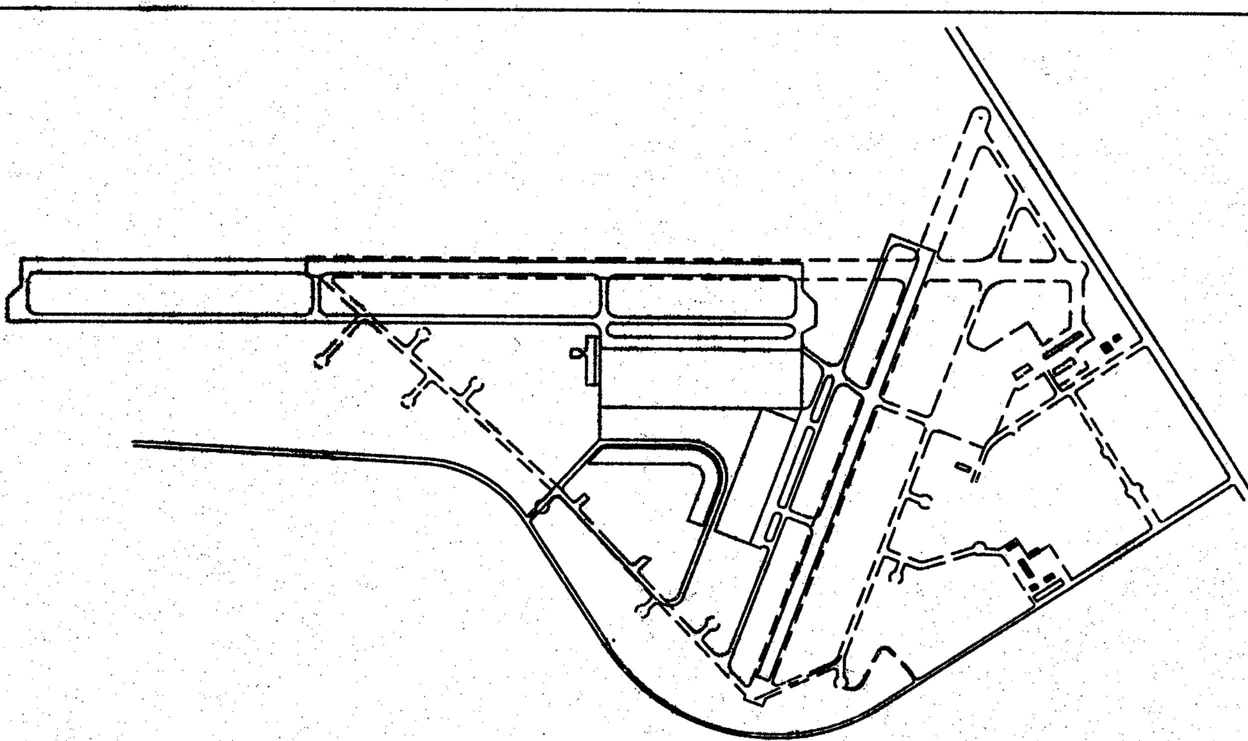

MASTER PLAN

FOR

OROVILLE MUNICIPAL AIRPORT

CITY OF OROVILLE
BUTTE COUNTY, CALIFORNIA

JULY 1990

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OROVILLE MUNICIPAL AIRPORT

"The preparation of this document was financed in part through a planning grant from the Federal Aviation Administration as provided under Section 13 of the Airport Improvement Act of 1982 as amended by the Airport and Airway Safety and Capacity Expansion Act of 1987. The contents of this report reflect the views of Reinard W. Brandley, Consulting Airport Engineer, who is responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policy of the F.A.A. Acceptance of this report by the F.A.A. does not in any way constitute a commitment on the part of the United States to participate in any development depicted herein, nor does it indicate that the proposed development is environmentally acceptable in accordance with Public Laws 91-190, 91-258, and/or 90-495."

REINARD W. BRANDLEY
CONSULTING AIRPORT ENGINEER

MASTER PLAN
FOR
OROVILLE MUNICIPAL AIRPORT

CITY OF OROVILLE
BUTTE COUNTY, CALIFORNIA

JULY 1990

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Appendix B	Model Zoning Ordinance
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AVIATION TERMINOLOGY

ACCESS ROAD - The right-of-way, the roadway and all improvements constructed thereon connecting the airport to a public highway.

AIRCRAFT OPERATIONS AREA - Any area of the airport used or intended to be used for the landing, takeoff, or surface maneuvering of aircraft. An aircraft operations area shall include such paved or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiway, or apron.

AIRPORT - An area of land or water which is used or intended to be used for the landing and takeoff of aircraft, and includes its buildings and facilities, if any.

AIRPORT IMPROVEMENT PROGRAM (AIP) - A grant-in-aid program administered by the Federal Aviation Administration.

AIRPORT LAYOUT PLAN - The plan of an airport showing the layout of existing and proposed airport facilities.

ALTIMETER - An instrument for measuring altitude.

APPROACH SLOPE - A surface longitudinally centered on the extended runway centerline and extending outward and upward from each end of the primary surface. An approach slope is applied to each end of each runway based upon the type of approach available or planned for that runway end.

APRON - Aprons provide parking for airplanes, access to the terminal facilities, fueling, and surface transportation.

CLEAR ZONE - An area used to enhance the safety of aircraft operations. It is at ground level beyond the runway end.

DME - DISTANCE MEASURING EQUIPMENT - Provides pilots with the distance the aircraft is to or from a point.

FIXED BASE OPERATOR (FBO) - A fixed base operator's building usually provides space for the commercial activities, maintenance, and repair of aircraft, air charter, and the like.

HOLDING APRON - Holding aprons provide a standing space for airplanes awaiting final air traffic control clearance and to permit those airplanes already cleared to move to their runway takeoff position. By virtue of their size, they enhance maneuverability for holding airplanes while also permitting bypass operations.

ILS - INSTRUMENT LANDING SYSTEM - The instrument landing system provides pilots with electronic guidance for aircraft alignment, descent gradient, and position until visual contact confirms the runway alignment and location.

MSL - Mean sea level.

NDB - NON-DIRECTIONAL BEACON - The non-directional beacon radiates a signal which provides directional guidance to and from the transmitting antenna.

NON-PRECISION INSTRUMENT RUNWAY - A runway having an existing instrument approach procedure utilizing air navigation facilities with only horizontal guidance, or area type navigation equipment, for which a straight-in non-precision instrument approach procedure has been approved or planned.

RUNWAY - The area on the airport prepared for the landing and takeoff of aircraft.

TAXIWAY - The portion of the aircraft operations area of an airport that has been designated by competent airport authority for movement of aircraft to and from the airport's runways or aircraft parking areas.

TEE HANGAR - Building constructed for the storage of individual aircraft.

THRESHOLD - The beginning of that portion of the runway available for landing. When the threshold is located at a point other than at the beginning of the pavement, it is referred to as either a displaced or a relocated threshold depending on how the pavement behind the threshold may be used.

Displaced Threshold - The portion of pavement behind a displaced threshold may be available for takeoffs in either direction and landings from the opposite direction.

Relocated Threshold - The portion of pavement behind a relocated threshold is not available for takeoff or landing. It may be available for taxiing of aircraft.

TIE DOWN - Portion of the aircraft parking apron for the tying down of parked aircraft.

VOR - VERY HIGH FREQUENCY OMNIRANGE STATION - Provides the bearing of the aircraft to or from the VOR station.

OROVILLE MUNICIPAL AIRPORT - MASTER PLAN STUDY

Summary of Recommendations

1. Construct Runway 1-19 to be 100' wide x 6,000' long.

2. Relocate thresholds on Runway 12-30 to provide a 100' wide x 3,540' long runway.

3. Design Runway 1-19 including clear zones so it has the capability of becoming a non-precision approach runway in the future.

4. Displace the thresholds to Runway 12 and Runway 19 such that the clear zones for these runways are located entirely within public land (Airport property or City, County or State Road Right of Way).

5. Relocate airport operations areas - tiedowns, hangars, fixed base operations, etc., to the triangular area South of Runway 12-30 and East of Runway 1-19.

6. Reserve land for airport operations area expansion beyond the twenty year forecast level.

7. Provide taxiways to serve the new runway layout.

8. Provide new road access from Larkin Road and automobile parking.

9. Acquire land to the South of the existing airport property for the future Runway 1-19 construction and for the clear zone to Runway 01.

10. Designate and encourage development of excess land on East and North side of the airport for commercial aviation uses.

11. Reserve excess land on the West side of Runway 1-19 for possible golf course expansion.

12. Accept the Airport Layout Plan, Sheet No. 1 of 5, dated July 1990, as the current Master Plan for the Oroville Municipal Airport.

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JULY 1990

MASTER PLAN

FOR

OROVILLE MUNICIPAL AIRPORT
CITY OF OROVILLE
BUTTE COUNTY, CALIFORNIA

I. INTRODUCTION

In 1989 the City of Oroville engaged the services of Reinard W. Brandley, Consulting Airport Engineer, for the purpose of preparing a master plan for the development of the Oroville Municipal Airport.

This master plan consisted of research into the history and present conditions of the airport, forecast for future development, analysis of development costs, environmental considerations, and the preparation of airport layout plans for this airport. This report presents the results of these studies.

II. AIRPORT REQUIREMENTS

A. Inventory

1. History. The City of Oroville acquired the original 188 acres for airport purposes in 1936. In 1941 the runways were extended in length by the City and Work Project Administration, and airport land was increased to 428 acres. On May 1, 1942, the United States Army commandeered Oroville Airport for the duration of the war and improved the runways to their present

width and length. In May 1947 the Army returned the airport jurisdiction to the City. Additional land has since been acquired and the current size of the airport is approximately 804 acres. Approximately 300 acres of this property are leased for various uses including a golf course, riding arena, and a mosquito abatement district complex.

The airport facilities, when turned back to the City in 1947, consisted of two runways, a series of taxiways, and a small apron for aircraft parking. The airport has been upgraded over the past 36 years under three projects funded by the Federal Aviation Administration including:

- Apron Extension and Runway Marking in 1962 under FAA Project No. 9-04-106-6403.
- Runway 1-19 Strengthening Overlay and a Non-Directional Beacon in 1984 under AIP No. 3-06-0178-01.
- The Overlay of Runway 12-30, Overlay and Reconstruction of Taxiway C, Edge Lighting of Runway 1-19, and Security Fencing in 1989 under AIP Project 3-06-0178-03.

2. <u>Previous Airport Plans</u>. The current airport layout plan was prepared by the City of Oroville, Department of Public Works and was last updated in March 1988. That update consisted of relocating the thresholds on Runway 12 and Runway 19 such that the visual clear zones (20:1 approach) for these runways would be located entirely within public land. This plan not only addressed the needs for the development of the aviation related facilities on the airport but set aside surplus land for commercial development.

Two reports pertaining to airport development have been prepared by the City of Oroville and the Butte County Land Use Commission. These reports are entitled:

- "Oroville Municipal Airport General Plan Update for the Oroville Municipal Airport" prepared by the City of Oroville dated November 1985.
- "Oroville Airport Land Use Plan" prepared and adopted by the Butte County Airport Land Use Commission dated September 16, 1985.

These reports set forth the basic development goals for the airport and land use criteria for the property located around the airport.

3. Existing Land Use and Height Limit Zoning Documents. The City of Oroville has not established height limit zoning on land within the City limits surrounding the airport. The County of Butte is currently preparing height limit zoning around all County airports. Both the City and the County should zone land surrounding the airport that is within their jurisdiction to conform to the height limit zoning requirements of the Federal Aviation Administration. A model zoning ordinance is included as Appendix B to this report to assist the City and County in developing the Height Limit Zoning Ordinance for the Oroville Municipal Airport. It is recommended that both the City and the County adapt this ordinance to provide protection to the existing and planned facilities from encroachment by offsite development.

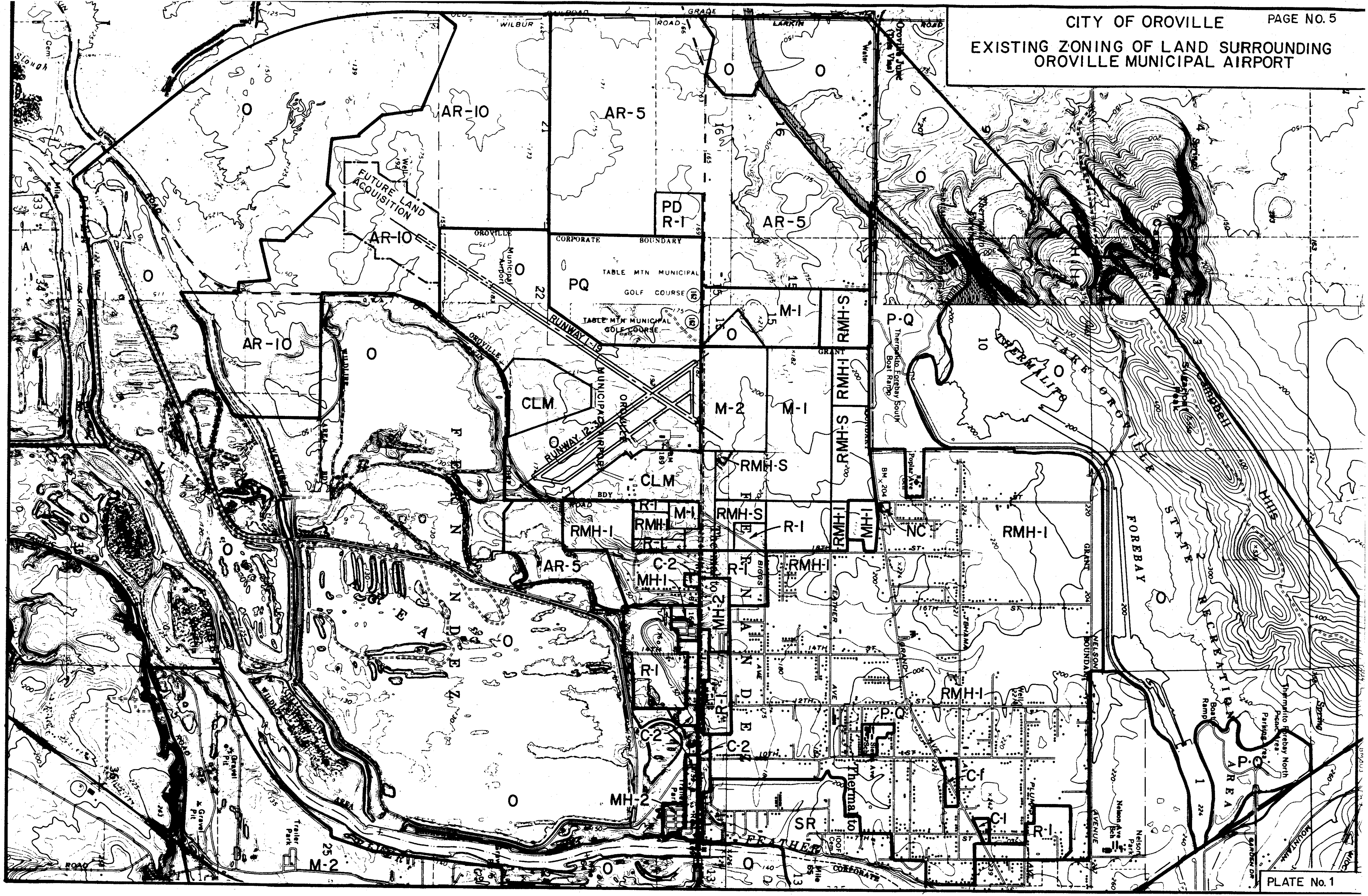
The land surrounding the airport at the approaches to the airport is zoned: "Public or Quasi Public," "Agriculture," "Low-Density Residential," Industrial," and/or "Open Space". The existing zoning of the land surrounding the airport is shown on the attached zoning map, Plate No. 1.

4. Site Review and Environs. The City of Oroville is located on the eastern edge of the Sacramento Valley adjacent to the foothills of the Sierra-Nevada mountain range. The Sacramento Valley in this portion of California is mostly agriculture land. The mountains to the east are forested. Oroville is located approximately 15 miles southeast of the City of Chico and approximately 26 miles miles north of the cities of Marysville and Yuba City. The major highway serving this area is California State Route 70 which extends from Sacramento through Marysville, Oroville and on through the Feather River Canyon to Quincy and points east. State Route 162 extends westerly from Oroville and connects to State Highway 99. State Route 162 runs past the northern boundary of the Oroville Municipal Airport. The Union Pacific Railroad passes through Oroville from Marysville/Yuba City area and extends on to the north and east through the Feather River Canyon.

5. Wind Data. Wind data were originally obtained from the Forest Service Station located 2.9 miles east of the Oroville Airport for the period July 1968 to July 1972. Additional wind analyses were conducted in 1985 by the City of Oroville in preparation of the General Plan Update for the Oroville Municipal Airport. Additional evaluations were conducted for

CITY OF OROVILLE

EXISTING ZONING OF LAND SURROUNDING OROVILLE MUNICIPAL AIRPORT



CITY OF OROVILLE

DEFINITION OF ZONING SYMBOLS

SYMBOL	DEFINITION
O	Open Space
PQ	Public or Quasi Public
PD	Planned Unit Development
R1	Single Family Residential
AR1	Agricultural Residential - 10-Acres
AR5	Agricultural Residential - 5-Acres
MH-1	Low Density Mobile Home
RMH-1	Residential Mobile Home
RMH-3	Residential Mobil Home Suburban
NC	Neighborhood Commercial
C1	Restricted Commercial
C2	Heavy Commercial
CLM	Commercial Light Manufacturing
M1	Limited Industrial
M2	Industrial

this study, as well as review of wind data for the Chico Municipal Airport and the Yuba County Airport in Marysville.

The results of these studies show that the wind rose which was prepared as part of the Oroville Airport Plan in 1965 is still valid. Coverages for the two runways at the Oroville Municipal Airport were computed on the basis of crosswind components not exceeding thirteen knots. It was found that Runway 1-19 provides 94.8% wind coverage for a thirteen knot crosswind component; whereas, Runway 12-30 provides 97.6% wind coverage for thirteen knot crosswind components. Both runways combined provide in excess of 99% wind coverage.

6. Air Space. Air space surrounding the Oroville Municipal Airport is affected by the Instrument Approach Facilities at the Chico Municipal Airport, the Beale Air Force Base, and the Yuba County Airport in Marysville. The Chico Municipal Airport has an ILS approach to Runway 13L, a VOR-DME approach to Runway 13L, a VOR approach to Runway 31R and a NDB approach to Runway 13L. Yuba County Airport at Marysville has an ILS approach to Runway 14, a VOR approach to Runways 14 and 32, and a NDB approach to Runway 14. Oroville Airport has a VOR Approach to Runway 1 from the Marysville VOR and FAA is now preparing to publish a NDB approach to Runway 1.

ILS approaches affect air space for a considerable distance around an airport. The existence of ILS approaches to runways at Marysville, Chico, and Beale will seriously limit the air space available around the Oroville Airport, particularly for instrument approaches. While these limitations will not preclude ILS approaches to Oroville Airport in the future, they could have a significant effect on the instrument approach pattern to all of the surrounding airports.

7. Noise Exposure. There have been few complaints of noise from the Oroville Municipal Airport, mainly because the population on the lands immediately surrounding the airport is widely scattered and the use of the airport with large aircraft at this time is limited. Runway 1-19 is the longest runway and will be used by all of the heavy aircraft and the jet aircraft. The southerly departure from this runway is over land which is currently zoned for large acreage development and then over the Thermalito Afterbay which is government property that will never be developed. Recommendation of this report is that the airport acquire the land at the approach to Runway 1 which is between the airport and the afterbay. The northerly approach to Runway 19 is over the land currently zoned for commercial development. Runway 12-30 is a short runway and will be used exclusively by small general aviation aircraft which do not create excess noise.

8. Financial Resources. To date the fees charged to users do not pay the entire cost of airport operation. The only source of funds for development of the airport must come from the City, County, State Division of Aeronautics, and the Federal Government. Grants are available from the State through the

CAAP program and through the Federal Government through the Airport Improvement Program (AIP) of the Federal Aviation Administration. Commercial and recreational land leases of surplus airport property can contribute to revenue for airport operation and development.

9. <u>Existing Airport Facilities</u>. The existing airport occupies approximately 804 acres of land. Approximately 300 acres of this land are leased for various uses including a golf course, riding academy, and mosquito abatement district complex. A portion of the property is also leased to the Fixed Based Operator and Helicopter Facilities.

Current facilities consist of two runways and a series of taxiways serving these runways. Runway 1-19 has a total physical length of approximately 6,000 feet and is 150 feet wide. This runway has been shortened to an effective length of 4,580 feet by relocation of the threshold to Runway 19. Runway 12-30 has a paved section of approximately 4,800 feet long and 150 feet wide but has been shortened to an effective length of 3,180 feet by relocation of the threshold to Runway 12. There is also a displacement of some 218 feet of the threshold to Runway 30.

Both Runways 1-19 and 12-30 were originally paved to a width of 150 feet and the runway edge lights are installed at a distance of 10 feet beyond the edge of the 150-foot pavement. When these runways were overlaid, the overlay section was limited to 100 feet in width. The pavement was then tapered at a 5 percent maximum slope to match existing pavement and the remaining existing pavement was chip sealed to form a paved shoulder. The effective width of these runways is now 100 feet.

Runway 12-30 is served by a parallel taxiway located some 500 feet to the northeast of this runway. There is also a taxiway connecting the original threshold to Runway 19 and Runway 12 and a taxiway which is now abandoned also connects the threshold to Runway 1 and Runway 30. There is a taxiway which connects the existing aircraft parking apron to the approximate center of Runway 12-30 and then extends across the infield to intersect Runway 1-19 at the approximate center of the total length of this runway.

The terminal area at this airport consists of an aircraft parking apron, a series of tee hangars, and a FBO hangar. In addition there is an unimproved taxiway leading to a paved aircraft parking apron adjacent to the golf course. A business park is currently being developed on excess airport property located in the northeastern corner of the airport.

Navigational facilities to this airport consist of a non-directional beacon on the airport which is commissioned, and F.A.A. is expected to publish approved NDB approach procedures in the near future. VOR approaches are also available from the Marysville VOR.

VOR and/or ILS approaches could be added to the Oroville Airport as traffic increases to a point where F.A.A. can justify funding the equipment needed for such approaches or the City and/or County decide to fund the installation of the required equipment.

B. Forecasts of Aviation Demand

Forecasts of aviation activity at the Oroville Municipal Airport have been prepared by reviewing population forecasts, by reviewing forecasts prepared by the California State Division of Aeronautics in 1988, by reviewing the F.A.A. aviation forecasts, and by reviewing the history of aviation activity at this airport. The data utilized are summarized in the following plates:

Plate No. 2 - Butte County Population Forecast.

Plate No. 3 - Aircraft Operation Forecast - Oroville Airport.

Plate No. 4 - Based Aircraft Forecast.

In Table No. 1 the forecast operations have been broken down as to type of aircraft which are forecast to be using the airport from the period 1989 through 2010. A large part of the jet type operations, helicopter operations, and large reciprocating aircraft operations are those currently used and forecast to be used by the Louisiana Pacific Company Fleet.

On each of these plates, the actual activities have been included through 1988. The forecasts for the State of California Division of Aeronautics have been shown and Brandley Recommended Forecasts are included. A brief description of the basis of these forecasts shown on each of these Plates No. 2 through 4 is presented herewith:

TABLE NO. 1

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

FORECAST OPERATIONS

YEAR	ANNUAL OPERATIONS									
	G-2	CITATION III	CITATION II	OTHER BUSINESS JETS	KING AIR	SMALL TWIN	SINGLE G.A.	HELICOPTER	MILITARY	TOTAL
1989	24	48	600	48	600	3,000	56,476	154	100	61,050
1995	24	72	800	80	800	3,500	58,424	300	100	64,100
2005	36	90	1,000	200	900	4,000	62,474	400	100	69,200
2010	50	100	1,100	250	1,000	5,000	64,000	600	100	72,200

Note: One Operation Equals One Departure Or One Arrival

Summary of Distribution of Traffic

R/W 12-30 25% of Single G.A.

R/W 1-19 All Others

After 6:00 p.m.: 10% All Others
20% G.A. Single

Note: 1989 operations of Louisiana Pacific fleet shown below:

Aircraft	Annual Operations
Citation II	600
Citation III	48
G2	24
King Air	600
Jet Ranger Helicopter	104

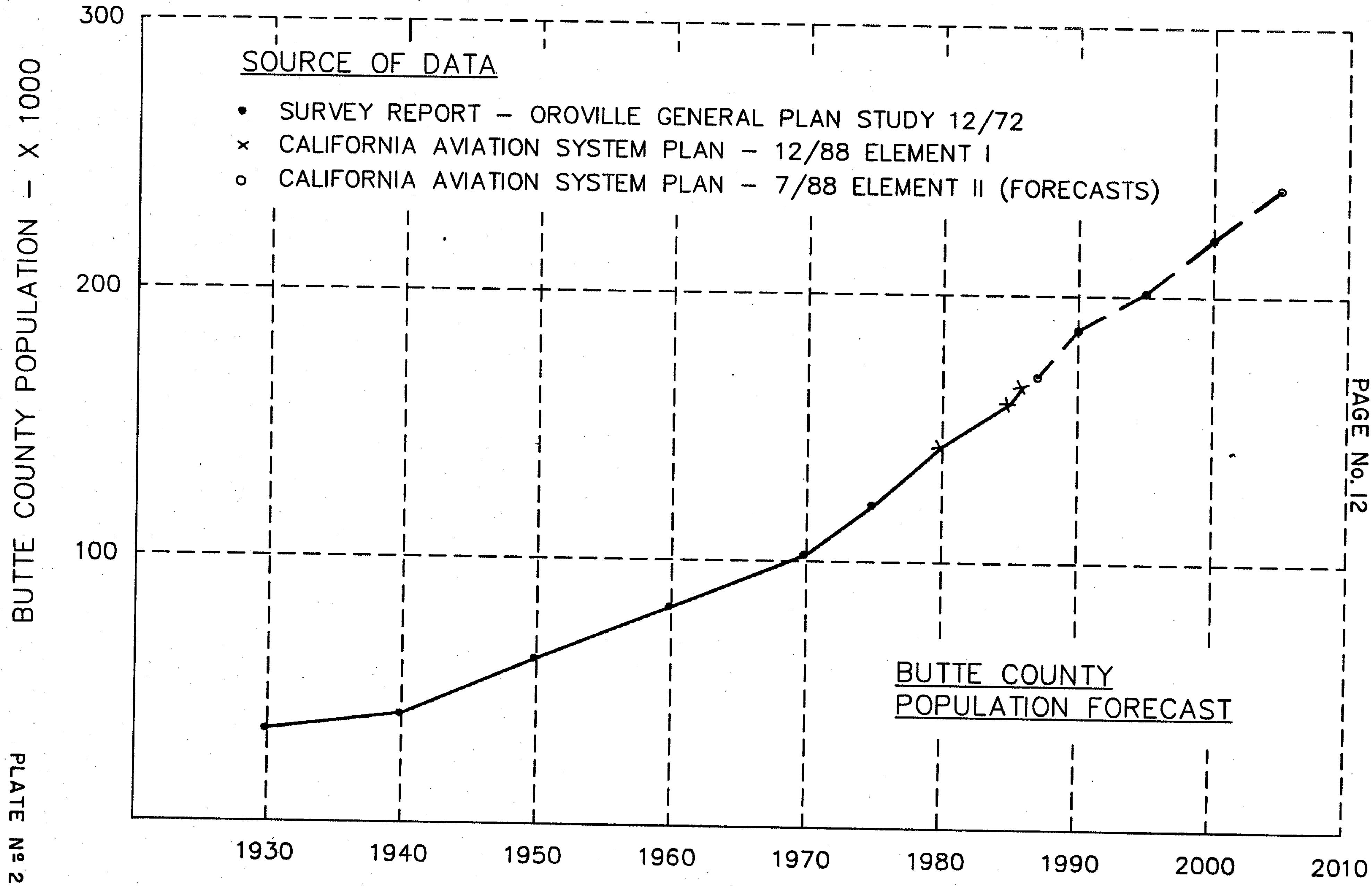

BUTTE COUNTY POPULATION – X 1000
300
200
100
SOURCE OF DATA
• SURVEY REPORT – OROVILLE GENERAL PLAN STUDY 12/72
× CALIFORNIA AVIATION SYSTEM PLAN – 12/88 ELEMENT I
o CALIFORNIA AVIATION SYSTEM PLAN – 7/88 ELEMENT II (FORECASTS)
BUTTE COUNTY
POPULATION FORECAST
1930
1940
1950
1960
1970
1980
1990
2000
2010

PLATE Nº 2

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA
AIRCRAFT OPERATION FORECASTS

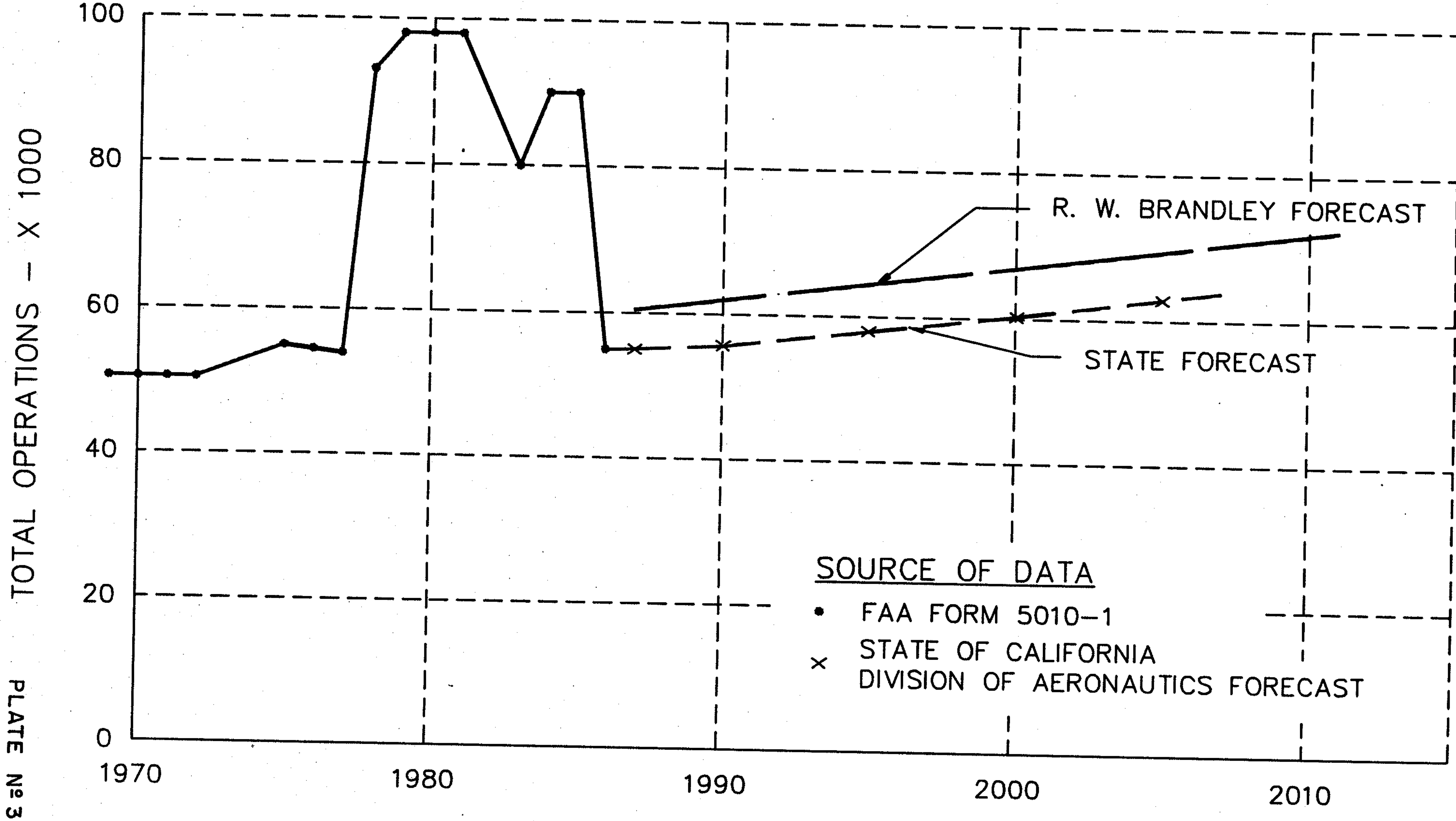
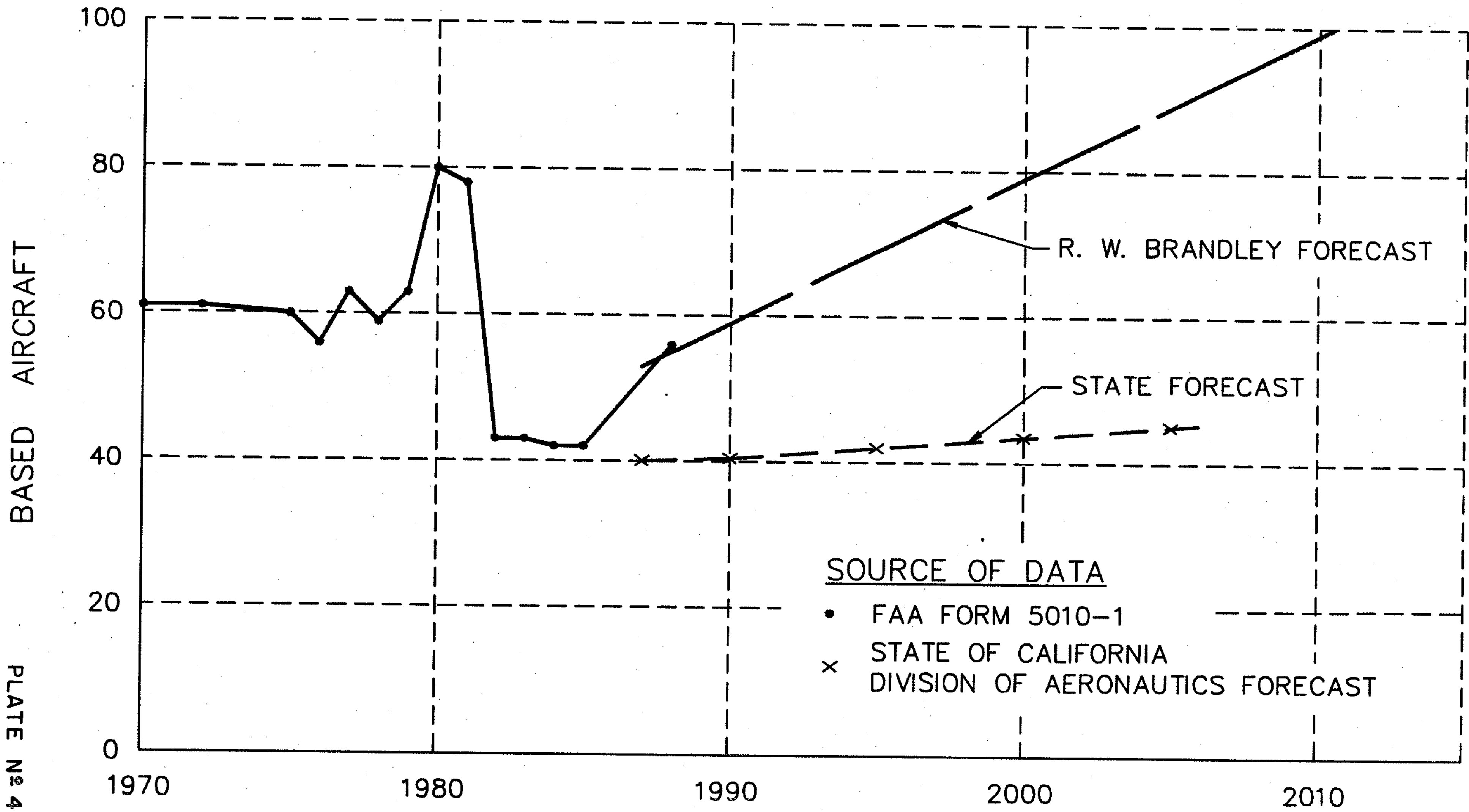


PLATE № 3

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

BASED AIRCRAFTFORECASTS



1. Population, Plate No. 2. Population forecasts were obtained from the California State Aviation System Plan, Element No. 1 dated December 1988 and Element No. 2 dated August 1988. The existing population data were obtained from the survey report of the Oroville General Plans Study dated December 1972. The forecast population growth shows a steady increase over the next twenty years.

2. Total Operations, Plate No. 3. Aircraft operations showed a sharp increase in 1977 and then a corresponding sharp decrease in 1985. Since 1985, there has been a slow, steady increase in operations. The State of California Division of Aeronautics forecast a continuation of this slow increase. Brandley forecasts parallel the State forecast but are somewhat higher. The decrease in operations in the mid to late 1980's is due largely to the decrease in general aviation activity caused by higher purchase and operating costs of aircraft. It is forecast the number of operations will continue to show a modest annual increase following the increase in population in Butte County. As shown in Table No. 1, a major portion of the jet aircraft operations, the King Air operations, and the helicopter operations are resulting from the Louisiana Pacific Company's Fleet operations at the Oroville Municipal Airport. A large portion of the forecast increase in operations will be a result of increases in operations by Louisiana Pacific Company Fleet as well as some increase in other business jet and large twin aircraft operations. As industrial development

in the Oroville area increases there will be a significant increase in jet aircraft and large twin engine operations. The further development of the airport to accommodate these aircraft will also have a significant impact on the attractiveness of the area for industrial development.

3. Based Aircraft, Plate No. 4. The number of based aircraft held steady from 1970 to 1977 then showed a sharp increase by 1980 and a major decrease between 1981 and 1982. Since that time the number of based aircraft held steady to 1985 and then showed a significant increase to 1988. The State Division of Aeronautics forecast a very slight increase in the number of based aircraft from forty to forty-three between 1987 and the year 2005. Brandley forecast represents a more rapid increase in based aircraft but still by the year 2000 it is forecasted there will only be 100 based aircraft at the Oroville Municipal Airport.

C. Demand Capacity Analysis.

In general the aircraft which will use the Oroville Airport will consist of light single engine and twin engine aircraft with reciprocating engines. Some business jet aircraft and helicopters will also use this airport. Currently the main business jets, large twin engine aircraft, and helicopter operations are conducted by the Louisiana Pacific Company. They operate the Citation III, Citation II, Gulfstream II, King Air, and the Jet Ranger Helicopter. Louisiana Pacific Company Flight Operations Section have been contacted and they forecast that they will continue to use this mix of aircraft at the Oroville Airport and that over the next twenty years the frequency of operation of these aircraft will increase somewhat. As industrial land develops in and around Oroville, other companies will use the Oroville Airport for business jet and other large twin engine aircraft operations. The airport will continue to be used by the small single engine general aviation aircraft, by the light twin engine aircraft, and by helicopters which are normally used by private pilots and flight training operations.

Aviation forecasts have been prepared which indicate only modest increases in based aircraft and aircraft activity at the Oroville Airport over the next twenty years. Forecasting of general aviation growth is difficult at this time because of the uncertainties of general aviation development brought about by the Aircraft Manufacturing Moratorium and the large increases in cost of operation and purchasing of aircraft. There are indications at this time that some light plane manufacturing will resume which will increase the availability of aircraft, and as the population of the area and commercial industrial development of the area continue to grow the demand for aircraft could increase faster than has been forecast. The foothills of the Sacramento Valley are experiencing major growth starting in the Auburn/Placerville area and spreading north and south. This area growth could cause significant growth in the Oroville area which would also cause the growth of aviation operations to exceed the forecast growth. It is therefore considered prudent in the preparation of a Master Plan for the Oroville Airport to plan the general aviation facilities to accommodate forecast growth plus a reserve capacity of at least 100% for unexpected growth. Based on the forecast and allowing reserves for the unexpected growth, the estimated facility requirements for this airport have been developed:

1. Runways.

Wind analysis studies show that Runway 1-19 provides 94.8% wind coverage with thirteen knot crosswinds, Runway 12-30 provides 97.6% wind coverage for thirteen knot crosswinds, and both runways provide in excess of 99% wind coverage for a thirteen knot crosswind.

Runway 12-30 is so oriented that it cannot be extended without major relocation of existing roads. In fact thresholds for both Runway 12 and Runway 30 must be displaced or relocated to provide clearance for vehicles traveling on Larkin Road and Highway 162.

Runway 1-19 can be extended to the south as far as needed to provide necessary length for the aircraft operating and forecast to operate at this airport. The wind analysis indicates that two runways are required at this airport. Runway 19 will be developed as the main instrument runway and will be extended as necessary to accommodate the business jet and large general aviation aircraft. Runway 12-30 will be a short runway and will be used in heavy crosswind conditions by the small general aviation aircraft. The large business jets and large twins will not be able to use the short runway.

In order to maintain clearance over existing roads and wherever possible keep the clear zone within the airport property, relocated or displaced thresholds will be required on both runways. Runway 12-30 will be strictly a visual runway and will have 20 to 1 approach slopes. Runway 1-19 should be designed as a non-precision instrument runway with 34 to 1 approach slopes and clear zones. In order to properly serve the large business jet type aircraft Runway 1-19 must be constructed to a 6,000-foot length and a minimum of 100-foot width. Runway 12-30 can be constructed to a considerably shorter length, and if the clear zone to Runway 12 is held entirely within public property and the threshold to Runway 30 is displaced enough so that there is adequate clearance over Larkin Road, the maximum length of Runway 12-30 available will be 3,540 feet. It is recommended that this runway also be 100 feet in width.

