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Pueblo Memorial Airport, Pueblo, Colorado

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13. ABSTRACT (*Maximum 200 words*)

At the request of the 302 AW (AFRES) a pavement evaluation team from HQ Air Force Civil Engineer Support Agency (HQ AFCESA) did a partial evaluation of the Pueblo, Colorado municipal airport. The objective of the evaluation was to determine if the now closed Runway 12/30 is suitable for C-130 assault operations. The evaluation was done on 5-7 April 1994. The runway pavement has failed and is structurally weak. Severe block cracking, alligator cracking, heaving, and rutting is prevalent. The runway is not suitable for C-130 assault operations and would have to be reconstructed to accommodate this mission.

14. SUBJECT TERMS
Airfield Pavements
Airfield Pavement Evaluation
Allowable Gross Loads
Pavement Classification Number
Electronic Cone Penetrometer
Dynamic Cone Penetrometer

15. NUMBER OF PAGES

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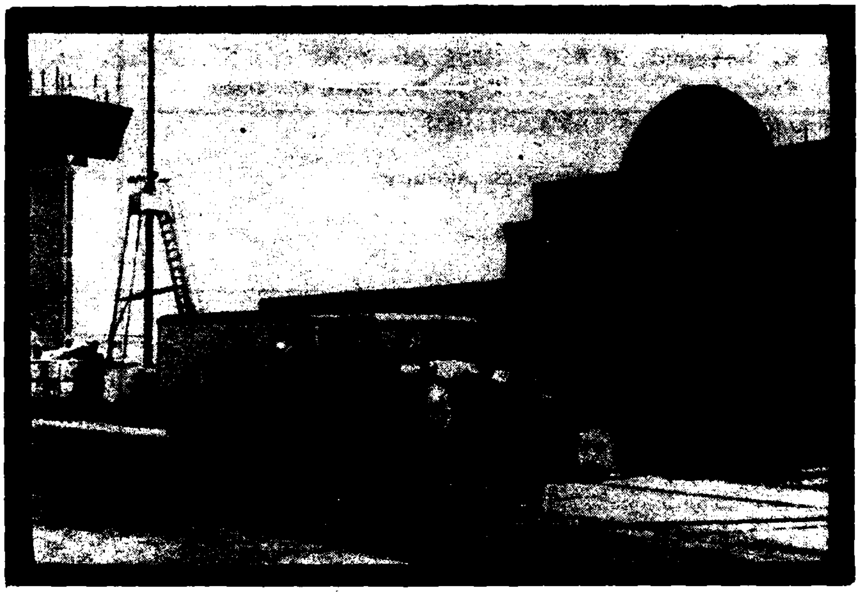

TEAM PHOTO WITH THE CONTINGENGY VAN : LEFT TO RIGHT
LT. COL. WALROND, CAPT. BOSWORTH, SSgt. COX, SSgt. GEER,
Mr. CHAMBERLIN, Mr. SIKES, MSgt. CROMPTON.

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TABLE OF CONTENTS

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SECTION I: INTRODUCTION

A. Scope

1. At the request of the 302 AW (AFRES) a pavement evaluation team from HQ Air Force Civil Engineer Support Agency (HQ AFCESA) did a partial evaluation of the Pueblo, CO municipal airport. The objective of the evaluation was to determine if the now closed Runway 12/30 is suitable for C-130 assault operations. The evaluation was done on 5-7 April 94. The report uses several appendices to easily report the vast amount of data gathered. The following list describes each appendix.

Appendix	Description
A	Airfield Layout Plan: The drawings depict the airfield's pavement features, and primary pavements.
B	Construction History: This is an updated list showing the construction history for the evaluated features.
C	Core and Test Locations: A drawing of the core extraction locations. It shows core thicknesses, Portland Cement Concrete (PCC) flexural strengths, Electronic Cone Penetrometer (ECP), and Dynamic Cone Penetrometer (DCP) results.
D	Condition Survey: A drawing of feature surface condition ratings. These ratings are a qualitative assessment based upon visual observations. The rating scale is the same as used in AFR 93-5 (Reference 1).
E	Summary of Physical Property Data and Laboratory Test Results: A tabulation of physical properties of each pavement feature evaluated. Included are feature dimensions, material types, thicknesses of layers, and engineering properties.
F	Allowable Gross Loads (AGLs) and Pavement Classification Numbers (PCNs): Not Used.
G	Related Information: Contains climatic data.

SECTION II. BACKGROUND DATA

A. General Description of Airfield

1. Pueblo Airport is located five miles east of Pueblo, CO. It is approximately 45 miles from the Rocky Mountains. The airfield sits on an elevated shelf on the north side of the Arkansas River valley. Lowlands of the river adjoin the site immediately to the south, with elevated ridges extending northwest-southeast through the northeast corner of the reservation. The original site surface was intercepted by many gullies, washes and several small arroyos. The area immediately east of the airfield is studded with numerous rounded shale mounds varying from low hummocks to hillS approximately twenty feet high. A large arroyo transverses the airfield site boundary from the northeast to the west and south. Alkali springs cause surface and subsurface water to flow around and possibly under the runway.

2. The airport was constructed for B-24 operations during August - September 1943. Runway 12/30 was designed for a 60,000 pound wheel load using a 12 inch stabilized river run gravel base course, a 2 inch asphalt stabilized sand, and a 2 inch asphalt concrete wearing surface. All pavements were constructed of sand and gravel obtained from the Arkansas River, to which was added crushed and graded gravel and boulders. (Reference Two)

B. Climatic Data

1. The design freezing index of Pueblo is 736 and the rain rate is 0.485. The soil frost classification for the base is F3, the subbase is F4 and the subgrade classifies as F3 and F4. According to Reference Three, the maximum depth of frost penetration is 36 inches. During severe winters, frost heave is a problem as evident in feature R06A. The freezing period is November through March. The thaw period is March through April. The weather during the evaluation is shown in Table One.

