time extension to the contractor. This six-month delay did not affect ROD; five months of float remained for this contract.

The following contracts had some progress shortfalls that eventually affected the Project schedule:

- The **A165** contractor experienced some delays due to his failure to realize the extent of utility relocation work required. These delays were determined to be within the contractor's control.

- The **A171** contractor experienced delays with tunnel work and was progressing slowly on the tunnel cross passages. Since the contractor had been working under an early completion schedule, these delays had a minor impact to the contractual completion date. However, the contractor's projected productivity rates were optimistic, and concern over his progress was mounting.

- The **A175** contractor experienced delays in mobilization, sewer relocation activities, and excavation, all of which contributed to a 75-day schedule delay. Additionally an interface problem existed at the boundaries of Contract **A175** and **A171**. It was projected that the following milestones would be missed:

  - Trackwork access
  - Stage II access
  - Contract completion

  There was no immediate impact to the overall MOS-1 Project schedule due to the considerable float.

As of September 1988, both Contract **A141** and **A135** were on the critical path. The **A141** contractor partially implemented the Action Plan to mitigate delay, and the **A135** contractor was expediting work activities on the critical path. The major uncertainties at this time were the date on which the **A146** contractor would resume tunneling, the ability of the **A141** and **A146** contractors to achieve their planned tunnel production rates, and the successful implementation of an Action Plan to control the ongoing delays at the interface of the boundaries of Contracts **A171** and **A175**.

In addition, the delays to the contracts that construct the station shell (Stage I) were affecting the start of the contracts that finish the station interiors (Stage II) and the interface dates with the Systems contractors. This contributed to a situation where the ability of the Systems contractors to complete their work within schedule was becoming questionable.

D. Current Status: March 17, 1989 (See MOS-1 Contract Schedule History - Summary, Attachment No. 1)

A number of negative events have occurred since the publication of Revision 6C in September 1988, particularly in the last 90 days. While one or two of these events alone may have been mitigated to maintain ROD, their cumulative effect jeopardizes ROD.

The most significant of these negative events are listed below:

- The **A141** contractor's tunnel excavation rate has been slowed by cobblestones in the tunnel path which have affected the progress of the equipment used to drill the magnetometer probe holes. In addition, tunnel machine equipment problems have slowed tunnel progress, and strut overstressing and failures at Civic Center Station resulted in the shutdown of the station work until reinforcement of the strut system was completed. Since this contract is on the critical path, these delays represent a 2-month delay to ROD.

- A work stoppage again occurred at Contract **A146** in early January. Modifications to the tunnel shield were required for improved tunneling operations. A plan to implement a chemical grouting program for soil stabilization was developed and implemented prior to the resumption of tunneling this week. The current delay to ROD is one and one-half months.

- The **A175** contractor cannot complete excavation at the interface with Contract **A171** until the **A171** contractor provides additional excavation support struts in the access shaft. The lack of resolution of the **A171/A175** contract interface problem is delaying the completion of Contract **A175**. Contract **A171** was delayed due to alignment problems and slower-than-anticipated cross passage work, so that the contractor has not been able to complete the tunnel work which would allow the access shaft to be turned over to the A175 contractor as originally scheduled. While these delays do not yet impact ROD, float has decreased to less than one month.

- The **A130** contract is delayed due to the lack of an approved design for the slurry wall construction. Additionally, there is a potential interface problem between the Caltrans busway work at the Union Station area and the Contract **A130** slurry guidewall construction. The contractor has also encountered contaminated materials, the extent of which has yet to be determined. Work is currently 3 months behind schedule and this contract is on the critical path with no float remaining.

- The **A135** contractor's potential start-up delays have been resolved through close monitoring and expediting of advance work required by LAUPT and Amtrak prior to site access for Metro Rail work. However, the rate of construction of the recently started slurry wall work is slower than scheduled, and electrical work is behind schedule; mitigation is necessary. The current plan is to mitigate delays and avoid impact to ROD; however, there is no float remaining, and this contract remains on the critical path.

- The **A145** contractor is behind schedule due to problems in the relocation of duct banks, the discovery of contaminated soil which requires special handling, and inefficiencies in strut installation. The Project float has decreased to zero, and this contract is on the critical path. This problem represents potential delay to ROD, as the extent of contaminated soil is still unknown.

- The **A165** contractor continues to work towards mitigating the current delays. There is no impact to Metro Rail ROD. However, this contract is on the Light Rail critical path.