Economic studies have been conducted for the construction of Runway 1-19 to a length of 6,000 feet. The results of these studies are presented in the financial section of this report. Two analyses were conducted - one in which the clear zone for Runway 19 is located entirely within public property which requires an approximate 2,200-foot relocation of the threshold to Runway 19 and the second in which the threshold to Runway 19 is relocated a sufficient distance to provide 17-foot clearance between the pavement on State Route 162 and the approach surface to the runway. This requires a relocation of approximately 1,000 feet for the threshold of Runway 19. A 6,000-foot effective runway length was used for both analyses. These cost analyses showed that there was very little difference in the cost of the two runway design systems when taking into account the value of the land to the north of State Route 162 on which easements would have to be acquired or land acquired in fee simple and the value of the land to the south of Runway 19 which would have to be acquired for the extension of the runway and the clear zone in that area.

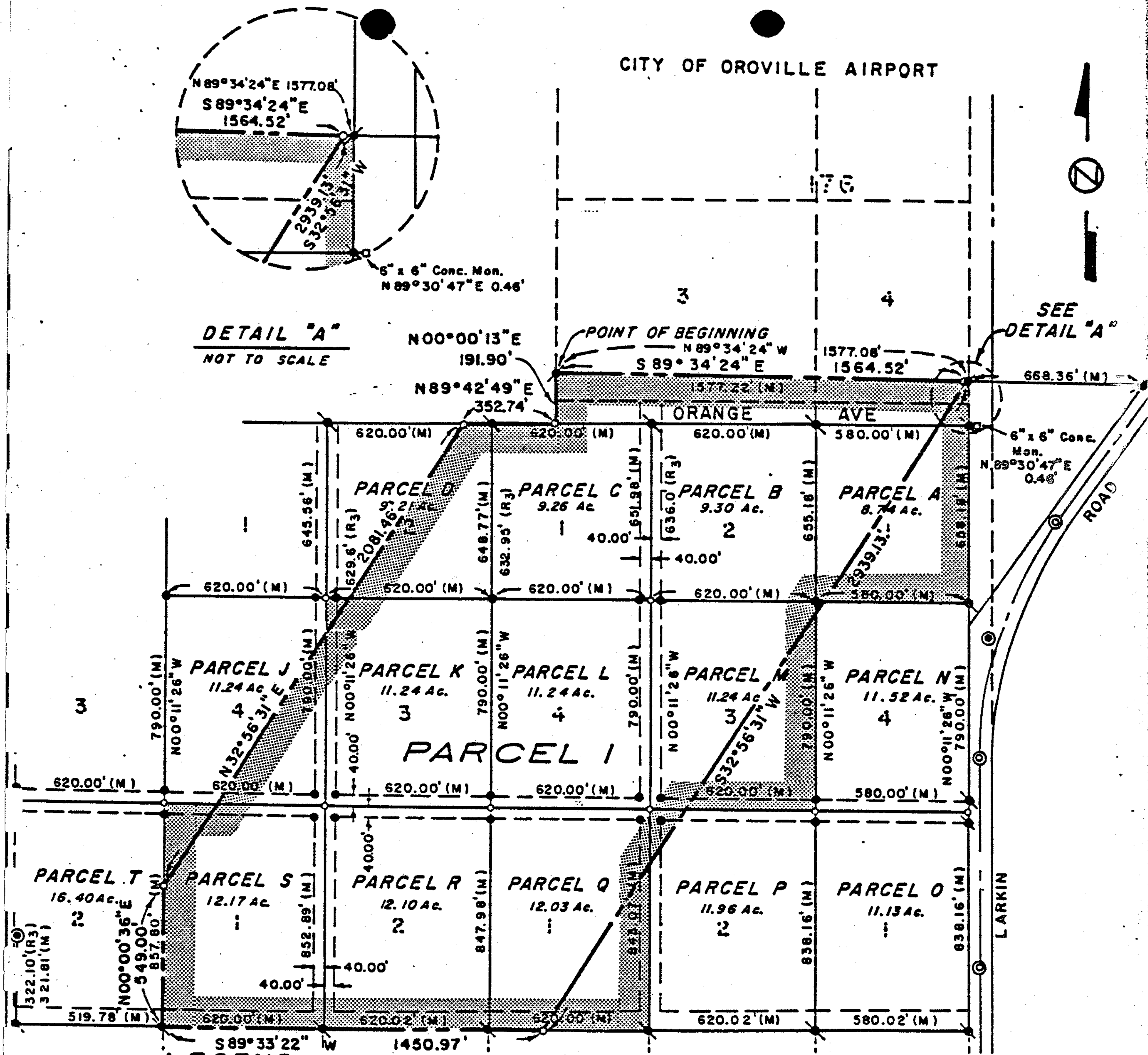
If Runway 1-19 is constructed in such a manner that the clear zone for Runway 19 is entirely within public property and this runway is extended to the south approximately 2,200 feet beyond the southerly end of the existing runway, the departure to the south from this runway will be over City-owned property or the publicly-owned afterbay property and aircraft approaching from the north will be higher above private property north of State Route 162. This relocation of the threshold to Runway 19 will also minimize the constraints on the development of the land north of State Route 162.

The only disadvantage of relocating Runway 1-19 to the south is inconvenience of taxiing to the existing general aviation tie down facilities. The area available for future tie down facilities in the existing tie down area limits the growth capability of this airport. To improve access to the airport operations areas and to provide area for ultimate growth capability at the airport, it is recommended that the aircraft operations area be moved to the south side of Runway 12-30 into the triangle between Runways 12-30 and 1-19.

It is therefore recommended that the threshold for Runway 19 be relocated such that the 34:1 clear zone for Runway 19 is entirely within public property which requires a threshold relocation of approximately 2,200 feet. It is further recommended that Runway 1-19 be extended to the south such that it will provide a runway length of 6,000 feet. This will require the acquisition of land to the south of the airport for the runway extension and for the clear zone to Runway 1. This acquisition will require the purchase of land between the current airport property and the Thermalito Afterbay.

The extension of Runway 1-19 to the south will require the acquisition of land to the south of the existing airport boundary. Land should also be acquired such that a non-precision instrument clear zone to Runway 1 will be located entirely within publicly-owned property. The Airport Layout Plan, Sheet No. 1, shows the proposed Runway 1-19 extension and clear zone to Runway 1. This plan also shows the outline of the proposed property acquisition required for this development.

The property proposed for acquisition is located entirely within the Afterbay Estates Subdivision. Details of a portion of this subdivision showing the area of proposed acquisition are shown in Plate No. 5. Where acquisition required to obtain all land within the proposed development area or clear zone



LEGEND

- FND D.W.R. R/W MON. - 1½" I.P. W/BRASS CAP
- FND BUTTE COUNTY STREET SURVEY MON. S-11
- SET 2" I.P. R.C.E. 13062 PER R/S 74-57
- SET ¾" I.P. R.C.E. 13062 PER R/S 74-57
- SET 1¼" C.I.P. L.S. 4202 PER R/S 96-78 thru 82
- o DIMENSION POINT ONLY - NOTHING FOUND OR SET
- (M) MEASURED DISTANCE
- (R_3) 2 M.O.R. 176 SOUTH THERMALITO SUBD.
- AREA OF ACQUISITION

CITY OF OROVILLE — DEPARTMENT OF PUBLIC WORKS

DRAWN BY T. F. CHECKED BY J.J.
DATE 9-12-89 SCALE NOT TO SCALE
APPROVED BY
DIRECTOR OF PUBLIC WORKS - R.C.E. 41977

AREA OF ACQUISITION

PLATE NO. 5

area split an existing parcel, the entire parcel is shown to be acquired when it was estimated that parcel splitting costs would equal total acquisition costs.

The profile of Runway 1-19 currently sags in the middle and the grade into this sag from both ends is approximately one percent (1%). By extending the runway to the south the southerly end of the existing runway will be rebuilt to lower the grade at this end to decrease the gradient of this runway which will improve the operation of aircraft on this runway.

Oroville Airport currently has a published VOR instrument approach to Runway 1 from the Marysville VOR. The F.A.A. is now prepared to publish a NDB approach procedure to Runway 1. The IFR minimum ceiling with the proposed NDB approach will be 1,000 feet MSL due to the existence of a GWEN Radio Tower located 4.4 miles south of the airport along the extended centerline of Runway 1-19. The high minimums are due to uncertainties as to the elevation of the top of this tower. Once accurate surveys are obtained the ceiling minimums should be reduced to approximately 500 feet and when an altimeter is established at the airport, the minimums can be reduced an additional 88 feet. Future development of the airport and an increase in instrument operations will emphasize the need for further instrumentation. It is recommended that the runway-taxiway spacing, clear zones and approach surfaces all be sized for Runway 1-19 to become a Non-Precision Instrument Runway and Runway 12-30 to remain a Visual Runway.

2. Taxiways.

Good taxiway access will be required for both runways. A parallel taxiway for the main non-precision instrument Runway 1-19 will be required and will be located some 400 feet centerline to centerline distance from the runway and to the east of the runway. Four right angle cross taxiways will be required for adequate operation of this runway. Aircraft holding aprons should be constructed at each end of the runway. All taxiways should be 50 feet wide.

Runway 12-30 will be a short runway used only for light general aviation aircraft. A parallel taxiway located south of this runway should be constructed with a centerline spacing of 300 feet from the runway and the taxiway should be 40 feet wide. Four cross taxiways will be required to connect the parallel taxiway to Runway 12-30.

Connecting taxiways will be required from the parallel taxiway system to connect the two runway systems together and to connect the taxiway-runway system to the future aircraft tie down apron and tee hangar apron areas.

3. Aircraft Parking and Storage Facilities.

Due to uncertainties of the general aviation development the Master Plan should provide for the current number of based aircraft, anticipated growth for the design period, and a reserve for unanticipated growth. Tie down apron space will also be required for transient parking. Initial facilities should be sized to accommodate 93 aircraft; at least 18 should be located in tee hangars and 75 in aircraft tie down spaces. Twenty of these spaces should be reserved for transient operations. By the year 2010 space will be required for 100 based aircraft, 30 transient aircraft, and a reserve space for at least 100 aircraft. It is anticipated that by the year 2010, 50 of these aircraft will be stored in tee hangars.

4. Fixed Based Operator Plots.

Space should be reserved on the airport for three Fixed Based Operator plots. These facilities should be sized such as to accommodate a full service Fixed Based Operator in each of the three plots.

5. Access Roads.

When the general aviation operations move to the new area reserved for development in the triangle between the two runways, a new access road will be required off from Larkin Road. The existing abandoned taxiway connecting the existing ends of Runway 1 and Runway 30 can be used as a portion of the loop road proposed for access to the Fixed Base Operator areas, aircraft parking areas, and tee hangar areas. Automobile parking will be required within the loop road system.

6. Recreational, Commercial and Industrial Land Use.

The existing Table Mountain Golf Course occupies the western portion of the airport property. This is good compatible land use for land surrounding an airport and the continued use of this land by golf course should be encouraged. There is a section of land west of Runway 1-19 and south of the existing golf course which will not be necessary for aviation use and this land could properly be used for an expansion to the golf course.

Sufficient land should be reserved for development of all forecast aviation requirements and land should be reserved for unexpected growth. Any additional land available on airport property over and above that which is required for aviation use and reserves should be set aside for commercial development which is compatible to aviation operations. No commercial operation which produces smoke, electromagnetic interference, or visual interference for aircraft operations should be allowed to develop on airport property. Some of the airport property not used for aviation uses will be located such as to allow direct access to the runways and taxiways from the commercial property.

7. Highway Access.

Current access to the airport is from California Highway 162. This access is adequate for the current airport operations and should be adequate for anticipated future operations. When the general aviation facilities have moved to the triangular area between the two runways the access to the airport will be off from Larkin Road. Larkin Road's access is off from State Highway 162. With the minimal traffic anticipated at the airport, the Larkin Road access will be adequate and airport operations will not significantly affect the capacity of this road.

8. Sequence of Development.

The runway and taxiway systems are required as soon as they can be developed. The development of the new aircraft parking apron and tee hangar access roads can be expanded as needed. It is not considered necessary to abandon the existing aircraft operations facilities at this time, but any additional facilities should be constructed in the area set aside for the future development and the operations transferred to the south side of Runway 12-30 in an orderly manner as the need develops.

III. ENVIRONMENTAL ASSESSMENT

A series of environmental assessment reports have previously been prepared for the City of Oroville and for Butte County for development in and around the City of Oroville and Butte County. These reports have been reviewed in detail. The reports reviewed included the following:

- "Butte County Non-Attainment Plan" produced by Earth Metrics Incorporated, Palo Alto, California, dated January 17, 1979.
- "Final Environmental Impact Report for the Chico Area Land Use Plan and Amendment to the Butte County General Plan" by the Butte County Planning Department in Oroville dated July 1982.
- "Survey Reports, Oroville General Plans Study" prepared by Lampman and Associates, Sacramento, California, December 1972.
- "Final Environmental Impact Report, City of Oroville Enterprise Zone," dated February 3, 1986.
- "EIR Oroville Land Use Plan" prepared for Butte County Airport Land Use Commission by Butte County Planning Department.

These reports have been reviewed in detail and only those areas where significant differences in conditions exist were detailed analyses conducted including noise evaluation, air pollution, and the requirement for the effects of construction on the environment. The evaluations presented in the previous reports have been summarized and are accepted as valid for this report also.

A. Impact on the Natural Environment.

1. Geology - Soils. Oroville is located at the edge of the foothills of the Sierra-Nevada mountains. The downtown area is located on the alluvial plain of the Feather River near where it emerges from its canyon to the foothill belts of the mountains. The suburbs extend both to the east into the foothills and to the west onto the flats near Thermalito. The airport is located on the flats.

The soils at the airport site consist essentially of sands, sandy silts, and clayey silts. These soils are compacted stable materials. Bedrock in the area consists of medasedimentary and metavolcanic rocks typical of those normally present in the foothills of the Sierras. These are firm to hard depending on the depth of weathering and rates of erosion of the residual soils.

All of Butte County, including the project site, is located in Earthquake Intensity Zone VIII. The last large earthquake occurred in August 1, 1975, registering a magnitude of about 6.0 on the Richter Scale. Structural damage occurred throughout the community.

2. Water Pollution. Runoff is to the east and the south into the low areas developed by the excavation for the Oroville Dam

construction. This water is currently discharged into the property immediately east of Larkin Road and causes some flooding and erosion in this area. With the development of the airport the discharge should be channeled into controlled channels or pipes to eliminate the erosion and flooding in this area.

Erosion will be controlled on the airport by controlling grades, drainage, and reseeding. Any erosion that does occur will be trapped in sedimentation basins and controlled. All erosion, dust, and runoff will be controlled during construction.

Water pollution from the aircraft parking ramp and proposed Fixed Base Operator areas will be controlled by requiring proper disposition of all wastes from aircraft maintenance. The discharge of pollutants from the aircraft operations will be slight because of the light use of this area resulting from the small number of aircraft that are based at this airport. The drainage of the apron will be designed such that all of the drainage from the aircraft parking apron, the tee hangar areas, the Fixed Base Operator areas, and the automobile parking lots will be discharged from the site at one location. The design will be prepared such that oil/water separators can be installed in the future if a contamination problem develops.

3. Water Supply. The City of Oroville has a 12-inch water main constructed into the golf course clubhouse on the west

side of the airport and a 12-inch water main along Oro Dam Boulevard (State Route 162). An 8-inch water main has been carried into the commercial area south of Oro Dam Boulevard and west of Larkin Road. The development of the aircraft operations area and fixed base operations south of Runway 12-30 and east of Runway 1-19 will require the extension of water service into this area.

4. Sewage Treatment. Existing sewers exist along Oro Dam Boulevard and the northern portion of Larkin Road. The development of the new aircraft operations area and Fixed Base Operator area will require the ultimate extension of sewer lines to this area. Due to the topography of this area it will probably be necessary to install a lift station and pressure sewer to carry the sewage to existing lines.

5. Air Pollution. Butte County is currently designated as a "non-attainment area for photo chemical oxidants" caused by the transportation of pollutants from the Sacramento/San Francisco Bay area, agriculture burning, pesticide and herbicide applications, and local traffic. The traffic at Oroville Airport and the number of based aircraft will increase even if no changes in layout and design are implemented. There will be some additional increase in business aircraft use resulting from the proposed development of this airport, but the effect on air quality caused by this increase in business aircraft traffic will be more than offset by moving all operations 2,000 feet south and locating the aprons near the center of the runways.

Moving the air operations facilities south of Runway 12-30 should have a beneficial effect on air quality in this area since the source of airport pollution will be moved away from the commercial industrial development along Oro Dam Boulevard which will disperse the air pollutants over a larger area. By moving the aircraft operations to the new development area, there will be a major decrease in aircraft taxiing operations, which will in turn considerably decrease the air pollution caused by aircraft operations since the major air pollution from aircraft operation is attributed to taxiing operations. The moving of the aircraft operations south of Runway 12-30 will increase the distance that automobiles and trucks will have to travel to reach the airport. The increase in travel distance will be approximately 1 mile. The distance from the intersection of Oro Dam Boulevard and Larkin Road to the existing airport operating areas is approximately 1/2 mile; whereas, the distance to the center of the proposed new development will be approximately 1-1/2 miles. The net effect of moving the airport operating facilities to the south of Runway 12-30 would be a slight improvement in air quality.

6. Impact on Marine Life in Adjacent Creeks and Rivers. The drainage from the current airport operations is to the low lying area to the east of Larkin Road and this will not change with the new development. The new development of the airport will be such as to improve the drainage to this area by better controlling the offsite drainage. The development of the new

proposed air operations areas will also be such as to protect against pollutants discharging into the runoff and providing for the installation of oil/water separators to control these discharges when required. It is, therefore, considered that there will be little or no additional impact on marine life in adjacent creeks and rivers.

7. Impact on Wild Life Refuge. The Thermalito Afterbay is immediately east and south of the airport and is designated as wild life refuge. There will be no changes in operation of aircraft or other facilities in or over this wild life refuge by the proposed new development other than lowering the flight path over the refuge for approaches and departures to Runway 1-19 by some 30 to 60 feet, depending on operation. Noise levels in these areas will not be significantly affected by moving the threshold to Runway 1 approximately 2,000 feet farther south.

8. Impact on Prime Agricultural Lands. There are no prime agricultural lands in the area affected by the airport. The land around the airport is used essentially for grazing purposes. The development of the runway extension to the south, taxiway expansion, and general aviation storage and operating facilities will remove some of this grazing land from production.

B. Impact on Human Environment.

1. Relocation of Persons. The proposed development will not cause the relocation of any persons. There is currently only

one residence adjacent to the proposed land acquisition and development area which residence is located outside of the 57 CNEL contour for both existing and proposed development.

2. Compatible Land Use. The current City of Oroville Zoning Ordinance adequately protects the airport from incompatible development. It is recommended that the current zoning be maintained for a distance of at least 4,000 feet on each side of Runway 1-19 and for a distance of 7,000 feet beyond the end of all runways. Within this area it is recommended that commercial, industrial, low density residential, open space, and golf course type use be maintained.

Additional airport compatible commercial land use is recommended in this plan for airport land not required for aviation uses. The commercial uses of this land will increase vehicular traffic, noise, air pollution, and storm water runoff but will improve the economic base of the airport and of the community.

3. Effect on Historic or Archeological Sites. There are no known historic or archeological sites on the property which will be affected by the proposed development.

4. Effect on Public Parks. There are no public parks which will be affected by the proposed development.

5. Aesthetic and Visual Effects. There will be no significant change in the aesthetic or visual effect of the area by the development of the relocated aircraft operation area and runway extension.

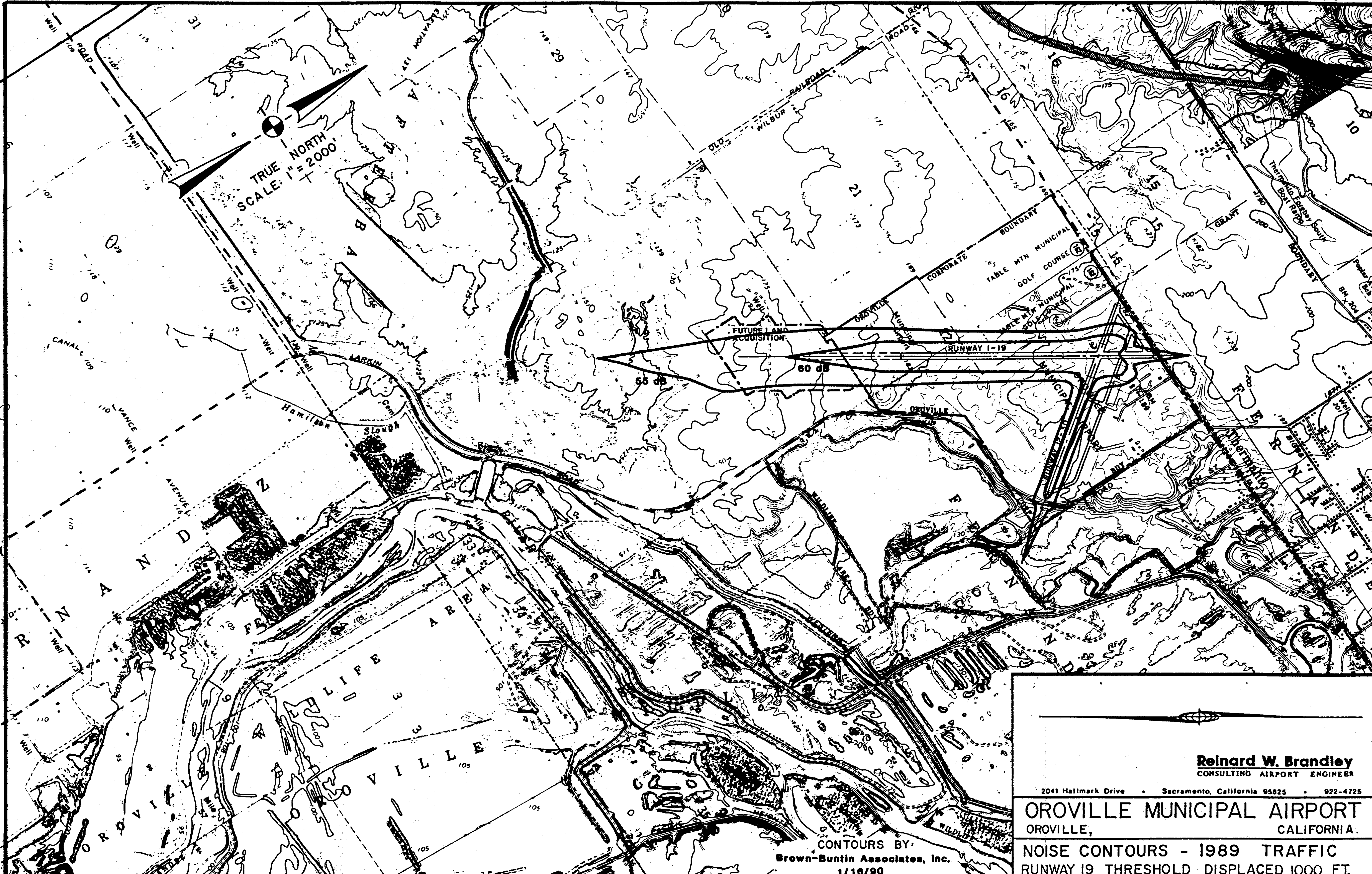
The proposed commercial development of excess airport property will have an aesthetic effect on the property in that commercial buildings will be constructed on property that is now vacant. Commercial development of these areas will fit well with the existing and proposed commercial and airport development of adjacent lands.

6. <u>Secondary Effects</u>. The development of the proposed aircraft operating facilities will create a modest increase in automobile traffic on Larkin Road but this increased traffic on Larkin Road will not significantly affect the capacity of this road. It is anticipated that the development of the airport will provide sufficient improvement in capability for the airport to accommodate business jets and larger general aviation aircraft and that it will have a significant effect on attracting industrial growth to the area which will significantly improve the economy of the area.

7. <u>Noise Pollution</u>. Detailed noise studies have been conducted by the Acoustical Consultant - Brown Buntin, Sacramento, California. The detailed Brown Buntin report is included as Appendix A.

The noise analyses were conducted for two different conditions of runway location and two time periods. The plots of the CNEL noise contours are presented as follows:

- Plate No. 6 - Runway 19 Threshold Displaced 1,000 Feet, 1989 Traffic.
- Plate No. 7 - Runway 19 Threshold Displaced 1,000 Feet, 2010 Traffic.



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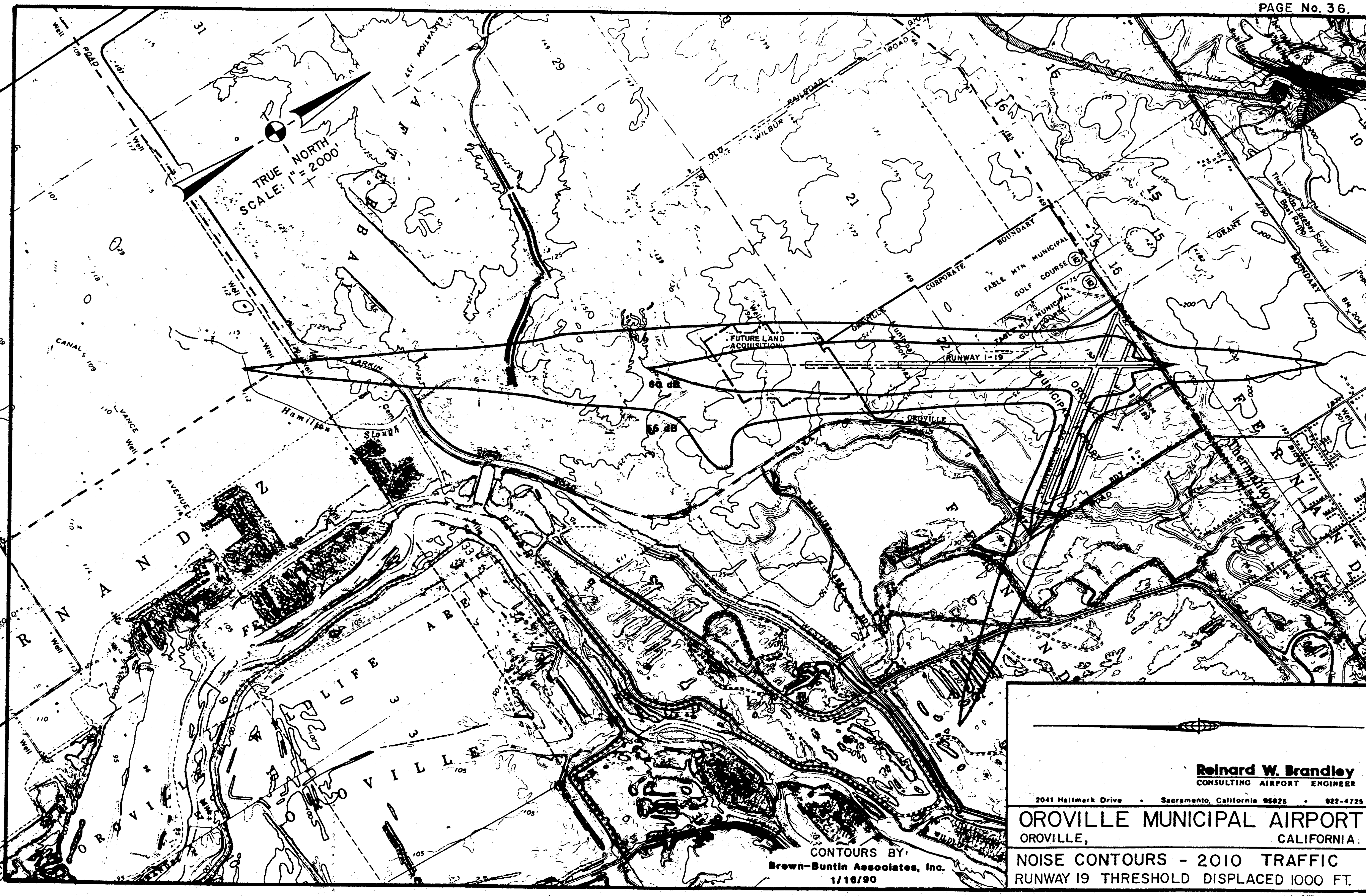
OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA.

NOISE CONTOURS - 1989 TRAFFIC
RUNWAY 19 THRESHOLD DISPLACED 1000 FT.

CONTOURS BY:
Brown-Buntin Associates, Inc.
1/16/90

PLATE No. 6


TRUE NORTH
SCALE: 1" = 2000'
FUTURE LAND ACQUISITION
RUNWAY 1-19
60 dB
55 dB
TABLE MTN MUNICIPAL GOLF COURSE
CORPORATE BOUNDARY
OLD WILBUR RAILROAD
Hamilton Slough
LARKIN
VANCE AVENUE
CANAL
Thermalito
Thermalito Forebay South Boat Ramp
GRANT
BOUNDARY
CONTOURS BY:
Brown-Buntin Associates, Inc.
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OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA.
NOISE CONTOURS - 2010 TRAFFIC
RUNWAY 19 THRESHOLD DISPLACED 1000 FT.

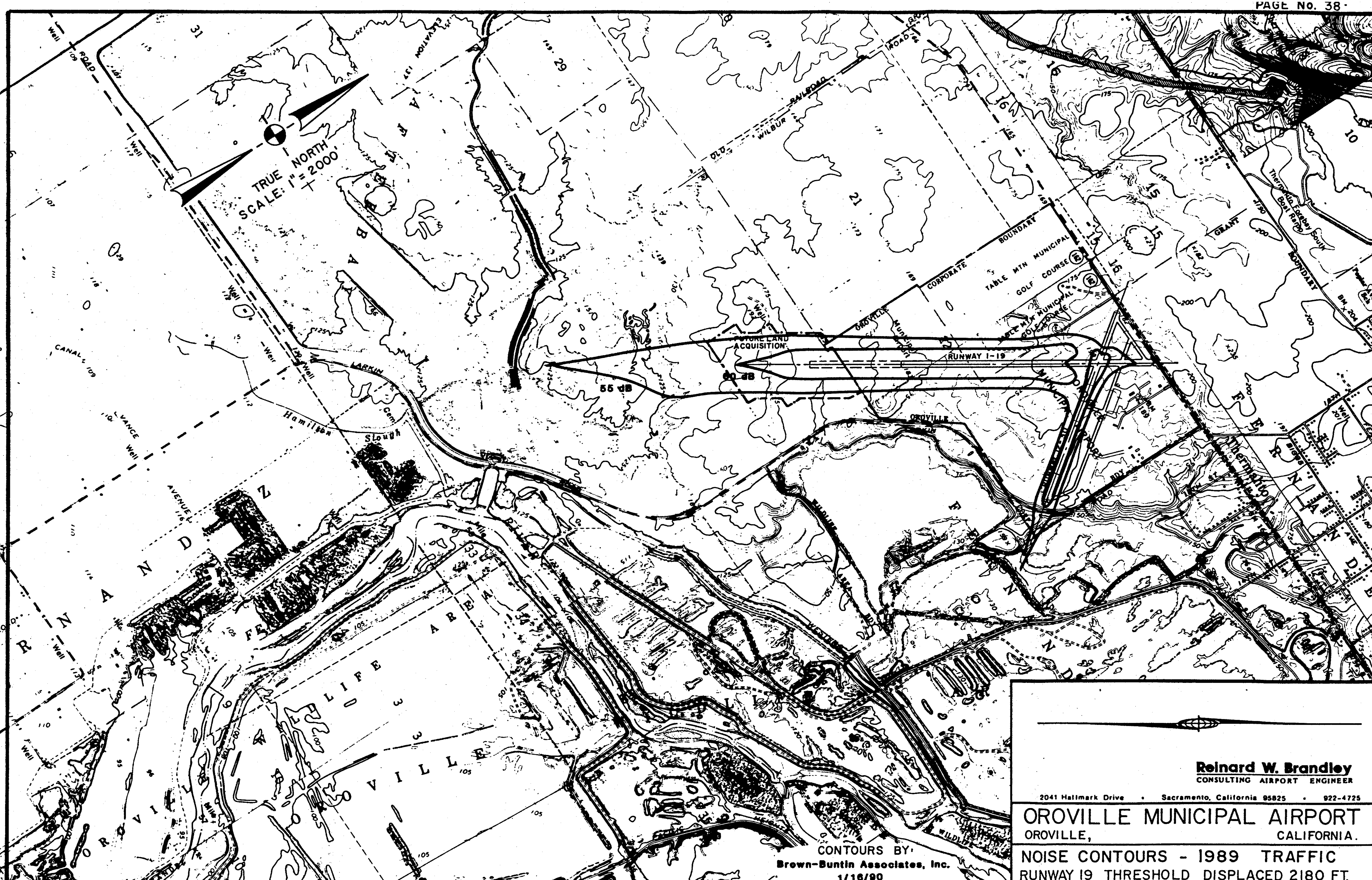
PLATE No. 7

- Plate No. 8 - Runway 19 Threshold Displaced 2,180 Feet, 1989 Traffic.
- Plate No. 9 - Runway 19 Threshold Displaced 2,180 Feet, 2010 Traffic.

In addition to determining the location of the CNEL contours, the single event noise exposure was calculated for the location of the nearest residence located immediately west of the proposed property acquisition at the south end of the proposed Runway 1-19.

CNEL is the descriptor used by the California Division of Aeronautics to describe the noise impact boundary of California airports. A CNEL value of 65 decibels (dB) is the noise impact criterion for noise-sensitive land uses, such as single and multi-family dwellings, trailer parks, and schools. Such uses are considered compatible with airport/aircraft noise exposures of 65 dB CBEL or less. The CNEL descriptor is also employed by the California Office of Noise Control (ONC) as a means of specifying compatible land uses for other community noise sources. The ONC "Guidelines for the Preparation and Content of Noise Elements of the General Plan" indicate that residential land uses are normally acceptable where the noise exposure is 60 dB CNEL or less, and that such uses are conditionally acceptable where the noise exposure does not exceed 70 dB CNEL. The table showing Land Use Compatibility for community noise environs is shown in Figure No. 1 of Appendix A.

Even for 2010 forecast traffic the 65 CNEL contour, which is not shown on the drawings, is located entirely within


TRUE NORTH
SCALE: 1" = 2000'
RUNWAY 1-19
FUTURE LAND ACQUISITION
60 dB
55 dB
TABLE MTN MUNICIPAL GOLF COURSE
CORPORATE BOUNDARY
OLD WILBUR RAILROAD
Thermalito Forebay South Boat Ramp
LARKIN
Hamilton Slough
AVENUE
VANCE
CANAL
OROVILLE
WILDLIFE AREA
FERNANDEZ
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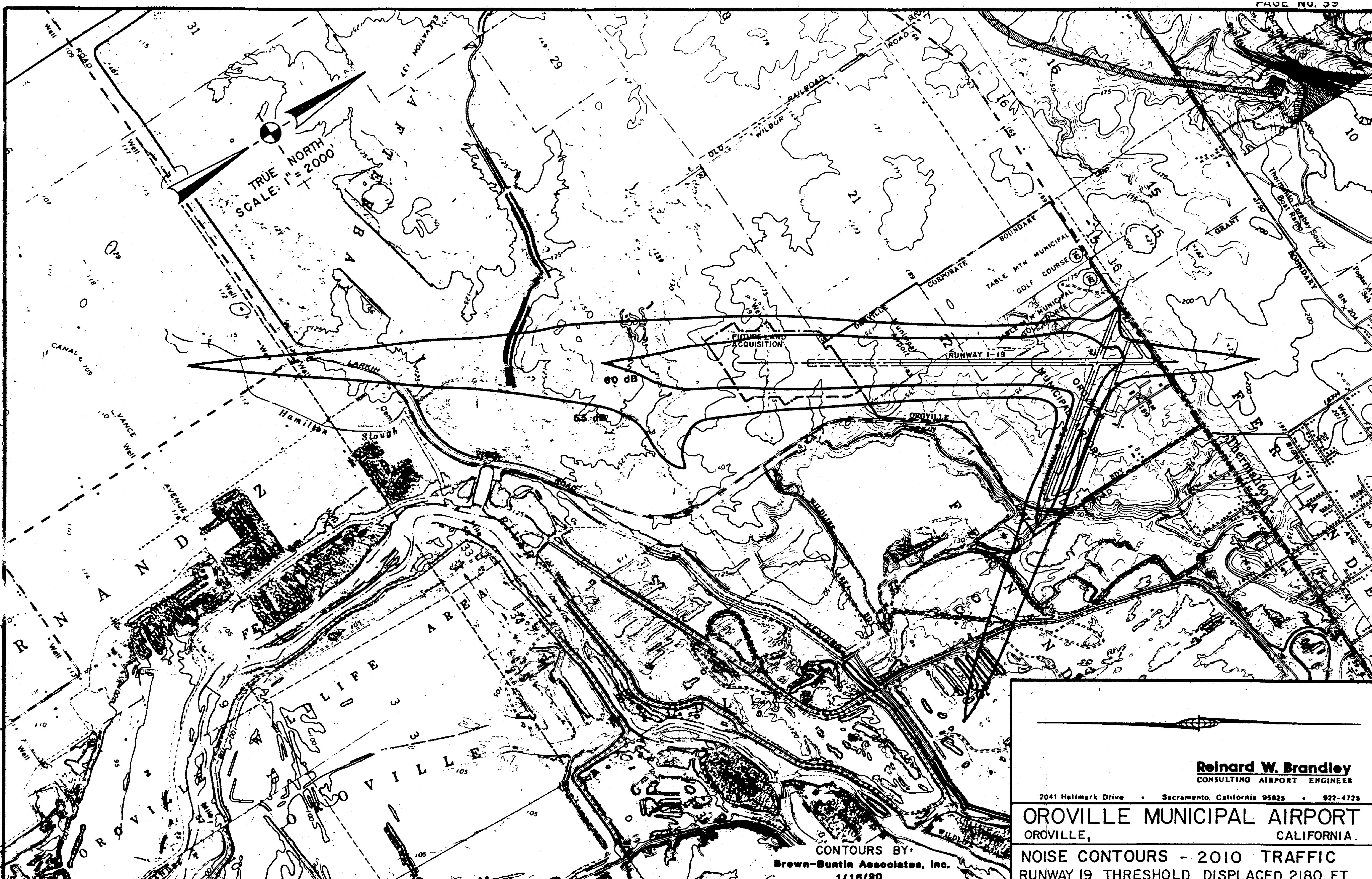
RUNWAY 19 THRESHOLD DISPLACED 2180 FT.
CONTOURS BY:
Brown-Buntin Associates, Inc.
1/16/90



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OROVILLE, CALIFORNIA.

NOISE CONTOURS - 2010 TRAFFIC
RUNWAY 19 THRESHOLD DISPLACED 2180 FT.

PLATE No. 9

airport property next to the runway. The 60 CNEL contour is located entirely within public property except for a small section north of Oro Dam Boulevard on Runway 1-19 centerline extended. Even the 55 CNEL contour is mostly located within public property.

Some single event noise levels are fairly high at the existing residence located southwest of the southerly end of Runway 1-19 extended. There is insignificant single event noise level differences between existing conditions at the airport and those that will exist with the proposed runway.

8. Air Pollution. Butte County is currently designated a "non-attainment area for photo chemical oxidants". The growth of aircraft traffic at the Oroville Airport will increase in approximately the same proportion even if the new proposed development is not accomplished. The only increase in operations by extending the runway and moving the general aviation facilities to the south side of Runway 12-30 will be a slight increase in business jets and larger business general aviation aircraft which will be a small percentage of the total operations on the airport.

By moving aircraft operations to the south there will be a dispersal of air pollutants over a wider area which will tend to improve air quality. There will also be a major decrease in aircraft taxiing requirements by moving operations to the south of Runway 12-30 which will decrease the air pollution caused by taxiing of aircraft. There will be added automobile traffic since each trip will require approximately 1 mile additional travel in each direction for the operations in the new development area.

9. Considerations Relative to the Wet-Lands. The development of the proposed runway extension and relocated aircraft operation areas will have no significant effect on wet-lands.

C. Adverse Effects That Cannot Be Avoided.

There are some environmental effects resulting from the expansion and proposed development of the Oroville Municipal Airport which cannot be avoided. These have been covered in the previous sections of this report. Summarized herewith are the effects - neutral and adverse - of the proposed development.

1. Natural Environment

- There will be no significant destruction or displacement of wild life and/or marine life.
- There will be no detrimental effect on any lakes, streams, rivers, water conservation areas, swamps or creeks since none exist on the airport.
- There are no endangered species on the airport and therefore no impact on endangered species.
- There are no local, state, federal, or national recreation areas affected by the airport except for some minor noise increase in that portion of the Thermalito Afterbay along the extended centerline of Runway 1-19.
- Consumption of undeveloped land. There will be some land on which the use will be changed. Some lands will be paved for the runway/taxiway extensions, some lands will be paved for tie down aprons, aircraft parking facilities, tee hangar development areas, and fixed based operator development.

- There will be no impact on wild life refuge, water flow area, or flood plain area and there will be no significant impact on the wild life breeding, nesting or feeding grounds.

2. Human Environment

- The development of this airport will not have a dividing or disrupting influence on an established community or cutoff access to recreation or shopping areas.

- There are no conflicting community interests or controversies over the proposed development other than the noise and air quality impact of those people living in the area immediately adjoining the airport.

- The acquisition of land for the proposed development does not cause any derogation of historical sites listed on the National Register of Historic Sites.