TABLE ONE

WEATHER DURING EVALUATION

Date	Temperature Hi	Lo	Mean	Weather
5 Apr 94	33	20	26	3 inches accumulated snowfall, snowed until 1300, gradual warming with rapid snow melt
6 Apr 94	55	20	37	Clear, dry with calm winds and snow melted
7 Apr 94	55	45	50	Clear, dry with calm winds

C. Drainage

1. The region has a low average annual precipitation of less than 12 inches, but sometimes the rate of accumulation are high. Therefore, provisions for handling storm water are required. The runway is slightly crowned and the shoulders and surrounding terrain slopes to a drain ditch on the south side of the runway and an arroyo on the north side of the runway. The shoulders were improved with gravel, and the surrounding soil is clay with a vegetation cover. Slow moving water is absorbed in the soil prior to reaching the drainage ditches. Some or the core holes penetrated show evidence of soil saturation with water, and the possibility that underground water moves beneath the runway. Dense turf growth combined with dirt and gravel build up at the runway edges inhibits drainage from the runway edges. Consequently, the outside 12 to 24 feet of the runway have severe raveling and potholes

SECTION III: TEST PROCEDURES

A. Field Testing

1. Modified destructive testing was accomplished using AFCESA's contingency van shown in Figure One. Core holes were drilled to extract asphalt concrete (AC) and portland cement concrete (PCC) samples. An electronic cone penetrometer (ECP) and a dynamic cone penetrometer (DCP) were use to determine base, subbase CBRs and thickness. The depth to subgrade and its CBR were also determined using these penetrometers. Small aperture CBR tests were done at selected locations. Appendix Page C-2 shows the test locations.

2. To do the DCP test, a cone tipped rod is driven through the pavement layers by dropping a weighted hammer from a predetermined height. The test is typically performed to a depth of 4 feet and the depth of penetration per blow is plotted. The plot is correlated to CBR and used to identify soil layer thicknesses.

3. The ECP is a instrumented cone attached to a steel shaft. The cone is driven into the ground at a constant rate by a hydraulic ram. The cone tip and sleeve pressure is measured once each second. These pressures are used to determine both the soil type and CBR from correlation curves developed by the Army Corps of Engineers', Waterways Experiment Station, located in Vicksburg, Mississippi. This test is typically done to a depth of seven feet. Core flexural strength and DCP results aid the calculation of allowable gross loads and pavement classification numbers for each pavement feature.

B. Laboratory Testing:

1. Split tensile tests are done on the PCC cores, using the Universal Testing Machine (UTM) and in accordance with ASTM C 496-90 "Standard Test Methods for Splitting Tensile Strength of Cylindrical Concrete Specimens." The core tensile strengths convert to flexural strengths using an empirical relationship developed in Reference 4. The "Core and DCP Location Plan" in Appendix C and the "Summary of Physical Property Data" in Appendix E report the flexural strength.

2. Laboratory procedures, done in accordance with ASTM's "Standard Test Methods," classified soil samples using the Unified Soil Classification System (USCS) listed in Reference 6. Appendix page E-2 shows the grain size distributions of soils samples taken from this runway.

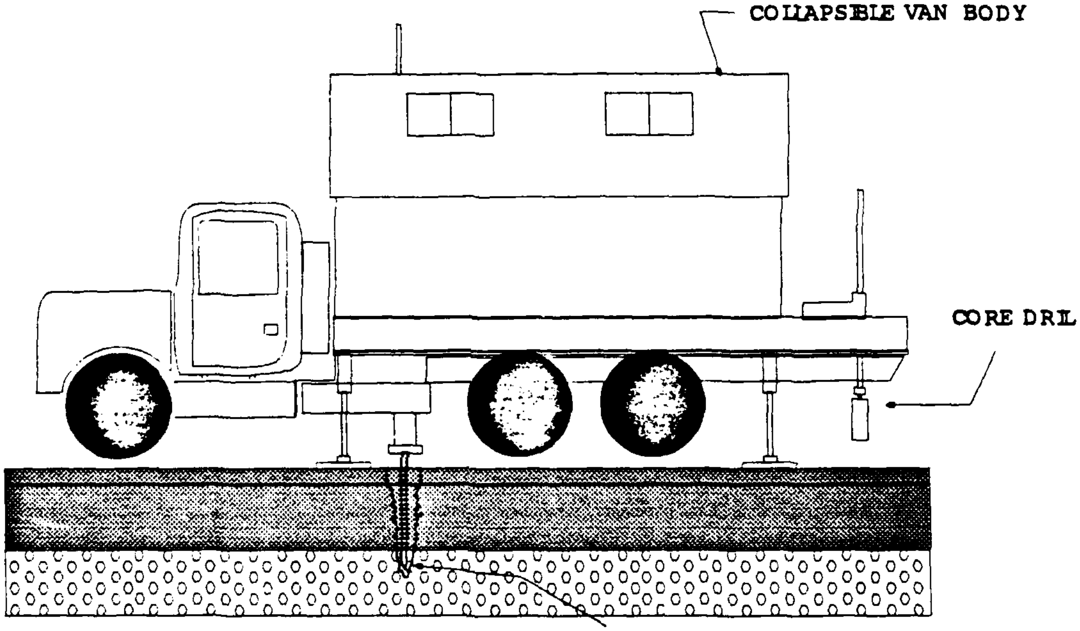

FIGURE ONE: CONTINGENCY VAN

SECTION IV: METHODOLOGY OF ANALYSIS

A. Physical Property Data:

1. The principal parameters used for determining AGLs are pavement type, thickness, flexural strength (for PCC only), and CBR. Appendix E summarizes these parameters. The failure criterion for rigid pavements limits concrete tensile stress. Flexible pavement failure criterion limits compressive subgrade strain and asphalt concrete tensile strain.

B. Determination of Allowable Gross Loads (AGLs):

1. The computer program, GOAPE, calculated the allowable gross loads for each feature. The Army Corps of Engineers' Waterways Experiment Station at Vicksburg, Mississippi developed the computer model. AGLs were reduced 25% for those Features with a condition rating of POOR or worse.

2. The traffic designator at the end of each feature number (A, B, or C) indicates the normal type of traffic. "A" designates channelized traffic by fully loaded aircraft. "B" is used for fully loaded, nonchannelized aircraft traffic on areas such as parking aprons. "C" designates less than full aircraft loading, such as occurs on runway interiors where the wing lift reduces the wheel loading. The "B" designator raises AGLs approximately 5 per cent, while the "C" designator raises AGLs 25 per cent. Consider this when comparing AGLs of a feature with "A" traffic to those with "B" or "C" traffic. The AGLs are listed in Tables One and Two.