Delays in contracts that construct the station shell (Stage I) are holding up the start-up of contracts that finish the station interiors (Stage II) and will cause delayed access by the Systems contractors into the stations for installation of equipment. These delays are seriously

jeopardizing the feasibility of the Systems contractors' installation schedule durations, and the period of time allocated for testing may no longer be adequate.

METHOD OF SCHEDULE ANALYSIS

Each major facility and systems contract that has the potential of impacting the critical path, and thus ROD, has been evaluated to determine the optimistic, pessimistic, and probable schedule scenarios. The following definitions were applied to develop each scenario:

Optimistic

This scenario is based on optimum productivity rates and minimal potential delays. The productivity rates are generally those identified by the contractors as the basis for developing their current approved schedule. Rates in excess of those developed by the contractor were identified as separate assumptions. The rates established by the contractors are based on optimum circumstances. Since the contractor will be compensated for all costs and time incurred for changed conditions, the optimistic schedule does not have time built into it for potential delays. In general, this scenario assumes that past problems will not be repeated, i.e. the contractor has overcome inefficiencies, minimal contamination or underground obstructions may be found and will not impact cost or schedule, and contractors will work in earnest to meet the schedule. In most cases existing delays are not mitigated, except where a high probability of successful mitigation is indicated.

Pessimistic

This scenario is based on conservative productivity rates and allowances for potential delays. This schedule is based on productivity rates and delays experienced to date with virtually no improvement. In general, it assumes past problems and inefficiencies will continue, that obstructions, contamination, or archaeological finds will continue to be found, and that there will be no significant changes in contractor performance. These factors impact the cost and schedule of each contract.

Probable

This scenario is based on reasonably achievable productivity rates and reasonable allowances for potential delays. These productivity rates and allowances for potential delays are based on the combined assessment of the Resident Engineer and Project Engineer for each contract, using current contractor experiences. The allowances for potential delays consider the remaining uncertainty on each contract in terms of remaining underground excavation; the probability of meeting scheduled rates for concrete production, cable, and equipment installation; and testing.

Hold ROD

A scenario based on applying required production rates to hold the current ROD was developed. However, based on the current status of each contract, the required rates are unachievable. If the production rates are not met, then the time allowed for system testing and pre-revenue operations will be decreased to an unachievable and unacceptable time period. Additionally, there is no valid method for assessing the potential acceleration and disruption costs associated with this scenario. Therefore, this option was deamed infeasible.

ANALYSIS

Each contract was evaluated independently by the Resident Engineer, Project Engineer, and Project Scheduler assigned to the contract to determine the factors that could affect the remaining schedule under each of the scenarios. Impacts to each of the factors were assessed, and resultant schedules developed. The Facilities contracts were studied first. Once their key interface dates were determined, schedules were developed for each of the Systems contracts under each of the scenarios, using the contractually approved schedules as the basis for adjustments by the Resident Engineer and Project Engineer. The combined evaluation of the Facilities and Systems contracts resulted in an MOS-1 schedule for each scenario; optimistic, pessimistic, and probable (see Attachment No. 2). This information was then reviewed with senior project management. Modifications and adjustments were made to incorporate their judgments. For all scenarios, a contingency was also included between Facilities and Systems contracts to cover unanticipated events or circumstances. Following final review and acceptance of the schedules for each scenario by senior project management, cost impacts were developed.

The cost implications of each scenario includes an assessment of the following elements:

- Costs for added scope of work to achieve ROD.
- Costs for contractors' overhead for extended duration.
- Escalation costs for work remaining.

An analysis was also made of areas where changes in logic could potentially be made in the future in order to recover time, if it became necessary. This was done to provide additional information on the amount of contingency in the schedule.

The optimistic scenario is only achievable if all the contracts proceed with minimum disruption. This has not been the case to date and, while some contracts may proceed with minimum disruption, there is little likelihood that all contracts will progress in that manner.

The pessimistic scenario summarizes the impact of conservative production rates and allowances for delays. As with the optimum case, some of the contracts may experience the potential problems identified in this scenario; however, there is little likelihood that all contracts will incur such problems.

The probable scenario struck a balance between the optimistic scenario and the pessimistic scenario. Production rates and allowances for delays have been tempered with reasonable expectations.

The option to hold ROD was considered. However, based upon the current status of the underground excavation, the unknowns were too great to prudently recommend this option. Two of the major Facilities contracts which involve excavation, Contracts **A171** and **A165**, have completed excavation. The other six contracts, **A130, A135, A141, A145, A146,** and **A175**, have significant station and tunnel excavation quantities remaining. The experience gained to date with regard to potential excavation problems preclude achieving ROD without unduly risking disruption delay claims by the Stage II and System contractors.