- Any water pollution which may occur either during construction or during operation of the airport will be handled on the airport in such a manner as to minimize pollution and contain the pollution levels within state standards.

- Air quality should not be affected by the development of these airport facilities since the location of the major source of air pollutants will be moved away from other major sources and taxiing distances will be decreased.

- There will be an increase in noise pollution, both permanent and temporary, as a result of the increase in the airport operations, however, most of the increase in air operations would occur even in the "do nothing" scenario and if Runway 1-19 is not displaced to the south, then the area north of the airport which is the more likely area to develop will be exposed to more noise than it would be with the runway being displaced. See Plates No. 6 through 9.

D. Evaluation of Alternates to the Master Plan.

Three alternates to the Master Plan have been evaluated. One is the "do nothing" approach in which the airport operations area remain where they are and the runways remain in their present condition. The second is to extend Runway 1-19 from its present threshold such as to produce a 6,000-foot length of runway and allow the clear zone to extend north of Oro Dam Boulevard as much as possible and leave aircraft operation facilities where they currently exist. The third was the recommended master plan development in which the threshold to Runway 1-19 is relocated sufficiently to allow the clear zone to be entirely within public property which requires an approximate 2,200-foot relocation from the north physical end of the runway and moving the aircraft operations area into the triangular area between the two runways.

If Runway 1-19 is developed as a non-precision instrument runway, then for all three options the land south of the airport will have to be acquired in order to provide protection to the airport from noise claims, for use in development of the airport, and for clear zone use. The noise in the major noise-sensitive areas is less for the master plan development than for either of the other two scenarios since the source of aircraft noise is moved approximately 1,200 feet south with this plan, moving the noise source from noise-sensitive land north of Oro Dam Boulevard to open space to the south. The master plan development is the only plan that provides adequate reserve for growth which has not been forecast. The master plan development provides more prime land for aviation commercial development than does the other plans in that it opens up the area in the southwest corner of Oro Dam Boulevard and Larkin Road for ultimate commercial use thus providing an economic base for development and operation of the airport. The future development of the airport land designated for future commercial use will have an environmental impact that cannot be avoided with growth including loss of open space; increased noise, air and water pollution; and increased traffic. The extension of Runway 19 to 6,000 feet will facilitate operations of the business jet aircraft and large twin general aviation aircraft into this airport which can have a significant impact in attracting industrial growth to the Oroville area which in turn will improve the economy of the community.

If the threshold to Runway 19 is not displaced, then a major portion of the non-precision instrument clear zone will be over private property north of Oro Dam Boulevard which property will either have to be acquired in fee title or easements acquired, both of which would be costly.

E. Mitigating Measures Proposed to Minimize the Impact.

The paving of sections of this site resulting from the proposed development will increase the amount and rate of runoff. This will be controlled by development of adequate drainage facilities, both onsite and offsite, to control the runoff from the airport.

Noise will be increased as a result of increased operations. The noise effect will be held to a minimum by taking the following actions:

- By relocating the threshold to the south the noise source will be moved away from the noise-sensitive areas north of Oro Dam Boulevard to open land over the Thermalito Afterbay.
- The acquisition of land between the airport and the Thermalito Afterbay will preclude any development in the noise-sensitive areas in this section of the airport.
- Controlling traffic patterns such that the traffic pattern for Runway 1-19 is held to the west of this runway and the traffic pattern for Runway 12-30 is held to the south of this runway will decrease the number of people subjected to noise from the airport.

- If Runway 19 is designated as the calm wind runway, then the takeoff noise will be concentrated over the uninhabited area over the Thermalito Afterbay.
- If midfield takeoffs on Runway 1-19 are prohibited for any aircraft with greater than 180 horsepower engines, the noise at the edge of the runway will be decreased.

Loss of agriculture land as a result of this development can be held to a minimum by encouraging the policy of continued farming in as much of the clear zone land of the airport as possible.

F. Growth Inducing Impact of the Proposed Action.

The development of the Oroville Municipal Airport is proposed basically to serve the existing and proposed general aviation and business aviation in the area. The development of the airport itself can attract industrial development to the Oroville area because of good air access that this facility will provide. There is also some increased growth resulting from the development of the area because of increased number of people that will be employed at the airport in flight operations including sales, rentals, schools, maintenance, etc. The commercial development of excess airport land will increase the number of people employed on airport property.

IV. TECHNICAL STUDIES

A. Pavement Evaluation Studies

Detailed pavement evaluation studies have been conducted at the Oroville Municipal Airport, including non-destructive testing on the existing pavements, soil borings, and soil testing on proposed future development areas. The results of these studies are presented in detail in Appendix C to this report and summarized herewith.

The subgrade soils at this airport range from silty sands and fine gravels to sandy silts to clayey silts to sandy silty clays. The California Bearing Ratio of these subgrade soils ranges from 12 for the sandy silt materials to 8 for the clayey sandy silts to 5 for the sandy silty clays. The sandy silty clay soils are prevalent throughout the site and are the critical subgrade soils for design using the F.A.A. design methodology.

The non-destructive tests conducted on the existing pavements showed the following modulus of elasticity and Poisson's Ratio values for existing pavement, base, and subgrade materials at average pavement temperatures:

Material	Modulus of Elasticity psi	Poisson's Ratio
A.C. Pavement	200,000	0.40
Aggregate Base	60,000	0.35
Subgrade	10,000 to 20,000	0.40

Using the test data developed in this study the following pavement sections are recommended for development of this Airport:

Gross Aircraft Weight - lb.		Pavement Section - Inches			
Single Gear	Dual Gear	Asphaltic Concrete	Aggregate Base	Aggregate Subbase	Total Section
12.5	--	3	6	4	13
20	35	3	7	6	16
34	50	4	9	7	20

It is recommended that Runway 1-19 and associated taxiways and portions of the apron be designed for a 50,000 pound dual gear type aircraft which will accommodate the Gulfstream II and all other business jets.

Runway 12-30 and associated taxiways should be designed for single gear aircraft with a gross aircraft weight of 20,000 pounds to accommodate small twins.

Those portions of the tie down apron and tee hangar area reserved for small aircraft should be designed for single gear aircraft with a gross aircraft weight of 12,500 pounds.

B. Topographic Surveys

Topographical surveys of the portion of the airport on which development is proposed have been completed using aerial survey methodology. Cartwright Aerial Surveys were the consultants for this phase of the work. The topographic surveys have been presented separate from this report. These surveys were used to prepare the Preliminary Engineering design work and cost estimates.

C. Overall Drainage Plan

Drainage studies conducted for the existing facilities show that all runoff is carried by pipes and ditches to the low lying ground to the east and southeast across Larkin Road. There are reports of some flooding and erosion caused by this drainage outfall in areas immediately east of Larkin Road.

Preliminary engineering studies prepared show that all drainage from the proposed development will continue to discharge into the same low lying areas located east and southeast of the airport. The drainage will still be carried by pipes and ditches. Erosion and flooding problems in the area east of Larkin Road will be corrected by offsite drainage structure development.

V. AIRPORT PLANS

As a result of this study, a series of airport plans have been prepared. These plans are presented separately and include the following:

Sheet No. 1 - Airport Layout Plan

Sheet No. 2 - Terminal Area Layout Plan

Sheet No. 3 - Airport Zoning Plan

Sheet No. 4 - Approach Profile - Runway 1-19

Sheet No. 5 - Approach Profile - Runway 12-30

A. Airport Layout Plan - Sheet No. 1

The Airport Layout Plan shows the proposed development, including reserve and unanticipated growth through the year 2010.

Runway 12-30 is shown as a short visual general aviation runway with displaced or relocated thresholds such that the clear zone for Runway 12 is entirely within public property and the approach surface for Runway 30 provides necessary clearances over Larkin Road. The land to the east of Larkin Road drops off so rapidly that the approach surface is sufficiently high over the land that it will not cause any problems or significant height restrictions in this area. Runway 12-30 will be used only by the light single engine and twin engine aircraft, and the pavement will be designed for a gross aircraft weight of 20,000 pounds for single gear aircraft. The current runway is 150 feet wide, and runway edge lights have been installed 10 feet beyond the 150-foot width. Runway 12-30 is being overlaid in the summer of 1990 to a width of 100 feet but uniform tapers are being constructed to the existing pavement and the outside edges of the pavement will be slurry sealed. The strengthened section of this runway will be 100 feet wide, but the total 150-foot width will be usable.

Runway 1-19 will be constructed to a width of 100 feet and a total length of 6,000 feet. The threshold to Runway 19 will be relocated approximately 2,200 feet to the south from the north physical end of pavement such that the 34:1 non-precision instrument clear zone will be located entirely within public property. This will require an extension of 2,180 feet to the south. This runway, when finally constructed, will be 100 feet wide by 6,000 feet long. The current runway has a sag in the middle and is high on both ends. The gradient of each segment is approximately one percent. When the runway is extended, the existing runway will be reconstructed from the depressed area to decrease this gradient and provide a better profile for the runway. The extension of the runway will require acquisition of land to the south of the airport and the non-precision approach clear zone will also require acquisition of additional land. If the land shown on the Airport Layout Plan is acquired, then the City will own all of the land along the runway alignment between the airport and the Thermalito Afterbay. A south departure on Runway 19 will then be over City-owned property and public-owned property.

Once the threshold to Runway 19 is relocated, then the existing aircraft tie down and tee hangar area will be located in an area which will be inconvenient for operation of Runway 1-19, and a large portion of this apron will be within the clear zone. There is also insufficient area available for forecast expansion and reserve for the unknown expansion. It is, therefore, recommended that the aircraft operational areas be relocated at this airport to the triangular area between the two runways, which is south of Runway 12-30 and east of Runway 1-19. It is not anticipated that the aircraft operations will be transferred immediately to this area, but that the existing facilities will be used and that any expansion required be in the proposed new location. The transfer of aircraft activities to the new area will, no doubt, be gradual and take place over several years.

Parallel taxiways will be required for both runways located on the airport operation side of the runways. Runway 1-19 has the capability of becoming a non-precision instrument runway and the parallel taxiway has been established at a centerline distance of 400 feet to the east of the runway. This taxiway will be 50 feet wide. Four cross taxiways are planned to connect the parallel taxiway to Runway 1-19. An aircraft holding apron is planned for each end of the runway.

The parallel taxiway to serve Runway 12-30 will be located 300 feet south of Runway 12-30, will be 40 feet wide, and there will be four connecting taxiways between the parallel taxiway and Runway 12-30.

Connecting taxiways are planned to interconnect the two runway/taxiway systems and to connect the proposed aircraft parking apron and tee hangar areas to the parallel taxiways.

Runway 12-30 and associated taxiways will be used only for light aircraft and the pavements will be designed for a gross weight of

20,000 pounds on a single gear type aircraft. Runway 1-19 and associated taxiways will be the main instrument runway and will be used for all of the business jet type aircraft and large general aviation aircraft. The pavement for this runway complex should be designed to accommodate gross aircraft weight of 35,000 pounds for single gear aircraft and 50,000 pounds for dual gear aircraft. The 50,000-pound capacity is required to accommodate the Gulfstream business jets which are now using this airport and will be adequate for occasional use by dual gear aircraft weighing as much as 60,000 pounds.

Aircraft parking apron, tee hangar development areas, and Fixed Base Operator plots have been reserved adjacent to the parallel taxiways in the triangular area between the two runways. Even though the total forecast for based aircraft for the year 2010 is 100 aircraft and the forecast total requirement allowing room for transient parking is no more than 150 aircraft, provision has been made in the plan for aircraft tie down apron capable of storing 300 aircraft and tee hangar area capable of storing 72 aircraft. In addition, an area has been reserved for aircraft tie down expansion and/or corporate hangar development to the south of the proposed aircraft tie down apron and an area has been reserved for tee hangar expansion to the east of the tee hangar area to accommodate an additional 40 units. These reserve areas should be held until such time as future demand indicates that there is no need for this development area at the Oroville Airport, which probably will be 10 to 20 years from now.

Area has been reserved east of the aircraft tie down apron for three Fixed Base Operator plots and a section has been set aside for a future Air Traffic Control Tower. A helicopter landing pad and storage area has been shown to the south of the aircraft tie down apron.

Fuel is currently dispensed to aircraft from a fuel island that is equipped with underground tanks. An area has been reserved adjacent to Larkin Road and south of the proposed new access road to the operational areas on the airport for a new fuel farm. Because of the problems with fuel leakage and contamination of ground water from underground tanks it is recommended that all new tanks in the new fuel farm be located above ground. Minimum initial fuel tankage should consist of a 10,000-gallon tank for jet fuel and a 10,000-gallon tank for 100 octane aviation fuel.

New access roads and parking lots have been provided on this plan to serve the aircraft tie down, tee hangar areas, and FBO plots. This road is served from Larkin Road, which in turn ties into State Highway 162. With the small number of based aircraft forecast for this airport, the vehicular traffic will be light and will not significantly impact the capacity of Larkin Road or State Highway 162.

After all aviation uses have been provided and major areas reserved for possible future expansion, there are still fairly extensive areas of undeveloped land available on the airport. At the west side of the airport Table Mountain Golf Course is in operation and is a good compatible use adjacent to the airport. It is recommended that this golf course remain in operation at its current location. There are approximately 54 acres of land south of the golf course and west of Runway 1-19 which are not required for airport development. This land does not have ready access to public roads, and golf course expansion in this area would be a good compatible land use for the airport.

On the east side of Runway 1-19 between Taxiway A and Larkin Road and south of the aircraft tie down area there is a fairly large segment of land which can be readily used for aviation commercial development. This land could have ready access to the airfield and can be easily served from Larkin Road. There is excess land within the proposed loop road which is not required for automobile parking which can also be used for aviation commercial. The land between Larkin Road and the proposed loop road is also available for commercial development. This land has good access off from Larkin Road. Once the general aviation operation areas are moved from the north side of Runway 12-30 to the new proposed location, then the area occupied by these facilities, together with that land to the east of existing airport facilities, can also be used for aviation commercial use extending the current commercial development in the southwest corner of State Highway 162 and Larkin Road.

B. <u>Terminal Area Layout Plan - Sheet No. 2</u>

The Terminal Area Layout Plan is a larger scale drawing of the general aviation development area showing the proposed and reserve areas for aviation development. On this drawing recommended construction staging has also been indicated.

C. Airport Zoning Map - Sheet No. 3

Runway 1-19 is planned as a future non-precision instrument runway. Currently, there is a non-directional beacon located at the airport and F.A.A. is now preparing approach procedures for a non-directional beacon approach to this airport. There is currently a VOR approach to the airport from the Marysville VOR. The non-directional beacon approach will be to Runway 1. Lower minimums can be obtained for Runway 1 because of the terrain. South Table Mountain to the north limits the approach minimums for a Runway 19 approach.

The imaginary surfaces surrounding the airport as set forth in the Federal Aviation Administration Federal Air Regulations Part 77 are superimposed on a U.S.G.S. quad sheet in the form of contours. These imaginary surfaces are depicted on the Airport Zoning Map, Sheet No. 3 for non-precision approaches to both ends of Runway 1-19 and visual approaches to Runways 12 and 30. The approaches to Runways 1 and 19 are 34:1 and the approaches to Runways 12 and 30 are 20:1.

The only items penetrating these imaginary surfaces are in the upper portion of Sugar Loaf Peak located to the northwest of the airport, approximately 3 miles from the airport reference point.

A model Height Limit Zoning Ordinance has been prepared and is included as Appendix B to this report. It is recommended that this Zoning Ordinance be adopted by both the City of Oroville and the County of Butte to protect the airport.

D. Approach Profile - Runway 1-19 (Non-Precision Approach - 3/4 Mile Visibility) - Sheet No. 4

Approaches profiles have been prepared for Runway 1-19 for the condition of a non-precision approach with 3/4-mile visibility limits. This profile is shown on Sheet No. 4. There are no objects penetrating the approaches to this runway.

E. Approach Profile - Runway 12-30 (Visual Runway) - Sheet No. 5

The approach profiles for the general aviation Runway 12-30 are shown on Sheet No. 5. Standard VFR 20:1 approach slopes are shown. There are no objects which penetrate any of these approach surfaces.

F. Airport Access Plan

A separate Airport Access Plan has not been prepared, but access is shown on the Airport Layout Plan, Sheet No. 1. Access to the new airport development will be from State Highway 162 by way of Larkin Road. The airport access road will come off from Larkin Road and a loop road will be constructed with automobile parking and aviation commercial located within the loop.

VI. FINANCIAL PLAN

A. Schedules and Cost Estimates of Proposed Development

Development cost estimates have been prepared for different design concepts considered practical for the development of the Oroville Municipal Airport. The results of these studies are presented in Appendix D to this report.

Based on these estimates and the studies conducted in the preparation of this Master Plan for the Oroville Municipal Airport the recommended airfield configuration has evolved and is as shown on the Airport Layout Plan. The estimated development costs showing total costs, F.A.A. eligible costs, potential F.A.A. participation and local participation are summarized in Table No. 2 for this plan.

It is not anticipated that the entire work shown in Table No. 2 would be constructed at one time. The first construction should be the development of Runway 1-19 and associated taxiways. Aircraft operations and storage would remain at its present location on the north side of Runway 12-30. As funding becomes available and the need for expansion of aircraft storage or FBO facilities develops then the proposed new apron, access road and tee hangar area should be developed. The water and sewer line extensions along Larkin Road will be required for future planned development along Larkin Road and the costs can be shared.

F.A.A. will not participate in the cost of sewer and water lines or for the cost of the construction of tee hangars or maintenance hangars. All other work is eligible for Federal funding or State of California funding in the amount of 90% of the total cost of eligible items.

B. Financial and Economic Feasibility

All work proposed in the Master Plan except the water and sewer lines and the tee hangar construction are eligible for a Federal or State grant in the amount of 90% of all eligible costs. A preapplication has already been submitted to the Federal Aviation Administration to cover the following work.

TABLE NO. 2

OROVILLE MUNICIPAL AIRPORT
OROVILLE, BUTTE COUNTY, CALIFORNIA

SUMMARIZATION OF DEVELOPMENT COSTS

ITEM NUMBER	ITEMS	COSTS: CONSTRUCTION COST	COSTS: ENGINEERING AND CONTINGENCIES	COSTS: TOTAL PROJECT	F.A.A. ELGIBILE	F.A.A. PARTICIPATION	LOCAL PARTICIPATION
1	Runway 1-19 and Associated Taxiways	$6,607,314.00	$1,651,828.00	$8,259,142.00	$8,259,142.00	$7,833,228.00	$825,914.00
2	Runway 12-30 Taxiway	1,031,091.00	257,773.00	1,288,864.00	1,288,864.00	1,159,978.00	128,886.00
3	Tie Down Apron (75 Aircraft)	607,950.00	151,863.00	759,813.00	759,813.00	683,832.00	75,981.00
4	Tee Hangar Development (18 Units)	494,000.00	123,500.00	617,500.00	347,500.00	312,750.00	304,750.00
5	Access Road (First Stage)	248,000.00	62,000.00	310,000.00	310,000.00	279,000.00	31,000.00
6	Sewer and Water Services	620,000.00	155,000.00	775,000.00	0.00	0.00	775,000.00
7	Land Acquisition	152,000.00	38,000.00	190,000.00	190,000.00	171,000.00	19,000.00
	TOTAL	$9,760,355.00	$2,439,964.00	$12,200,319.00	$11,155,319.00	$10,439,788.00	$2,160,531.00

NOTES:
1. Master plan option used with threshold of Runway 19 displaced 2,180 feet.
2. Runway 1-19 - 100′ wide x 6,000′ long.
3. Taxiways for Runway 12-30 constructed.
4. First Stage Apron (75 aircraft) constructed.
5. First Stage Tee Hangars (18 units) constructed.
6. First Stage Road constructed.
7. Aircraft Class C & D used. Trial No. 2 Estimates used.

1. Land acquisition.

2. Reconstruct and extend Runway 1-19 and associated taxiways.

3. Construct first stage tie down apron and tee hangar taxiways.

4. Construct access road.

5. Construct taxiways to serve Runway 12-30.

Airport generated fees from tie downs, hangars, fuel sales, FBO operations, etc. will not pay for the proposed improvements. Potential sources of financing for this work are:

- City of Oroville Public Works Development Funds.
- County of Butte participation.
- Federal Aviation Administration grant through the AIP program.
- State of California grant through the CAAP program.
- Revenues derived from the lease of commercial land on the airport.

The Oroville Municipal Airport serves both the City of Oroville and that portion of Butte County surrounding the airport. It should be in the interest of Butte County to share the cost of developing this airport.

The development of the airport as envisioned in the Master Plan will be a significant factor in attracting industry to the Oroville area which will benefit the local economy.

Reinard W. Brandley

RWB/jha

PREPARATION OF AIRPORT NOISE CONTOURS

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

PREPARED FOR:

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FEBRUARY 1, 1990

PREPARED BY:

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INTRODUCTION:

Brown-Buntin Associates, Inc. (BBA) has completed an analysis of aircraft/airport operations and related noise levels for the Oroville Municipal Airport to prepare Community Noise Equivalent Level (CNEL)* noise exposure maps for year 1989 and year 2010 airport operating conditions. The maps are to be incorporated into the Airport Master Plan being prepared for the airport by Reinard W. Brandley.

Federal Aviation Administration (FAA) and BBA noise level file data were used as the basis for preparing a predictive aircraft noise model based on Version 3.9 of the Federal Aviation Administration Integrated Noise Model (INM) (Reference 1). Existing and projected data for aircraft activity, aircraft fleet mix and airport configuration used in the noise modeling process were obtained from Reinard W. Brandley. The following report provides a summary of the data, methods and assumptions used in preparing the CNEL noise exposure maps.

The noise descriptors used in this analysis are the Community Noise Equivalent Level (CNEL), the Sound Exposure Level (SEL) and the maximum A-weighted noise level due to a single aircraft noise event (L_{max}). The CNEL descriptor is a method of averaging single event noise levels over a typical 24-hour day, applying penalties to noise events occurring during evening (7 p.m. to 10 p.m.) and nighttime (10 p.m. to 7 a.m.) hours. CNEL is usually defined in terms of average annual conditions, so that the CNEL measured on a given day may be either less than or greater than the annual average.

CNEL is the descriptor used by the California Division of Aeronautics to describe the noise impact boundary of California airports. A CNEL value of 65 decibels (dB) is the noise impact criterion for noise-sensitive land uses, such as single and multi-family dwellings, trailer parks and schools. Such uses are considered compatible with airport/aircraft noise exposures of 65 dB CNEL or less. The CNEL descriptor is also employed by the California Office of Noise Control (ONC) as a means of specifying compatible land uses for other community noise sources. The ONC "Guidelines for the Preparation and Content of Noise Elements of the General Plan" indicate that residential land uses are normally acceptable where the noise exposure is 60 dB CNEL or less, and that such uses are conditionally acceptable where the noise exposure does not exceed 70 dB CNEL (See Figure 1).

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* For explanation of these terms, see Appendix 1: " Acoustical Terminology".

The Federal Aviation Administration (FAA) uses a descriptor called the Day-Night Average Level (L_{dn}) to describe land use compatibility with respect to aircraft noise exposures. Like CNEL, the L_{dn} descriptor is a method of averaging aircraft noise levels over an annual average 24-hour period, except that the evening period defined by CNEL is included into the daytime hours, with no penalties assigned to those hours. The FAA airport/aircraft noise compatibility criterion for residential land uses is 65 dB L_{dn}.

The maximum A-weighted noise level associated with a given noise event (L_{max}) is expressed in terms of decibels, A-weighted (dBA). The L_{max} is useful as an index of the relative noisiness of a given event, easily compared to other noise sources, such as passing trucks, lawnmowers, or ordinary conversation. Figure 1 illustrates typical maximum A-weighted noise levels of several community noise sources.

The importance of the L_{max} values described in this report to persons exposed to noise from aircraft operations can be judged by comparison to Figure 2. For example, an L_{max} exceeding 60 dBA could be expected to interfere with speech. Indoors, maximum noise levels exceeding 45 to 50 dBA could result in sleep disturbance. Levels of 80 to 90 dBA are comparable to the noise of a passing truck at a distance of about 50 feet.

L_{max} is used in this analysis to relate noise level experienced during a single aircraft operation to noise levels an individual may observe using a hand-held sound level meter. Estimated L_{max} values for civil aircraft at reference measurement locations have been reported by the FAA in Advisory Circular 36-3E.

The Sound Exposure Level (SEL) is a measure of the total noise level accumulated during a noise event. Defined as the level of the time-integrated A-weighted sound pressure level for a given time interval, based upon a reference of duration of one second, the SEL represents the total noise energy of a noise event as though it occurred in a one-second period. For noise events longer than one second, the SEL is a higher level than the L_{max}. For typical jet aircraft takeoffs and landings in the near vicinity of airports, the SEL would be 5 dB to 10 dB higher than the L_{max} for a given noise event.

AIRCRAFT NOISE LEVEL DATA:

Noise level data for aircraft operating at the Airport were primarily obtained from the data base prepared by the Federal Aviation Administration for use with the Integrated Noise Model. The current data base contains generalized noise level and operational characteristics for 81 different aircraft types and variations, and reflects much of the current aircraft fleet.

The majority of the aircraft cited in the INM data base are jet aircraft, with few entries available for propeller-driven aircraft. The relative lack of representative propeller-driven aircraft types posed particular concerns at Oroville Municipal Airport, where the projected fleet contains a variety of single- and twin-engine aircraft. The INM data base now contains three single-engine and two twin-engine propeller-driven aircraft types. Aircraft operations at Oroville Municipal Airport were divided into these and other categories. A correction was made to the INM data for twin piston engine propeller-driven aircraft to account for the noise emission characteristics of light twins used at the Oroville Airport.

Helicopter noise level and flight profile data are not included in the INM data base, but may be obtained from other published data. The helicopter fleet at Oroville Municipal Airport is expected to include helicopters such as the Bell 206L. Noise emission and flight profile data developed by the FAA for that aircraft (Reference 2) were used as inputs to the INM to conservatively represent helicopter noise exposure at the airport.

For the year 1989 and year 2010 scenarios, two different runway configurations were used. The "existing" 01-19 runway configuration was assumed to extend from STA 110+0 to STA 162+75. The "future" configuration for runway 01-19 was assumed to extend from STA 88+20 to STA 148+20.

AIRPORT OPERATIONS:

Airport operational factors which can significantly affect overall noise levels as described by CNEL include the total number of operations, aircraft fleet mix and the time of day when aircraft operations occur. Table I summarizes the number and distribution of annual average daily operations by aircraft type for Oroville Municipal Airport for existing and future conditions, based upon analyses of airport activity prepared by Reinard W. Brandley.

Runway utilization factors significantly influence noise levels as defined by CNEL. Projected operations at Oroville Municipal Airport were assumed to occur 15% on runways 01 or 12, and 85% on runways 19 or 30. Pattern operations were assumed to occur for 20% of all single-engine propeller-driven aircraft. Use of runway 12-30 was assumed to be limited to single-engine propeller-driven aircraft.

Aircraft flight tracks were described from data provided by Reinard W. Brandley. The generalized flight tracks were used in the noise modeling process to describe areas with a concentration of aircraft overflights.

TABLE I
AIRCRAFT OPERATION ASSUMPTIONS
Annual Average Day: 1989 and 2010
Oroville Municipal Airport

Aircraft Type	1989 Total	2010 Total	% Daily Operations Day	Evening	Night
Single Engine Prop	156.327	179.093	80	18	2
Twin Engine Prop: Piston	8.200	13.668	90	9	1
Twin Engine: Turboprop	0.820	1.367	90	9	1
Helicopter	0.142	0.547	90	9	1
Business Jet	0.983	1.869	90	9	1
Military	0.273	0.273	90	9	1

PREPARATION OF CNEL NOISE EXPOSURE MAPS:

The Integrated Noise Model (INM) Version 3.9 was used to prepare CNEL noise exposure maps for the airport based upon the aircraft noise level and airport operational factors described in the previous sections. The INM was developed for the FAA, and represents the federally-sanctioned and preferred method for analyzing aircraft/airport noise exposure. Version 3.9 is the most recent version of the INM available, and incorporates an updated data base of aircraft performance parameters and noise levels.

The INM calculates aircraft noise exposure by mathematically combining aircraft noise levels and airport operational factors at a series of points within a cartesian coordinate system which defines the location of airport runways and aircraft flight tracks. User inputs to the INM include the following:

a. Airport altitude and mean temperature
b. Runway configuration
c. Aircraft flight track definition
d. Aircraft stage length
e. Aircraft departure and approach profiles
f. Aircraft traffic volume and fleet mix
g. Flight track utilization by aircraft types

The INM data base includes aircraft performance parameters and noise level data for 81 commercial, military and general aviation aircraft classes. When the user specifies a particular aircraft class from the INM data base, the model automatically provides the necessary inputs concerning aircraft power settings, speed, departure profile and noise levels. For Oroville Municipal Airport, additional inputs were developed from FAA file data to represent helicopter operations.

After the model had been prepared for the aircraft classes described in Table I, input files containing the number of operations by aircraft class, time of day and flight track were prepared for the described levels of airport activity. A separate input file was prepared for each year and runway configuration. CNEL contours prepared from these inputs have been plotted on mylar overlays for superimposing on maps of the area surrounding the airport.

The noise contours prepared by this study are included in the main body of the Master Plan Report as Plates 6, 7, 8, and 9.

Table II describes the noise impact of Oroville Municipal Airport in terms of the approximate land area contained within each of the CNEL contour values of 55 to 65 dB.

TABLE II

APPROXIMATE LAND AREA
(SQUARE MILES)
WITHIN CNEL CONTOURS
Oroville Municipal Airport

Year	Runway	CNEL Contour 55 dB	60 dB	65 dB
1989	Existing	0.57	0.20	0.08
1989	Future	0.58	0.21	0.08
2010	Future	1.53	0.48	0.18
2010	Future	1.53	0.51	0.19

The Integrated Noise Model calculates CNEL values at selected grid points using the following formula:

$$CNEL = \overline{SEL} + 10 \log N_{eq} - 49.4, \text{ dB; where:}$$

$\overline{SEL}$ is the mean Sound Exposure Level predicted for each aircraft type, N_{eq} is the number of daytime aircraft operations plus 3 times the number of evening operations and 10 times the number of nighttime operations, and 49.4 is 10 times the logarithm of the number of seconds in a 24-hour day.

The CNEL at a given location is the sum of the CNEL contributions by each of the aircraft operations affecting that site. Thus the INM accounts for the noise level produced by individual overflights of each aircraft type, the number of overflights experienced and the time of day in which the overflights occur.

Table III shows the predicted SEL values, by scenario, for takeoffs by different aircraft types at the nearest residence, located immediately west of the future land acquistion area at the south end of runway 01-19. Table IV shows the predicted CNEL values at the same residence.

TABLE III

PREDICTED SINGLE EVENT NOISE LEVELS OF DIFFERENT AIRCRAFT TYPES AT NEAREST RESIDENCE: YEARS 1989 AND 2010

	Predicted SEL, dB	
Aircraft Type	Existing Runway	Future Runway
G-2	110.7	110.5
Citation III	95.2	95.8
Citation II	86.6	87.0
Other Jets	105.1	105.2
King Air	79.5	79.4
Small Twin	83.4	83.5
Single	81.7	81.6
Helicopter	78.7	78.9
Military	83.4	83.5

TABLE IV

PREDICTED CNEL VALUES AT NEARBY RESIDENCE

Year	Runway	CNEL, dB
1989	Existing	53.0
1989	Future	53.3
2010	Existing	57.2
2010	Future	57.7

Respectfully submitted,

[signature]

Jim Buntin
Vice President

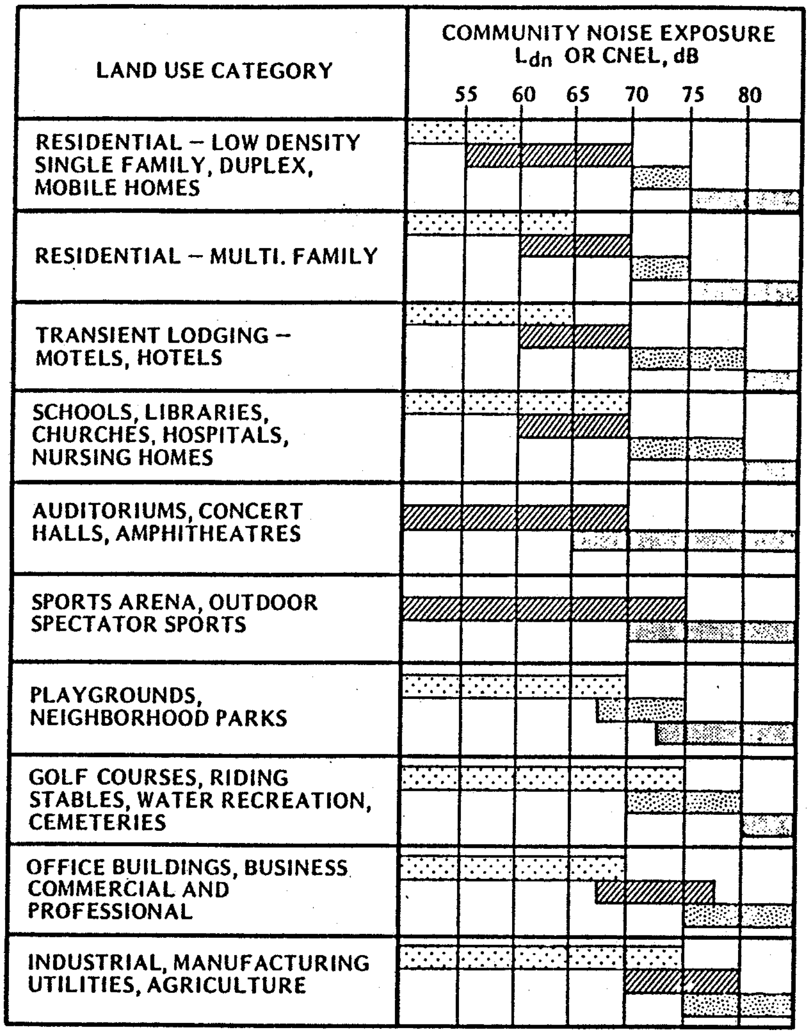
REFERENCES

1. U.S. Department of Transportation, Federal Aviation Administration; Integrated Noise Model, Version 3.9, 1988.

2. Helicopter Noise Exposure Curves for Use in Environmental Impact Assessment, U.S. DOT, FAA, Report No. FAA-EE-82-16, November 1982.

FIGURE 1

LAND USE COMPATIBILITY FOR COMMUNITY NOISE ENVIRONMENTS



INTERPRETATION

NORMALLY ACCEPTABLE

Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

CONDITIONALLY ACCEPTABLE

New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

NORMALLY UNACCEPTABLE

New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

CLEARLY UNACCEPTABLE

New construction or development should generally not be undertaken.

CONSIDERATIONS IN DETERMINATION OF NOISE–COMPATIBLE LAND USE

A. NORMALIZED NOISE EXPOSURE INFORMATION DESIRED

Where sufficient data exists, evaluate land use suitability with respect to a "normalized" value of CNEL or L_{dn}. Normalized values are obtained by adding or subtracting the constants described in Table 1 to the measured or calculated value of CNEL or L_{dn}.

B. NOISE SOURCE CHARACTERISTICS

The land use-noise compatibility recommendations should be viewed in relation to the specific source of the noise. For example, aircraft and railroad noise is normally made up of higher single noise events than auto traffic but occurs less frequently. Therefore, different sources yielding the same composite noise exposure do not necessarily create the same noise environment. The State Aeronautics Act uses 65 dB CNEL as the criterion which airports must eventually meet to protect existing residential communities from unacceptable exposure to aircraft noise. In order to facilitate the purposes of the Act, one of which is to encourage land uses compatible with the 65 dB CNEL criterion wherever possible, and in order to facilitate the ability of airports to comply with the Act, residential uses located in Community Noise Exposure Areas greater than 65 dB should be discouraged and considered located within normally unacceptable areas.

C. SUITABLE INTERIOR ENVIRONMENTS

One objective of locating residential units relative to a known noise source is to maintain a suitable interior noise environment at no greater than 45 dB CNEL of L_{dn}. This requirement, coupled with the measured or calculated noise reduction performance of the type of structure under consideration, should govern the minimum acceptable distance to a noise source.

D. ACCEPTABLE OUTDOOR ENVIRONMENTS

Another consideration, which in some communities is an overriding factor, is the desire for an acceptable outdoor noise environment. When this is the case, more restrictive standards for land use compatibility, typically below the maximum considered "normally acceptable" for that land use category, may be appropriate.

FIGURE 2

EXAMPLES OF NOISE LEVELS

NOISE SOURCE	NOISE LEVEL	SUBJECTIVE DESCRIPTION
AMPLIFIED ROCK'N ROLL BAND ►	120 dB(A)	
COMMERCIAL JET TAKEOFF AT 200 FEET ►		DEAFENING
	100 dB(A)	
BUSY URBAN STREET ►		VERY LOUD
	80 dB(A)	
FREEWAY TRAFFIC AT 50 FEET ►		LOUD
NORMAL CONVERSATION AT 6 FEET ►	60 dB(A)	
TYPICAL OFFICE (INTERIOR) ►		MODERATE
SOFT RADIO MUSIC ►	40 dB(A)	
TYPICAL RESIDENTIAL (INTERIOR) ►		FAINT
TYPICAL WHISPER AT 6 FEET ►	20 dB(A)	
HUMAN BREATHING ►		VERY FAINT
	0 dB(A)	

APPENDIX 1

ACOUSTICAL TERMINOLOGY

AMBIENT NOISE LEVEL: The composite of noise from all sources near and far. In this context, the ambient noise level constitutes the normal or existing level of environmental noise at a given location.

CNEL: Community Noise Equivalent Level. The average equivalent sound level during a 24-hour day, obtained after addition of approximately five decibels to sound levels in the evening from 7:00 p.m. to 10:00 p.m. and ten decibels to sound levels in the night before 7:00 a.m. and after 10:00 p.m.

DECIBEL, dB: A unit for describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).

L_{dn}: Day-Night Average Sound Level. The average equivalent sound level during a 24-hour day, obtained after addition of ten decibels to sound levels in the night after 10:00 p.m. and before 7:00 a.m.

L_{eq}: Equivalent Sound Level. The sound level containing the same total energy as a time varying signal over a given sample period. L_{eq} is typically computed over 1, 8 and 24-hour sample periods.

NOTE: CNEL and L_{dn} represent daily levels of noise exposure averaged on an annual basis, while L_{eq} represents the average noise exposure for a shorter time period, typically one hour.

L_{max}: The maximum sound level recorded during a noise event.

L_n: The sound level exceeded "n" percent of the time during a sample interval. L_{10} equals the level exceeded 10 percent of the time (L_{90}, L_{50}, etc.)

BBA

ACOUSTICAL TERMINOLOGY

NOISE EXPOSURE CONTOURS: Lines drawn about a noise source indicating constant levels of noise exposure. CNEL and L_{dn} contours are frequently utilized to describe community exposure to noise.

SEL or SENEL: Sound Exposure Level or Single Event Noise Exposure Level. The level of noise accumulated during a single noise event, such as an aircraft overflight, with reference to a duration of one second. More specifically, it is the time-integrated A-weighted squared sound level for a stated time interval or event, based on a reference pressure of 20 micropascals and a reference duration of one second.

SOUND LEVEL: The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear and gives good correlation with subjective reactions to noise.

OROVILLE MUNICIPAL AIRPORT

MODEL ZONING ORDINANCE TO LIMIT HEIGHT OF OBJECTS AROUND AN AIRPORT

AN ORDINANCE REGULATING AND RESTRICTING THE HEIGHT OF STRUCTURES AND OBJECTS OF NATURAL GROWTH, AND OTHERWISE REGULATING THE USE OF PROPERTY, IN THE VICINITY OF THE OROVILLE MUNICIPAL AIRPORT BY CREATING THE APPROPRIATE ZONES AND ESTABLISHING THE BOUNDARIES THEREOF; PROVIDING FOR CHANGES IN THE RESTRICTIONS AND BOUNDARIES OF SUCH ZONES; DEFINING CERTAIN TERMS USED HEREIN; REFERRING TO THE OROVILLE MUNICIPAL AIRPORT ZONING MAP WHICH IS INCORPORATED IN AND MADE A PART OF THIS ORDINANCE; PROVIDING FOR ENFORCEMENT; ESTABLISHING A BOARD OF ADJUSTMENT; AND IMPOSING PENALTIES.

This Ordinance is adopted pursuant to the authority conferred by ____3/. It is hereby found that an obstruction has the potential for endangering the lives and property of users of Oroville Municipal Airport, and property or occupants of land in its vicinity; that an obstruction may affect existing and future instrument approach minimums of Oroville Municipal Airport; and that an obstruction may reduce the size of areas available for the landing, takeoff, and maneuvering of aircraft, thus tending to destroy or impair the utility of Oroville Municipal Airport and the public investment therein.

(1) that the creation or establishment of an obstruction has the potential of being a public nuisance and may injure the region served by Oroville Municipal Airport;

(2) that it is necessary in the interest of the public health, public safety, and general welfare that the creation of establishment of obstructions that are a hazard to air navigation by prevented; and

(3) that the prevention of these obstructions should be accomplished, to the extent legally possible, by the exercise of the police power without compensation.

It is further declared that the prevention of the creation or establishment of hazards to air navigation, the elimination, removal, alteration or mitigation of hazards to air navigation, or the marking and lighting of obstructions are public purposes for which a political subdivision may raise and expend public funds and acquire land or interests in land.