TABLE ONE

AGLs FOR C-130

Feature	Passes	AGL	Overlay for 500 Passes
R03C	< 10	A	10 inches
R04A	< 10	A	16 inches
R05A	500	113	--
R06A	< 10	A	6 inches
R07A	< 10	A	3.5 inches
R08A	25	A	5.5 inches
R09A	< 20	A	7 inches
R10A	58	72	3 inches
R11A	not suitable for aircraft traffic		
R12A	1000	+	

Aircraft evaluated at 120,000 gross weight and 500 passes

"A" Denotes the lowest possible weight of the C-130 exceeds the AGL for the pavement feature.

"+" Denotes the AGL for the pavement feature exceeds the highest possible C-130 gross weight.

TABLE TWO

AGLs FOR C-130 - FROST CONDITIONS

Feature	Passes	AGL	Overlay for 500 Passes
R03C	< 10	A	16 inches
R04A	< 10	A	16 inches
R05A	500	113	--
R06A	< 10	A	7 inches
R07A	< 10	A	3.5 inches
R08A	25	A	5.5 inches
R09A	< 20	A	7 inches
R10A	58	72	3.75 inches
R11A	not suitable for aircraft traffic		
R12A	1000	+	

Aircraft evaluated at 120,000 gross weight and 500 passes

"A" Denotes the lowest possible weight of the C-130 exceeds the AGL for the pavement feature.

"+" Denotes the AGL for the pavement feature exceeds the highest possible C-130 gross weight.

SECTION FIVE: PAVEMENT ASSESSMENT

A. General

1. A detailed pavement condition survey was done in accordance with the procedures outlined on AFR 93-5. Overall the runway has FAILED. The asphalt concrete is severely weathered, the binder material is brittle and the aggregate is easily dislodged from the mix. When vehicles turn on the AC, stones are dislodged and tracks left in the pavement. This would be a problem with aircraft turning and tire spinup on landing. In addition, holding brakes at high power setting would likely scrub the pavement surface. The northwest 3000 feet of the runway (Feature R03C) is in such a poor state it doesn't qualify as an aircraft operating surface. The subgrade is very week. In 1990, earth moving equipment used Features R03C and R04A for a haul road. As a result the pavement is severely rutted with associated alligator cracking. The runway is rough with many areas of swell, some posing a hazard to aircraft operations. The runway was full of dense weed growth, which was cleared off by grading in March 94. The weeds still protrude through the cracks and will return. Long term weed control is required. The predominant distresses are block cracking and longitudinal and transverse cracking. Load related distresses have been covered with numerous AC overlays. Feature R01A and R02A were not evaluated.

B. Runway Features

1. In general, Feature R03C is unsuitable for aircraft operations. High severity depressions cover one-third of the AC surface (Photo 1). The center one-third of the AC surface is covered with high severity rutting and alligator cracking (Photo 1), caused by fully loaded earth moving equipment using this area as a haul road. The northwestern two-thirds of the feature is covered with dense weed growth. The northwestern 1000 feet of the feature has 3 - 6 inches of mud covering the north half of the runway. The feature rated FAILED. The cleared portion of this feature is poor shape (Photo 2)

2. The predominant distress in Feature R04A is block cracking. On the north side of centerline there are areas of medium to high severity rutting with associated alligator cracking. In this same area, the pavement was destroyed by the earth moving equipment entering and exiting the runway enroute to the borrow pit (Photo 3). The rut shown is 3 - 4 inches deep. The center one-third of this feature is smooth enough for aircraft operations.

3. Seventy-five per cent of Feature R05A is covered with high severity block cracking. Fifteen percent of the fcature is covered with alligator cracking, and this area butts up against Feature R06A (Photo 4). This feature has a one inch overlay, indicating this area of alligator cracking extends into the original AC surface. The overlay was probably laid down to cover this cracking. An area of medium severity alligator cracking runs the entire length of the feature along the paving lane joint, 24 feet south of

centerline. The feature is smooth enough for aircraft operations. This feature rated FAILED.

4. Transverse and longitudinal cracking predominate in Feature R06A. Three areas of high severity swells make this feature unsafe for aircraft operations (Photos 5 and 7). Two of the swells show indications of frost heave (Photo 6). The swell in Photo 7 is at the edge of a shale stratum about 3 feet below the pavement surface. There isn't any shale under the swell, and water may running off the shale strata and accumulating in the swell area. The AC on the northwestern side of the swell is 10 inches thick, while the AC over the swell is 5 inches. These factors make this section of the runway susceptible to frost heave. This feature rates FAILED. The roughness profile of the runway is shown in Appendix page D-5. The Aeronautical Systems Center/Weapons Range and Airbase Systems Program Office (ASC/VXO) at Eglin AFB, Florida did a surface roughness analysis for this runway using the computer program TAXIG, and the results are shown in Appendix page D-6. In summary, the bumps on this runway will not overstress the C-130 landing gear.

5. Feature R08A rated VERY POOR. It is an 1 to 2 inch overlay. The predominant distresses are high severity block, longitudinal and transverse cracking. This area is smooth enough for aircraft operations. The edges of the overlay are badly raveled.

6. Features R09A and R10 A are covered with block cracking and areas of high severity depressions (Photo 8). The depressions appear to be caused by pavement raveling due to standing water. These features rated FAILED.

7. Feature R11A rated FAILED. It is so badly weathered and deteriorated that it is no longer distinguishable as an AC pavement (Photo 9).

8. Feature R12A is an AC over PCC pavement. All PCC joints have reflected through the AC and the AC has 100 per cent coverage of block cracking (Photo10). The PCC pavement did not show evidence of load induced cracks reflecting through the AC layer. However, the core sample taken from this feature showed the PCC to be deteriorating from alkali reactions. This feature rated FAILED. The joint between Feature R11A and R12A has shoving damage and has caused a 2 inch ridge along the entire width of the runway.