An example of the analysis performed on all contracts is shown in summary for Contract **A141** in Attachment No. 3.

Conclusion

Based on the analysis, the current and alternative MOS-1 schedules and cost impacts are as follows:

	ROD	Slippage (months)	Cost Range (x $1000)
Revision 6D (Current Schedule)	Jan 93	0	N/A
Optimistic	May 93	4	$11,000 - $13,000
Pessimistic	Apr 94	15	$40,000 - $42,000
Probable	Sep 93	8	$23,000 - $25,000

The recommended alternative allows the District to mitigate claims from Systems contractors for acceleration and disruption resulting from compressing their installation and testing time to achieve the current ROD. Additionally, the award of Stage II contracts will be delayed until Stage I contracts are sufficiently complete to allow Stage II work to proceed without undue delays. This will prevent claims for acceleration and disruption. The possibility of paying Stage I contractors for acceleration, only to have several facilities completed while waiting for uncompleted facilities, is reduced. The recommended scenario allows for an orderly completion of facility work which supports efficient utilization of Systems contractor resources. The recommended scenario also establishes obtainable milestones for the contractors without relaxing contractual compliance requirements. Contractors must still justify requests for contractual milestone extensions. The District is not obligated to release milestones due to contractor caused delays.

Presently, six of the eight major facilities contracts still have significant amounts of excavation remaining. Uncharted obstacles and difficult and contaminated soil are potential problems. These issues will be dealt with as they occur. Only preliminary contractor performance data is available to project production rates.

In Contracts **A141** and **A146**, tunnel excavation is less than 21% complete. Start-up problems and production problems have been encountered, and there is no firm basis to project individual production rates at this time. Additionally, excavation at Union Station has not begun, and excavation at the Yard Leads and Transfer Zone has only recently begun.

Given all the complexities of an undertaking of this magnitude, the Project is doing well. Constant monitoring and adjustments will be required, and I will keep you advised with periodic updates.