IT IS HEREBY ORDAINED BY THE CITY COUNCIL OF THE CITY OF OROVILLE, CALIFORNIA, AS FOLLOWS:

Note: City or County to fill in blanks left in this model ordinance to satisfy legal requirements. See attached Listing of Reference Numbers and Descriptions for guidance.

SECTION I: SHORT TITLE

This Ordinance shall be known and may be cited as the Oroville Municipal Airport Zoning Ordinance.

SECTION II: DEFINITIONS

As used in this Ordinance, unless the context otherwise requires:

1. AIRPORT - Means Oroville Municipal Airport.

2. AIRPORT ELEVATION - The highest point of an airport's usable landing area measured in feet from sea level.

3. APPROACH SURFACE - A surface longitudinally centered on the extended runway centerline, extending outward and upward from the end of the primary surface and at the same slope as the approach zone height limitation slope set forth in Section IV of this Ordinance. In plan the perimeter of the approach surface coincides with the perimeter of the approach zone.

4. APPROACH, TRANSITIONAL, HORIZONTAL, AND CONICAL ZONES - These zones are set forth in Section III of this Ordinance.

5. BOARD OF ADJUSTMENT - A Board consisting of ________ 6/ members appointed by the _______ 6/ as provided in ________ 6/.

6. CONICAL SURFACE - A surface extending outward and upward from the periphery of the horizontal surface at a slope of 20 to 1 for a horizontal distance of 4,000 feet.

7. HAZARD TO AIR NAVIGATION - An obstruction determined to have a substantial adverse effect on the safe and efficient utilization of the navigable airspace.

8. HEIGHT - For the purpose of determining the height limits in all zones set forth in this Ordinance and shown on the zoning map, the datum shall be mean sea level elevation unless otherwise specified.

9. HORIZONTAL SURFACE - A horizontal plane 150 feet above the established airport elevation, the perimeter of which in plan coincides with the perimeter of the horizontal zone.

10. LARGER THAN UTILITY RUNWAY - A runway that is constructed for and intended to be used by propeller driven aircraft of greater than 12,500 pounds maximum gross weight and jet powered aircraft.

11. NONCONFORMING USE - Any pre-existing structure, objective of natural growth, or use of land which is inconsistent with the provisions of this Ordinance or an amendment thereto.

12. NONPRECISION INSTRUMENT RUNWAY - A runway having an existing instrument approach procedure utilizing air navigation facilities with only horizontal guidance, or area type navigation equipment, for which a straight-in nonprecision instrument approach procedure has been approved or planned.

13. OBSTRUCTION - Any structure, growth, or other object, including a mobile object, which exceeds a limiting height set forth in Section IV of this Ordinance.

14. PERSON - An individual, firm, partnership, corporation, company, association, joint stock association, or governmental entity; includes a trustee, a receiver, an assignee, or a similar representative or any of them.

15. PRIMARY SURFACE - A surface longitudinally centered on a runway. When the runway has a specially prepared hard surface, the primary surface extends 200 feet beyond each end of that runway; for military runways or when the runway has no specially prepared hard surface, or planned hard surface, the primary surface ends at each end of that runway. The width of the primary surface is set forth in Section III of this Ordinance. The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline.

16. RUNWAY - A defined area on an airport prepared for landing and take-off of aircraft along its length.

17. STRUCTURE - An object, including a mobile object, constructed or installed by man, including but without limitation, buildings, towers, cranes, smokestacks, earth formation, and overhead transmission lines.

18. TRANSITIONAL SURFACES - These surfaces extend outward at 90 degree angles to the runway centerline and the runway centerline extended at a slope of seven (7) feet horizontally for each foot vertically from the sides of the primary and approach surfaces to where they intersect the horizontal and conical surfaces. Transitional surfaces for those portions of the precision approach surfaces, which project through and beyond the limits of the conical surface, extend a distance of 5,000 feet measured horizontally from the edge of the approach surface and at 90 degree angles to the extended runway centerline.

19. TREE - Any object of natural growth.

20. UTILITY RUNWAY - A runway that is constructed for and intended to be used by propeller driven aircraft of 12,500 pounds maximum gross weight and less.

21. VISUAL RUNWAY - A runway intended solely for the operation of aircraft using visual approach procedures.

SECTION III: AIRPORT ZONES

In order to carry out the provisions of this Ordinance, there are hereby created and established certain zones which include all of the land lying beneath the approach surfaces, transitional surfaces, horizontal surfaces, and conical surfaces as they apply to the Oroville Municipal Airport. Such zones are shown on Oroville Municipal Airport Zoning map consisting of 1 sheet, prepared by Reinard W. Brandley, Consulting Airport Engineer, and dated January 1990, which is attached to this Ordinance and made a part hereof. An area located in more than one (1) ofthe following zones is considered to be only in the zone with the more restrictive height limitation. The various zones are hereby established and defined as follows:

1. Utility Runway Visual Approach Zone (Runway 12-30) - The inner edge of this approach zone coincides with the width of the primary surface and is 500 feet wide. The approach zone expands outward uniformly to a width of 1,250 feet at a horizontal distance of 5,000 feet from the primary surface. Its centerline is the continuation of the centerline of the runway.

2. Runway Larger Than Utility with a Visibility Minimum as Low as 3/4 Mile, Nonprecision Instrument Approach Zone (Runway 1-19) - The inner edge of this approach zone coincides with the width of the primary surface and is 1,000 feet wide. The approach zone expands outward uniformly to a width of 4,000 feet at a horizontal distance 10,000 feet from the primary surface. Its centerline is the continuation of the centerline of the runway.

3. Transitional Zones - The transitional zones are the areas beneath the transitional surfaces.

4. Horizontal Zone - The horizontal zone is established by swinging arcs of 10,000 feet radii from the center of each end of the primary surface of the non-precision instrument runway and 5,000 feet radii from the center of each end of the primary surface of the utility runway and connecting the adjacent arcs by drawing lines tangent to those arcs. The horizontal zone does not include the approach and transitional zones.

5. Conical Zone - The conical zone is established as the area that commences at the periphery of the horizontal zone and extends outward therefrom a horizontal distance of 4,000 feet.

SECTION IV: AIRPORT ZONE HEIGHT LIMITATIONS

Except as otherwise provided in this Ordinance, no structure shall be erected, altered, or maintained, and no tree shall be allowed to grow in any zone created by this Ordinance to a height in excess of the applicable height limit herein established for such zone. Such applicable height limitations are hereby established for each of the zones in question as follows:

1. Utility Runway Visual Approach Zone - Slopes twenty (20) feet outward for each foot upward beginning at the end of and at the same elevation as the primary surface and extending to a horizontal distance of 5,000 feet along the extended runway centerline.

2. Non-Precision Instrument Runway, Nonprecision Instrument Approach Zone - Slopes 34 feet outward for each foot upward beginning at the end of and at the same elevation as the primary surface and extending to a horizontal distance of 10,000 feet along the extended runway centerline.

3. Runway Larger Than Utility Visual Approach Zone - Slopes twenty (20) feet outward for each foot upward beginning at the end of and at the same elevation as the primary surface and extending to a horizontal distance of 5,000 feet along the extended runway centerline.

4. Transitional Zones - Slope seven (7) feet outward for each foot upward beginning at the sides of and at the same elevation as the primary surface and the approach surface, and extending to a height of 150 feet above the airport elevation which is 340.47 feet above mean sea level. In addition to the foregoing, there are established height limits sloping seven (7) feet outward for each foot upward beginning at the sides of and at the same elevation as the approach surface, and extending to where they intersect the conical surface. Where the precision instrument runway approach zone projects beyond the conical zone, there are established height limits sloping seven (7) feet outward for each foot upward beginning at the sides of and at the same elevation as the approach surface, and extending a horizontal distance of 5,000 feet measured at 90 degree angels to the extended runway centerline.

5. Horizontal Zone - Established at 150 feet above the airport elevation or at a height of 340.47 feet above mean sea level.

6. Conical Zone - Slopes twenty (20) feet outward for each foot upward beginning at the periphery of the horizontal zone and at 150 feet above the airport elevation and extending to a height of 350 feet above the airport elevation.

7. Excepted Height Limitations - Nothing in this ordinance shall be construed as prohibiting the construction or maintenance of any structure, or growth of any tree to a height up to 35 feet above the surface of the land.

SECTION V: USE RESTRICTIONS

Notwithstanding any other provisions of this Ordinance, no use may be made of land or water within any zone established by this Ordinance in such a manner as to create electrical interference with navigational signals or radio communication between the airport and aircraft, make it difficult for pilots to distinguish between airport lights and others, result in glare in the eyes of pilots using the airport, impair visibility in the vicinity of the airport, create bird strike hazards, or otherwise in any way endanger or interfere with the landing, takeoff, or maneuvering of aircraft intending to use the airport.

SECTION VI: NONCONFORMING USES

1. Regulations Not Retroactive - The regulations prescribed by this Ordinance shall not be construed to require the removal, lowering, or other change or alteration of any structure or tree not confirming to the regulations as of the effective date of this Ordinance, or otherwise interfere with the continuance of nonconforming use. Nothing contained herein shall require any change in the construction, alteration, or intended use of any structure, the construction or alteration of which was begun prior to the effective date of this Ordinance, and is diligently prosecuted.

2. Marking and Lighting - Notwithstanding the preceding provision of this Section, the owner of any existing nonconforming structure or tree is hereby required to permit the installation, operation, and maintenance thereon of such markers and lights as shall be deemed necessary by the ________ 11/ to indicate to the operators of aircraft in the vicinity of the airport the presence of such airport obstruction. Such markers and lights shall be installed, operated, and maintained at the expense of the County of El Dorado, California.

SECTION VII: PERMITS

1. Future Uses - Except as specifically provided in a, b, and c hereunder, no material change shall be made in the use of land, no structure shall be erected or otherwise established, and no tree shall be planted in any zone hereby created unless a permit therefor shall have been applied for and granted. Each application for a permit shall indicate the purpose for which the permit is desired, with sufficient particularity to permit it to be determined whether the resulting use, structure, or tree would conform to the regulations herein prescribed. If such determination is in the affirmative, the permit shall be granted. No permit for a use inconsistent with the provisions of this Ordinance shall be granted unless a variance has been approved in accordance with Section VII, 4.

a. In the area lying within the limits of the horizontal zone and conical zone, no permit shall be required for any tree or structure less than 75 feet of vertical height above the ground, except when, because of terrain, land contour, or topographic features, such tree or structure would extend above the height limits prescribed for such zones.

b. In areas lying within the limits of the approach zones, but at a horizontal distance of not less than 4,200 feet from each end of the runway, no permit shall be required for any tree or structure less than 75 feet of vertical height above the ground, except when such tree or structure would extend above the height limit prescribed for such approach zones.

c. In the areas lying within the limits of the transition zones beyond the perimeter of the horizontal zone, no permit shall be required for any tree or structure less than 75 feet of vertical height above the ground, except when such tree or structure, because of terrain, land contour, or topographic features, would extend above the height limit prescribed for such transition zones.

Nothing contained in any of the foregoing exceptions shall be construed as permitting or intending to permit any construction, or alteration of any structure, or growth of any tree in excess of any of the height limits established by this Ordinance except as set forth in Section IV, 12.

2. Existing Uses - No permit shall be granted that would allow the establishment or creation of an obstruction or permit a nonconforming use, structure, or tree to become a greater hazard to air navigation than it was on the effective date of this Ordinance or any amendments thereto or than it is when the application for a permit is made. Except as indicated, all applications for such a permit shall be granted.

3. Nonconforming Uses Abandoned or Destroyed - Whenever the ______ 13/ determines that a nonconforming tree or structure has been abandoned or more than 80 percent torn down, physically deteriorated, or decayed, no permit shall be granted that would allow such structure or tree to exceed the applicable height limit or otherwise deviate from the zoning regulations.

4. Variances - Any person desiring to erect or increase the height of any structure, or permit the growth of any tree, or use property, not in accordance with the regulations prescribed in this Ordinance, may apply to the Board of Adjustment for a variance from such regulations. The application for variance shall be accompanied by a determination from the Federal Aviation Administration as to the effect of the proposal on the operation of air navigation facilities and the safe, efficient use of navigable airspace. Such variances

shall be allowed where it is duly found that a literal application or enforcement of the regulations will result in unnecessary hardship and relief granted, will not be contrary to the public interest, will not create a hazard to air navigation, will do substantial justice, and will be in accordance with the spirit of this Ordinance. Additionally, no application for variance to the requirements of this Ordinance may be considered by the Board of Adjustment unless a copy of the application has been furnished to the ________ 14/ for advice as to the aeronautical effects of the variance. If the ________ 14/ does not respond to the application within fifteen (15) days after receipt, the Board of Adjustment may act on its own to grant or deny said application.

5. Obstruction Marking and Lighting - Any permit or variance granted may, if such action is deemed advisable to effectuate the purpose of this Ordinance and be reasonable in the circumstances, be so conditioned as to require the owner of the structure or tree in question to install, operate, and maintain, at the owner's expense, such markings and lights as condition may modified to require the owner to permit the County of El Dorado, California, at its own expense, to install, operate, and maintain the necessary markings and lights.

SECTION VIII: ENFORCEMENT

It shall be the duty of the ________ 15/ to administer and enforce the regulations prescribed herein. Applications for permits and variances shall be made to the ________ 15/ upon a form published for that purpose. Applications required by this Ordinance to be submitted to the _______ 15/ shall be promptly considered and granted or denied. Application for action by the Board of Adjustment shall be forthwith transmitted by the ________ 15/.

SECTION IX: BOARD OF ADJUSTMENT

1. There is hereby created a Board of Adjustment to have and exercise the following powers: (1) to hear and decide appeals from any order, requirement, decision, or determination made by the _____ 15/ in the enforcement of this Ordinance; (2) to hear and decide special exceptions to the terms of this Ordinance upon which such Board of Adjustment under such regulations may be required to pass; and (3) to hear and decide specific variances.

2. The Board of Adjustment shall consist of ___ members appointed by the ________ 12/ and each shall serve for a term of ___ years until a successor is duly appointed and qualified. Of the members first appointed, one shall be appointed for a term of ___ year, ___ for a term of ___, and ___ for a term of ___ years. Members shall be removable by the appointing authority for cause, upon written charges, after a public hearing.

3. The Board of Adjustment shall adopt rules for its governance and in harmony with the provisions of this Ordinance. Meetings of the Board of Adjustment shall be held at the call of the Chairperson and at such other times as the Board of Adjustment may determine. The Chairperson or, in the absence of the Chairperson, the Acting Chairperson may administer oaths and compel the attendance of witnesses. All hearings of the Board of Adjustment shall be public. The Board of Adjustment shall keep minutes of its proceedings showing the vote of each member upon each question; or if absent or failing to vote, indicating such fact, and shall keep records of its examinations and other officials actions, all of which shall immediately be filed in the office of ________ 15/ and on due cause shown.

4. The Board of Adjustment shall make written findings of facts and conclusions of law giving the facts upon which it acted and its legal conclusions from such facts in reversing, affirming, or modifying any order, requirement, decision, or determination which comes before it under the provisions of this Ordinance.

5. The concurring vote of a majority of the members of the Board of Adjustment shall be sufficient to reverse any order, requirement, decision, or determination of the ________ 15/ or decide in favor of the applicant or any matter upon which it is required to pass under this Ordinance, or to effect variation to this Ordinance.

SECTION X: APPEALS

1. Any person aggrieved, or any taxpayer affected, by any decision of the ________ 15/ made in the administration of the Ordinance, may appeal to the Board of Adjustment.

2. All appeals hereunder must be taken within a reasonable time as provided by the rules of the Board of Adjustment, by filing with the ________ 15/ a notice of appeal specifying the grounds thereof. The ________ 15/ shall forthwith transmit to the Board of Adjustment all the papers constituting the record upon which the action appealed from was taken.

3. An appeal shall stay all proceedings in furtherance of the action appealed from unless the ________ 15/ certifies to the Board of Adjustment, after the notice of appeal has been filed with it, that by reason of the facts stated in the certificate a stay would in the opinion of ________ 15/ cause imminent peril to life or property. In such case, proceedings shall not be stayed except by the order of the Board of Adjustment on notice to the ________ 15/ and on due cause shown.

4. The Board of Adjustment shall fix a reasonable time for hearing appeals, give public notice and due notice to the parties in interest, and decide the same within a reasonable time. Upon the hearing, any party may appear in person or by agent or by attorney.

5. The Board of Adjustment may, in conformity with the provisions of this Ordinance, reverse or affirm, in whole or in part, or modify the order, requirement, decision, or determination appealed from and may make such order, requirement, decision, or determination as may be appropriate under the circumstances.

SECTION XI: JUDICIAL REVIEW

Any person aggrieved, or any taxpayer affected, by any decision of the Board of Adjustment, may appeal to the Court of _______ as provided in Section ___ of Chapter ___ of the Public Laws of ________ 16/.

SECTION XII: PENALTIES

Each violation of this Ordinance or of any regulation, order, or ruling promulgated hereunder shall constitute a misdemeanor and shall be punishable by a fine of not more than _______ dollars or imprisonment for not more than _____ days or both; and each day a violation continues to exist shall constitute a separate offense.

SECTION XIII: CONFLICTING REGULATIONS

Where there exists a conflict between any of the regulations or limitations prescribed in this Ordinance and any other regulations applicable to the same area, whether the conflict be with respect to the height of structures or trees, and the use of land, or any other matter, the more stringent limitation or requirement shall govern and prevail.

SECTION XIV: SEVERABILITY

If any of the provisions of this Ordinance or the application thereof to any person or circumstances are held invalid, such invalidity shall not affect other provisions or applications of the Ordinance which can be given effect without the invalid provisions or application, and to this end, the provisions of this Ordinance are declared to be severable.

SECTION XV: EFFECTIVE DATE

WHEREAS, the immediate operation of the provisions of this Ordinance is necessary for the preservation of the public health, public safety, and general welfare, an EMERGENCY is hereby declared to exist, and this Ordinance shall be in full force and effect from and after its passage by the Board of Supervisors , County of El Dorado, California and publications and posting as required by law.
Accepted by the _____ this _____ day of _____, 19___.

MODEL ZONING ORDINANCE

LISTING OF REFERENCE NUMBERS AND DESCRIPTIONS

3/ This citation should be made to conform to the usual method of citing your state laws.

6/ Insert the number of members appointed to the Board of Adjustment, the appointing body, and the enabling legislation authorizing same.

11/ Insert the title of the appropriate official who has been charged with the responsibility for determining the necessity for marking and lighting.

12/ Insert the name of the appropriate political body or subdivision.

13/ Insert here the title of the appropriate official charged with making this determination.

14/ Insert here the official or body responsible for operation and maintenance of the airport to be zoned.

15/ Insert here the title of the appropriate official, such as Director, Department of Public Works, etc.

16/ Insert the jurisdiction. Consideration should be given the desirability of setting forth this procedure here, or as an alternative attaching to all copies of this Ordinance, a copy of excerpts from the statute cited.

Reinard W. Brandley
CONSULTING AIRPORT ENGINEER

2041 Hallmark Drive * Sacramento, California 95825 * (916) 922-4725

APPENDIX C

OROVILLE MUNICIPAL AIRPORT
CITY OF OROVILLE
BUTTE COUNTY, CALIFORNIA

<u>SOIL STUDIES AND PAVEMENT EVALUATION STUDIES</u>

APPENDIX C

OROVILLE MUNICIPAL AIRPORT
OROVILLE, BUTTE COUNTY, CALIFORNIA

SOIL STUDIES AND PAVEMENT EVALUATION STUDIES

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APPENDIX C

OROVILLE MUNICIPAL AIRPORT
CITY OF OROVILLE
BUTTE COUNTY, CALIFORNIA

SOIL STUDIES AND PAVEMENT EVALUATION STUDIES

I. INTRODUCTION

A. Airport Layout

The existing Oroville Municipal Airport consists of two runways, a series of supporting taxiways, a general aviation tie down apron, and some tee hangar facilities. Runway 1-19 is 150 feet wide by 6,000 feet long with relocated thresholds shortening the runway. Runway 12-30 is 150 feet wide by 5,000 feet long with displaced or relocated thresholds shortening this runway. Taxiway R parallels Runway 12-30 on the north side. Taxiway L connects Runway 1-19 to Runway 12-30 to the aircraft tie down apron. Taxiway V connects the thresholds of Runway 1 and Runway 30. Taxiway S connects the apron to the threshold of Runway 19 to the threshold of Runway 12.

It is anticipated that the threshold to Runway 19 will be relocated approximately 2,180 feet to the south, and this runway will be extended 2,180 feet to the south. The aircraft operations area will be moved to the triangular area between the runways and a new taxiway system will be constructed to serve the runways and the aircraft operations area.

B. Role of the Airport

The Oroville Municipal Airport is a general aviation facility which will serve the general aviation and business aviation needs of the Oroville area. Aircraft currently using the airport include most of the general aviation and business aviation fleet up to and including the Gulfstream II business jet. It is anticipated that this airport will continue to serve this type of aircraft in the forecast future.

C. Pavement Composition

All pavements on this airport are flexible pavements. Runway 1-19 received an asphaltic concrete pavement overlay in 1985 and a contract has been awarded to overlay Runway 12-30 and Taxiway L in the summer of 1990. All other pavements are in their original condition and show significant deterioration due largely to environmental conditions. The existing pavement sections of different segments of this airport are as shown in the following table:

	Pavement Section (inch)		
Location	AC	AB	Total
Runway 1-19 Northerly 2,500'	6	9	15
Runway 1-19 Southerly 3,500'	5	12	17
Runway 12-30 Westerly 4,000'	3	6	9
Runway 12-30 Easterly 1,000'	2	12	14
Taxiways R, V, S & L	2	12	14
Taxiway T	2	6	8
Aircraft Parking Apron	2	6	8

D. Need for Study and Purpose of Test Program

The proposed southerly extension of Runway 1-19 will require extensive cuts and fills to provide adequate profile for the runway. The development of the new taxiways and aircraft operating facilities will also require fairly extensive cuts and fills. Soil studies are required in these areas for the purpose of determining the type soils to be encountered at various depths and the type of subgrade material that will be available for construction of the pavement sections. These soil studies are required to determine the problems, if any, that may be encountered in excavation and placement of embankment. Soil studies are also required to determine the adequacy of the soils for subgrade for pavement sections and the pavement section requirements. The relocation of aircraft operations to the proposed new location will occur gradually and existing facilities will be used for several more years.

The existing pavements at this site have been in operation for an extensive period of time and have performed well under the applied loadings. The distress which is apparent at this time is largely due to environmental conditions. Detailed pavement evaluation studies on existing pavements are useful for the purpose of determining the life of existing pavements and overlay or reconstruction requirements of these pavements to adequately perform under anticipated and forecast traffic and to serve as a guide for the design of new pavements to be constructed at this site.

This report presents the results of the soil studies and nondestructive pavement evaluation studies conducted at this site.

II. TEST PROGRAM

A. Soil Conditions and Pavement Sections

A series of test borings, test pits, and core holes has been conducted as part of this study and previous studies conducted by our office at this airport. The core holes were cut in the existing pavement of Runway 1-19 prior to overlay of this pavement to determine the thickness and character of the existing pavement sections. The test pits were excavated along the edge of Runway 1-19 to determine the soil conditions below the pavement sections in this area. Test borings were drilled as a portion of this program in the vicinity of the Runway 1-19 extension and the relocated aircraft operation areas to determine the general characteristics of the soils in this area. Access to properties outside the airport was difficult to obtain; therefore, the amount of testing in future land to be acquired was limited to the one test boring where access could be obtained. The location of these core holes, test pits, and test borings is shown on the Test Hole Location Map, Plate No. C-1. The Log of the Test Pits along Runway 1-19 is shown on Table No. C-1. The Log of the Core Holes conducted on the Runway 1-19 pavement section is summarized in Table No. C-2. The Log of the Test Borings is summarized in Tables No. C-3, C-4, C-5, and C-6.

These test borings and pits indicate that the soils encountered at this site range from silty fine sands to clayey fine sands to clayey silts to sandy clays. All the soils are reasonably compact and stable. The California Bearing Ratio (CBR) tests conducted on the various materials show the following results:

Material	CBR
Existing Aggregate Base Course	30
Silty Fine Sands	15
Sandy Silts	12
Sandy Clayey Silts	8
Sandy Clays	5

The critical subgrade soil is the sandy clay with a California Bearing Ratio of 5 and required pavement sections set forth in this appendix are based on this material being the critical subgrade soil in each location. By selective grading it may be possible to utilize the sand soils for the upper six inches of subgrade and thus decrease the pavement section required, but this decision will have to be deferred until each project is designed.

No ground water was encountered in any of the test holes or test pits at the time they were drilled.

B. Pavement Condition Survey

As an aid to determining the performance to date of the existing pavements and to provide a guide for the test program to be conducted in this study, a detailed condition survey of all existing pavements was made. This survey consisted of visually observing all pavements and noting deficiencies in areas of distress. A summary of the observations made is as follows:

1. Runway 1-19

Runway 1-19 was overlaid in 1985 and the pavement is in very good condition. There are only minor instances of cracking developing along the joints between construction lanes. No other cracking was detected.

2. Runway 12-30

The pavement on Runway 12-30, except for the intersection with Runway 1-19, is original pavement which has not received any overlays. In the easterly 900 feet of this runway the pavement is in good condition with only minor cracking. The remaining portion of the pavement shows extensive cracking, with cracks spaced at two to four feet on centers. The cracks are generally 1/8 to 3/8 inch wide and there is some minor spalling. There is little or no indication of rutting. The deterioration appears to be mainly caused by environmental conditions and the age of the pavement. This runway will be overlaid in the summer of 1990.

3. Taxiway R

Taxiway R parallels Runway 12-30 to the north. The easterly end of Taxiway R up to the intersection with Runway 1-19 has a crack pattern with spacing of approximately five feet. The cracks are well defined with openings as large as 1/4 inch. West of Runway 1-19 there is only minor cracking. There are no indications of spalling or rutting. The deterioration appears to be mainly caused by environmental conditions and the age of the pavement.

4. Taxiway V

Taxiway V connects the threshold of Runway 1 to the threshold of Runway 30. This taxiway is closed at this time and the major portion of it is proposed to be abandoned in the future development. The central portion of this taxiway will be used as part of the loop road to serve the aircraft operations areas. The pavement on this taxiway shows extensive cracking with crack spacing of approximately five to eight feet. There is some minor spalling, but little or no rutting on this pavement. This pavement has been used in the past as a drag strip and two concrete slabs have been installed in a portion of the pavement. The distress in this pavement appears to be related to the age of the pavement and environmental conditions.

5. Taxiway L

Taxiway L connects the central portion of Runway 1-19 to the central portion of Runway 12 to the eastern end of the aircraft parking apron. The pavement on this taxiway is in good condition with some separation at the joints between paving lanes. The northerly portion of this taxiway will be overlaid in the summer of 1990 and the southwesterly portion will be abandoned and replaced with Taxiway E, which is also proposed for construction in 1990. Both of these projects are currently under contract.

6. Taxiway S

Taxiway S connects the threshold of Runway 12 to the threshold of Runway 19 and then extends in a easterly direction to the aircraft parking apron. The westerly portion of this taxiway between Runway 19 and Runway 12 has extensive cracking but no apparent rutting. The taxiway between the threshold of Runway 19 and the apron is in reasonably good condition with only minor cracking and no visual rutting. The distress on this pavement appears to be related to age and environmental conditions.

7. Taxiway T

Taxiway T is the old existing taxiway extending between Taxiway R and the Butte County Mosquito Abatement facilities. The pavements on this taxiway are cracked with spacing of six to eight feet, and there appears to be no rutting of this pavement. The distress on this pavement appears to be related to age of pavement and environmental conditions.

8. Aircraft Parking Apron

The aircraft parking apron was constructed in two phases. The north end of the apron is the older pavement and shows significant cracking. There is much less cracking in the southerly end of this pavement. There is some broken pavement in the northerly apron around the helicopter maintenance building. All other pavements show little sign of rutting or distress other than cracking caused by age of pavement and environmental conditions.

C. Falling Weight Deflectometer

The pavement evaluation methodology which was utilized for this appendix is the Fatigue Analysis developed by our office. This methodology is described in detail in a paper presented at a Symposium on Nondestructive Test and Evaluation of Airport Pavements sponsored by the U.S. Army Corps of Engineers Waterways Experiment Station at Vicksburg, Mississippi, in 1975. A copy of this paper is included as Exhibit C-1 to this appendix.

This method of design is a rational method of design and utilizes basic soil parameters of Modulus of Elasticity and Poisson's Ratio of each layer of pavement and subsoil. From these data the life of the existing pavements under existing traffic conditions can be predicted, and the expected life of the pavement section after overlays and/or reconstruction of the pavement sections can also be predicted.

In order to utilize this fatigue analysis methodology, it is necessary to determine the modulus of elasticity of each layer of pavement in place, of each overlay material, and of each layer of subsoil under the pavement section. These data have previously been obtained by full-scale testing, in which deflections at the surface of each layer were measured under aircraft or simulated aircraft wheel loadings. Later we were able to obtain reliable data by the use of repetitive plate bearing tests conducted in test pits excavated in the pavement sections.

Recently nondestructive test methods have been developed whereby vibratory, static or falling weight loads are imposed on the pavement surface and the deflections are accurately measured. Once the deflections have been measured, not only under the applied load but for a distance of six to eight feet from the applied load, then there are methods utilizing computer programs by which modulus of elasticity values of each layer can be back-calculated from these deflection measurements.

Research has shown that reasonably good correlation can be obtained between tests conducted using the heavy vibratory loads, such as the Corps of Engineers W.E.S. Pavement Tester, and by the heavy falling weight deflectometer test equipment which imposes forces of 25,000 to 30,000 pounds on a 12-inch-diameter plate. These vibratory and falling weight deflectometer tests accurately show the relative strength of one section of pavement with relation to another and when calibrated with repetitive plate-bearing tests or full-scale load tests can accurately provide values for modulus of elasticity of each soil layer. Nondestructive tests can be conducted very quickly, and many tests can be performed in a short period of time to provide a considerable amount of data for the entire pavement section.

The falling weight deflectometer (FWD), which can impose forces of 25,000 to 30,000 pounds on a 12-inch-diameter plate, was used to evaluate and test all of the pavements at this airport. On the runway two rows of tests at approximately 200-foot spacing were conducted; one on each side of the centerline at a distance to 15 to 20 feet from the centerline. On the taxiways one row of tests was conducted at a 200-foot spacing along the wheel path of the taxiway. On the apron tests were conducted at a spacing of approximately 200 feet.

These tests were made by dropping a calibrated weight a sufficient distance to represent the designated loading on the pavement. In the tests a force of 10,000, 14,000, and 23,000 pounds was applied to the 12-inch-diameter plate. Deflection readings of the surface of the pavement caused by these loadings were measured at the center of the plate and at distances of 12, 24, 36, 48, 60, and 72 inches from the center of the plate.

These data gave a magnitude and shape of the deflection bowl under the applied loadings at each location. It also provided information whereby the relative strength of each section could be quickly obtained.

The maximum deflection at the center of the plate under the 10,000-pound, 14,000-pound, and 23,000-pound loadings for each pavement section are shown in Plates C-2 through C-13. These test results show the uniformity of strength of the pavement section and clearly show the weak areas of each section. There was considerable variation from one location to the other, but average strength could be developed for each section of pavement, and horizontal dashed lines are shown on each graph indicating the average deflection for each loading for each section. These average values of deflection were used with the computer program for determining stresses, strains, and deflections in multi-layered systems under various applied loads to back-calculate modulus of elasticity values for the pavement section itself and the subgrade soils on which the pavement section is constructed. The results of these analyses showing the modulus of elasticity for each section of pavement and subgrade are shown on Table No. C-7.

III. ANALYSIS AND EVALUATION

A. Introduction

Flexible pavements must be designed such that the following conditions are satisfied:

- The subsoil conditions, including embankment construction and preparation, must be such that excessive settlements or expansion of subsoils will not cause significant profile deterioration on a pavement section such as to cause unacceptable roughness.

- The total section thickness and quality must be sufficient to protect the subgrade soils from over stress under the magnitude and frequency of the forecast loadings.

- The materials that make up the pavement sections must be of such quality that they will withstand the applied loads without failure.

Rigid pavements must be designed such that the following conditions are satisfied:

- The subsoil conditions, including embankment construction and preparation, must be such that excessive settlements or expansion of subsoils will not cause significant profile deterioration on a pavement section such as to cause unacceptable roughness.

- The total section thickness and quality must be sufficient to protect the subgrade soils from overstress under the magnitude and frequency of the forecast loadings.

- The materials that make up the pavement section must be of such quality that they will withstand the applied loads without failure.

- The Portland cement concrete slab thickness must be sufficient that the concrete will not be overstressed under the applied loads.

- The joints in the Portland cement concrete slabs must be designed with adequate support and load transfer such that stress concentrations will not develop at the edge and corner of slabs of sufficient magnitude to cause distress.

Economic considerations rule out the use of rigid pavements at this airport at this time, and the analysis performed in this study is limited to flexible pavement sections.

The Fatigue Analysis method of design has been utilized to evaluate the pavement sections with regard to total section thickness and quality of pavement section materials required to protect the subgrade soils. The Federal Aviation Administration has adopted the U.S. Army Corps of Engineers design procedures using California Bearing Ratio test data to evaluate and design quality and thickness requirements for materials making up flexible pavement sections. Both the Fatigue Analysis methodology and the F.A.A. methodology for pavement evaluation and design have been used for the evaluation of existing pavements and design of new pavements at the Oroville Municipal Airport and are included in this appendix.

In order to evaluate pavement sections with the Fatigue Analysis methodology, it is necessary to know the type, weight, and number of operations of aircraft which will occur over each section of pavement, both at the present time and in the future, and to know the basic soil parameters of modulus of elasticity and Poisson's Ratio of each layer of the pavement and underlying soils. To evaluate the pavements using the F.A.A.-Corps of Engineers procedures, it is necessary to know the critical design aircraft type and loading; the classification and CBR of the base course, subbase course, and subgrade soils; and the annual departures of aircraft of each type from the facility.

The soil parameters for both the Fatigue Analysis methodology and the F.A.A.-Corps of Engineers methodology have been determined and have been presented previously in this appendix.

B. Forecast Operations and Aircraft Characteristics

The current activity and forecast activity for this airport have been prepared and included in the Forecast section of the Master Plan Report and are shown in Table No. 1 to that report. This table has been reproduced as Table No. C-8 in this appendix. This table shows the type aircraft anticipated to use this facility and the annual operations of all of these aircraft types through the year 2010. All of the larger aircraft will be required to use Runway 1-19. Only the single engine general aviation aircraft and the small twin engine general aviation aircraft will be able to use Runway 12-30 because of its short length.

For the purpose of evaluation of the pavements it has been assumed that Runway 1-19 will receive 100 percent of the Gulfstream II, the Cessna Citation business jet aircraft, all other business jet aircraft, the large twin engine aircraft such as the King Air, and all military aircraft. It has also been assumed that Runway 1-19 will receive 80 percent of the small twin engine general aviation aircraft and 60 percent of the single engine general aviation aircraft. Runway 12-30 will be used by 20 percent of the small twin engine general aviation aircraft and 40 percent of the single engine general aviation aircraft.

The Gulfstream II when fully loaded weighs approximately 60,000 pounds, which is carried on a dual gear. All other business jets are considerably lighter. The number of operations of the Gulfstream II at this airport is small and it is not usually operated at gross weight. It is, therefore, recommended that Runway 1-19 and associated taxiways and apron designated for use by the business jets be designed using as the critical aircraft the Gulfstream II loaded to a gross aircraft weight of 50,000 pounds. Runway 12-30 and associated taxiways and the rest of the apron will be used only by the smaller aircraft, including the general aviation single engine and twin engine aircraft. Since Runway 12-30 may be used infrequently by some of the larger twin engine aircraft it is recommended that the pavements for this runway and taxiway be designed for a gross aircraft on single gear weighing 20,000 pounds and that the pavements for the aircraft parking areas which will be limited to the light single engine airplanes be designed for a gross aircraft weight of 12,500 pounds.

C. Fatigue Analysis Evaluation

1. Modulus of Elasticity Calculations

Modulus of elasticity values for each portion of the pavement section and for the subgrade at each area tested were determined by back-calculating these values using data from the falling weight deflectometer. The results of these analyses are shown in Table No. C-7. The values for Poisson's Ratio were assumed based on previous experience. The computer program for calculating stresses, strains, and deflections is not sensitive to variations in Poisson's Ratio values and estimated values are sufficiently accurate for this analysis.

2. Predicted Pavement Performance

For each runway, taxiway, or apron evaluated, and for each different pavement section or soil parameter developed from this analysis, the Fatigue Analysis method of design was utilized to predict pavement performance. These predicted pavement performance analyses were made for each pavement section as it currently exists and/or for various overlays.

For the runway and taxiway sections the existing pavement section was evaluated and various overlays ranging in thickness up to five inches of asphaltic concrete pavement were evaluated. In addition, various pavement sections using different thicknesses of pavement and base course materials were also evaluated for each subgrade modulus value determined from the falling weight deflectometer tests. From this data, subgrade deflections for each type of aircraft were computed for each of the test pavement sections and then, using the Fatigue Analysis methodology, the number of coverages of each aircraft allowed on each pavement section before failure were computed. All of these data are included in Table No. C-7.

The results of this analysis indicate that the existing pavement on Runway 1-19 will support the forecast traffic for at least 15 years and that if an additional three-inch overlay is placed, this pavement will have a life in excess of 20 years. The Gulfstream II aircraft is the critical aircraft.

The analysis shows that the existing pavement on Runway 12-30 will have a life under forecast traffic of eight years based on subgrade strength only. This analysis does not take into consideration the weather-related damage to the pavement. When the three-inch asphalt overlay which is being placed on this runway in 1990 has been constructed, the pavements on Runway 12-30 will have a life in excess of 20 years under forecast traffic.

All existing taxiways, except for Taxiway T, will have a pavement life in excess of 20 years under forecast traffic except for surface deterioration caused by weathering.

The general aviation apron will have a pavement life of only three years in areas where the Gulfstream II operations are concentrated but will have a pavement life of 10 years under forecast traffic of all other aircraft. If the total pavement section on the apron is increased to 13 inches by either overlay or reconstruction, then the pavement life for areas used by all aircraft other than the Gulfstream II will be in excess of 20 years. For areas used by the Gulfstream II the total pavement section should be increased to 19 inches to obtain a 20-year life.

For new pavement sections the Fatigue Analysis methodology indicates that for the Gulfstream II loaded to 50,000 pounds gross aircraft weight a total pavement section of 18 inches will be required, for a general aviation aircraft loaded to 20,000 pounds on single gear configuration a 14-inch pavement section is required, and for a single engine aircraft on single gear configuration loaded to 12,500 pounds a 13-inch total pavement section is required.

D. Federal Aviation Administration Design Method

The Federal Aviation Administration has adopted a method of design and evaluation of airport pavements that has been presented in F.A.A. Advisory Circular 150/5320-6C. The F.A.A. design method is based on the California Bearing Ratio design procedure for flexible pavements. Based on the soil test data obtained in this and previous studies, the California Bearing Ratio of the subgrade materials can be expected to range between 5 and 15, with 5 being the critical subgrade. The California Bearing Ratio of existing base course materials under existing pavements was found to be 30 and the California Bearing Ratio of any new aggregate base course materials used at this site will be 100+. Using these data and the critical aircraft, the following pavement design sections for various critical aircraft and various subgrade conditions have been determined. These pavement section requirements are summarized in the following table:

Aircraft	Gross Wt - Lb.	Type Gear	Annual Operations	Subgrade CBR	Pavement Section Requirements (Inches) AC	AB	Total
G II	50,000	Dual	1,200	5	3	15	18
			3,000		3	16	19
			1,200	8	3	10	13
			3,000		3	11	14
			1,200	12	3	6	9
			3,000		3	7	10
			1,200	15	3	5	8
			3,000		3	5	8
Small Business Jet	20,000	Single	1,200	5	3	10.5	13.5
			3,000		3	11.5	14.5
			1,200	8	3	7	10
			3,000		3	8	11
			1,200	12	3	4	7
			3,000		3	5	8
			1,200	15	3	3.5	6.5
			3,000		3	4	7
General Aviation	12,500	Single	3,000	5	2	11	13
				8	2	8	10
				12	2	5	7
				15	2	3.5	5.5

It will be noted that the pavement requirements for both the Fatigue Analysis method of design and the CBR method of design for the same number of aircraft operations and subgrade conditions are similar. It is recommended that the following pavement sections be utilized for overlay and reconstruction of existing pavements and for the construction of new pavements:

Recommended Pavement Design Sections

Location	Critical Aircraft	Gross Load (Lb.)	Type Gear	Pavement Section - inches AC	AB**	Total
R/W 1-19 (Overlay)	G II	50,000	Dual	8	9	17*
R/W 1-19 (New Construction)	G II	50,000	Dual	3	16	19
R/W 12-30	GA Twin	20,000	Single	3	11.5	14.5
T/Ws A, B, C, D & E	G II	50,000	Dual	3	16	19
T/Ws J, K, L & N	GA Twin	20,000	Single	3	11.5	14.5
Tie Down Apron - Jet Aircraft	G II	50,000	Dual	3	16	19
Tie Down Apron - Light GA	GA Twin	12,500	Single	2	11	13
Tee Hangar Area - Light Business Jet	Bus. Jet	20,000	Single	3	11.5	14.5
Tee Hangar Area - Light GA	GA Twin	12,500	Single	2	11	13

NOTES: 1. All data based on critical subgrade CBR = 5.