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

1. The AC pavement on this runway has reached the end of its useful life. It is badly weathered and aircraft operations will cause rapid deterioration of the surface. There will be a constant Foreign Object Damage (FOD) hazard due to loose stones on the runway. Additionally, Runway 26R/08R will have loose stones blown on it from the prop wash, creating a FOD hazard for that runway as well. Vehicular traffic exiting Runway 18/30 onto Runway 26R/08R tracks stones onto Runway 26R/08R. The base and subgrade are structurally weak, so rutting and alligator cracking along the runway centerline will soon manifest themselves. Extensive clearing and cleaning of the runway shoulders and edges will be required to reduce the FOD hazard and fix drainage problem. Finally, high severity swells, some in excess of six inches pose a structural hazard to C-130 aircraft.

B. Recommendations

1. To make this runway suitable for assault landing practice its recommended the southeastern 1000 feet north of Runway 26R be designated an overrun. This will provide prop wash FOD protection for Runway 26R. The next 4000 feet should be smoothed and reconstructed. The next 1000 feet should be designated an overrun. The northwestern 3000 feet of this runway should be abandoned because of the very weak subgrade CBR. This portion of the runway requires complete reconstruction to include a new drainage system and subgrade stabilization.

2. Finally, there is a 105 feet tall grain elevator at an elevation of 4604 feet above Mean Sea Level (MSL) (elevation of top of elevator is 4709 feet above MSL) located 2000 feet south of the Runway 26R threshold. This elevator is on the Runway 12/30 centerline, and must be evaluated for obstruction clearance criteria before opening Runway 12/30 to assault operations.

GLOSSARY

Allowable Gross Load (AGL) - The maximum aircraft load that can be supported by a pavement feature for a particular number of passes.

Base or Subbase Courses - Natural or processed materials placed on the subgrade beneath the pavement.

Compacted Subgrade - The upper part of the subgrade, which is compacted to a density greater than the portion of the subgrade below.

Feature - A unique portion of the airfield pavement distinguished by traffic area, pavement type, pavement surface thickness and strength, soil layer thicknesses and strengths, construction period, and surface condition.

Frost Evaluation - Pavement evaluation during the frost-melting period, when the pavement load-carrying capacity will be reduced unless protection has been provided against detrimental frost action in underlying soils

Pass - On a runway, the movement of an aircraft over an imaginary line 500 feet down from the approach end. On a taxiway, the movement of an aircraft over an imaginary line connecting an apron with the runway. AFR 93-5, Chapter 2.

Pass Intensity Levels (PIL) - Specific repetitions of aircraft over a pavement feature, regardless of time, that are dependent on aircraft design category. AFR 93-5, Chapter 2.

Pavement Condition Index (PCI) - A numerical indicator between 0 and 100 that reflects the surface operational condition of the pavement. AFR 93-5, Chapter 3.

Subgrade - The natural soil in-place, or fill material, upon which a pavement, base, or subbase course are constructed.

Type A Traffic Areas - Type A Traffic Areas are those pavement facilities that receive the channelized traffic and full design weight of the aircraft. AFM 88-6, Chapter 1.

Type B Traffic Areas - Type B Traffic Areas are considered to be those areas where traffic is more nearly uniform over the full width of the pavement facility, but which receive the full design weight of the aircraft. AFM 88-6, Chapter 1.

Type C Traffic Areas - Type C Traffic Areas are considered to be those on which the volume of traffic is low or the applied weight of the operating aircraft is less than the design weight. AFM 88-6, Chapter 1.

CONVERSION FACTORS

BRITISH TO INTERNATIONAL SYSTEMS (SI) OF UNITS

British units of measurements are used in this report and can be converted to SI (Metric) units as follows:

TO CONVERT	TO	MULTIPLY BY
LENGTH		
inch (in)	millimetre (mm)	25.400
inch (in)	metre (m)	0.0254
foot (feet)	metre (m)	0.305
yard (yd)	metre (m)	0.915
mile (mi)	kilometre (km)	1.609
AREA		
square inch (in^2)	square millimetre (mm^2)	645.2
square inch (in^2)	square metre (m^2)	0.0006452
square foot ($feet^2$)	square metre (m^2)	0.093
square yard (yd^2)	square metre (m^2)	0.8361
square mile (mi^2)	square kilometres (km^2)	2.59
acres	square kilometres (km^2)	0.004046
VOLUME		
cubic inch (in^3)	cubic millimetre (mm^3)	16487.0
cubic foot ($feet^3$)	cubic metre (m^3)	0.028
cubic yard (yd^3)	cubic metre (m^3)	0.7646
MASS		
pound (lb)	kilogram (kg)	0.454
FORCE		
pound (lb f)	Newton (n)	4.448
kip (1000 lb f)	kilogram (kg)	453.6
STRESS		
pound per square inch (psi)	kilo Pascals (kPa)	6.895
MODULUS OF SUBGRADE REACTION (K-VALUE)		
pounds per square inch per inch (psi/in)	kilo Pascals per millimetre (kPa/mm)	0.2715

DEGREES

Degrees Fahrenheit(^{o}F) (F^{o}-32)	degrees Celsius (^{o}C)	5/9

DENSITY

pounds per cubic foot (pounds mass)	kilogram per cubic metre (kg/m^3)	16.052

REFERENCES

1. AFR 93-5, Procedures for US Army and US Air Force Airfield Condition Surveys, Jul 1989.

2 Pavement Evaluation Report, Pueblo Airfield, Pueblo, Colorado, USCEC TL725.3, U. S. Engineer Department, Missouri River Division, 18 January 1942

3. AFM 88-24/TM 5-818-3, Chapter 4, Pavement Evaluation for Frost Conditions", Departments of the Army and Air Force, December 1966.

4. Hammitt, G. M. III, Concrete Strength Relationships, Research Paper, Texas A & M University, College Station, Texas, December 1971.