Respectfully,

Alan F. Pegg

William J. Rhine
Assistant General Manager

MOS-1 CONTRACT SCHEDULE HISTORY - SUMMARY

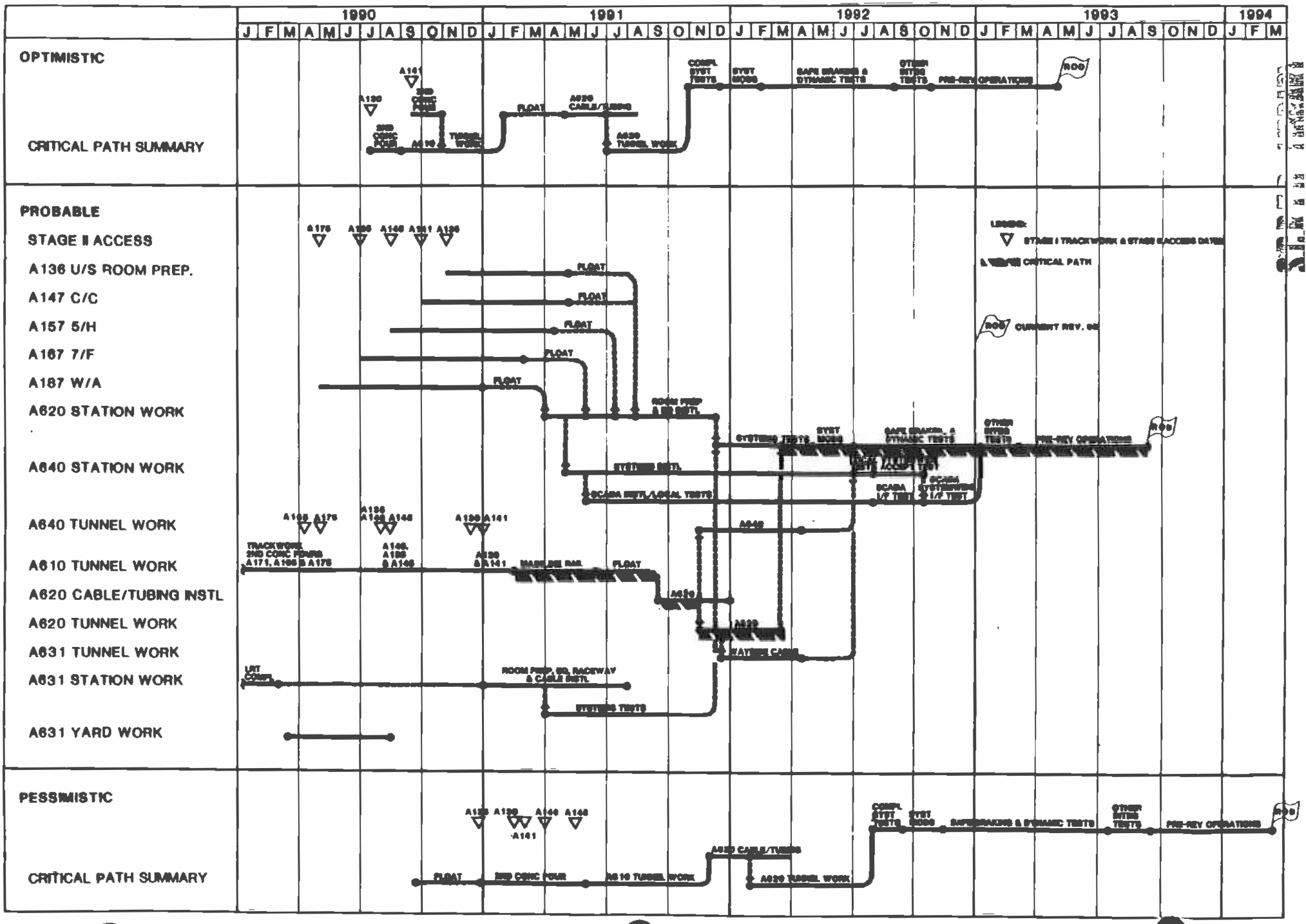
	REV. 6C - SEPTEMBER 30, 1988			CURRENT STATUS - MARCH 17, 1989		
CONTRACT	CAUSE OF DELAY	MOS. OF DELAY	MITIGATION EFFORTS/COMMENTS	CAUSE OF DELAY	MOS. OF DELAY	COMMENTS
A130	NTP ISSUED JUN 88, ONE MONTH LATER THAN EXPECTED	1	CONTRACT SCHEDULE SHORTENED	DESIGN FOR SLURRY WALL NOT APPROVED; INTERFACE PROBLEM BETWEEN CALTRANS BUSWAY WORK AT UNION STATION AND SLURRY GUIDEWALL CONSTRUCTION; PRESENCE OF CONTAMINATED MATERIALS	3	ON CRITICAL PATH; NO FLOAT
A135	NTP ISSUED JUNE 88, ONE MONTH LATER THAN EXPECTED	1	CONTRACT SCHEDULE SHORTENED	SLURRY WALL WORK CONSTRUCTION RATE SLOWER THAN SCHEDULED	1	ON CRITICAL PATH; NO FLOAT; AFFECTS ROD BY ONE MONTH
A141	DELAYED SITE ACCESS CONTRACT ON CRITICAL PATH	4	ACTION PLAN TO MITIGATE 16 MONTH DELAY BY 6-8 MONTHS; ABILITY TO ACHIEVE TUNNEL PRODUCTION RATE UNCERTAIN	SLOW TUNNEL EXCAVATION; TUNNEL MACHINE EQUIPMENT PROBLEMS; SHUTDOWN OF STATION WORK PENDING REINFORCEMENT OF STRUT SYSTEM	2	ON CRITICAL PATH; AFFECTS ROD BY TWO MONTHS
A145	DISCOVERY OF 4 UNDERGROUND TANKS, CONTAMINATED SOIL	2	ABILITY TO ACHIEVE SCHEDULED PRODUCTION RATES UNCERTAIN	RELOCATION OF DUCT BANKS; DISCOVERY OF ADDITIONAL CONTAMINATED SOIL; INEFFICIENCIES IN STRUT INSTALLATION	2	EXTENT OF CONTAMINATED SOIL IS UNKNOWN
A146	DISPUTE ON BUILDING SETTLEMENT CRITERIA CAUSED WORK STOPPAGE	10	UNCERTAIN DATE OF RESUMPTION OF TUNNELING; ABILITY TO ACHIEVE SCHEDULED TUNNEL PRODUCTION RATE UNCERTAIN	MODIFICATION OF TUNNEL SHIELD AND IMPLEMENTATION OF CHEMICAL GROUTING PROGRAM CAUSED WORK STOPPAGE	4	AFFECTS ROD BY ONE MONTH