2. With selective grading, CBR of subgrade may be upgraded with corresponding decrease in pavement section.

*Based on 3-inch AC overlay over existing section.
**Subbase course materials can be substituted for the lower portion of the base course materials.

The design requirements set forth are preliminary and based on the sandy clayey soils (CBR 5) being the critical subgrade. As each project is developed further, studies will indicate whether a uniform subgrade can be developed with higher strength soils and, if so, the pavement sections can be modified accordingly using the values presented for the F.A.A. analysis. For the purpose of cost estimates and preliminary design, the critical condition of subgrade CBR 5 should be used.

RWB:aw

TABLE NO. C-1

OROVILLE MUNICIPAL AIRPORT
OROVILLE, BUTTE COUNTY, CALIFORNIA

RUNWAY 1-19 PAVEMENT EVALUATION STUDY

LOG OF TEST PITS

Test Pit No.	Location Station	Location Offset (Ft.)	Depth Below Surface (Ft.)	Natural Moisture Content (Percent)	Material Description
P1	68+60	125 Rt.	0-3	9.9	Brown Clayey Sandy Silt
			3-5	10.7	Brown Sandy Silt
			5-8	14.0	Brown Clayey Silt
P2	61+00	125 Lt.	0-3.1	4.7	Brown Sandy Silt
			3.1-6.3	16.8	Brown Sandy Clayey Silt
			6.3-8.0	25.0	Brown Sandy Clayey Silt
P3	53+00	125 Rt.	0-3	11.3	Brown Clayey Sandy Silt
			3-5	22.8	Brown Sandy Clay
			5-8	18.0	Brown Sandy Clay
P4	45+00	125 Lt.	0-3	5.1	Brown Sandy Silt
			3-5	6.0	Brown Sandy Silt to Silty Fine Sand
			5-8	16.0	Brown Clayey Silty Fine Sand
P5	37+00	125 Rt.	0-2	3.5	Clayey Sandy Silt
			2-4.2	17.8	Sandy Silt to Silty Fine Sand
			4.2	13.8	Hardpan - Compact Silty Fine Sand
P6	29+00	125 Lt.	0-2.8	11.5	Brown Sandy Silt (Clayey)
			2.8		Hardpan
P7	21+00	125 Rt.	0-2.0	7.8	Brown Sandy Silt
			2.0		Hardpan
P8	11+00	125 Lt.	0-3.5	7.9	Brown Silty Fine Sand (Gravelly)
			3.5-8.0	12.8	Brown Silty Fine Sand (Gravelly)
			8.0	16.9	Brown Silty Fine to Medium Sand

TABLE NO. C-2

OROVILLE MUNICIPAL AIRPORT
OROVILLE, BUTTE COUNTY, CALIFORNIA

RUNWAY 1-19 PAVEMENT EVALUATION STUDY

LOG OF CORE HOLES

Core Hole No.	Location		Depth Below Surface (In.)	Natural Moisture Content (Percent)	Material Description
	Station	Offset (Ft.)			
T1	68+50	50 Rt.	0-2 3/4		Asphaltic Concrete
			2 3/4-13 1/4	6.0	Aggregate Base - Silty Sand and Gravel
			13 1/4-19	13.6	Brown Sandy Clayey Silt
T2	61+00	50 Lt.	0-3		Asphaltic Concrete
			3-12	7.6	Aggregate Base - Silty Sand and Gravel
			12-18	11.4	Brown Sandy Silt (Slightly Clayey)
T3	53+00	50 Rt.	0-3 1/4		Asphaltic Concrete
			3 1/4-12	11.1	Aggregate Base - Clayey Sand and Gravel
			12-17	17.9	Brown Sandy Clayey Silt
T4	45+00	50 Lt.	0-3		Asphaltic Concrete
			3-12	8.2	Aggregate Base - Sand and Gravel (Silty)
			12-16	9.6	Brown Sandy Silt
T5	37+00	50 Rt.	0-3 3/4		Asphaltic Concrete
			3 3/4-12	8.8	Aggregate Base - Sand and Gravel (Clayey)
			12-16	18.2	Brown Clayey Sand
T6	29+00	50 Lt.	0-3 1/4		Asphaltic Concrete
			3 1/4-14	4.0	Aggregate Base - Sand and Gravel, Partially Crushed
			14-20	14.6	Brown Sandy Clay
T7	21+00	50 Rt.	0-3		Asphaltic Concrete
			3-13	3.8	Crushed Aggregate Base
			13-19	12.0	Brown Sandy Silt
T8	11+00	50 Lt.	0-3		Asphaltic Concrete
			3-16	3.7	Aggregate Base - Sand and Gravel, Partially Crushed
			16-22	14.0	Brown Sandy Silt (Clayey)

TABLE NO. C-3

PROJECT: Oroville Municipal Airport
Master Plan Report

LOG OF BORING NO. U1

Date Drilled: 11-16-89

Surface Elevation: 190 feet

Elev.	Sample No.	Blows/ Ft.	Water Level	Dry Unit Weight lb/cu ft	Natural Moisture Content %	Description
1 -		20				
2 -	1	36				Red Brown Silty Fine Sand - Gravel Embedded
3 -		50/12		135	7.3	
4 -						
5 -						
6 -	2	50/6		114	12.6	Red Brown Clay Silty Fine Sand
7 -						
8 -						
9 -						
10 -						Reddish Brown Silty Fine Sand (Clayey)
11 -		37				
	3			-122-	-18.4	
12 -		50/10		127	10.6	Reddish Brown Clayey Silt
13 -						
14 -						
15 -						
16 -		16				
17 -	4	37		111	19.0	
				-120-	-16.2	
18 -		34				Red Brown Silty Fine Sand (Clayey)
19 -						Boring Terminated at 18 feet
20 -						

REINARD W. BRANDLEY, CONSULTING AIRPORT ENGINEER

TABLE NO. C-4

PROJECT: Oroville Municipal Airport
Master Plan Report

LOG OF BORING NO. U2

Date Drilled: 11-16-89

Surface Elevation: 175 feet

Elev.	Sample No.	Blows/ Ft.	Water Level	Dry Unit Weight lb/cu ft	Natural Moisture Content %	Description
1 -		10				
2 -	1	26				Brown Clayey Sandy Silt
3 -		50/8		126	9.6	
4 -						
5 -						Orange Brown Sandy Silt
6 -	2	50/10		104	20.7	
7 -						
8 -						
9 -						
10 -						
11 -		23				
12 -	3	38		106	23.2	Orange Brown Sandy Clayey Silt
13 -		50/12				
14 -						
15 -						
16 -	4	50/8		101	25.0	Brown Sandy Clayey Silt
17 -						Boring Terminated at 16 feet
18 -						
19 -						
20 -						

REINARD W. BRANDLEY, CONSULTING AIRPORT ENGINEER

TABLE NO. C-5

PROJECT: Oroville Municipal Airport
Master Plan Report

LOG OF BORING NO. U3

Date Drilled: 11-16-89

Surface Elevation: 185 feet

Elev.	Sample No.	Blows/ Ft.	Water Level	Dry Unit Weight lb/cu ft	Natural Moisture Content %	Description
1 -		22				
	1					Red Brown Silty Fine to Coarse Sand DG
2 -		50/6		125	13.1	
3 -						
4 -						
5 -						
6 -	2	50/6		122	12.4	
7 -						
8 -						
9 -						Light Brown Silty Fine to Coarse Sand DG
10 -						
11 -	3	50/4		117	10.9	
12 -						
13 -						
14 -						
15 -						Brown Sandy Silt, Slightly Clayey
16 -	4	50/6			20.5	
						Boring Terminated at 16 feet
17 -						
18 -						
19 -						
20 -						

REINARD W. BRANDLEY, CONSULTING AIRPORT ENGINEER

TABLE NO. C-6

PROJECT: Oroville Municipal Airport
Master Plan Report

LOG OF BORING NO. U4

Date Drilled: 11-16-89

Surface Elevation: 182 feet

Elev.	Sample No.	Blows/ Ft.	Water Level	Dry Unit Weight lb/cu ft	Natural Moisture Content %	Description
1 -		9				
	1					Red Brown Sandy Clayey Silt
2 -		50/8		120	13.6	
3 -						
4 -						
5 -						
6 -	2	50/4		104	19.4	Orange Silt (Sandy)
7 -						
8 -						
9 -						
10 -						
11 -	3	50/11		117	21.6	Brown Sandy Clayey Silt
12 -						Boring Terminated at 11 feet
13 -						
14 -						
15 -						
16 -						
17 -						
18 -						
19 -						
20 -						

REINARD W. BRANDLEY, CONSULTING AIRPORT ENGINEER

TABLE NO. C-7

OROVILLE MUNICIPAL AIRPORT
OROVILLE, BUTTE COUNTY, CALIFORNIA

PAVEMENT PERFORMANCE DATA

Location	Pavement Section			E Ksi			Deflection x 10^{-3} (inch)				Coverage to Failure x 10^3			
	AC	AB	Total	AC	AB	Subgrade	G II	Citation	Twin	Single	G II	Citation	Twin	Single
Runway 1-19* (Northerly 2,500')	6	9	15	200	60	20	28.2	7.9	4.2	2.2	14	850	5,000	10,000+
	6	12	18				25.4	6.8	3.7	1.9	47	1,800	9,500	10,000+
	6	18	24				21.3	5.4	2.9	1.6	230	9,000	10,000+	10,000+
	8	9	18				25.69	6.9	3.7	1.9	50	1,800	10,000+	10,000+
	8	12	21				23.4	6.1	3.3	1.7	90	4,200	10,000+	10,000+
	8	18	26				19.9	5.0	2.7	1.4	270	11,000	10,000+	10,000+
Runway 1-19* (Southerly 3,500')	5	12	17	200	60	12	39.8	10.6	5.7	3.0	12	440	2,700	10,000+
	5	18	23				32.8	8.3	4.5	2.4	46	2,400	10,000+	10,000+
	8	12	20				34.9	8.9	4.8	2.6	28	1,300	7,500	10,000+
	8	18	26				29.5	7.3	3.9	2.1	80	4,300	10,000+	10,000+
Runway 12-30* (Westerly 4,000')	3	6	9	200	60	14	50.4	16.4	8.9	4.5	1.2	31	109	1,200
	3	12	15				38.8	10.9	5.8	3.0	7.7	300	1,700	10,000+
	3	18	21				31.5	8.2	4.4	2.3	40	1,800	9,000	10,000+
	6	6	12				42.4	12.1	6.6	3.4	3.8	140	670	4,000
	6	12	18				33.8	8.9	4.8	2.5	20	900	5,000	10,000+
	6	18	24				28.1	7.1	3.8	2.0	90	4,500	10,000+	10,000+
	8	6	14				38.0	10.4	5.6	2.9	8	330	2,000	11,000
	8	12	20				31.0	8.0	4.3	2.3	40	1,800	10,000	10,000+
	8	18	26				26.2	6.5	3.5	1.9	103	7,000	10,000+	10,000+

*Existing Section
Note: All other sections analyzed except existing section based on overlay or reconstruction.

Location	Pavement Section			E Ksi			Deflection x 10^{-3} (inch)				Coverage to Failure x 10^3			
	AC	AB	Total	AC	AB	Subgrade	G II	Citation	Twin	Single	G II	Citation	Twin	Single
Runway 12-30*	2	12	14	200	60	20	30.6	9.0	4.9	2.5	14	500	2,800	10,000+
(Easterly 1,000′)	2	18	20				24.9	6.7	3.6	1.9	70	3,000	10,000+	10,000+
	4	12	16				27.8	7.8	4.2	2.2	22	1,000	6,000	10,000+
	4	18	22				22.9	6.0	3.2	1.7	125	5,500	10,000+	10,000+
	6	12	18				25.5	6.8	3.7	1.9	47	2,000	10,000	10,000+
	6	18	24				21.3	5.4	2.9	1.6	200	10,000	10,000+	10,000+
Taxiways R, V, S & L*	2	12	14	200	60	15	38.7	11.1	6.0	3.1	7	270	1,400	10,000
	2	18	20				31.3	8.2	4.4	2.3	40	1,700	9,000	10,000+
	4	12	16				35.0	9.6	5.2	2.7	13	500	3,000	10,000+
	4	18	22				28.7	7.4	4.0	2.1	65	3,100	10,000+	10,000+
	6	12	18				32.0	8.5	4.5	2.4	25	1,000	6,000	10,000+
	6	18	24				26.6	6.7	3.6	1.9	40	5,500	10,000+	10,000+
Taxiway T*	2	6	8	200	60	20	39.0	14.2	7.8	3.9	2.5	40	240	1,700
	2	12	14				30.6	9.0	4.9	2.5	14	450	2,700	10,000+
	2	18	20				24.9	6.7	3.6	1.9	80	3,000	10,000+	10,000+
	4	6	10				35.2	11.3	6.1	3.1	4.7	130	700	4,800
	4	12	16				27.8	7.8	4.2	2.2	23	1,000	5,200	10,000+
	4	18	22				22.9	6.0	3.2	1.7	120	5,000	10,000+	10,000+
	6	6	12				31.6	9.3	5.0	2.6	9	300	1,800	11,000
	6	12	18				25.5	6.8	3.7	1.9	47	2,000	10,000	10,000+
	6	18	24				21.3	5.4	2.9	1.6	190	8,000	10,000+	10,000+

*Existing Section

Note: All other sections analyzed except existing section based on overlay or reconstruction.

Oroville Municipal Airport

Pavement Performance Data

Location	Pavement Section			E Ksi			Deflection x 10^{-3} (inch)				Coverage to Failure x 10^3			
	AC	AB	Total	AC	AB	Subgrade	G II	Citation	Twin	Single	G II	Citation	Twin	Single
Apron*	2	6	8	200	60	10	71.5	23.6	13.0	6.5	0.35	10	50	400
	2	12	14				53.5	14.9	8.1	4.2	2.7	120	630	4,200
	2	18	20				42.8	11.1	5.9	3.2	15	800	4,500	10,000+
	4	6	10				63.0	18.7	10.2	5.2	0.9	27	170	1,100
	4	12	16				48.2	12.9	6.9	3.6	5.3	220	1,500	8,000
	4	18	22				39.2	10.0	5.3	2.9	25	1,300	7,000	10,000+
	6	6	12				55.7	15.5	8.4	4.3	17	72	400	2,800
	6	12	18				43.8	11.4	6.1	3.2	10	460	2,600	10,000+
	6	18	24				36.3	9.1	4.9	2.6	37	2,200	11,000	10,000+

*Existing Section

Note: All other sections analyzed except existing section based on overlay or reconstruction.

TABLE NO. C8

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

FORECAST OPERATIONS

YEAR	ANNUAL OPERATIONS									
	G-2	CITATION III	CITATION II	OTHER BUSINESS JETS	KING AIR	SMALL TWIN	SINGLE G.A.	HELICOPTER	MILITARY	TOTAL
1989	24	48	600	48	600	3,000	56,476	154	100	61,050
1995	24	72	800	80	800	3,500	58,424	300	100	64,100
2005	36	90	1,000	200	900	4,000	62,474	400	100	69,200
2010	50	100	1,100	250	1,000	5,000	64,000	600	100	72,200

Note: One Operation Equals One Departure Or One Arrival

Summary of Distribution of Traffic

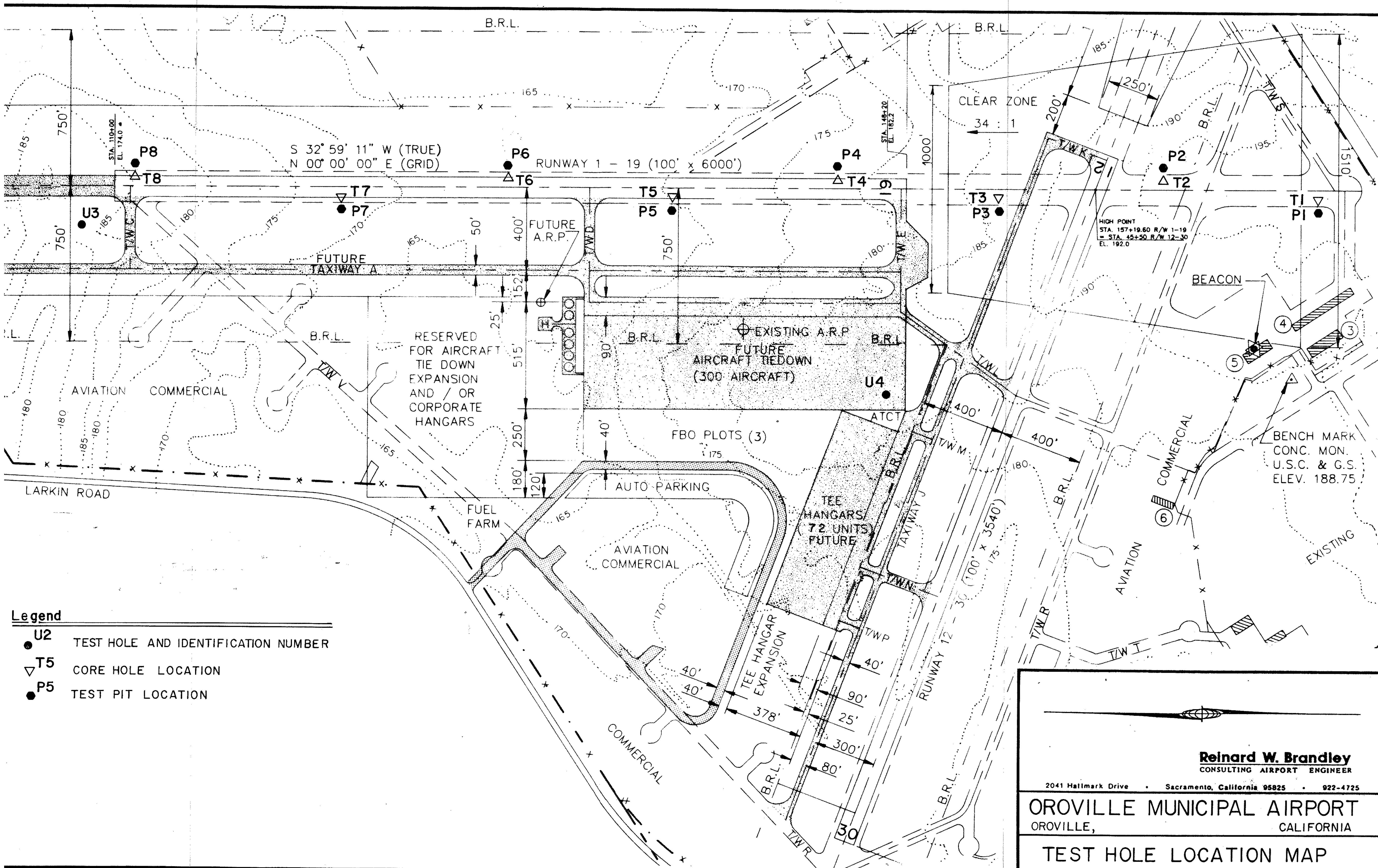
R/W 12-30 25% of Single G.A.

R/W 1-19 All Others

After 6:00 p.m.: 10% All Others
20% G.A. Single

Note: 1989 operations of Louisiana Pacific fleet shown below:

Aircraft	Annual Operations
Citation II	600
Citation III	48
G2	24
King Air	600
Jet Ranger Helicopter	104



Legend

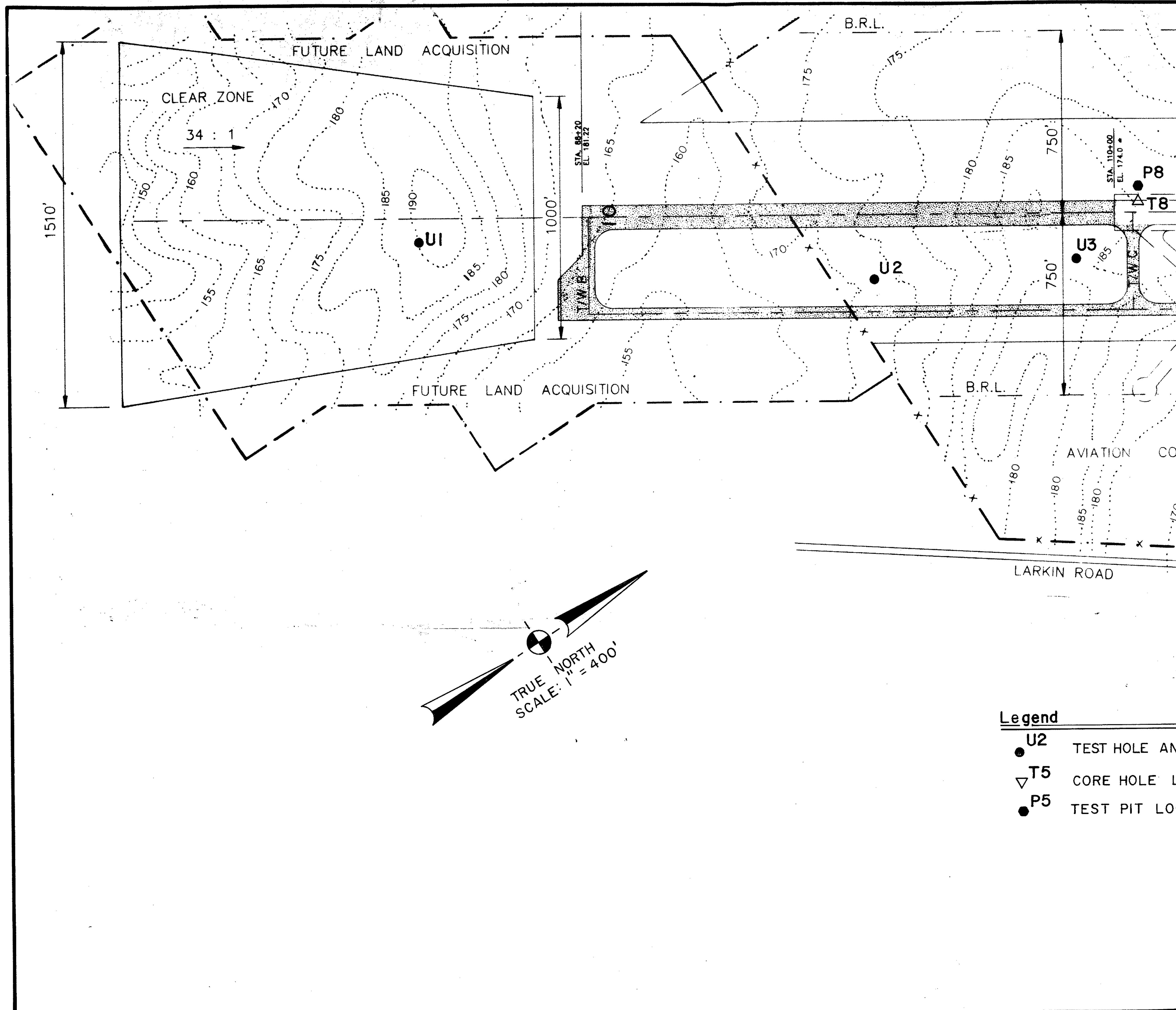
- U2 TEST HOLE AND IDENTIFICATION NUMBER
- T5 CORE HOLE LOCATION
- P5 TEST PIT LOCATION

Reinard W. Brandley
CONSULTING AIRPORT ENGINEER
2041 Hallmark Drive • Sacramento, California 95825 • 922-4725

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

TEST HOLE LOCATION MAP

PLATE No. C1


FUTURE LAND ACQUISITION
CLEAR ZONE
34 : 1
1510'
1000'
U1
STA. 88+20
EL. 181.22
T/W B
U2
U3
T/W C
STA. 110+00
EL. 174.0
P8
T8
750'
B.R.L.
AVIATION COM
LARKIN ROAD
TRUE NORTH
SCALE: 1" = 400'
Legend
U2 TEST HOLE AND
T5 CORE HOLE LO
P5 TEST PIT LOCA

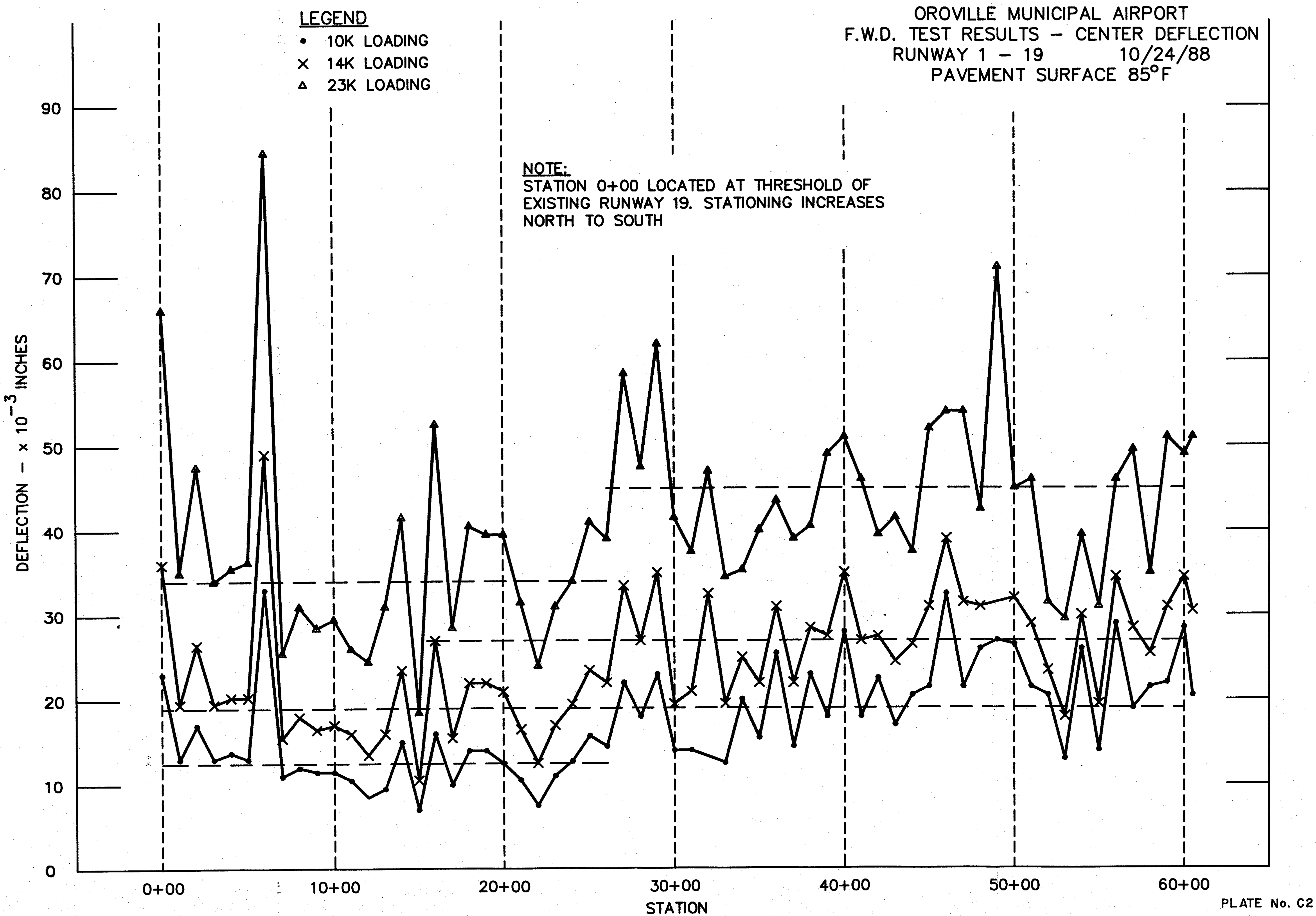

OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS – CENTER DEFLECTION
RUNWAY 1 – 19 10/24/88
PAVEMENT SURFACE 85°F
LEGEND
• 10K LOADING
× 14K LOADING
△ 23K LOADING
NOTE:
STATION 0+00 LOCATED AT THRESHOLD OF EXISTING RUNWAY 19. STATIONING INCREASES NORTH TO SOUTH
DEFLECTION – x 10^-3 INCHES
0
10
20
30
40
50
60
70
80
90
0+00
10+00
20+00
30+00
40+00
50+00
60+00
STATION

PLATE No. C2

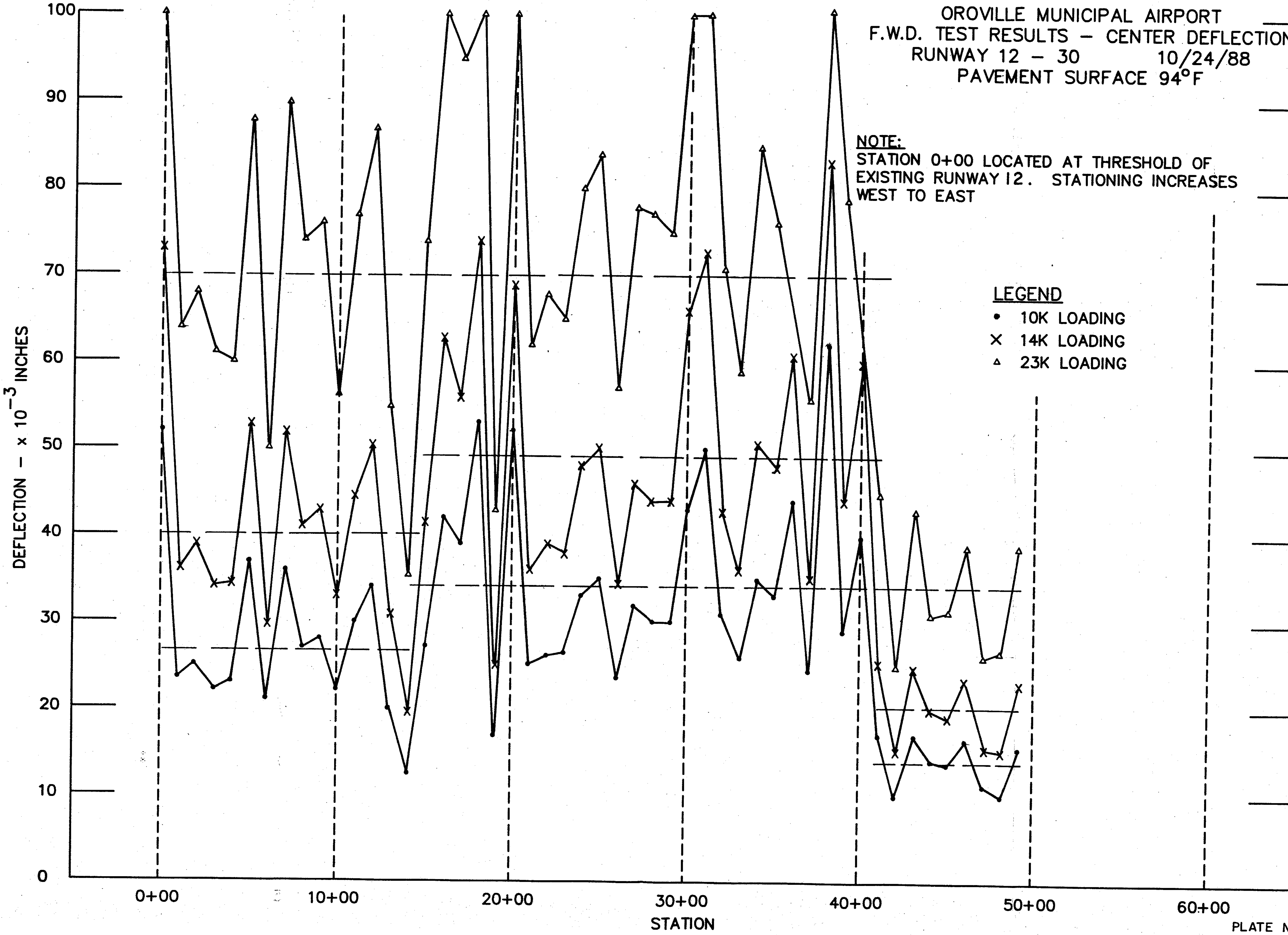
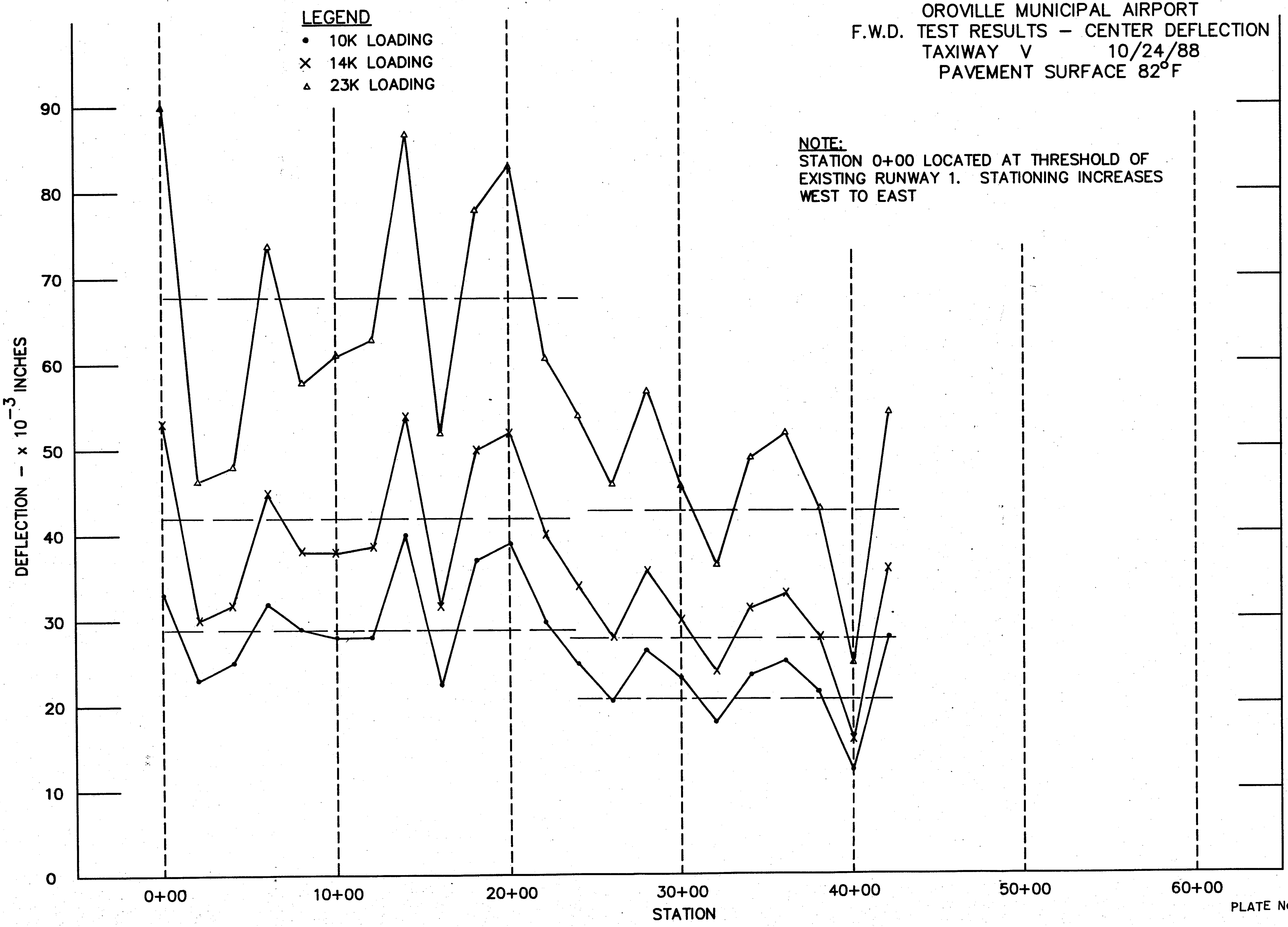
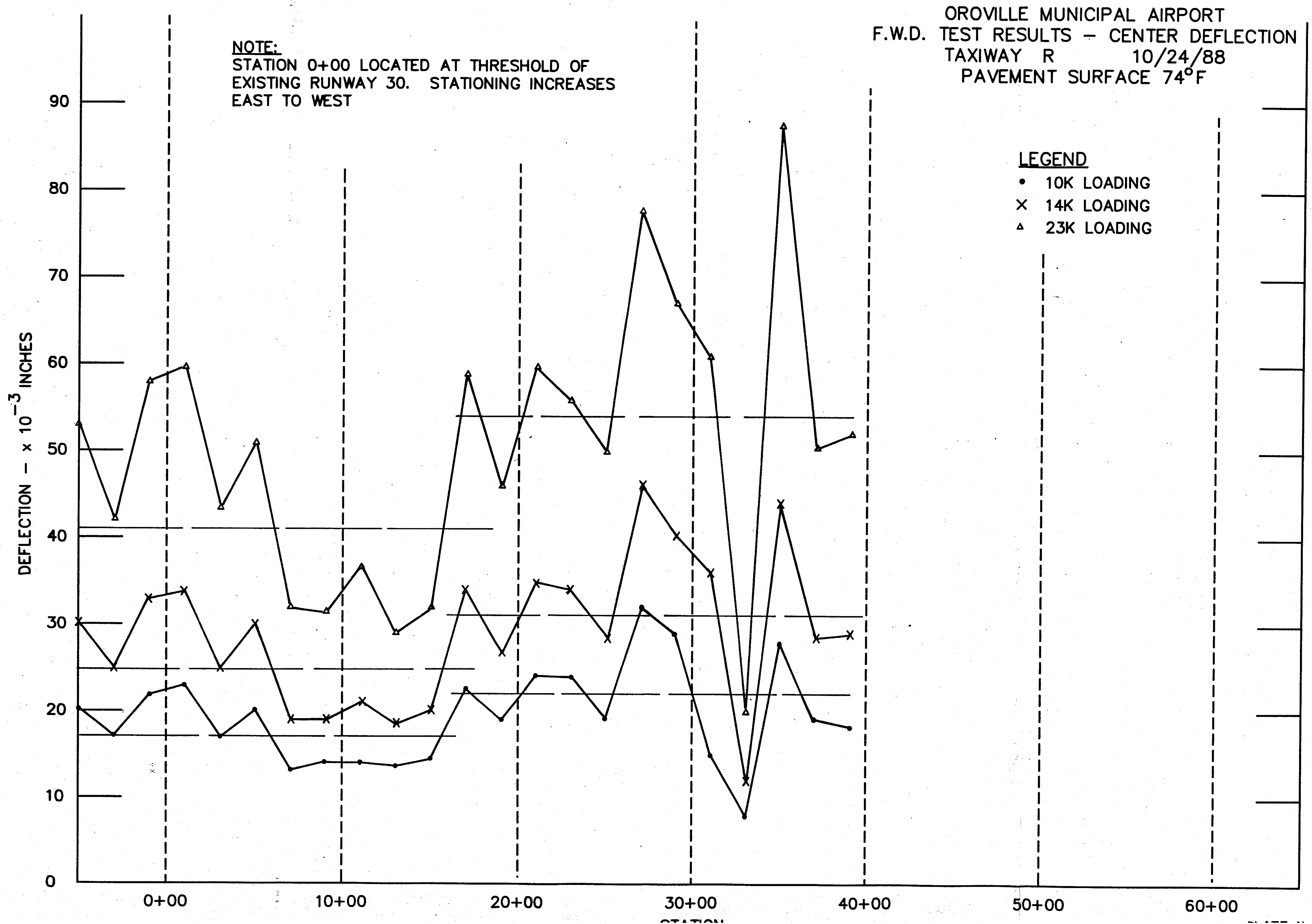
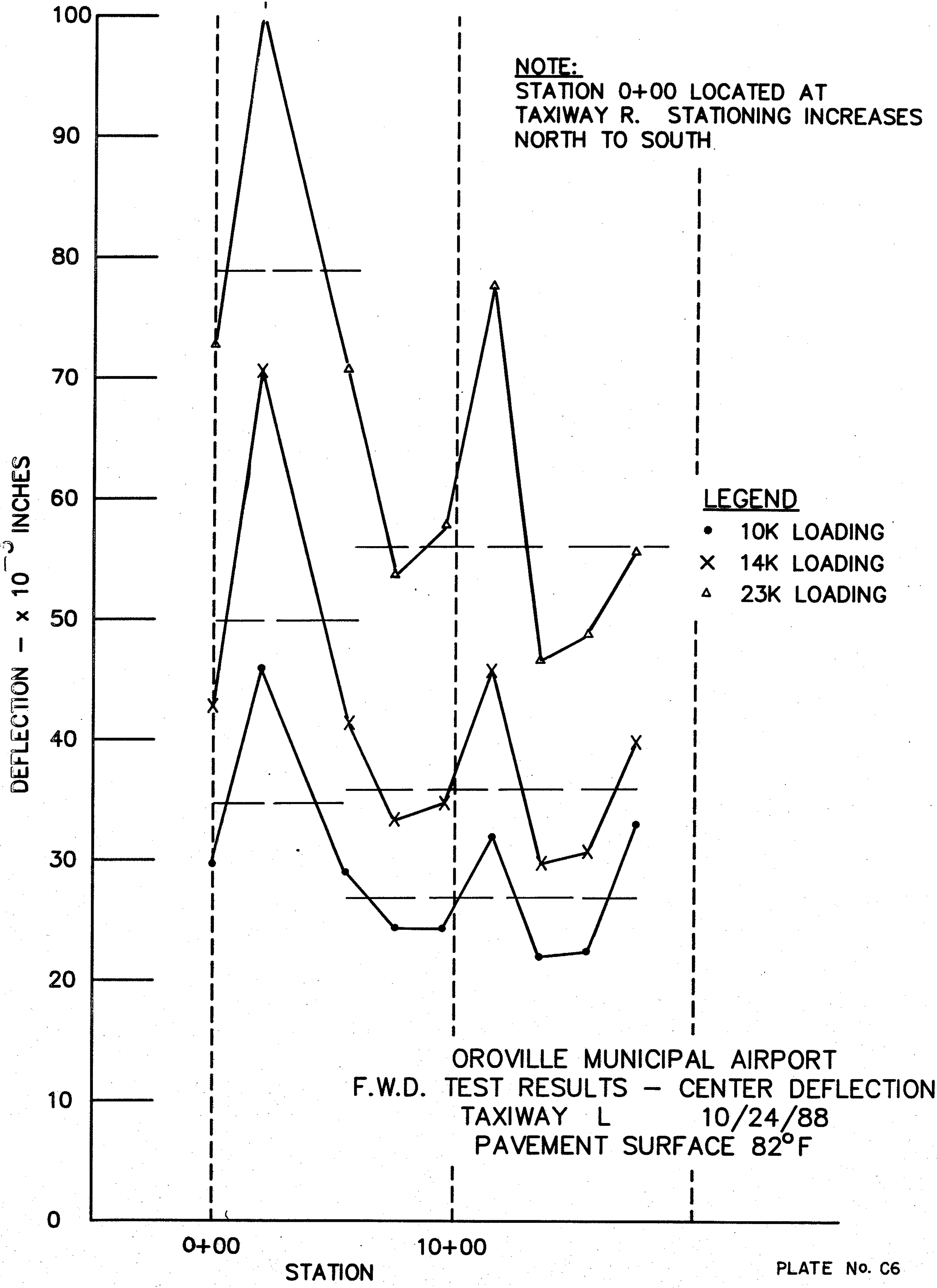

OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS – CENTER DEFLECTION
RUNWAY 12 – 30 10/24/88
PAVEMENT SURFACE 94°F
NOTE:
STATION 0+00 LOCATED AT THRESHOLD OF EXISTING RUNWAY 12. STATIONING INCREASES WEST TO EAST
LEGEND
10K LOADING
14K LOADING
23K LOADING
DEFLECTION – x 10^-3 INCHES
0
10
20
30
40
50
60
70
80
90
100
0+00
10+00
20+00
30+00
40+00
50+00
60+00
STATION

PLATE No. C3

OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS – CENTER DEFLECTION
TAXIWAY V 10/24/88
PAVEMENT SURFACE 82°F

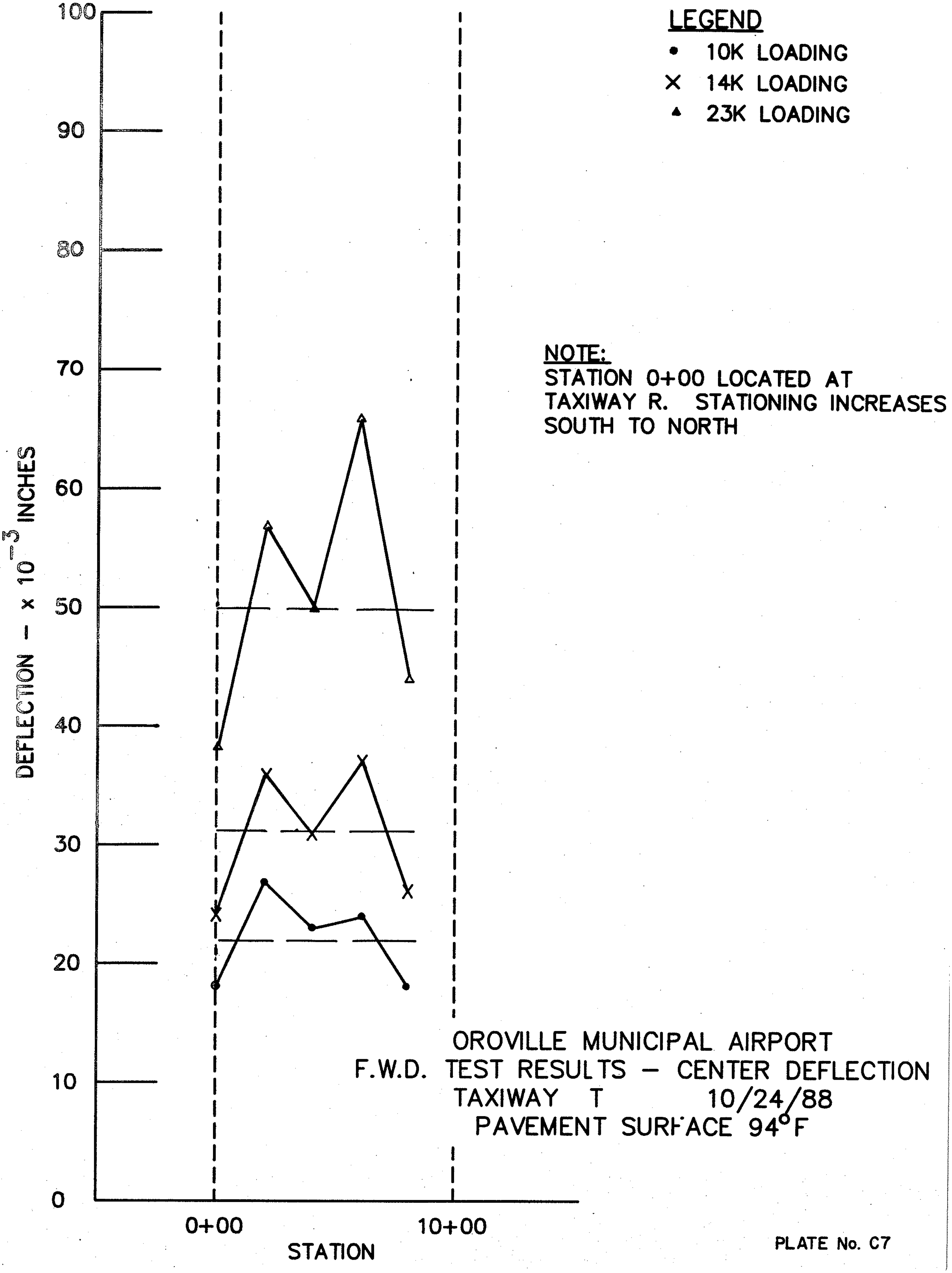


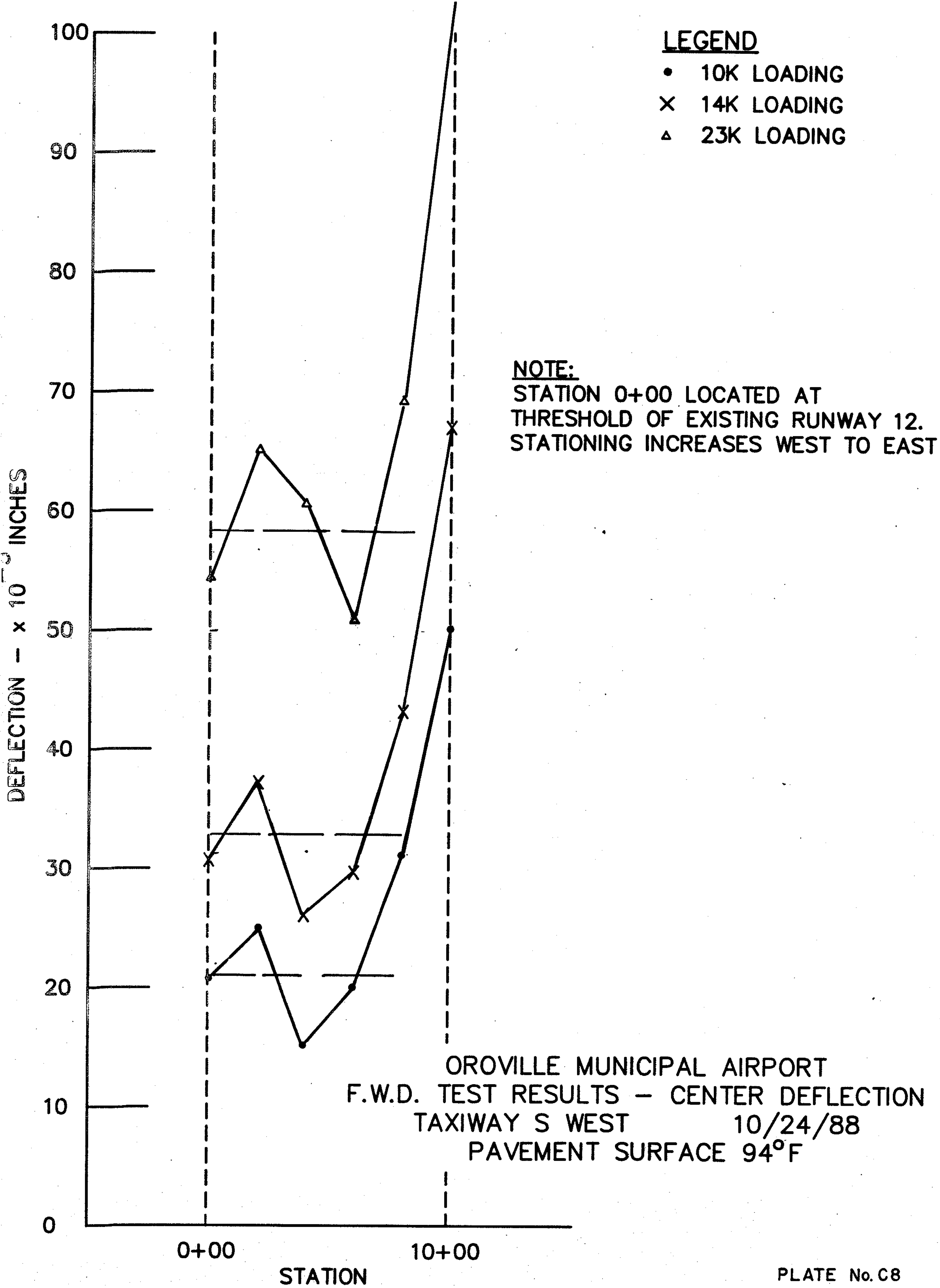

OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS – CENTER DEFLECTION
TAXIWAY R 10/24/88
PAVEMENT SURFACE 74°F
NOTE:
STATION 0+00 LOCATED AT THRESHOLD OF EXISTING RUNWAY 30. STATIONING INCREASES EAST TO WEST
LEGEND
• 10K LOADING
× 14K LOADING
▵ 23K LOADING
DEFLECTION – x 10⁻³ INCHES
0
10
20
30
40
50
60
70
80
90
0+00
10+00
20+00
30+00
40+00
50+00
60+00



OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS – CENTER DEFLECTION
TAXIWAY L 10/24/88
PAVEMENT SURFACE 82°F

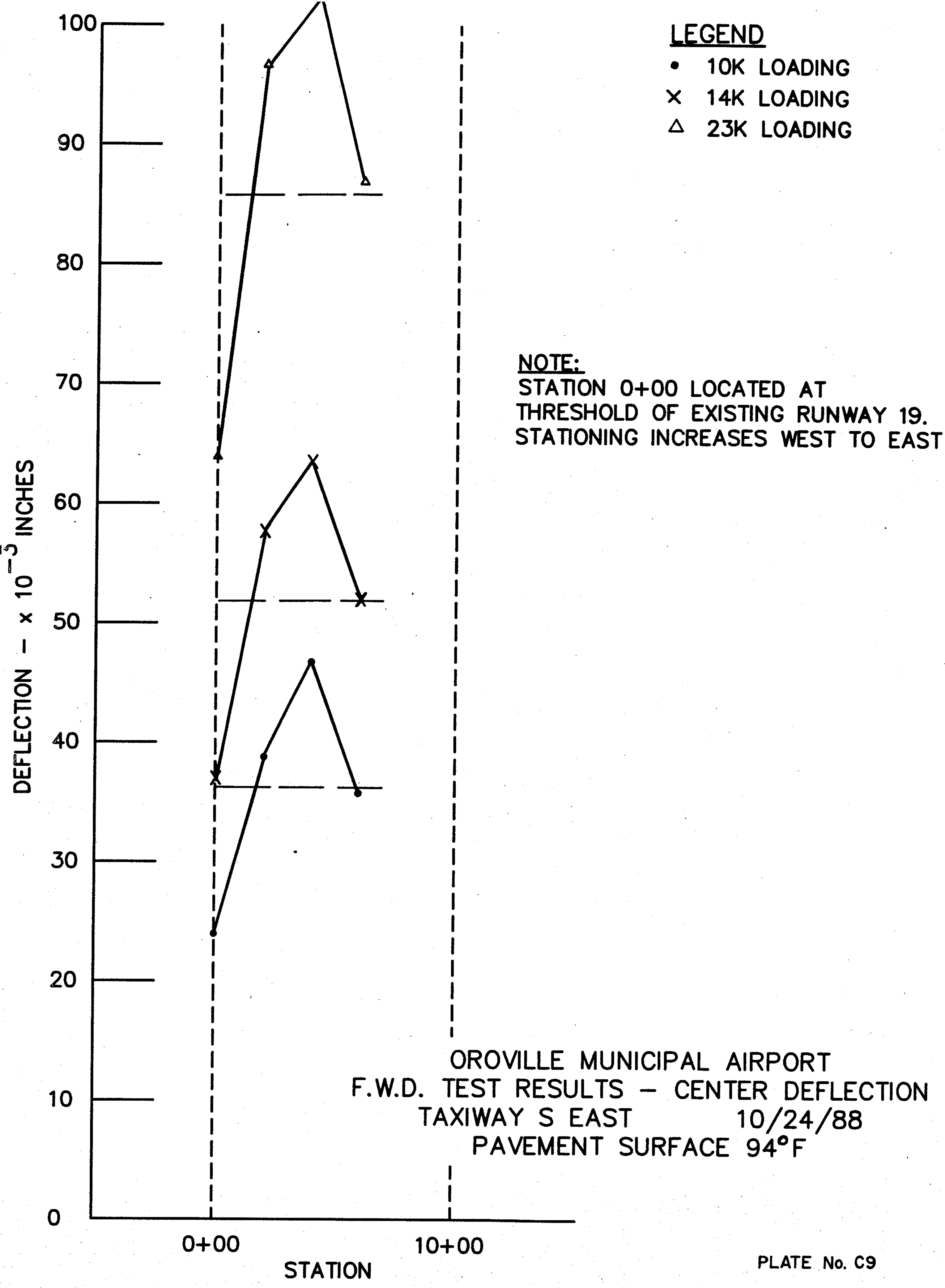
PLATE No. C6


LEGEND
• 10K LOADING
× 14K LOADING
▲ 23K LOADING
NOTE:
STATION 0+00 LOCATED AT TAXIWAY R. STATIONING INCREASES SOUTH TO NORTH
DEFLECTION – x 10⁻³ INCHES
100
90
80
70
60
50
40
30
20
10
0
0+00
10+00
STATION
OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS – CENTER DEFLECTION
TAXIWAY T 10/24/88
PAVEMENT SURFACE 94°F



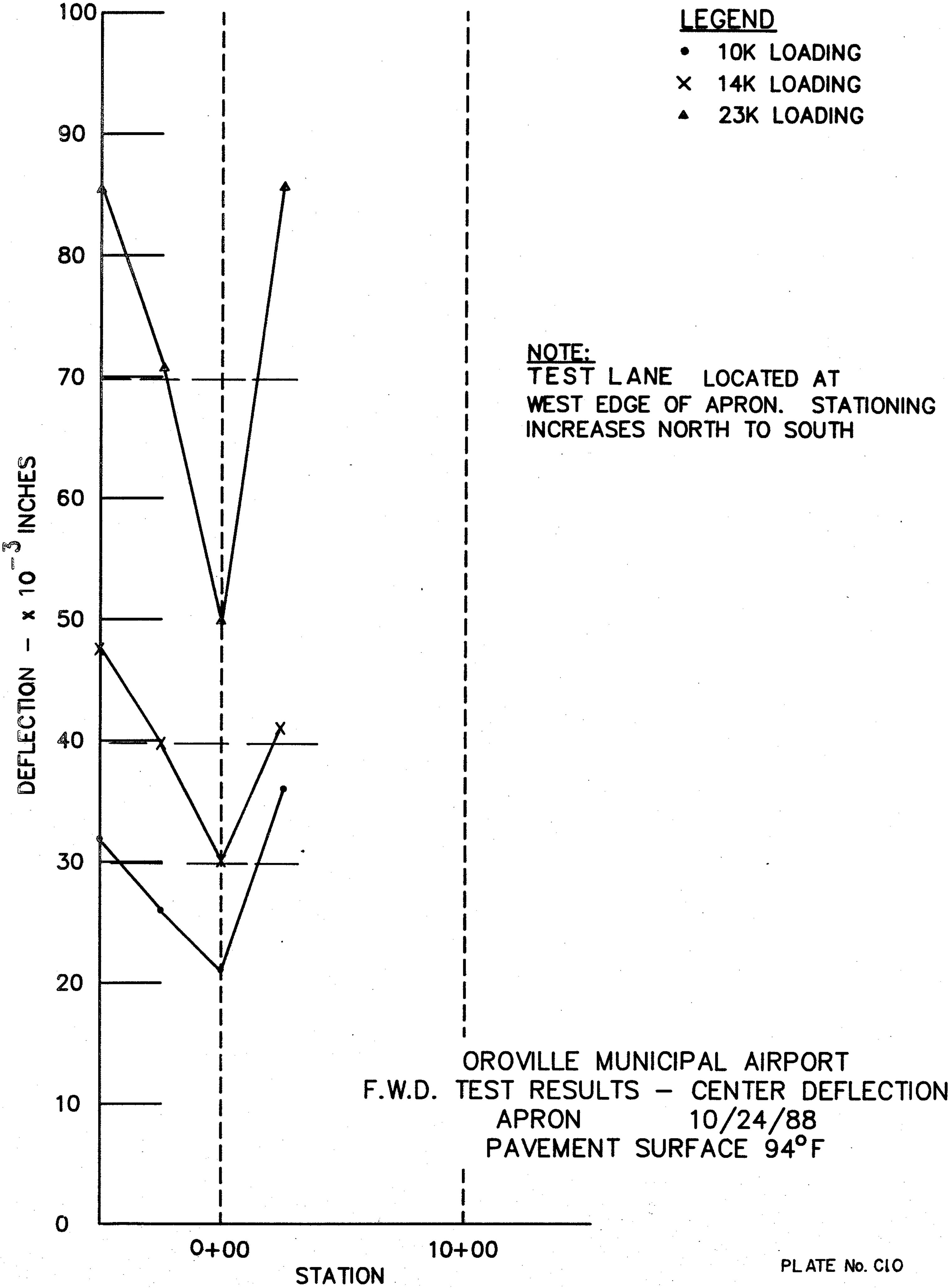
OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS – CENTER DEFLECTION
TAXIWAY S WEST 10/24/88
PAVEMENT SURFACE 94°F

PLATE No. C8



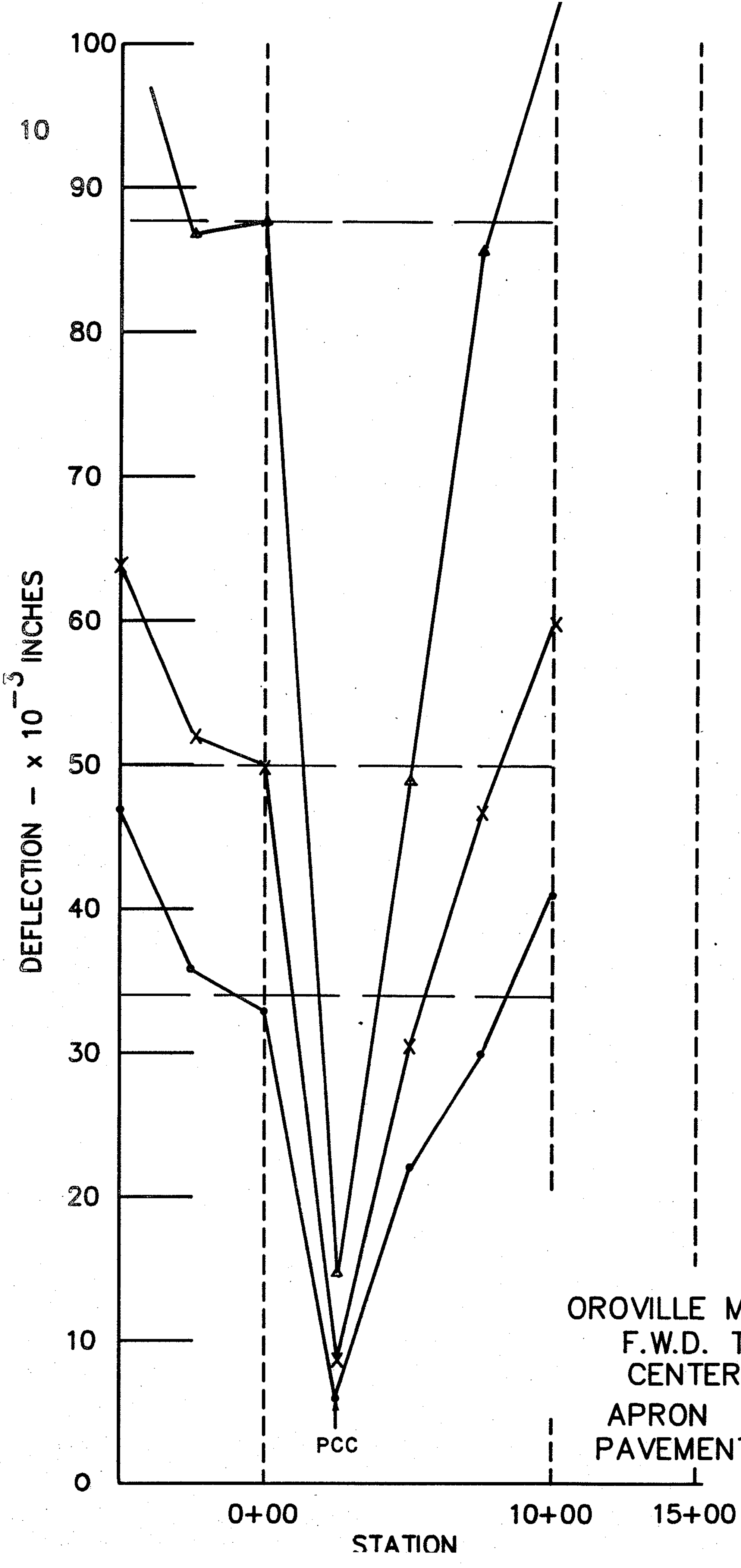
OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS – CENTER DEFLECTION
TAXIWAY S EAST 10/24/88
PAVEMENT SURFACE 94°F

PLATE No. C9



OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS – CENTER DEFLECTION
APRON 10/24/88
PAVEMENT SURFACE 94°F

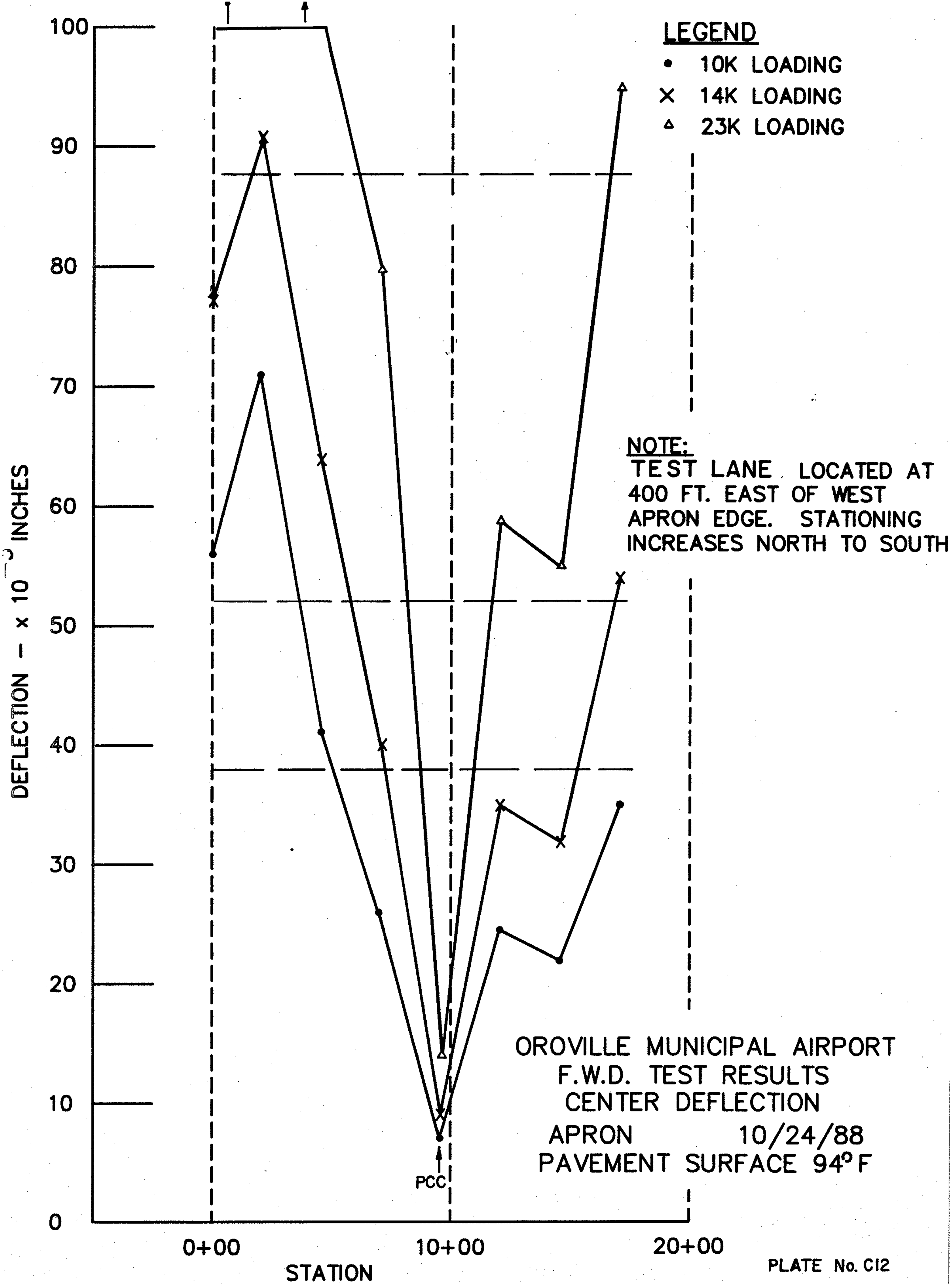
PLATE No. C10



NOTE:
TEST LANE LOCATED AT 200 FT. EAST OF WEST APRON EDGE. STATIONING INCREASES NORTH TO SOUTH

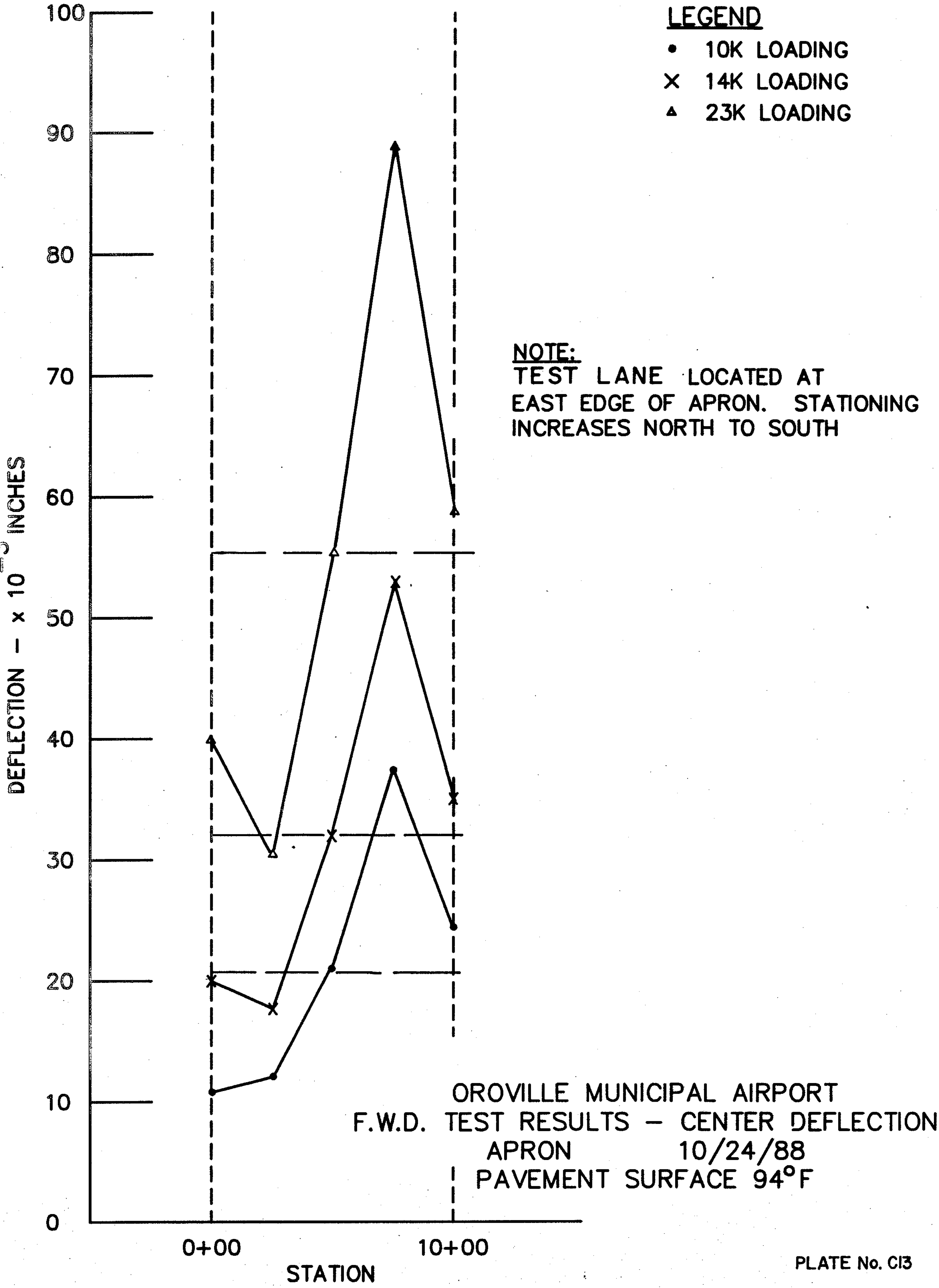
OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS
CENTER DEFLECTION
APRON 10/24/88
PAVEMENT SURFACE 94° F

PLATE No. C11



LEGEND
10K LOADING
14K LOADING
23K LOADING
NOTE:
TEST LANE LOCATED AT 400 FT. EAST OF WEST APRON EDGE. STATIONING INCREASES NORTH TO SOUTH
DEFLECTION – x 10⁻³ INCHES
STATION
0+00
10+00
20+00
PCC
0
10
20
30
40
50
60
70
80
90
100
OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS
CENTER DEFLECTION
APRON 10/24/88
PAVEMENT SURFACE 94° F

PLATE No. C12



LEGEND
10K LOADING
14K LOADING
23K LOADING
NOTE:
TEST LANE LOCATED AT EAST EDGE OF APRON. STATIONING INCREASES NORTH TO SOUTH
DEFLECTION – x 10^-3 INCHES
100
90
80
70
60
50
40
30
20
10
0
0+00
10+00
STATION
OROVILLE MUNICIPAL AIRPORT
F.W.D. TEST RESULTS – CENTER DEFLECTION
APRON 10/24/88
PAVEMENT SURFACE 94°F

PLATE No. C13

EXHIBIT C-1

FATIGUE-ANALYSIS METHOD

FOR PAVEMENT EVALUATION AND DESIGN

by

Reinard W. Brandley
Consulting Airport Engineer
2041 Hallmark Drive
Sacramento, California 95825

For Presentation at:

Symposium on
Nondestructive Test and Evaluation
of Airport Pavement

November 18-20, 1975
Vicksburg, Mississippi

Sponsored by U.S. Army Engineers
Waterways Experiment Station

FATIGUE ANALYSIS METHOD
FOR PAVEMENT EVALUATION AND DESIGN

by

Reinard W. Brandley
Consulting Airport Engineer
Sacramento, California

I INTRODUCTION

A pavement section on an airport or highway normally does not suddenly collapse and allow the vehicle to sink into the pavement unless the pavement is grossly under-designed or unless some major defect suddenly occurs within the pavement section. The normal type of failure on a pavement is a progressive failure which takes place over a period of time and gradually causes the pavement to deteriorate to a point where normal maintenance is no longer economically feasible. When a pavement reaches this condition of deterioration or failure, it is normally strengthened or reconstructed in order that its life can be extended.

The type of failure which occurs with a flexible type pavement is somewhat different from that which occurs with a rigid type pavement. With a flexible pavement, failure is usually associated with excessive vertical displacement, both permanent and recoverable. When deflections in a flexible pavement section exceed the allowable limits, then the pavement section ruts and cracking occurs in the pavement surface. The first signs of cracking are usually longitudinal cracks in the pavement. Transverse cracks develop shortly thereafter, and eventually a map-pattern cracking develops throughout the pavement section. Shortly after this cracking pattern develops, a complete failure of the section can be anticipated.

With the rigid type pavement the first signs of distress are generally cracking of the pavement slab, corner-cracking, and/or spalling at the joints. This is followed by vertical displacements of sections of the slab and eventually deterioration to a point where maintenance is no longer feasible.

The present design criteria for pavements are largely empirical, and there is no assurance that pavements designed by these empirical methods will necessarily perform as anticipated. The design of rigid pavements is based on a more theoretically exact design method, but even these designs are based on empirical considerations, and there is some question as to the reliability of the tests used to determine the modulus of soil reaction (K-factor) which is utilized in the design. The inherent weaknesses in these criteria prompted the development of a rational design method which can be used for the design and evaluation of rigid pavements, flexible pavements, and pavements using combinations of materials, either stabilized or unstabilized.

II PAVEMENT DESIGN CONSIDERATIONS

There are four major consideration which must be taken into account in pavement evaluation and design:

- Protect the subgrade and underlying soils from fatigue failures under load.
- Design the pavement section such that it will distribute loadings to the subgrade without failure of the pavement section itself.
- Design the section such that permanent deformations are limited to levels which do not over-stress the pavement section and do not cause roughness or rutting.
- Design the section which is most economical from the standpoint of initial cost, maintenance cost, and operational cost.

The design of a pavement section and the materials which are used can be controlled by the Engineer. The materials utilized for the section can be selected and placed such that sufficient strength and durability can be provided to distribute the loads to the subgrade without failure of the pavement section itself. The Engineer can utilize Portland cement concrete, bituminous surface course, cement-treated base, lime-stabilized bases, untreated bases, or combinations thereof, to provide the necessary stability within the pavement section. The design of the pavement section itself can be accomplished using a fatigue analysis in which the first-crack theory can be utilized for rigid pavements and the limiting strain criteria for flexible pavements.

Permanent deformations are caused by consolidation of the subgrade and underlying soils and by compaction of the pavement sections under load. By the application of Soil Mechanics Theories, the amount of consolidation and compaction of subgrade and pavement section materials under loading, both dynamic and static, can be anticipated. The design of the section can be adjusted to minimize the permanent deformations due to consolidation or compaction. Such techniques as over-excavation of soft subgrade materials and replacement with denser compacted embankments, pre-consolidation of soft materials by the use of pre-loading, and the use of stable foundation and base course materials adequately compacted or cemented serve this purpose.

Stable pavement sections which adequately protect the subgrade and subsoils can be developed using many combinations of stabilized or unstabilized base or subbase materials and be using flexible or rigid pavements. The pavement sections can be designed to support the proposed loadings without failure for one, five, twenty years, or longer. Economic evaluations will normally dictate the type of section used. Initial construction costs are not the only costs that must be considered in such an analysis. The costs of subsequent overlays, maintenance and operational expenses during maintenance and reconstruction must also be taken into account. On airport pavements the operational expenses incurred during maintenance and reconstruction often are a significant factor in design.

The author has developed a fatigue-analysis method for pavement evaluation and design. This method of analysis is a rational approach to pavement design in which the soil constants used for design are the fundamental properties of the soils and each layer of the pavement sections. These are the Modulus of Elasticity and Poisson's Ratio.

III BASIS FOR FATIGUE ANALYSIS

A. Early Research

Extensive research has been conducted over the past thirty years to study the performance of pavements under repeated load applications of pneumatic-tired vehicles. During and shortly after World War II, the U. S. Army Corps of Engineers conducted a series of accelerated traffic tests on airfield pavements in which various pavement sections were constructed, instrumented, and tested. Testing consisted of repeated loading of the pavement sections with test vehicles. Data accumulated consisted of elastic deflection measurements under load, permanent deformation under load, as well as performance of the section under the applied load. During the same period the Canadian Government and the British Government, as well as other governmental agencies throughout the world, conducted extensive research on the subject of pavement performance under load.

B. Development of Limiting Subgrade Deflection Criteria

The author utilized the data developed by the various governments in the preparation of a doctorate thesis at Harvard University, Graduate School of Engineering, to develop performance criteria for pavements under repetitive loading. This research showed that there was a direct relationship between performance of the pavement section as defined by the number of coverages before failure and the deflection or strain in the upper portion of the subgrade soils.

These studies have led to the development of a Limiting Subgrade Deflection Criterion to determine the capability of the pavement section to perform under repeated loadings without fatigue failure. The Limiting Subgrade Deflection Criteria developed by this research are present in Plate No. 1. It will be noted that the criteria relate subgrade deflection with pavement section thickness and the total number of coverages that can be applied to the section before a fatigue failure will occur. A similar criterion can be developed relating subgrade strain with performance as defined by the number of coverages of a load before failure will occur. The subgrade deflection and thickness of section above the subgrade was utilized in this analysis since it was more readily measured than subgrade strain. Subgrade deflection used in this analysis is the maximum subgrade deflection measured under a given loading.

C. Independent Research

Over the past twenty years the author has conducted extensive research at various airports throughout the United States, including Sacramento Metro Airport, Sacramento, California; Stockton Metropolitan Airport, Stockton, California; Honolulu International Airport, Honolulu, Hawaii; Seattle-Tacoma International Airport, Seattle, Washington; Standiford Field, Louisville, Kentucky; Nashville Metropolitan Airport, Nashville, Tennessee; and Chicago-O'Hare International Airport, Chicago, Illinois. These research programs were conducted not only for the purpose of evaluating the specific pavements, but for the purpose of augmenting the data which had been developed as a result of the author's research work at Harvard University

Sufficient data have been obtained from these research projects to refine the original Limiting Subgrade Deflection curves prepared by the author and to validate their accuracy.

D. Field Performance

Experience has shown that the Limiting Subgrade Deflection Criteria can be used without modification with all types and combinations of types of pavement. The rigidity as measured by Modulus of Elasticity of any section of pavement is automatically taken into consideration by the effect it has on subgrade deflection under a given load.

Over the past twenty years this Limiting Subgrade Deflection Criterion has been used by the author to evaluate and design numerous pavement sections. The performance of these sections has been observed, and the relationship between forecast life and the actually life of the pavement under load has been remarkable. For example, at Stockton Metropolitan Airport a design was prepared in 1956 in which a total flexible pavement section of 44 inches over a heavy clay subgrade soil was recommended to provide a 20-year life under forecast traffic of airline-type jet aircraft used for pilot training. Because of F.A.A. design criteria at that time, the design section was limited to 33 inches. Failure was predicted under the applied loads within six to eight years, and failure actually occurred in seven years.

At Sacramento Metro Airport the pavement design was prepared on the basis of the Limiting Subgrade Deflection criteria and was designed for a 20-year life under forecast traffic. Both flexible and rigid pavements were utilized. The pavements have been in operation now for ten years under traffic approximately 50 percent greater than that forecast, and there have been no indications of any failures in any pavements on this airport.

At Nashville Metropolitan Airport pavement evaluation studies were conducted in the fall and winter of 1972. Using the Limiting Subgrade Deflection Criteria a fatigue failure was predicted on the parallel taxiway to Runway 2L-20R within three years. This taxiway failed on schedule in the summer of 1975.

E. Methodology for Computing Deflections

1. Introduction

In the original development of this method of fatigue analysis, it was necessary to obtain the actual subgrade deflection values under load by full-scale testing in which the pavement sections were fully instrumented. Full-scale loads were applied by the operating aircraft or the use of heavy-duty rubber-tired equipment, and resultant deflection, stress and strain measurements were made throughout the pavement section. This initial approach was a time-consuming and costly procedure.

Efforts have been made to develop methods whereby the deflection and strain measurements could be obtained by simpler and less expensive procedures.

2. Test Program

At each test site location, a series of test borings was made and a series of test pits excavated in the pavement sections themselves. Tests conducted in these test pits consisted of standard classification tests, plate bearing tests and field California Bearing Ratio tests. Detailed laboratory testing was also conducted on all samples of materials. The test was accomplished on each layer of the pavement section, other than the asphaltic concrete or Portland cement concrete pavement itself, and on the surface of the subgrade soil and on each major change in subgrade materials within the upper three to four feet of the subgrade.

3. Development of Repetitive Plate Bearing Test

The plate bearing test conducted was a repetitive test in which the loading and unloading cycle was repeated three to five times until repeatable results for elastic deflection could be obtained with each subsequent loading.