5. AFM 89-3, Materials Testing, August 1987.

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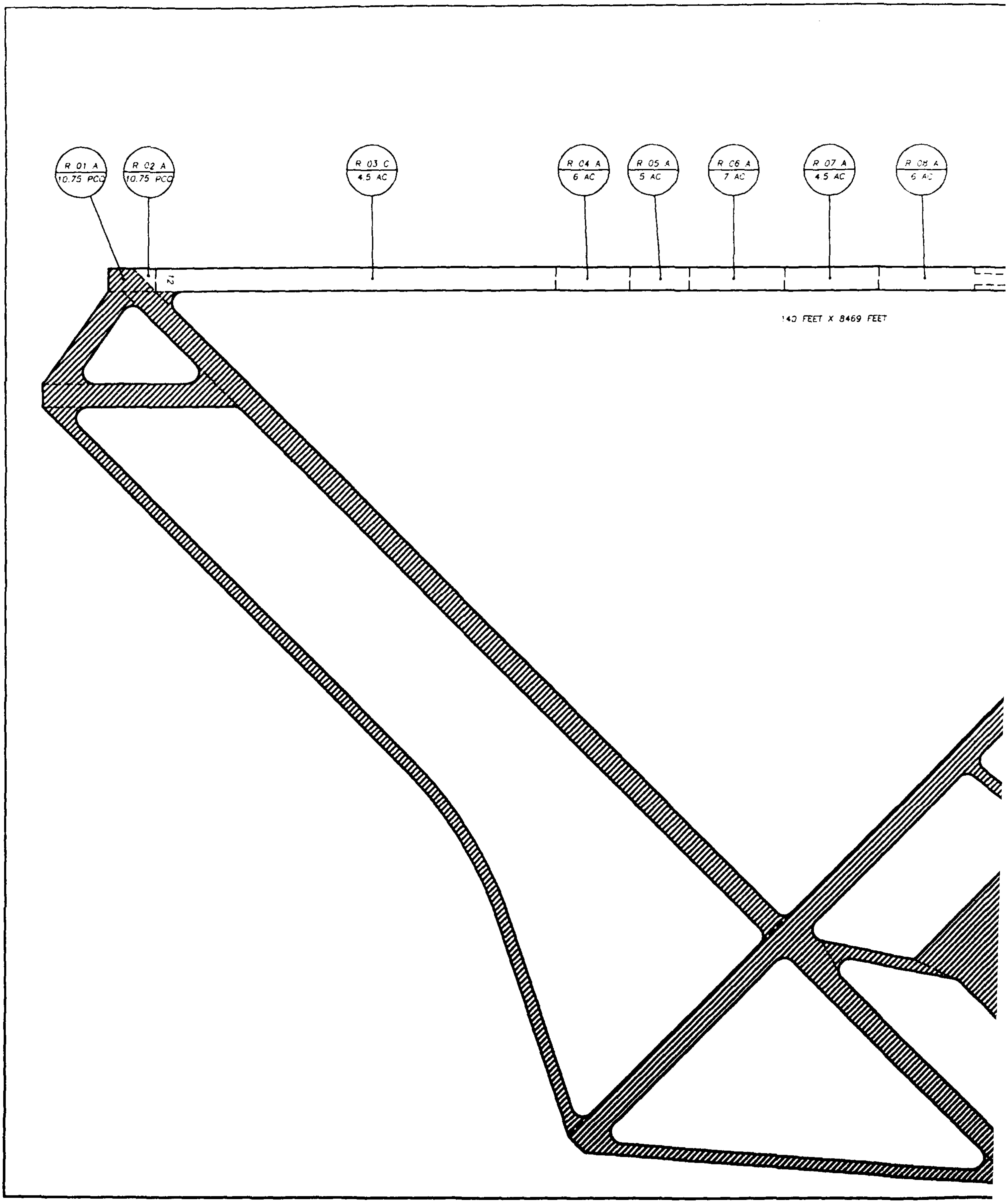
R 01 A
10.75 PCC
R 02 A
10.75 PCC
R 03 C
4.5 AC
R 04 A
6 AC
R 05 A
5 AC
R 06 A
7 AC
R 07 A
4.5 AC
R 08 A
6 AC
12
140 FEET X 8469 FEET

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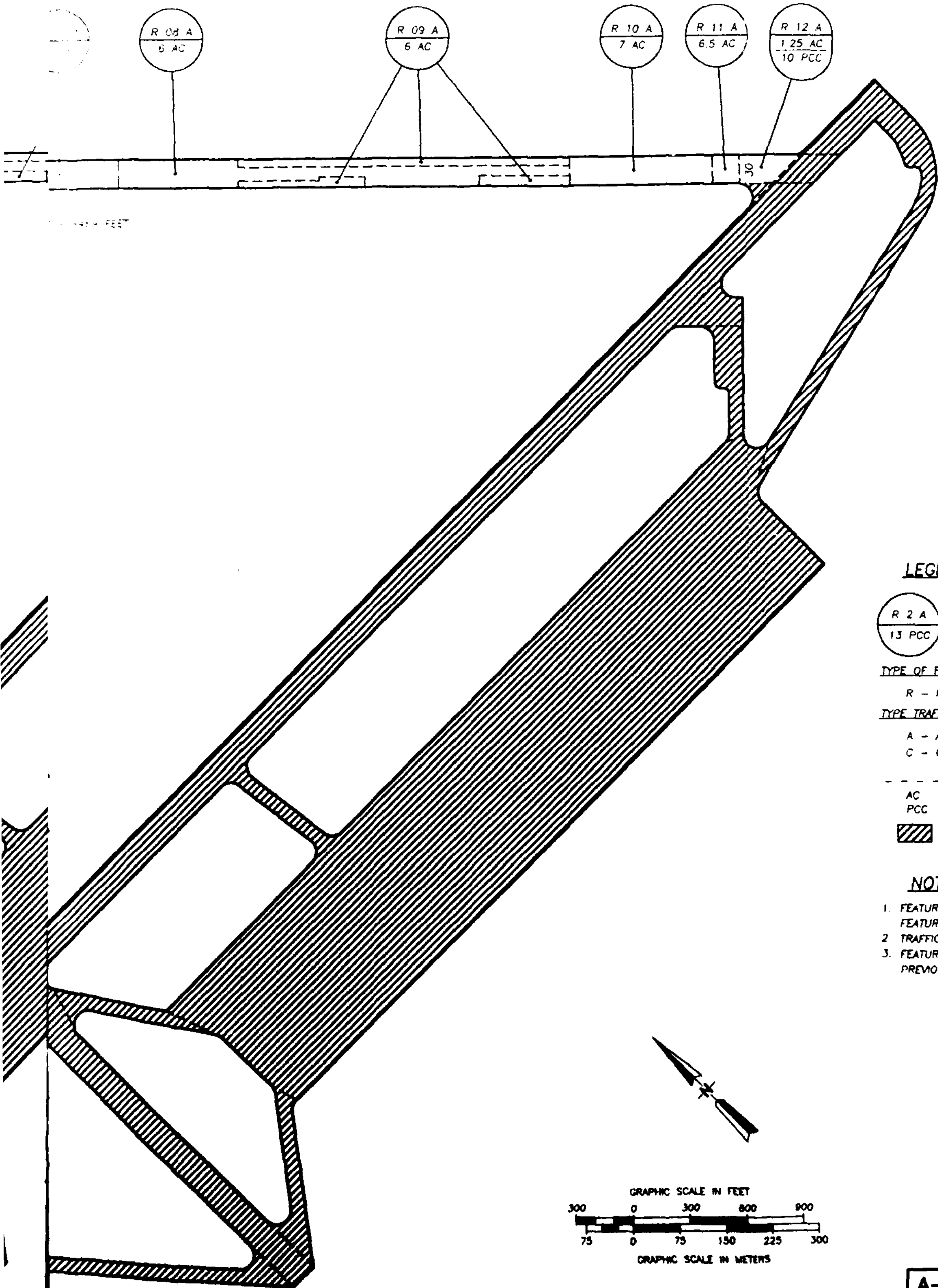