MOS-1 CONTRACT SCHEDULE HISTORY - SUMMARY

CONTRACT	REV. 6C - SEPTEMBER 30, 1988 CAUSE OF DELAY	MOS. OF DELAY	MITIGATION EFFORTS/COMMENTS	CURRENT STATUS - MARCH 17, 1989 CAUSE OF DELAY	MOS. OF DELAY	COMMENTS
A165	EXTENT OF UTILITY RELOCATION WORK GREATER THAN ANTICIPATED	0	WITHIN CONTRACTOR'S CONTROL	CONCRETE WORK BEHIND SCHEDULE	1	ON LIGHT RAIL CRITICAL PATH; CONTRACTOR WORKING TO MITIGATE DELAYS
A171	DELAYS IN TUNNEL WORK; SLOW PROGRESS ON TUNNEL CROSS-PASSAGES	0	OPTIMISTIC PRODUCTIVITY RATES CAUSED MOUNTING CONCERN OVER PROGRESS	ALIGNMENT PROBLEMS AND SLOWER-THAN-ANTICIPATED CROSS PASSAGE WORK CAUSED DELAY IN PLACING SUPPORTS	4	CONTINUES TO IMPACT A175 CONTRACTOR
A175	DELAYS IN MOBILIZATION, SEWER RELOCATION, EXCAVATION	2.5	DELAYED ACCESS PENDING A171 INSTALLATION OF STRUTS FOR REINFORCEMENT	EXCAVATION DELAYED PENDING FURTHER SUPPORT IN A171 ACCESS SHAFT	4	CONTRACTOR WORKING TO MAINTAIN SCHEDULE
STAGE II/ SYSTEMS CONTRACTS	ACCESS AFFECTED BY DELAYS TO STAGE I CONTRACTS	0 - 3	LIMITED THE ABILITY OF SYSTEMS CONTRACTORS TO COMPLETE WORK WITHIN SCHEDULE	DELAYED STARTUP DUE TO STAGE I DELAYS; DELAYED ACCESS FOR INSTALLATION OF SYSTEMS EQUIPMENT	0 - 4	INSTALLATION SCHEDULE IN JEAPARDY; INADEQUATE PERIOD OF TIME FOR TESTING

MOS-1 PROJECT SCHEDULE EVALUATION

ATTACHMENT NO. 2



Contract A141, Civic Center Station and Tunnel from Union Station Stage to Fifth/Hill

CASE	TRACKWORK	DAYS	STAGE II	DAYS	COMPLETION	DAYS
Current Contract	27 Oct 89		13 Oct 89		13 Apr 90	
REV 6D	15 Jun 90	0	2 Apr 90	0	9 Aug 90	0
OPTIMISTIC	17 Sep 90	94	4 Jun 90	63	15 Oct 90	67
PESSIMISTIC	1 Mar 91	259	1 Nov 90	213	1 May 91	265
PROBABLE	2 Jan 91	202	1 Sep 90	152	1 Mar 91	201

Note: Days are calendar day variance from the Rev 6D schedule.

Assumptions

Optimistic

1. The current 2 month delay is not mitigated.
2. The tunnel equipment problems subside and the remaining tunnel excavation is completed at a rate of 30'/day through first 10 days of each run, and 79'/day thereafter, causing an additional delay of 1 month.
3. The scheduled concrete production rates are maintained .
4. These items result in a 2 delay to the current schedule.

Pessimistic

1. The current 2 month delay is not mitigated.
2. Additional tunneling excavation problems occur resulting from soil stabilization problems or tunnel machine problems. The average tunneling rate for the remainder of the first AR drive is 47'/day. The average tunneling rate for the three remaining tunnel runs is 30'/day for first 10 days and 47'/day thereafter, except for the first 900' of AL tunnel through the cobblestones and curve, which has a rate of 30'/day. These rates cause a delay of 3 1/2 months.
3. Slower rate of concrete placement for tunnel invert, liner and walkway resulting in a 3 month delay.
4. These items result in an 8 1/2 month delay to trackwork access and Stage II access is delayed 6 months by the tunneling delay, plus an additional 1 month from tunnel concrete delays.

Probable

1. The current 2 month delay is not mitigated.
2. Some additional tunneling excavation problems occur. The average tunnel rate for remainder of AR drive #1 is 53'/day. Average tunnel rate for the three remaining tunnel runs is 30'/day for first 10 days and 53'/day thereafter, except the first 900' of AL tunnel through the cobblestones and curve, which has a rate of 30'/day. These rates cause a delay of 2 1/2 months.
3. Slower rate of concrete placement for tunnel invert, liner and walkway operation resulting in 2 months delay.
4. These items result in a 6 1/2 month delay to trackwork access. Stage II access is delayed 5 months by the tunneling delay.