Twenty years ago the author recognized that the standard plate bearing test, in which only one repetition of load was applied, gave erratic and unusable data. There was poor correlation between test results studies and pavement performance and between test results obtained from similar and adjacent test sites. Correlation could not even be obtained between tests conducted adjacent to each other in the same test pit. If a plate bearing test is repeated several times, then after a third or fourth repetition of loading, repeatable results are obtained with subsequent application of the load. Good correlation has been obtained between test data and pavement performance under load.

In Plate No. 2 a typical set of plate bearing test data is presented, which clearly shows the discrepancy between test results from the first repetition of loading and subsequent repetitions. It is apparent that many variables - such as seating of the plate, disturbance of the soil immediately below the plate, and compaction of the soil - cause the test data under the first repetition of loading to be distorted. The actual aircraft loadings are applied in a repetitive manner, and the data obtained from a repetitive plate bearing test more accurately represents the performance of the section under typical loading. Studies conducted have shown that the relationship between Modulus of Subgrade Reaction (K), as determined from the fourth repetition of loading, and that determined from the first repetition of loading ranges from 0.85 to 1 to 6 to 1, whereas the K-value obtained from the sixth to fourth repetition of loading is approximately the same.

4. Modulus of Elasticity Determination (E Value)

The results of the load deflection data obtained from the plate bearing tests after stable conditions have been obtained at the end of the third to fifth repetition of loading have been utilized with the Chevron Computer Program for determining stresses, strains, and deflections in multi-layered systems, to determine the Modulus of Elasticity for the various pavement section layers.

Repetitive plate bearing tests are conducted on the surface of each layer of pavement section, on the top of the subgrade, and on the top of each major change in soil within the upper three to four feet subsoil. If borings show major changes in subsoil stratification within the upper 30 feet, then assumptions of Modulus of Elasticity (E) and Poisson's Ratio (u) are made for these lower layers; otherwise, a semi-infinite thickness of the subgrade or lowest subsoil tested in assumed. Using the deflection data obtained from the repetitive plate bearing tests and the thickness of each layer as determined from the test pit and test boring program, Modulus of Elasticity (E) values can be computed using the Chevron Computer Program technique for each layer of soil and pavement section, starting with the bottom layer and progressing upward. For these analyses, assumed values of Poisson's Ratio (u) must be made. Research has shown that the computer program is not sensitive to moderate variations in Poisson's Ratio and that, if reasonable estimates are made for values of Poisson's Ratio for each layer tested, the error in computed value of Modulus of Elasticity (E) is not significant.

By this procedure, the Modulus of Elasticity (E), Poisson's Ratio, and thickness of each layer of the pavement section and underlying soils can be determined. The Modulus of Elasticity and Poisson's Ratio of materials which are to be constructed within the pavement section, or of overlay materials - cemented, stabilized, or unstabilized - can be determined. The Modulus of Elasticity of asphaltic concrete pavement materials is temperature dependent, and the relationship between temperature and Modulus of Elasticity of these materials has been determined by the Asphalt Institute and is present in Plate No. 3.

5. Field Performance

Once the value of Modulus of Elasticity, Poisson's Ratio, and thickness of each layer within the pavement section and beneath it has been determined, then the computer program for layered systems can be utilized with any aircraft loading system, and stresses, strains and deflections computed at any depth or location within or below the pavement section. This was accomplished on all test sites, and it was found that the correlation between measured maximum deflection and maximum computed deflection under the wheels was extremely good. In all cases the measured deflections were consistently about 85 percent of the computed deflections. This relationship held for all pavement conditions, whether the pavement section was flexible or rigid, whether the base materials were untreated or treated.

The correlation between measured and computed deflection is not as good near the edge of a deflection basin, but these data are not utilized in the Limiting Subgrade Deflection criteria. The close relationship between measured and computer maximum deflections is shown in Plate No. 4.

With the excellent correlation obtained, it is not possible to compute the maximum deflections and strains of the surface of the subgrade under applied wheel loadings and thereby eliminate the requirement for measuring subgrade deflections and strains. These subgrade deflections can be utilized with the Limiting Subgrade Deflection Curves shown in Plate No. 1 to determine the life of any given pavement and of any proposed design, including new construction, reconstruction or overlays.

IV FATIGUE ANALYSIS TECHNIQUES

It has been demonstrated that by the use of repetitive plate bearing tests conducted on the surface of each layer of a pavement section, on the surface of the subgrade soil, and on the surface of major changes in the subsoil, the Modulus of Elasticity of each layer can be determined. Using these data, any pavement section, including new construction, reconstruction and overlays using treated or untreated bases can be analyzed and deflections and strains of the surface of the subgrade computed. The Limiting Subgrade Deflection criteria presented in this paper can be used to determine the number of coverages a pavement section can withstand before failure. Depending upon the type of aircraft being used and the portion of the airport (runway, taxiway, etc.) which is being used, coverages can be converted to operations of the aircraft.

A fatigue analysis is conducted by the following general procedures:

A. The existing facility is tested by means of exploratory test holes carried to a minimum depth of 30 feet, from which undisturbed soil samples are obtained. Laboratory testing on the undisturbed soil samples obtained consists of classification, consolidation, and strength tests.

B. Test pits are excavated at the location of each test section, and repetitive plate bearing tests conducted on the surface of each layer of the existing pavement, on the surface of the subgrade soil and on the surface of each major change in subsoil within the upper three to four feet of the subgrade. These data are utilized with the computer program to compute values of Modulus of Elasticity (E) for each layer of the pavement section and for the subgrade and subsoil conditions. Values of Poisson's Ratio are assumed for each layer.

C. The traffic and forecast traffic over the period under consideration is determined.

D. For each aircraft and aircraft loading anticipated to use the facility, a computer analysis is conducted to determine maximum subgrade deflection and strain under load. The deflections are computed for the existing sections and for each condition of overlay or reconstruction to be considered in the analysis. The computed deflections are multiplied by a factor of 0.85 to convert the computed deflections to equivalent measured deflections.

E. Using the computed equivalent deflections for each aircraft and aircraft loading, the Limiting Subgrade Deflection criterion presented in Plate No. 1 is utilized to determine the number of coverages of each aircraft and aircraft loading that can be tolerated before failure of each pavement section.

F. The allowable coverages as determined from the Limiting Subgrade Deflection criteria are next converted to allowable operations for any pavement section for each aircraft.

G. Knowing the number of operations which are forecast and the allowable operations for each aircraft on a given pavement section, the percentage use of that pavement section over a one-year period can be computed for each aircraft and aircraft loading. These percentages can be added for all aircraft and aircraft loading to provide the total percentage use in one year of a given airport pavement under a forecast mix of aircraft and loading.

H. Knowing the percentage use each year, it is a simple matter to compute the life of the pavement based on 100 percent use of the section.

The analysis can be refined as much as desired. The weight of a given-type aircraft can be averaged, or the weights of each of the aircraft using the facility can be used. An average value of Modulus of Elasticity of bituminous pavement for a year or a segment of a year based on average pavement temperature can be used, or the analysis can be broken down into segments of the year or even segments of the day. It is normally not necessary to refine the analysis too much since the percentage use of a pavement section for the average loadings is approximately the same as the average percentage use of that determined from the high loading and the low loading. The same relationship holds true with temperature variations in flexible pavements.

An example of a typical analysis is shown in Plate No. 5, in which an existing pavement is analyzed, and the same pavement is analyzed with a 14-inch asphaltic concrete pavement overlay and then evaluated with a 14-inch Portland cement concrete overlay.

V CONCLUSIONS

The Fatigue Analysis Method developed by the author is a rational analysis of a pavement section in which the soil parameters used in the analysis are the Modulus of Elasticity (E) and the Poisson's Ratio (u) of each layer of the pavement section and of the underlying soils.

By use of this analysis technique, any pavement section can be evaluated, not only on the basis of whether it is strong or weak, adequate or inadequate, but also on the basis of how long it can be expected to perform satisfactorily under given loading conditions. The loading conditions can be varied. The effect on pavement life can be determined for any overlay condition or any type of reconstruction. Subbase course materials, base course materials, treated or untreated bases and subbases, cemented or lime-stabilized subbases and bases, rigid or flexible pavements can all be analyzed with the same criteria. The analysis can be conducted using various types of overlays or reconstructions, and a meaningful economic evaluation can be made in which not only initial cost can be considered, but maintenance costs and operational costs can also be taken into account.

VI REQUIREMENT FOR FURTHER RESEARCH

The Fatigue Analysis Method requires data obtained from repetitive plate bearing tests conducted throughout the pavement section. This is time-consuming and relatively expensive and requires considerable disruption of operations on the test pavement. Additional research is necessary to develop non-destructive test methods whereby Modulus of Elasticity values for each layer of the pavement section and of the underlying subgrade and subsoils can be determined from tests conducted on the pavement surface. The heavy-duty dynamic testing equipment developed by the U. S. Army Corps of Engineers Waterways Experiment Station has been utilized at test locations at Nashville Metropolitan Airport, Nashville, Tennessee, and at Chicago-O'Hare International Airport, where repetitive plate bearing tests have also been conducted. Research has been conducted utilizing this data, and it appears that some correlation can be developed between the results of the dynamic testing and plate bearing test results. Much more analysis of the existing data and testing and research are required before the repetitive plate bearing tests can be eliminated and non-destructive testing procedures substituted.

The Fatigue Analysis Methods presented in this paper can be used as a basis for ultimate development of a non-destructive test and evaluation procedure whereby a rational method of analysis can be utilized. The soil parameters of each layer of pavement section and underlying soils provide the basis for this analysis, not the soil parameters of the composite section. Non-destructive test procedures must be developed which will provide a method of determining the Modulus of Elasticity of each layer of the pavement section and of the subgrade soils.

November 10, 1975

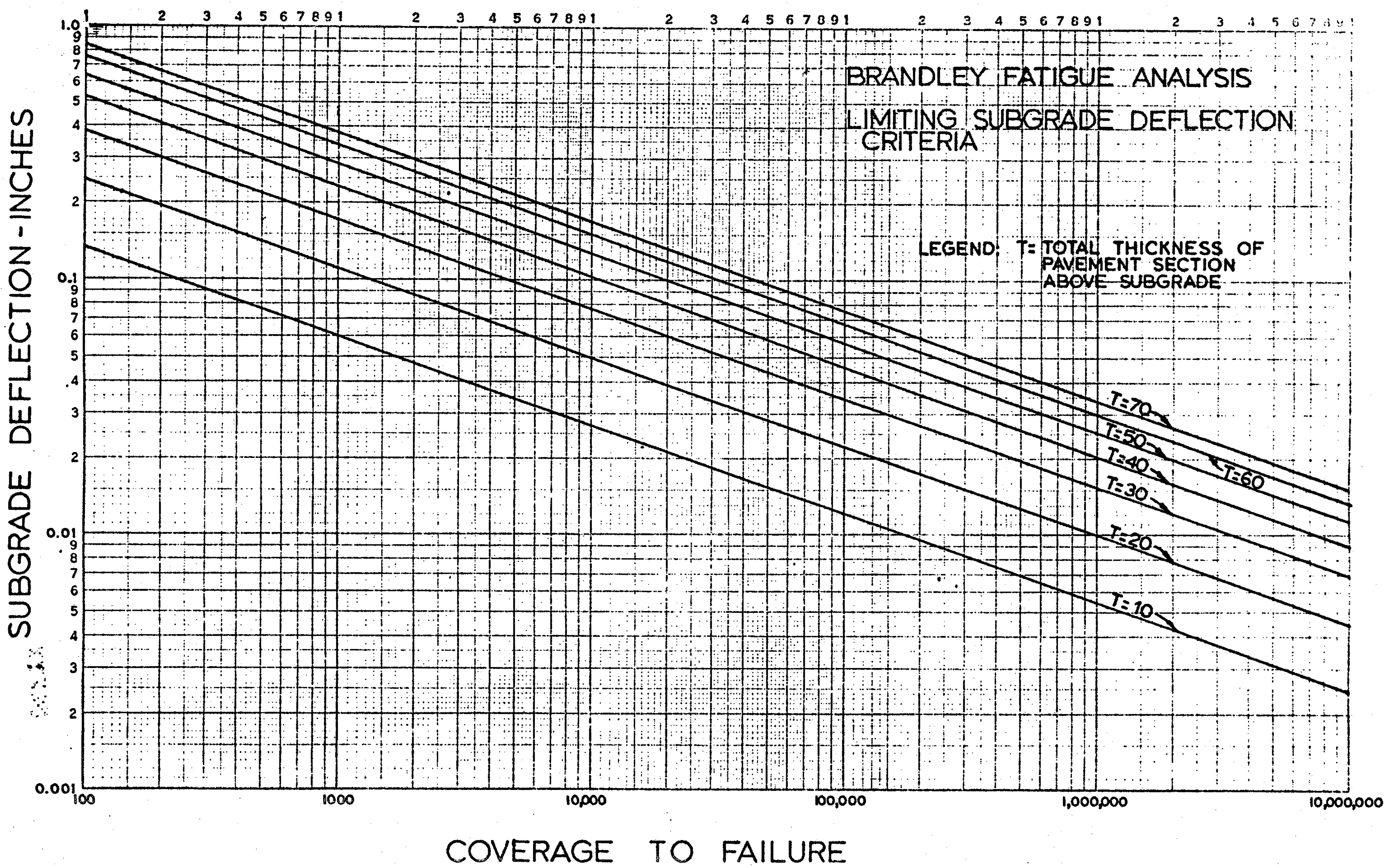
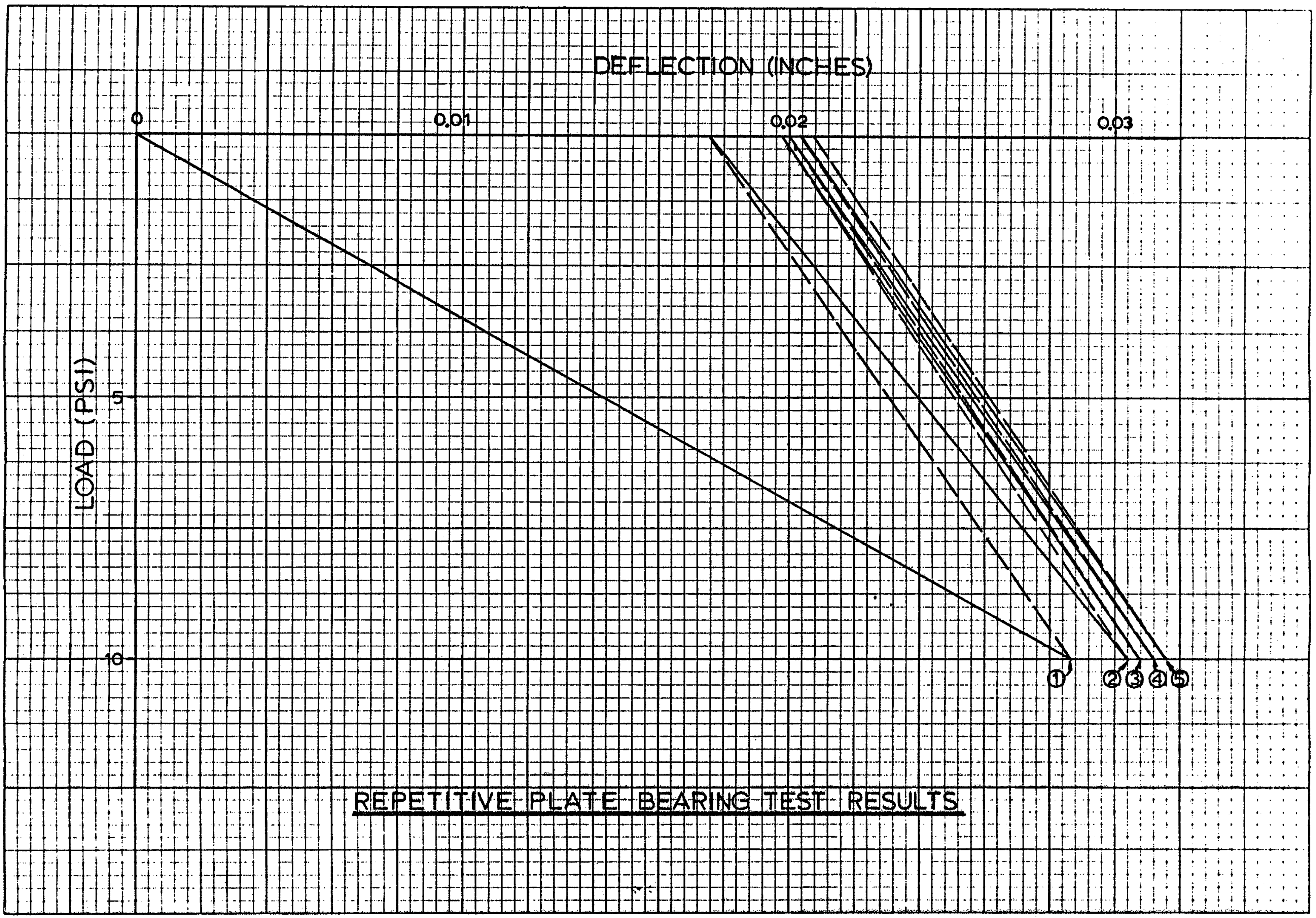

BRANDLEY FATIGUE ANALYSIS
LIMITING SUBGRADE DEFLECTION CRITERIA
LEGEND: T= TOTAL THICKNESS OF PAVEMENT SECTION ABOVE SUBGRADE
T=70
T=60
T=50
T=40
T=30
T=20
T=10
SUBGRADE DEFLECTION - INCHES
COVERAGE TO FAILURE
1.0
0.1
0.01
0.001
100
1000
10,000
100,000
1,000,000
10,000,000

PLATE 1



REPETITIVE PLATE BEARING TEST RESULTS

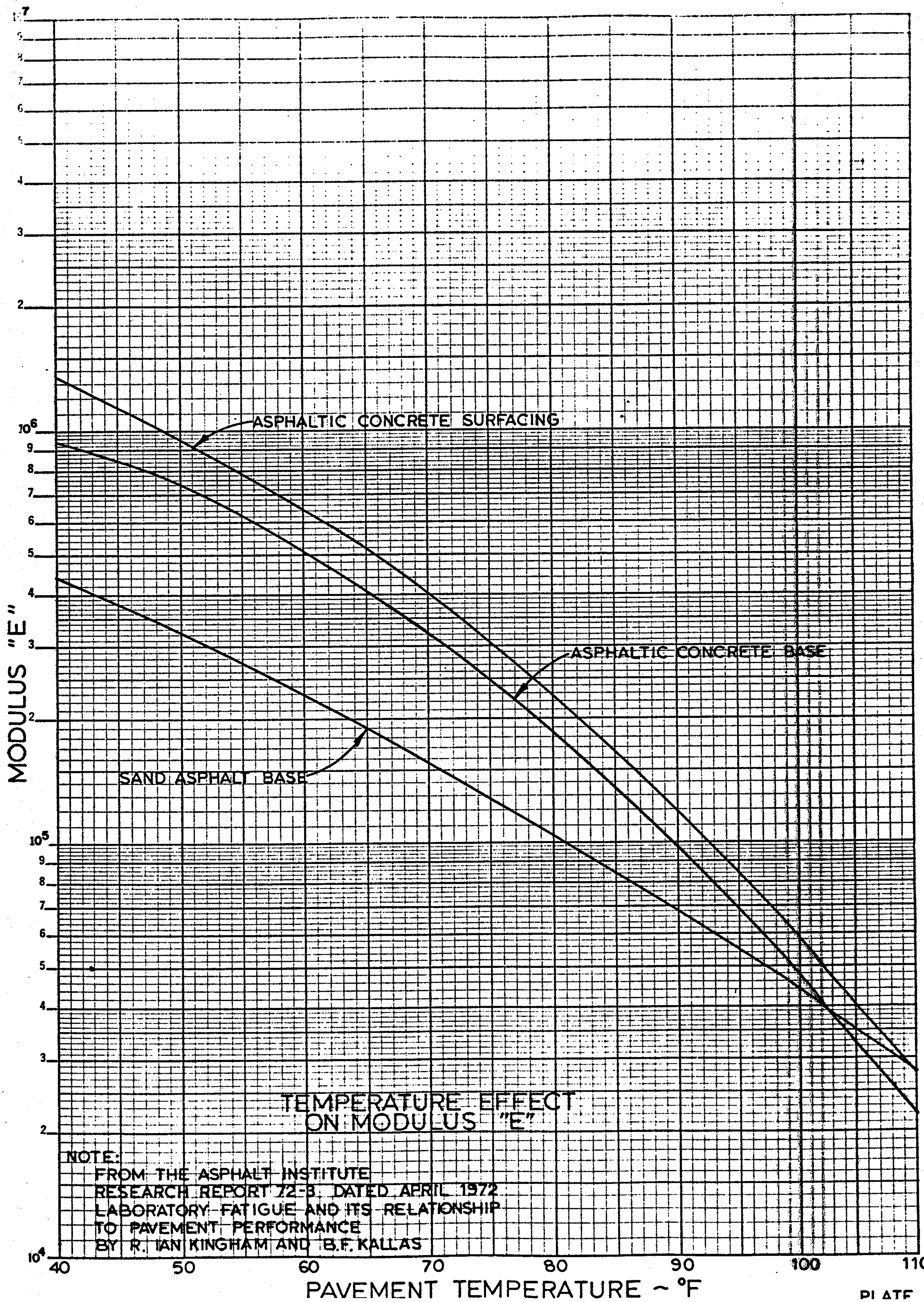

MODULUS "E"
10^7
9
8
7
6
5
4
3
2
10^6
10^5
10^4
ASPHALTIC CONCRETE SURFACING
ASPHALTIC CONCRETE BASE
SAND ASPHALT BASE
TEMPERATURE EFFECT
ON MODULUS "E"
NOTE:
FROM THE ASPHALT INSTITUTE
RESEARCH REPORT 72-3 DATED APRIL 1972
LABORATORY FATIGUE AND ITS RELATIONSHIP
TO PAVEMENT PERFORMANCE
BY R. IAN KINGHAM AND B.F. KALLAS
40
50
60
70
80
90
100
110
PAVEMENT TEMPERATURE ~ °F

PLATE 3

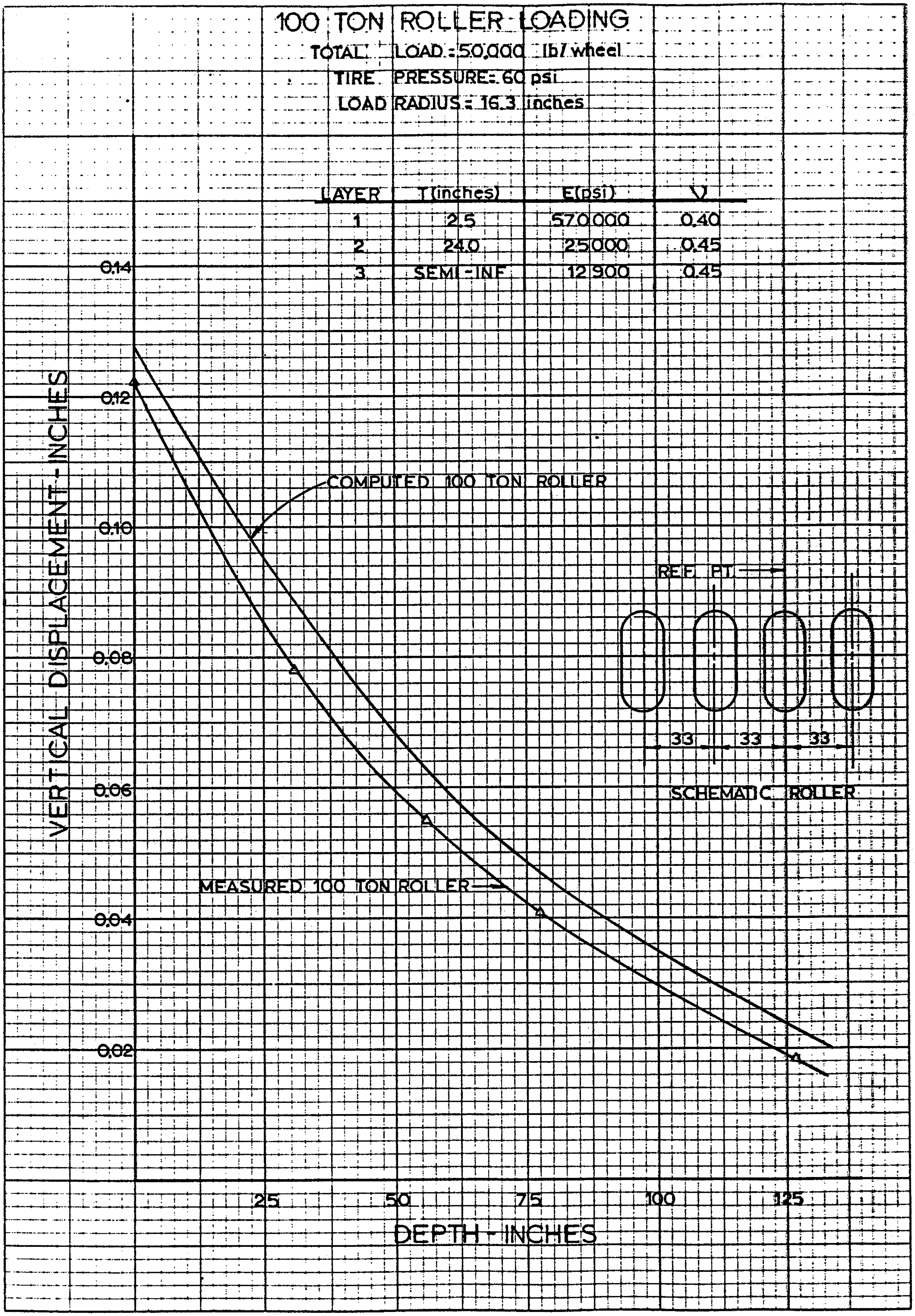

100 TON ROLLER LOADING
TOTAL LOAD = 50,000 lb/wheel
TIRE PRESSURE = 60 psi
LOAD RADIUS = 16.3 inches
LAYER T(inches) E(psi) ν
1 2.5 570,000 0.40
2 24.0 25,000 0.45
3 SEMI-INF 12,900 0.45
0.14
0.12
0.10
0.08
0.06
0.04
0.02
COMPUTED 100 TON ROLLER
MEASURED 100 TON ROLLER
REF. PT.
33 33 33
SCHEMATIC ROLLER
VERTICAL DISPLACEMENT - INCHES
25
50
75
100
125
DEPTH - INCHES

PLATE 4

PLATE NO. 5

TYPICAL FATIGUE ANALYSIS CALCULATIONS

A. TEST DATA

Material	*Stabilized Deflection Under PBT (Inches)	**Poisson's Ratio	Thickness of Layer (Inches)	Modulus of Elasticity (E) (psi)
Ashpaltic Concrete Pavement (AC)	-	0.45	8	650,000***
Portland Cement Concrete (PCC)	-	0.35	7	3,000,000
Aggregate Base	.033	0.35	10	69.300
Silty Clay Subgrade	.060	0.45	Semi-Infinite	4,000
Asphaltic Concrete Overlay	-	0.45	Variable	650,000***
Portland Cement Concrete Overlay	-	0.35	Variable	3,000,000

*Stabilized deflection under plate bearing test - 30-inch diameter plate, 10 psi loading.

**Assumed values based on character of materials.

***Pavement temperature - 60` F.

PLATE NO. 5 (Continued)

TYPICAL FATIGUE ANALYSIS CALCULATIONS

B. PAVEMENT PERFORMANCE CALCULATIONS

Pavement Section				Subgrade Deflection		***Allowable Coverings to Failure	****Allowable Operations to Failure
Type	Thickness (Inches)	Aircraft Type	Aircraft (lb.)	*Computed (Inches)	**Adjusted (Inches)		
Existing	25	DC8-55	303.000	0.202	0.172	520	3,120
		B727-200	160,000	0.114	0.097	2,700	27,000
Existing + 18" AC	47	DC8-55	303,000	0.128	0.109	10,100	60,600
		B727-200	160,000	0.076	0.064	45,000	450,000
Existing + 14" PCC	39	DC8-55	303,000	0.118	0.100	10,000	60,000
		B727-200	160,000	0.070	0.060	43,000	430.000

*Actual computed values of maximum deflection at surface of subgrade.

**Actual computed values of subgrade deflection x 0.85.

***From Limiting Subgrade Deflection criterion.

****Assuming taxiway section: B727-200 - 1 coverage = 10 operations.
DC8-55 - 1 coverage = 6 operations.

PLATE NO. 5 (Continued)

TYPICAL FATIGUE ANALYSIS CALCULATIONS

C. FATIGUE ANALYSIS

Overlay	Aircraft	Gross Weight (lbs.)	Allowable Operations to Failure	Annual Operations	% Use	Pavement Life (Years)
None	DC8-55	303,000	3,120	1,500	48.1	
	B727-200	160,000	27,000	15,000	55.6	
				Total	103.7	0.96
18" AC	DC8-55	303,000	60,600	1,500	2.48	
	B727-200	160,000	450,000	15,000	3.33	
				Total	5.81	17.2
12" PCC	DC8-55	303,000	60,000	1,500	2.50	
	B727-200	160,000	430,000	15,000	3.49	
				Total	5.99	16.7

ENGINEER'S ESTIMATES

Table Index

Table No. D1	Engineer's Estimate - Trial No. 2 - Class A & B Aircraft
Table No. D2	Engineer's Estimate - Trial No. 2 - Class C & D Aircraft
Table No. D3	Engineer's Estimate - Trial No. 2A - Class A & B Aircraft
Table No. D4	Engineer's Estimate - Trial No. 2A - Class C & D Aircraft
Table No. D5	Engineer's Estimate - Trial No. 3 - Class A & B Aircraft
Table No. D6	Engineer's Estimate - Trial No. 3 - Class C & D Aircraft
Table No. D7	Engineer's Estimate - Runway 12-30 Parallel Taxiway, Three Cross Taxiways, Clear Zone Runway 12 on Public Property
Table No. D8	Engineer's Estimate - Runway 12-30 Parallel Taxiway, Three Cross Taxiways, Clear Zone for Runway 12 Extend North Across Oro Dam Boulevard
Table No. D9	Summary of Development Costs - Trial No. 2
Table No. D10	Summary of Development Costs - Trial No. 2A
Table No. D11	Summary of Development Costs - Trial No. 3
Table No. D12	Engineer's Estimate - Aircraft Parking Apron & Lead In Taxiway, 75 Tie Down Spaces
Table No. D13	Engineer's Estimate - Tee Hangar Development Area
Table No. D14	Engineer's Estimate - Access Roads and Utilities

ENGINEER'S ESTIMATE

Engineer's estimates have been prepared for various options of Runway 1-19 development.

Trial No. 2 was prepared for the following assumptions:

- Runway 1-19 is 100' x 6,000'.
- Designed for both Aircraft Class A & B and Class C & D.
- The threshold for Runway 19 was displaced 2,190 feet so the clear zone would be entirely within public property.
- Grades on Runway 1-19 were set for a balanced cut and fill.

Trial No. 2A was prepared for the following assumptions:

- Runway 1-19 is 100' x 6,000'.
- Designed for both Aircraft Class A & B and Class C & D.
- The threshold for Runway 19 was displaced 940 feet so approach path clearance over Oro Dam Boulevard is 17 feet. Large portion of the clear zone is in private property north of Oro Dam Boulevard and it was assumed that land occupied by the clear zone would be acquired.
- Threshold for Runway 12 was displaced such as to provide 17-foot clearance of approach path over Oro Dam Boulevard. Clear zone land north of Oro Dam Boulevard would be acquired.
- Grades on Runway 1-19 were set same as Trial No. 2, which produced an unbalanced cut and fill.

Trial No. 3 was prepared for the following assumptions:

- Runway 1-19 is 100' x 6,000'.
- Designed for both Aircraft Class A & B and Class C & D.
- The threshold for Runway 19 was displaced 940 feet so approach path clearance over Oro Dam Boulevard is 17 feet. Large portion of the clear zone is in private property north of Oro Dam Boulevard and it was assumed that land occupied by the clear zone would be acquired.

- Threshold for Runway 12 was displaced such as to provide 17-foot clearance of approach path over Oro Dam Boulevard. Clear zone land north of Oro Dam Boulevard would be acquired.

- Grades on Runway 1-19 were set to provide balanced cut and fill which established an undesireably steep runway gradiant.

The results of these Engineer's Estimates are included in Tables D1 through D14.

The runway gradiant for Trial No. 3 is undesireably steep and the clear zones for Runway 12 and Runway 19 are on private property located north of Oro Dam Boulevard. Cost estimates for acquisition of this land are uncertain and use of this plan increases the area of private land exposed to noise over that with the greater displacement of the threshold to Runway 19. It is therefore recommended that this option not be used.

All designs for Runway 1-19 should be based on Aircraft Class C & D to accommodate the Gulfstream II aircraft currently using the airport.

The estimated development costs for Trial No. 2 and Trial No. 2A are sufficiently close that the advantages of the Trial No. 2 configuration in noise exposure reduction and safety of operations strongly favor the adoption of the runway configuration used in Trial No. 2, which is the configuration shown on the Airport Layout Plan.

The Trial No. 2 configuration includes the following:

- Runway 1-19 is 100' x 6,000'.

- The threshold for Runway 19 was displaced 2,190 feet to hold the clear zone for this runway entirely within public property.

- Threshold to Runway 12 is displaced to hold clear zone for this runway entirely within public property.

- Runway 1-19 profile is set such as to produce a balanced cut and fill.

TABLE NO. D1

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

TRIAL NO. 2 - CLASS A & B AIRCRAFT
EXTEND RUNWAY 1-19 (100' X 2,190')
CONSTRUCT 50' PARALLEL TAXIWAY
RUNWAY SAFETY AREA (150')
PRIMARY SURFACE WIDTH 1,000'
BALANCED CUT AND FILL

ENGINEER'S ESTIMATE

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
1	Mobilization	L.S.	L.S.	L.S.	$30,000.00	0.0	$0.00	0.0	$0.00	L.S.	$30,000.00
2	Temporary Airfield Marking	L.S.	L.S.	L.S.	15,000.00	0.0	0.00	0.0	0.00	L.S.	15,000.00
3	Clearing and Grubbing	Acre	$1,000.00	88.0	88,000.00	12.0	12,000.00	0.0	0.00	100.0	100,000.00
4	Excavation	Cu. Yd.	4.00	694,300.0	2,777,200.00	27,300.0	109,200.00	0.0	0.00	721,600.0	2,886,400.00
5	Scarify and Recompact 6 inches of Subgrade - 10' Beyond Paved Areas Only	Sq. Yd.	1.00	53,500.0	53,500.00	56,200.0	56,200.00	14,275.0	14,275.00	123,975.0	123,975.00
6	Aggregate Subbase	Ton	11.00	17,650.0	194,150.00	16,400.0	180,400.00	3,925.0	43,175.00	37,975.0	417,725.00
7	Aggregate Base Course	Ton	13.00	21,550.0	280,150.00	20,050.0	260,650.00	4,275.0	55,575.00	45,875.0	596,375.00
8	Bituminous Surface Course	Ton	35.00	12,200.0	427,000.00	8,250.0	288,750.00	1,675.0	58,625.00	22,125.0	774,375.00
9	Bituminous Prime Coat	Ton	300.00	50.5	15,150.00	47.0	14,100.00	11.3	3,390.00	108.8	32,640.00
10	Bituminous Tack Coat	Ton	350.00	39.2	13,720.00	19.1	6,685.00	4.0	1,400.00	62.3	21,805.00
11	Security Fence	Ln. Ft.	11.00	5,000.0	55,000.00	0.0	0.00	0.0	0.00	5,000.0	55,000.00

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
12	Airfield Marking	Sq. Ft.	$1.25	48,300.0	$60,375.00	0.0	$0.00	0.0	$0.00	48,300.0	$60,375.00
13	18" RCP, Class IV	Ln. Ft.	33.00	0.0	0.00	130.0	4,290.00	260.0	8,580.00	390.0	12,870.00
14	24" RCP, Class IV	Ln. Ft.	40.00	0.0	0.00	0.0	0.00	130.0	5,200.00	130.0	5,200.00
15	42" RCP, Class IV	Ln. Ft.	100.00	1,780.0	178,000.00	200.0	20,000.00	0.0	0.00	1,980.0	198,000.00
16	18" RCP End Section	Each	400.00	0.0	0.00	2.0	800.00	4.0	1,600.00	6.0	2,400.00
17	24" RCP End Section	Each	650.00	0.0	0.00	0.0	0.00	2.0	1,300.00	2.0	1,300.00
18	42" RCP End Section	Each	1,200.00	4.0	4,800.00	1.0	1,200.00	0.0	0.00	5.0	6,000.00
19	Drop Inlets	Each	3,000.00	0.0	0.00	1.0	3,000.00	0.0	0.00	1.0	3,000.00
20	Electrical Pullboxes	Each	2,500.00	2.0	5,000.00	16.0	40,000.00	14.0	35,000.00	32.0	80,000.00
21	1/C, No. 8, 5 KV Cable	Ln. Ft.	0.80	40,600.0	32,480.00	24,700.0	19,760.00	7,540.0	6,032.00	72,840.0	58,272.00
22	2-way, 3-inch, Type I Duct	Ln. Ft.	16.00	140.0	2,240.00	760.0	12,160.00	560.0	8,960.00	1,460.0	23,360.00
23	2-way, 3-inch, Type II Duct	Ln. Ft.	10.00	1,010.0	10,100.00	0.0	0.00	0.0	0.00	1,010.0	10,100.00
24	1-way, 2-inch, Type I Duct	Ln. Ft.	4.00	13,400.0	53,600.00	13,700.0	54,800.00	4,970.0	19,880.00	32,070.0	128,280.00
25	Medium Intensity Runway Edge Lights	Each	550.00	76.0	41,800.00	0.0	0.00	0.0	0.00	76.0	41,800.00
26	Medium Intensity Taxiway Edge Lights	Each	525.00	10.0	5,250.00	140.0	73,500.00	98.0	51,450.00	248.0	130,200.00
27	PAPI	Unit	16,000.00	2.0	32,000.00	0.0	0.00	0.0	0.00	2.0	32,000.00
28	Taxiway Guidance Signs, 1-character	Each	1,500.00	0.0	0.00	0.0	0.00	21.0	31,500.00	21.0	31,500.00

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
29	Taxiway Guidance Signs, 2-character	Each	$1,800.00	0.0	$0.00	0.0	$0.00	5.0	$9,000.00	5.0	$9,000.00
30	Taxiway Guidance Signs, 4-character	Each	2,200.00	0.0	0.00	0.0	0.00	2.0	4,400.00	2.0	4,400.00
31	Taxiway Guidance Signs, 5-character	Each	2,500.00	0.0	0.00	2.0	5,000.00	3.0	7,500.00	5.0	12,500.00
32	Taxiway Guidance Signs, 6-character	Each	2,600.00	0.0	0.00	0.0	0.00	1.0	2,600.00	1.0	2,600.00
33	Supplemental Wind Cone	Each	4,000.00	1.0	4,000.00	0.0	0.00	0.0	0.00	1.0	4,000.00
34	New Lighting Regulators	Each	6,000.00	1.0	6,000.00	2.0	12,000.00	0.0	0.00	3.0	18,000.00
35	Vault Labor & Equipment	L.S.	L.S.	L.S.	10,000.00	0.0	0.00	0.0	0.00	L.S.	10,000.00
36	New Vault	L.S.	L.S.	L.S.	30,000.00	0.0	0.00	0.0	0.00	L.S.	30,000.00
	TOTALS				$4,424,515.00		$1,174,495.00		$369,442.00		$5,968,452.00

TABLE NO. D2

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

TRIAL NO. 2 - CLASS C & D AIRCRAFT
EXTEND RUNWAY 1-19 (100' X 2,190')
CONSTRUCT 50' PARALLEL TAXIWAY
RUNWAY SAFETY AREA (500')
PRIMARY SURFACE WIDTH 1,000'
BALANCED CUT AND FILL

ENGINEER'S ESTIMATE

Item			Unit	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
No.	Description	Unit	Price	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
1	Mobilization	L.S.	L.S.	L.S.	$30,000.00	0.0	$0.00	0.0	$0.00	L.S.	$30,000.00
2	Temporary Airfield Marking	L.S.	L.S.	L.S.	15,000.00	0.0	0.00	0.0	0.00	L.S.	15,000.00
3	Clearing and Grubbing	Acre	$1,000.00	96.0	96,000.00	12.0	12,000.00	0.0	0.00	108.0	108,000.00
4	Excavation	Cu. Yd.	4.00	850,000.0	3,400,000.00	27,300.0	109,200.00	0.0	0.00	877,300.0	3,509,200.00
5	Scarify and Recompact 6 inches of Subgrade - 10' Beyond Paved Areas Only	Sq. Yd.	1.00	53,500.0	53,500.00	56,200.0	56,200.00	14,275.0	14,275.00	123,975.0	123,975.00
6	Aggregate Subbase	Ton	11.00	17,650.0	194,150.00	16,400.0	180,400.00	3,925.0	43,175.00	37,975.0	417,725.00
7	Aggregate Base Course	Ton	13.00	21,550.0	280,150.00	20,050.0	260,650.00	4,275.0	55,575.00	45,875.0	596,375.00
8	Bituminous Surface Course	Ton	35.00	12,200.0	427,000.00	8,250.0	288,750.00	1,675.0	58,625.00	22,125.0	774,375.00
9	Bituminous Prime Coat	Ton	300.00	50.5	15,150.00	47.0	14,100.00	11.3	3,390.00	108.8	32,640.00
10	Bituminous Tack Coat	Ton	350.00	39.2	13,720.00	19.1	6,685.00	4.0	1,400.00	62.3	21,805.00
11	Security Fence	Ln. Ft.	11.00	5,000.0	55,000.00	0.0	0.00	0.0	0.00	5,000.0	55,000.00