LEGEND

R 2 A — FEATURE DESIGNATION (SEE NOTE 1)
13 PCC — PAVEMENT THICKNESS IN INCHES & TYPE

TYPE OF FEATURE

R – RUNWAY

TYPE TRAFFIC AREA (SEE NOTE 2)

A – A TYPE TRAFFIC
C – C TYPE TRAFFIC

– – – – CHANGE IN FEATURE DESIGNATION
AC ASPHALTIC CONCRETE
PCC PORTLAND CEMENT CONCRETE

NOT EVALUATED

NOTES:

1. FEATURE DESIGNATION DENOTES TYPE OF FEATURE, NUMBER OF FEATURE FOR GIVEN FEATURE TYPE AND TYPE TRAFFIC AREA.
2. TRAFFIC AREA DESIGNATIONS ARE BASED ON AFM 88-6, CHAP. 1.
3. FEATURE DESIGNATIONS DO NOT CORRESPOND WITH THOSE FROM PREVIOUS REPORTS AND DRAWINGS.

UNITED STATES AIR FORCE
CIVIL ENGINEER SUPPORT AGENCY
TYNDALL AIR FORCE BASE, FLORIDA

AIRFIELD LAYOUT PLAN

PUEBLO, COLORADO

ENGINEER	DATE	DRAWING NUMBER
WALROND	MAY 1994	APPENDIX A
DRAWN: TIDWELL	SCALE: GRAPHIC	SHEET 1 OF 1

A–1

CONSTRUCTION HISTORY

Feature	Description	Type	Date	Remarks
R02A	Runway 12	PCC	1943	Original Construction
R03C	Runway 12	AC	1943	Original Construction
		AC	1967-70	Overlay
R04A	Runway 12	AC	1943	Original Construction
		AC	1967-70	Overlay
R05A	Runway 12	AC	1943	Original Construction
		AC	1967-70	Overlay
R06A	Runway 12	AC	1943	Original Construction
		AC	1967-70	Overlay
R07A	Runway 12/30	AC	1943	Original Construction
		AC	1967-70	Overlay
R08A	Runway 12/30	AC	1943	Original Construction over fill
		AC	After 1970	Overlay
R09A	Runway 12/30	AC	1967-70	Overlay
R10A	Runway 30	AC	1943	Original Construction over cut
R11A	Runway 30	AC	1943	Original Construction
R12A	Approach end Runway 12	PCC	1943	Original Construction
		AC	1967-70	Overlay