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
12	Airfield Marking	Sq. Ft.	$1.25	48,300.0	$60,375.00	3,750.0	$4,687.50	2,700.0	$3,375.00	54,750.0	$68,437.50
13	18" RCP, Class IV	Ln. Ft.	33.00	0.0	0.00	130.0	4,290.00	260.0	8,580.00	390.0	12,870.00
14	24" RCP, Class IV	Ln. Ft.	40.00	0.0	0.00	0.0	0.00	130.0	5,200.00	130.0	5,200.00
15	42" RCP, Class IV	Ln. Ft.	100.00	1,780.0	178,000.00	200.0	20,000.00	0.0	0.00	1,980.0	198,000.00
16	18" RCP End Section	Each	400.00	0.0	0.00	2.0	800.00	4.0	1,600.00	6.0	2,400.00
17	24" RCP End Section	Each	650.00	0.0	0.00	0.0	0.00	2.0	1,300.00	2.0	1,300.00
18	42" RCP End Section	Each	1,200.00	4.0	4,800.00	1.0	1,200.00	0.0	0.00	5.0	6,000.00
19	Drop Inlets	Each	3,000.00	0.0	0.00	1.0	3,000.00	0.0	0.00	1.0	3,000.00
20	Electrical Pullboxes	Each	2,500.00	2.0	5,000.00	16.0	40,000.00	14.0	35,000.00	32.0	80,000.00
21	1/C, No. 8, 5 KV Cable	Ln. Ft.	0.80	40,600.0	32,480.00	24,700.0	19,760.00	7,540.0	6,032.00	72,840.0	58,272.00
22	2-way, 3-inch, Type I Duct	Ln. Ft.	16.00	140.0	2,240.00	760.0	12,160.00	560.0	8,960.00	1,460.0	23,360.00
23	2-way, 3-inch, Type II Duct	Ln. Ft.	10.00	1,010.0	10,100.00	0.0	0.00	0.0	0.00	1,010.0	10,100.00
24	1-way, 2-inch, Type I Duct	Ln. Ft.	4.00	13,400.0	53,600.00	13,700.0	54,800.00	4,970.0	19,880.00	32,070.0	128,280.00
25	Medium Intensity Runway Edge Lights	Each	550.00	76.0	41,800.00	0.0	0.00	0.0	0.00	76.0	41,800.00
26	Medium Intensity Taxiway Edge Lights	Each	525.00	10.0	5,250.00	140.0	73,500.00	98.0	51,450.00	248.0	130,200.00
27	PAPI	Unit	16,000.00	2.0	32,000.00	0.0	0.00	0.0	0.00	2.0	32,000.00
28	Taxiway Guidance Signs, 1-character	Each	1,500.00	0.0	0.00	0.0	0.00	21.0	31,500.00	21.0	31,500.00

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
29	Taxiway Guidance Signs, 2-character	Each	$1,800.00	0.0	$0.00	0.0	$0.00	5.0	$9,000.00	5.0	$9,000.00
30	Taxiway Guidance Signs, 4-character	Each	2,200.00	0.0	0.00	0.0	0.00	2.0	4,400.00	2.0	4,400.00
31	Taxiway Guidance Signs, 5-character	Each	2,500.00	0.0	0.00	2.0	5,000.00	3.0	7,500.00	5.0	12,500.00
32	Taxiway Guidance Signs, 6-character	Each	2,600.00	0.0	0.00	0.0	0.00	1.0	2,600.00	1.0	2,600.00
33	Supplemental Wind Cone	Each	4,000.00	1.0	4,000.00	0.0	0.00	0.0	0.00	1.0	4,000.00
34	New Lighting Regulators	Each	6,000.00	1.0	6,000.00	2.0	12,000.00	0.0	0.00	3.0	18,000.00
35	Vault Labor & Equipment	L.S.	L.S.	L.S.	10,000.00	0.0	0.00	0.0	0.00	L.S.	10,000.00
36	New Vault	L.S.	L.S.	L.S.	30,000.00	0.0	0.00	0.0	0.00	L.S.	30,000.00
	TOTALS				$5,055,315.00		$1,179,182.50		$372,817.00		$6,607,314.50

TABLE NO. D3

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

TRIAL NO. 2A - CLASS A & B AIRCRAFT
EXTEND RUNWAY 1-19 (100' X 940')
CONSTRUCT 50' PARALLEL TAXIWAY
RUNWAY SAFETY AREA (150')
PRIMARY SURFACE WIDTH 1,000'
PROFILE SAME AS TRIAL #2
CUT & FILL NOT BALANCED

ENGINEER'S ESTIMATE

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
1	Mobilization	L.S.	L.S.	L.S.	$30,000.00	0.0	$0.00	0.0	$0.00	L.S.	$30,000.00
2	Temporary Airfield Marking	L.S.	L.S.	L.S.	15,000.00	0.0	0.00	0.0	0.00	L.S.	15,000.00
3	Clearing and Grubbing	Acre	$1,000.00	62.0	62,000.00	12.0	12,000.00	0.0	0.00	74.0	74,000.00
4	Excavation	Cu. Yd.	4.00	669,300.0	2,677,200.00	27,300.0	109,200.00	0.0	0.00	696,600.0	2,786,400.00
5	Scarify and Recompact 6 inches of Subgrade - 10' Beyond Paved Areas Only	Sq. Yd.	1.00	34,300.0	34,300.00	46,600.0	46,600.00	12,250.0	12,250.00	93,150.0	93,150.00
6	Aggregate Subbase	Ton	11.00	11,275.0	124,025.00	13,600.0	149,600.00	3,450.0	37,950.00	28,325.0	311,575.00
7	Aggregate Base Course	Ton	13.00	13,775.0	179,075.00	16,600.0	215,800.00	4,250.0	55,250.00	34,625.0	450,125.00
8	Bituminous Surface Course	Ton	35.00	13,600.0	476,000.00	7,000.0	245,000.00	1,450.0	50,750.00	22,050.0	771,750.00
9	Bituminous Prime Coat	Ton	300.00	32.3	9,690.00	39.0	11,700.00	10.0	3,000.00	81.3	24,390.00
10	Bituminous Tack Coat	Ton	350.00	34.0	11,900.00	16.2	5,670.00	3.4	1,190.00	53.6	18,760.00
11	Security Fence	Ln. Ft.	11.00	2,200.0	24,200.00	0.0	0.00	0.0	0.00	2,200.0	24,200.00

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
12	Airfield Marking	Sq. Ft.	$1.25	48,300.0	$60,375.00	3,125.0	$3,906.25	2,050.0	$2,562.50	53,475.0	$66,843.75
13	18" RCP, Class IV	Ln. Ft.	33.00	0.0	0.00	130.0	4,290.00	260.0	8,580.00	390.0	12,870.00
14	24" RCP, Class IV	Ln. Ft.	40.00	0.0	0.00	0.0	0.00	130.0	5,200.00	130.0	5,200.00
15	42" RCP, Class IV	Ln. Ft.	100.00	0.0	0.00	200.0	20,000.00	0.0	0.00	200.0	20,000.00
16	18" RCP End Section	Each	400.00	0.0	0.00	2.0	800.00	4.0	1,600.00	6.0	2,400.00
17	24" RCP End Section	Each	650.00	0.0	0.00	0.0	0.00	2.0	1,300.00	2.0	1,300.00
18	42" RCP End Section	Each	1,200.00	0.0	0.00	1.0	1,200.00	0.0	0.00	1.0	1,200.00
19	Drop Inlets	Each	3,000.00	0.0	0.00	1.0	3,000.00	0.0	0.00	1.0	3,000.00
20	Electrical Pullboxes	Each	2,500.00	4.0	10,000.00	16.0	40,000.00	13.0	32,500.00	33.0	82,500.00
21	1/C, No. 8, 5 KV Cable	Ln. Ft.	0.80	35,300.0	28,240.00	22,200.0	17,760.00	4,840.0	3,872.00	62,340.0	49,872.00
22	2-way, 3-inch, Type I Duct	Ln. Ft.	16.00	320.0	5,120.00	760.0	12,160.00	320.0	5,120.00	1,400.0	22,400.00
23	2-way, 3-inch, Type II Duct	Ln. Ft.	10.00	1,010.0	10,100.00	0.0	0.00	0.0	0.00	1,010.0	10,100.00
24	1-way, 2-inch, Type I Duct	Ln. Ft.	4.00	12,250.0	49,000.00	11,200.0	44,800.00	3,200.0	12,800.00	26,650.0	106,600.00
25	Medium Intensity Runway Edge Lights	Each	550.00	76.0	41,800.00	0.0	0.00	0.0	0.00	76.0	41,800.00
26	Medium Intensity Taxiway Edge Lights	Each	525.00	0.0	0.00	125.0	65,625.00	58.0	30,450.00	183.0	96,075.00
27	PAPI	Unit	16,000.00	2.0	32,000.00	0.0	0.00	0.0	0.00	2.0	32,000.00
28	Taxiway Guidance Signs, 1-character	Each	1,500.00	0.0	0.00	0.0	0.00	15.0	22,500.00	15.0	22,500.00

Item			Unit	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
No.	Description	Unit	Price	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
29	Taxiway Guidance Signs, 2-character	Each	$1,800.00	0.0	$0.00	0.0	$0.00	5.0	$9,000.00	5.0	$9,000.00
30	Taxiway Guidance Signs, 4-character	Each	2,200.00	0.0	0.00	0.0	0.00	2.0	4,400.00	2.0	4,400.00
31	Taxiway Guidance Signs, 5-character	Each	2,500.00	0.0	0.00	2.0	5,000.00	5.0	12,500.00	7.0	17,500.00
32	Taxiway Guidance Signs, 6-character	Each	2,600.00	0.0	0.00	0.0	0.00	1.0	2,600.00	1.0	2,600.00
33	Supplemental Wind Cone	Each	4,000.00	1.0	4,000.00	0.0	0.00	0.0	0.00	1.0	4,000.00
34	New Lighting Regulators	Each	6,000.00	1.0	6,000.00	2.0	12,000.00	0.0	0.00	3.0	18,000.00
35	Vault Labor & Equipment	L.S.	L.S.	L.S.	10,000.00	0.0	0.00	0.0	0.00	L.S.	10,000.00
36	New Vault	L.S.	L.S.	L.S.	30,000.00	0.0	0.00	0.0	0.00	L.S.	30,000.00
	TOTALS				$3,930,025.00		$1,026,111.25		$315,374.50		$5,271,510.75

Oroville Municipal Airport
Trial No. 2A - Class C & D Aircraft

Table No. D4
Page 2

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
12	Airfield Marking	Sq. Ft.	$1.25	48,300.0	$60,375.00	3,125.0	$3,906.25	2,050.0	$2,562.50	53,475.0	$66,843.75
13	18" RCP, Class IV	Ln. Ft.	33.00	0.0	0.00	130.0	4,290.00	260.0	8,580.00	390.0	12,870.00
14	24" RCP, Class IV	Ln. Ft.	40.00	0.0	0.00	0.0	0.00	130.0	5,200.00	130.0	5,200.00
15	42" RCP, Class IV	Ln. Ft.	100.00	0.0	0.00	200.0	20,000.00	0.0	0.00	200.0	20,000.00
16	18" RCP End Section	Each	400.00	0.0	0.00	2.0	800.00	4.0	1,600.00	6.0	2,400.00
17	24" RCP End Section	Each	650.00	0.0	0.00	0.0	0.00	2.0	1,300.00	2.0	1,300.00
18	42" RCP End Section	Each	1,200.00	0.0	0.00	1.0	1,200.00	0.0	0.00	1.0	1,200.00
19	Drop Inlets	Each	3,000.00	0.0	0.00	1.0	3,000.00	0.0	0.00	1.0	3,000.00
20	Electrical Pullboxes	Each	2,500.00	4.0	10,000.00	16.0	40,000.00	13.0	32,500.00	33.0	82,500.00
21	1/C, No. 8, 5 KV Cable	Ln. Ft.	0.80	35,300.0	28,240.00	22,200.0	17,760.00	4,840.0	3,872.00	62,340.0	49,872.00
22	2-way, 3-inch, Type I Duct	Ln. Ft.	16.00	320.0	5,120.00	760.0	12,160.00	320.0	5,120.00	1,400.0	22,400.00
23	2-way, 3-inch, Type II Duct	Ln. Ft.	10.00	1,010.0	10,100.00	0.0	0.00	0.0	0.00	1,010.0	10,100.00
24	1-way, 2-inch, Type I Duct	Ln. Ft.	4.00	12,250.0	49,000.00	11,200.0	44,800.00	3,200.0	12,800.00	26,650.0	106,600.00
25	Medium Intensity Runway Edge Lights	Each	550.00	76.0	41,800.00	0.0	0.00	0.0	0.00	76.0	41,800.00
26	Medium Intensity Taxiway Edge Lights	Each	525.00	0.0	0.00	125.0	65,625.00	58.0	30,450.00	183.0	96,075.00
27	PAPI	Unit	16,000.00	2.0	32,000.00	0.0	0.00	0.0	0.00	2.0	32,000.00
28	Taxiway Guidance Signs, 1-character	Each	1,500.00	0.0	0.00	0.0	0.00	15.0	22,500.00	15.0	22,500.00

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
29	Taxiway Guidance Signs, 2-character	Each	$1,800.00	0.0	$0.00	0.0	$0.00	5.0	$9,000.00	5.0	$9,000.00
30	Taxiway Guidance Signs, 4-character	Each	2,200.00	0.0	0.00	0.0	0.00	2.0	4,400.00	2.0	4,400.00
31	Taxiway Guidance Signs, 5-character	Each	2,500.00	0.0	0.00	2.0	5,000.00	5.0	12,500.00	7.0	17,500.00
32	Taxiway Guidance Signs, 6-character	Each	2,600.00	0.0	0.00	0.0	0.00	1.0	2,600.00	1.0	2,600.00
33	Supplemental Wind Cone	Each	4,000.00	1.0	4,000.00	0.0	0.00	0.0	0.00	1.0	4,000.00
34	New Lighting Regulators	Each	6,000.00	1.0	6,000.00	2.0	12,000.00	0.0	0.00	3.0	18,000.00
35	Vault Labor & Equipment	L.S.	L.S.	L.S.	10,000.00	0.0	0.00	0.0	0.00	L.S.	10,000.00
36	New Vault	L.S.	L.S.	L.S.	30,000.00	0.0	0.00	0.0	0.00	L.S.	30,000.00
	TOTALS				$3,936,025.00		$1,026,111.25		$315,374.50		$5,277,510.75

TABLE NO. D5

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

TRIAL NO. 3 - CLASS A & B AIRCRAFT
EXTEND RUNWAY 1-19 (100′ X 940′)
CONSTRUCT 50′ PARALLEL TAXIWAY
RUNWAY SAFETY AREA (150′)
PRIMARY SURFACE WIDTH 1,000′
STEEPER PROFILE GRADE THAN TRIAL 2A
BALANCED CUT AND FILL

ENGINEER′S ESTIMATE

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
1	Mobilization	L.S.	L.S.	L.S.	$30,000.00	0.0	$0.00	0.0	$0.00	L.S.	$30,000.00
2	Temporary Airfield Marking	L.S.	L.S.	L.S.	15,000.00	0.0	0.00	0.0	0.00	L.S.	15,000.00
3	Clearing and Grubbing	Acre	$1,000.00	56.0	56,000.00	12.0	12,000.00	0.0	0.00	68.0	68,000.00
4	Excavation	Cu. Yd.	4.00	440,100.0	1,760,400.00	27,300.0	109,200.00	0.0	0.00	467,400.0	1,869,600.00
5	Scarify and Recompact 6 inches of Subgrade - 10′ Beyond Paved Areas Only	Sq. Yd.	1.00	34,300.0	34,300.00	46,600.0	46,600.00	12,250.0	12,250.00	93,150.0	93,150.00
6	Aggregate Subbase	Ton	11.00	11,275.0	124,025.00	13,600.0	149,600.00	3,450.0	37,950.00	28,325.0	311,575.00
7	Aggregate Base Course	Ton	13.00	13,775.0	179,075.00	16,600.0	215,800.00	4,250.0	55,250.00	34,625.0	450,125.00
8	Bituminous Surface Course	Ton	35.00	13,600.0	476,000.00	7,000.0	245,000.00	1,450.0	50,750.00	22,050.0	771,750.00
9	Bituminous Prime Coat	Ton	300.00	32.3	9,690.00	39.0	11,700.00	10.0	3,000.00	81.3	24,390.00
10	Bituminous Tack Coat	Ton	350.00	34.0	11,900.00	16.2	5,670.00	3.4	1,190.00	53.6	18,760.00
11	Security Fence	Ln. Ft.	11.00	2,200.0	24,200.00	0.0	0.00	0.0	0.00	2,200.0	24,200.00

Item			Unit	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
No.	Description	Unit	Price	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
12	Airfield Marking	Sq. Ft.	$1.25	48,300.0	$60,375.00	3,125.0	$3,906.25	2,050.0	$2,562.50	53,475.0	$66,843.75
13	18" RCP, Class IV	Ln. Ft.	33.00	0.0	0.00	130.0	4,290.00	260.0	8,580.00	390.0	12,870.00
14	24" RCP, Class IV	Ln. Ft.	40.00	0.0	0.00	0.0	0.00	130.0	5,200.00	130.0	5,200.00
15	42" RCP, Class IV	Ln. Ft.	100.00	0.0	0.00	200.0	20,000.00	0.0	0.00	200.0	20,000.00
16	18" RCP End Section	Each	400.00	0.0	0.00	2.0	800.00	4.0	1,600.00	6.0	2,400.00
17	24" RCP End Section	Each	650.00	0.0	0.00	0.0	0.00	2.0	1,300.00	2.0	1,300.00
18	42" RCP End Section	Each	1,200.00	0.0	0.00	1.0	1,200.00	0.0	0.00	1.0	1,200.00
19	Drop Inlets	Each	3,000.00	0.0	0.00	1.0	3,000.00	0.0	0.00	1.0	3,000.00
20	Electrical Pullboxes	Each	2,500.00	4.0	10,000.00	16.0	40,000.00	13.0	32,500.00	33.0	82,500.00
21	1/C, No. 8, 5 KV Cable	Ln. Ft.	0.80	35,300.0	28,240.00	22,200.0	17,760.00	4,840.0	3,872.00	62,340.0	49,872.00
22	2-way, 3-inch, Type I Duct	Ln. Ft.	16.00	320.0	5,120.00	760.0	12,160.00	320.0	5,120.00	1,400.0	22,400.00
23	2-way, 3-inch, Type II Duct	Ln. Ft.	10.00	1,010.0	10,100.00	0.0	0.00	0.0	0.00	1,010.0	10,100.00
24	1-way, 2-inch, Type I Duct	Ln. Ft.	4.00	12,250.0	49,000.00	11,200.0	44,800.00	3,200.0	12,800.00	26,650.0	106,600.00
25	Medium Intensity Runway Edge Lights	Each	550.00	76.0	41,800.00	0.0	0.00	0.0	0.00	76.0	41,800.00
26	Medium Intensity Taxiway Edge Lights	Each	525.00	0.0	0.00	125.0	65,625.00	58.0	30,450.00	183.0	96,075.00
27	PAPI	Unit	16,000.00	2.0	32,000.00	0.0	0.00	0.0	0.00	2.0	32,000.00
28	Taxiway Guidance Signs, 1-character	Each	1,500.00	0.0	0.00	0.0	0.00	15.0	22,500.00	15.0	22,500.00

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
29	Taxiway Guidance Signs, 2-character	Each	$1,800.00	0.0	$0.00	0.0	$0.00	5.0	$9,000.00	5.0	$9,000.00
30	Taxiway Guidance Signs, 4-character	Each	2,200.00	0.0	0.00	0.0	0.00	2.0	4,400.00	2.0	4,400.00
31	Taxiway Guidance Signs, 5-character	Each	2,500.00	0.0	0.00	2.0	5,000.00	5.0	12,500.00	7.0	17,500.00
32	Taxiway Guidance Signs, 6-character	Each	2,600.00	0.0	0.00	0.0	0.00	1.0	2,600.00	1.0	2,600.00
33	Supplemental Wind Cone	Each	4,000.00	1.0	4,000.00	0.0	0.00	0.0	0.00	1.0	4,000.00
34	New Lighting Regulators	Each	6,000.00	1.0	6,000.00	2.0	12,000.00	0.0	0.00	3.0	18,000.00
35	Vault Labor & Equipment	L.S.	L.S.	L.S.	10,000.00	0.0	0.00	0.0	0.00	L.S.	10,000.00
36	New Vault	L.S.	L.S.	L.S.	30,000.00	0.0	0.00	0.0	0.00	L.S.	30,000.00
	TOTALS				$3,007,225.00		$1,026,111.25		$315,374.50		$4,348,710.75

TABLE NO. D6

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

TRIAL NO. 3 - CLASS C & D AIRCRAFT
EXTEND RUNWAY 1-19 (100′ X 940′)
CONSTRUCT 50′ PARALLEL TAXIWAY
RUNWAY SAFETY AREA (500′)
PRIMARY SURFACE WIDTH 1,000′
STEEPER GRADES THAN TRIAL 2A
BALANCED CUT AND FILL

ENGINEER′S ESTIMATE

Item			Unit	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
No.	Description	Unit	Price	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
1	Mobilization	L.S.	L.S.	L.S.	$30,000.00	0.0	$0.00	0.0	$0.00	L.S.	$30,000.00
2	Temporary Airfield Marking	L.S.	L.S.	L.S.	15,000.00	0.0	0.00	0.0	0.00	L.S.	15,000.00
3	Clearing and Grubbing	Acre	$1,000.00	64.0	64,000.00	12.0	12,000.00	0.0	0.00	76.0	76,000.00
4	Excavation	Cu. Yd.	4.00	440,100.0	1,760,400.00	27,300.0	109,200.00	0.0	0.00	467,400.0	1,869,600.00
5	Scarify and Recompact 6 inches of Subgrade - 10′ Beyond Paved Areas Only	Sq. Yd.	1.00	34,300.0	34,300.00	46,600.0	46,600.00	12,250.0	12,250.00	93,150.0	93,150.00
6	Aggregate Subbase	Ton	11.00	11,275.0	124,025.00	13,600.0	149,600.00	3,450.0	37,950.00	28,325.0	311,575.00
7	Aggregate Base Course	Ton	13.00	13,775.0	179,075.00	16,600.0	215,800.00	4,250.0	55,250.00	34,625.0	450,125.00
8	Bituminous Surface Course	Ton	35.00	13,600.0	476,000.00	7,000.0	245,000.00	1,450.0	50,750.00	22,050.0	771,750.00
9	Bituminous Prime Coat	Ton	300.00	32.3	9,690.00	39.0	11,700.00	10.0	3,000.00	81.3	24,390.00
10	Bituminous Tack Coat	Ton	350.00	34.0	11,900.00	16.2	5,670.00	3.4	1,190.00	53.6	18,760.00
11	Security Fence	Ln. Ft.	11.00	2,200.0	24,200.00	0.0	0.00	0.0	0.00	2,200.0	24,200.00

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
12	Airfield Marking	Sq. Ft.	$1.25	48,300.0	$60,375.00	3,125.0	$3,906.25	2,050.0	$2,562.50	53,475.0	$66,843.75
13	18" RCP, Class IV	Ln. Ft.	33.00	0.0	0.00	130.0	4,290.00	260.0	8,580.00	390.0	12,870.00
14	24" RCP, Class IV	Ln. Ft.	40.00	0.0	0.00	0.0	0.00	130.0	5,200.00	130.0	5,200.00
15	42" RCP, Class IV	Ln. Ft.	100.00	0.0	0.00	200.0	20,000.00	0.0	0.00	200.0	20,000.00
16	18" RCP End Section	Each	400.00	0.0	0.00	2.0	800.00	4.0	1,600.00	6.0	2,400.00
17	24" RCP End Section	Each	650.00	0.0	0.00	0.0	0.00	2.0	1,300.00	2.0	1,300.00
18	42" RCP End Section	Each	1,200.00	0.0	0.00	1.0	1,200.00	0.0	0.00	1.0	1,200.00
19	Drop Inlets	Each	3,000.00	0.0	0.00	1.0	3,000.00	0.0	0.00	1.0	3,000.00
20	Electrical Pullboxes	Each	2,500.00	4.0	10,000.00	16.0	40,000.00	13.0	32,500.00	33.0	82,500.00
21	1/C, No. 8, 5 KV Cable	Ln. Ft.	0.80	35,300.0	28,240.00	22,200.0	17,760.00	4,840.0	3,872.00	62,340.0	49,872.00
22	2-way, 3-inch, Type I Duct	Ln. Ft.	16.00	320.0	5,120.00	760.0	12,160.00	320.0	5,120.00	1,400.0	22,400.00
23	2-way, 3-inch, Type II Duct	Ln. Ft.	10.00	1,010.0	10,100.00	0.0	0.00	0.0	0.00	1,010.0	10,100.00
24	1-way, 2-inch, Type I Duct	Ln. Ft.	4.00	12,250.0	49,000.00	11,200.0	44,800.00	3,200.0	12,800.00	26,650.0	106,600.00
25	Medium Intensity Runway Edge Lights	Each	550.00	76.0	41,800.00	0.0	0.00	0.0	0.00	76.0	41,800.00
26	Medium Intensity Taxiway Edge Lights	Each	525.00	0.0	0.00	125.0	65,625.00	58.0	30,450.00	183.0	96,075.00
27	PAPI	Unit	16,000.00	2.0	32,000.00	0.0	0.00	0.0	0.00	2.0	32,000.00
28	Taxiway Guidance Signs, 1-character	Each	1,500.00	0.0	0.00	0.0	0.00	15.0	22,500.00	15.0	22,500.00

Item No.	Description	Unit	Unit Price	Runway 1-19		Parallel Taxiway		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
29	Taxiway Guidance Signs, 2-character	Each	$1,800.00	0.0	$0.00	0.0	$0.00	5.0	$9,000.00	5.0	$9,000.00
30	Taxiway Guidance Signs, 4-character	Each	2,200.00	0.0	0.00	0.0	0.00	2.0	4,400.00	2.0	4,400.00
31	Taxiway Guidance Signs, 5-character	Each	2,500.00	0.0	0.00	2.0	5,000.00	5.0	12,500.00	7.0	17,500.00
32	Taxiway Guidance Signs, 6-character	Each	2,600.00	0.0	0.00	0.0	0.00	1.0	2,600.00	1.0	2,600.00
33	Supplemental Wind Cone	Each	4,000.00	1.0	4,000.00	0.0	0.00	0.0	0.00	1.0	4,000.00
34	New Lighting Regulators	Each	6,000.00	1.0	6,000.00	2.0	12,000.00	0.0	0.00	3.0	18,000.00
35	Vault Labor & Equipment	L.S.	L.S.	L.S.	10,000.00	0.0	0.00	0.0	0.00	L.S.	10,000.00
36	New Vault	L.S.	L.S.	L.S.	30,000.00	0.0	0.00	0.0	0.00	L.S.	30,000.00
	TOTALS				$3,015,225.00		$1,026,111.25		$315,374.50		$4,356,710.75

TABLE NO. D7

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

RUNWAY 12-30 PARALLEL TAXIWAY (35′ X 3,540′)
THREE CROSS TAXIWAYS (50′ X 232.5′)
CLEAR ZONE RUNWAY 12 ON PUBLIC PROPERTY

ENGINEER'S ESTIMATE

Item			Unit	Parallel Taxiway Runway 12-30		Cross Taxiway		Total	
No.	Description	Unit	Price	Quantity	Cost	Quantity	Cost	Quantity	Cost
1	Mobilization	L.S.	L.S.	L.S.	$30,000.00	0.0	$0.00	L.S.	$30,000.00
2	Temporary Airfield Marking	L.S.	L.S.	L.S.	15,000.00	0.0	0.00	L.S.	15,000.00
3	Clearing and Grubbing	Acre	$1,000.00	7.5	7,500.00	0.0	0.00	7.5	7,500.00
4	Excavation	Cu. Yd.	4.00	10,000.0	40,000.00	0.0	0.00	10,000.0	40,000.00
5	Scarify and Recompact 6 inches of Subgrade - 10′ Beyond Paved Areas Only	Sq. Yd.	1.00	21,800.0	21,800.00	6,600.0	6,600.00	28,400.0	28,400.00
6	Aggregate Subbase	Ton	11.00	6,000.0	66,000.00	1,850.0	20,350.00	7,850.0	86,350.00
7	Aggregate Base Course	Ton	13.00	7,325.0	95,225.00	4,000.0	52,000.00	11,325.0	147,225.00
8	Bituminous Surface Course	Ton	35.00	2,625.0	91,875.00	800.0	28,000.00	3,425.0	119,875.00
9	Bituminous Prime Coat	Ton	300.00	17.2	5,160.00	25.5	7,650.00	42.7	12,810.00
10	Bituminous Tack Coat	Ton	350.00	6.1	2,135.00	1.9	665.00	8.0	2,800.00
11	Airfield Marking	Sq. Ft.	1.25	2,025.0	2,531.25	1,300.0	1,625.00	3,325.0	4,156.25
12	18" RCP, Class IV	Ln. Ft.	33.00	250.0	8,250.00	260.0	8,580.00	510.0	16,830.00

Oroville Municipal Airport
Runway 12-30 Parallel Taxiway
Three Cross Taxiways

Item No.	Description	Unit	Unit Price	Parallel Taxiway Runway 12-30		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost
13	33" RCP, Class IV	Ln. Ft.	$65.00	125.0	$8,125.00	0.0	$0.00	125.0	$8,125.00
14	18" RCP End Section	Each	400.00	4.0	1,600.00	4.0	1,600.00	8.0	3,200.00
15	33" RCP End Section	Each	1,000.00	2.0	2,000.00	0.0	0.00	2.0	2,000.00
16	Electrical Pullboxes	Each	2,500.00	4.0	10,000.00	6.0	15,000.00	10.0	25,000.00
17	1/C, No. 8, 5 KV Cable	Ln. Ft.	0.80	11,250.0	9,000.00	2,900.0	2,320.00	14,150.0	11,320.00
18	2-way, 3-inch, Type I Duct	Ln. Ft.	16.00	160.0	2,560.00	320.0	5,120.00	480.0	7,680.00
19	1-way, 2-inch, Type I Duct	Ln. Ft.	4.00	6,000.0	24,000.00	1,700.0	6,800.00	7,700.0	30,800.00
20	Medium Intensity Taxiway Edge Lights	Each	525.00	72.0	37,800.00	28.0	14,700.00	100.0	52,500.00
21	Relocate VASI	Each	3,000.00	1.0	3,000.00	0.0	0.00	1.0	3,000.00
22	Taxiway Guidance Signs, 1-character	Each	1,500.00	0.0	0.00	8.0	12,000.00	8.0	12,000.00
23	Taxiway Guidance Signs, 2-character	Each	1,800.00	0.0	0.00	5.0	9,000.00	5.0	9,000.00
24	Taxiway Guidance Signs, 5-character	Each	2,500.00	1.0	2,500.00	1.0	2,500.00	2.0	5,000.00
25	New Lighting Regulators	Each	6,000.00	1.0	6,000.00	0.0	0.00	1.0	6,000.00
26	Vault Labor & Equipment	L.S.	L.S.	L.S.	10,000.00	0.0	0.00	L.S.	10,000.00
	TOTALS				$502,061.25		$194,510.00		$696,571.25

TABLE NO. D8

OROVILLE MUNICIPAL AIRPORT
OROVILLE, CALIFORNIA

RUNWAY 12-30 PARALLEL TAXIWAY (35' X 4,250')
THREE CROSS TAXIWAYS (50' X 232.5')
CLEAR ZONE FOR RUNWAY 12
EXTEND NORTH ACROSS ORO DAM BOULEVARD

ENGINEER'S ESTIMATE

				Parallel Taxiway Runway 12-30		Cross Taxiway		Total	
Item No.	Description	Unit	Unit Price	Quantity	Cost	Quantity	Cost	Quantity	Cost
1	Mobilization	L.S.	L.S.	L.S.	$30,000.00	0.0	$0.00	L.S.	$30,000.00
2	Temporary Airfield Marking	L.S.	L.S.	L.S.	15,000.00	0.0	0.00	L.S.	15,000.00
3	Clearing and Grubbing	Acre	$1,000.00	8.7	8,700.00	0.0	0.00	8.7	8,700.00
4	Excavation	Cu. Yd.	4.00	12,000.0	48,000.00	0.0	0.00	12,000.0	48,000.00
5	Scarify and Recompact 6 inches of Subgrade - 10' Beyond Paved Areas Only	Sq. Yd.	1.00	24,900.0	24,900.00	6,600.0	6,600.00	31,500.0	31,500.00
6	Aggregate Subbase	Ton	11.00	7,150.0	78,650.00	1,850.0	20,350.00	9,000.0	99,000.00
7	Aggregate Base Course	Ton	13.00	8,750.0	113,750.00	4,000.0	52,000.00	12,750.0	165,750.00
8	Bituminous Surface Course	Ton	35.00	3,200.0	112,000.00	800.0	28,000.00	4,000.0	140,000.00
9	Bituminous Prime Coat	Ton	300.00	20.5	6,150.00	25.5	7,650.00	46.0	13,800.00
10	Bituminous Tack Coat	Ton	350.00	7.2	2,520.00	1.9	665.00	9.1	3,185.00
11	Airfield Marking	Sq. Ft.	1.25	2,380.0	2,975.00	1,300.0	1,625.00	3,680.0	4,600.00
12	18" RCP, Class IV	Ln. Ft.	33.00	250.0	8,250.00	260.0	8,580.00	510.0	16,830.00

Oroville Municipal Airport
Runway 12-30 Parallel Taxiway (35′ x 4,250′)
Three Cross Taxiways

Item No.	Description	Unit	Unit Price	Parallel Taxiway Runway 12-30		Cross Taxiway		Total	
				Quantity	Cost	Quantity	Cost	Quantity	Cost
13	33" RCP, Class IV	Ln. Ft.	$65.00	125.0	$8,125.00	0.0	$0.00	125.0	$8,125.00
14	18" RCP End Section	Each	400.00	4.0	1,600.00	4.0	1,600.00	8.0	3,200.00
15	33" RCP End Section	Each	1,000.00	2.0	2,000.00	0.0	0.00	2.0	2,000.00
16	Electrical Pullboxes	Each	2,500.00	4.0	10,000.00	6.0	15,000.00	10.0	25,000.00
17	1/C, No. 8, 5 KV Cable	Ln. Ft.	0.80	11,250.0	9,000.00	2,900.0	2,320.00	14,150.0	11,320.00
18	2-way, 3-inch, Type I Duct	Ln. Ft.	16.00	160.0	2,560.00	320.0	5,120.00	480.0	7,680.00
19	1-way, 2-inch, Type I Duct	Ln. Ft.	4.00	7,420.0	29,680.00	1,700.0	6,800.00	9,120.0	36,480.00
20	Medium Intensity Taxiway Edge Lights	Each	525.00	80.0	42,000.00	28.0	14,700.00	108.0	56,700.00
21	Relocate VASI	Each	3,000.00	1.0	3,000.00	0.0	0.00	1.0	3,000.00
22	Taxiway Guidance Signs, 1-character	Each	1,500.00	0.0	0.00	8.0	12,000.00	8.0	12,000.00
23	Taxiway Guidance Signs, 2-character	Each	1,800.00	0.0	0.00	5.0	9,000.00	5.0	9,000.00
24	Taxiway Guidance Signs, 5-character	Each	2,500.00	1.0	2,500.00	1.0	2,500.00	2.0	5,000.00
25	New Lighting Regulators	Each	6,000.00	1.0	6,000.00	0.0	0.00	1.0	6,000.00
26	Vault Labor & Equipment	L.S.	L.S.	L.S.	10,000.00	0.0	0.00	L.S.	10,000.00
	TOTALS				$577,360.00		$194,510.00		$771,870.00

TABLE NO. D9

OROVILLE -- AIRPORT LAYOUT PLAN

SUMMARY OF DEVELOPMENT COSTS

Trial No. 2

Primary Surface Width - 1,000 ft.
Clear Zones on Airport Property
R/W 1-19 100′ x 6,000′ (2,190′ Extension)
R/W 12-30 100′ x 3,540′
Balanced Cut and Fill

Aircraft Class	A & B	C & D
R/W Safety Area Width - ft.	150	500
Construction Costs:		
R/W 1-19	$4,424,515	$5,055,315
T/W 1-19	1,174,495	1,179,182
Cross T/W's	369,442	372,817
Subtotal	$5,968,452	$6,607,314
T/W 12-30 & Cross Taxiways	696,571	696,571
Light R/W 12-30 & Parallel T/W	334,520	334,520
Land Acquisition	152,000	152,000
Total Construction Cost	$7,151,543	$7,790,405
Engineering & Contingencies - 25%	1,787,861	1,947,601
Total Project Cost	$8,939,404	$9,738,006

TABLE NO. D10

OROVILLE -- AIRPORT LAYOUT PLAN

SUMMARY OF DEVELOPMENT COSTS

Trial No. 2a

Primary Surface Width - 1,000 ft.
Clear Zones North - Off Airport Property
R/W 1-19 100' x 6,000' (940' Extension)
R/W 12-30 100' x 4,250'
Grades Same as Trial 2
Unbalanced Cut and Fill

Aircraft Class	A & B	C & D
R/W Safety Area Width - ft.	150	500
Construction Costs:		
R/W 1-19	$3,930,025	$3,936,025
T/W 1-19	1,026,111	1,026,111
Cross T/W's	315,375	315,375
Subtotal	$5,271,511	$5,277,511
T/W 12-30 & Cross Taxiways	771,870	771,870
Light R/W 12-30 & Parallel T/W	334,520	334,520
Land Acquisition	1,100,000	1,100,000
Total Construction Cost	$7,477,901	$7,483,901
Engineering & Contingencies - 25%	1,869,475	1,870,975
Total Project Cost	$9,347,376	$9,354,876

TABLE NO. D11

OROVILLE -- AIRPORT LAYOUT PLAN

SUMMARY OF DEVELOPMENT COSTS

Trial No. 3

Primary Surface Width - 1,000 ft.
Clear Zones North - Off Airport Property
R/W 1-19 100' x 6,000' (940' Extension)
R/W 12-30 100' x 4,250'
Grades Steeper Than Trial 2
Balanced Cut and Fill

Aircraft Class	A & B	C & D
R/W Safety Area Width - ft.	150	500
Construction Costs:		
R/W 1-19	$3,007,225	$3,015,225
T/W 1-19	1,026,111	1,026,111
Cross T/W's	315,375	315,375
Subtotal	$4,348,711	$4,356,711
T/W 12-30 & Cross Taxiways	771,870	771,870
Light R/W 12-30 & Parallel T/W	334,520	334,520
Land Acquisition	1,100,000	1,100,000
Total Construction Cost	$6,555,101	$6,563,101
Engineering & Contingencies - 25%	1,638,775	1,640,775
Total Project Cost	$8,193,876	$8,203,876

TABLE NO. D12

OROVILLE MUNICIPAL AIRPORT

FIRST STAGE DEVELOPMENT AIRCRAFT OPERATIONS AREA

Aircraft Parking Apron & Lead In Taxiway
75 Tie Down Spaces

ENGINEER'S ESTIMATE

Apron - 300' X 700'

Taxiway - 50' x 350'

ITEM	COST
Grading - 10,000 cy @ $4	$40,000.00
Paving - 227,000 sq ft @ $1.85	419,950.00
Lighting Allowance	60,000.00
Drainage Allowance	60,000.00
Tie Down Anchors - 75 ea @ $300	22,500.00
Marking & Signing Allowance	5,000.00
Total Construction Cost	$607,450.00
Engineering & Contingencies - 25%	151,863.00
Total Project Cost	$759,313.00

TABLE NO. D13

OROVILLE MUNICIPAL AIRPORT

FIRST STATE DEVELOPMENT AIRCRAFT OPERATIONS AREA

Tee Hangar Development Area

ENGINEER'S ESTIMATE

Tee Hangar Paving - 280' x 380'

Tee Hangar Taxiways - 40' x 400'
50' x 160'

Tee Hangars - 18 Units

ITEM	COST
Grading - 5,000 cy @ $4	$20,000.00
Paving - 130,000 sq ft @ $1.60	208,000.00
Lighting Allowance	20,000.00
Drainage Allowance	20,000.00
Tee Hangars - 18 ea @ $12,000	216,000.00
Total Construction Cost	$484,000.00
Engineering & Contingencies - 25%	121,000.00
Total Project Cost	$605,000.00

Note: Approximately $500,000 cost of this work is ineligible for Federal Participation

TABLE NO. D14

OROVILLE MUNICIPAL AIRPORT

FIRST STATE DEVELOPMENT AIRCRAFT OPERATIONS AREA

Access Roads and Utilities

ENGINEER'S ESTIMATE

Access Road - 40' x 2,000'

ITEM	COST
Grading - 10,000 cy @ $4	$40,000.00
Paving - 80,000 sq ft @ $1.85	148,000.00
Drainage Allowance	20,000.00
Marking, Lighting & Signage Allowance	40,000.00
Sewer Lines - 7,000 ln ft @ $40	280,000.00
Sewer Lift Station	60,000.00
Water Lines - 7,000 ln ft @ $40	280,000.00
Total Construction Cost	$868,000.00
Engineering & Contingencies - 25%	217,000.00
Total Project Cost	$1,085,000.00

Note: The sewer & water lines are not eligible for FAA participation