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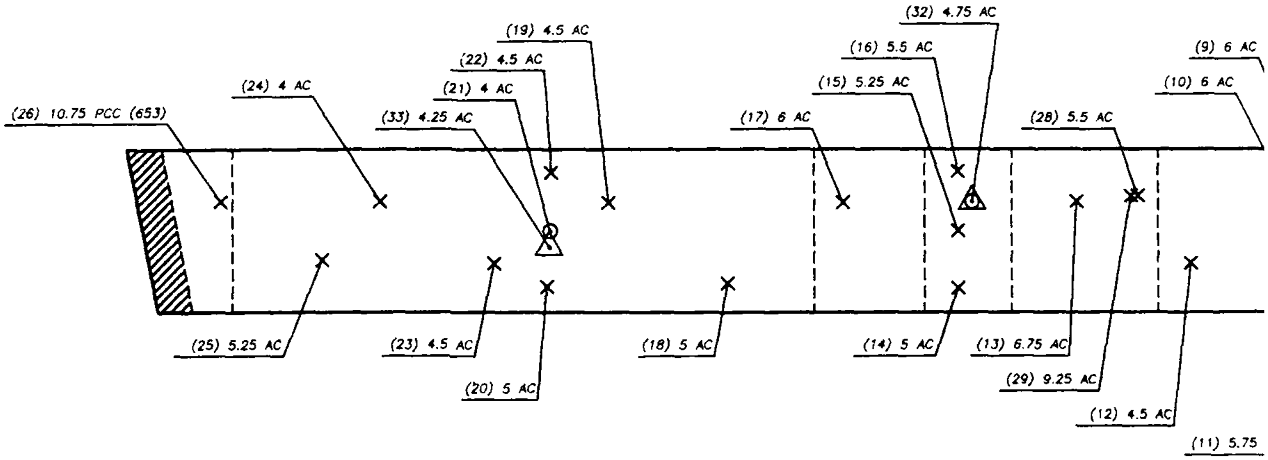
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(9) 6 AC
(22) 4.5 AC
(24) 4 AC
(21) 4 AC
(15) 5.25 AC
(10) 6 AC
(26) 10.75 PCC (653)
(33) 4.25 AC
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(28) 5.5 AC
(25) 5.25 AC
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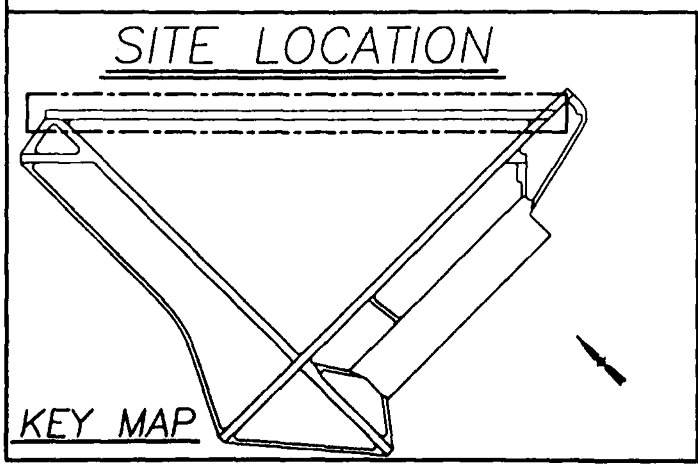
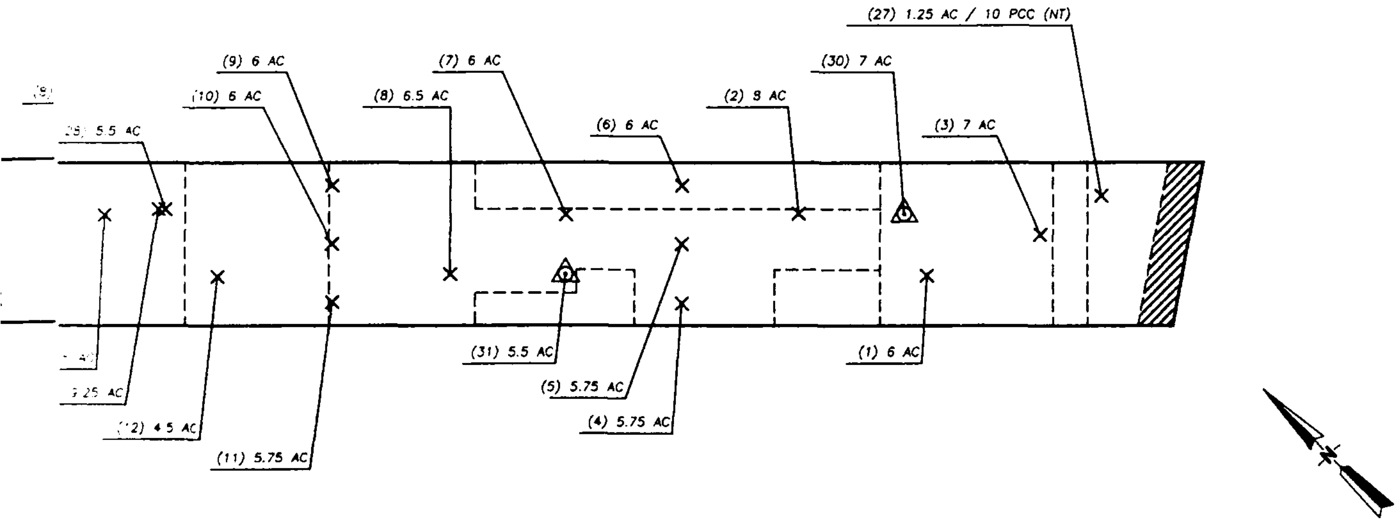
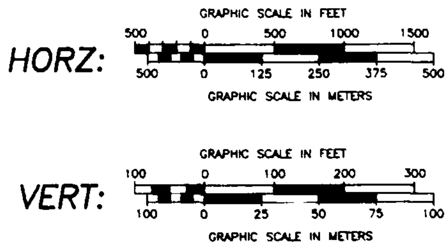

SITE LOCATION
KEY MAP





LEGEND

(25) 4 AC / 10 PCC (590)
CORE LOCATION, CORE NUMBER, PAVEMENT THICKNESS IN INCHES, PAVEMENT TYPE AND FLEXURAL STRENGTH OF CONCRETE FOR PCC CORES

O	DYNAMIC CONE PENTEROMETER (DCP) TEST LOCATION
X	ELECTRONIC CONE PENETROMETER (ECP) TEST LOCATION
Δ	SMALL APERATURE FIELD CBR TEST
AC	ASPHALTIC CONCRETE
PCC	PORTLAND CEMENT CONCRETE
NT	NOT TESTED
▨	NOT EVALUATED

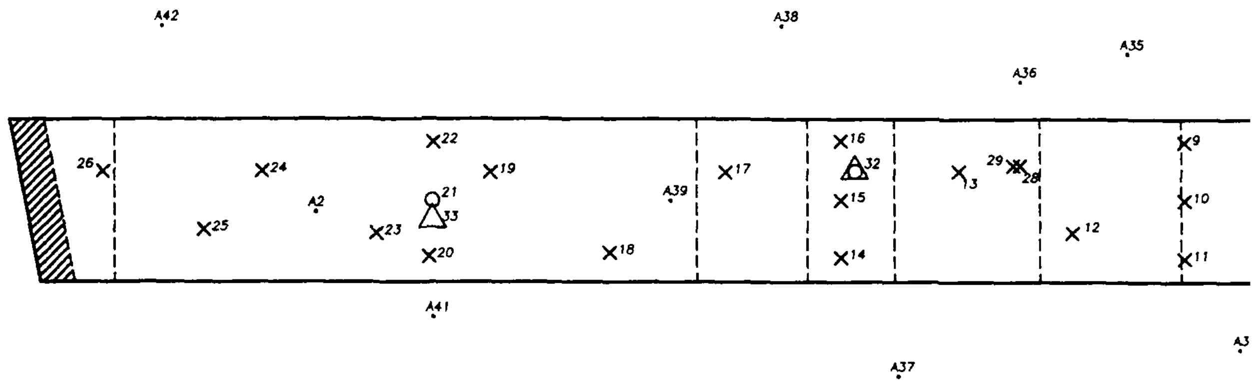
UNITED STATES AIR FORCE
CIVIL ENGINEER SUPPORT AGENCY
TYNDALL AIR FORCE BASE, FLORIDA

CORE / TEST LOCATIONS

PUEBLO, COLORADO

ENGINEER	DATE	DRAWING NUMBER
WALROND	MAY 1994	APPENDIX C
DRAWN	SCALE	
LEE	GRAPHIC	SHEET 1 OF 3

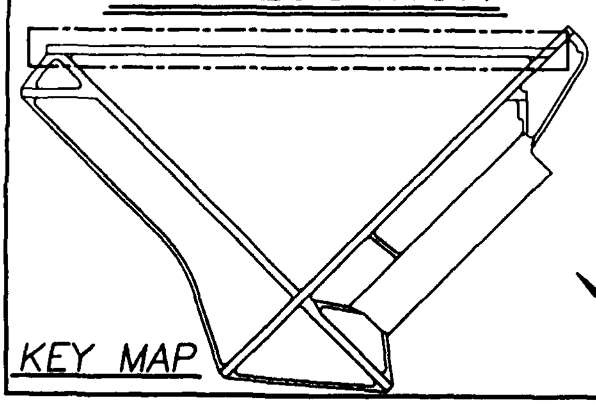
C-1



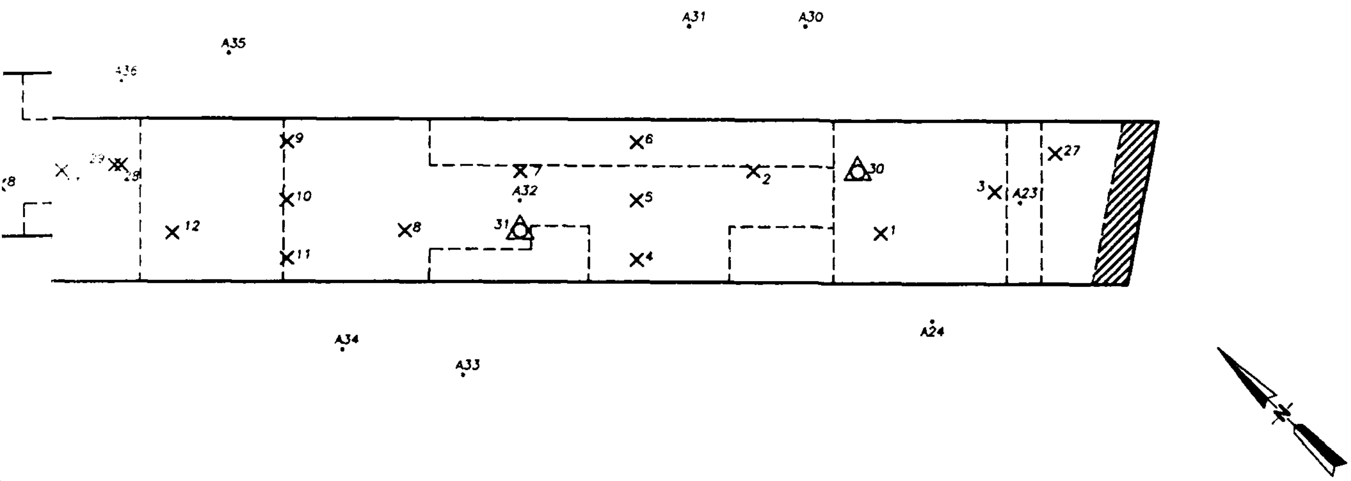
FIELD TEST RESULTS FROM US ENGINEER DEPARTMENT DATED: 18 JAN 44

NUMBER	DEPTH (IN FEET)	% CLAY	% SILT	LIQUID LIMIT	PLASTIC INDEX
A2	1.3 - 1.6 1.6 - 9.0	- -	- -	- -	- -
A 23	1.6 - 2.2 2.2 - 2.8	42 44	43 37	45 46	26 26
A 24	1.0 - 1.9 1.9 - 2.5 2.5 - 3.5	42 55 42	46 41 48	47 49 46	21 27 26
A 30	0.0 - 6.0 6.0 - 9.0	36 38	53 43	43 35	22 18
A 31	0.0 - 2.0 2.0 - 5.0	63 47	31 43	46 47	30 28
A 32	1.5 - 2.3 2.3 - 2.9 2.9 -	48 50 -	44 46 -	41 49 -	23 28 -
A 33	0.5 -	-	-	-	-
A 34	1.0 -	-	-	-	-
A 35	0.8 - 2.2 2.2 -	44 -	44 -	42 -	23 -
A 36	1.0 - 1.6 1.6 -	45 -	37 -	39 -	22 -
A 37	0.0 - 3.3 3.3 -	44 -	42 -	40 -	22 -
A 38	0.0 - 3.0 3.0 -	42 44	39 34	37 39	21 22
A 39	1.7 - 2.6 2.6 - 3.2	35 25	51 66	34 39	17 21
A 41	0.9 - 1.8 1.8 - 2.4	26 32	39 38	32 35	14 18
A 42	0.0 - 2.3 2.3 -	- -	- -	- -	- -

SITE LOCATION



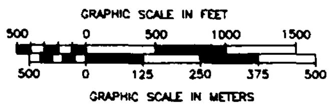
KEY MAP



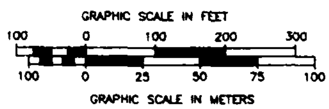
...ENGINEER DEPARTMENT DATED: 18 JAN 44

% CLAY	% SILT	LIQUID LIMIT	PLASTIC INDEX	SOIL CLASS
- -	- -	- -	- -	ML CL
4[illegible] 44	43 37	45 46	26 26	CL CL
4[illegible] [illegible] 42	46 41 48	47 49 46	21 27 26	CL CL CL
35 38	53 43	43 35	22 18	CL CL
53 47	31 43	46 47	30 28	CL CL
48 50 -	44 46 -	41 49 -	23 28 -	CL CH SHALE
-	-	-	-	SHALE
-	-	-	-	SHALE
44 -	44 -	42 -	23 -	CL SHALE
45 -	37 -	39 -	22 -	CL SHALE
44 -	42 -	40 -	22 -	CL SHALE
42 44	39 34	37 39	21 22	CL CL
35 25	51 66	34 39	17 21	CL CL
26 32	39 38	32 35	14 18	CL CL
- -	- -	- -	- -	CL SHALE

HORZ:



VERT:



LEGEND

- X ELECTRONIC CONE PENETROMETER (ECP) TEST LOCATION
- △ SMALL APERATURE FIELD CBR TEST
- O DYNAMIC CONE PENETROMETER (DCP) TEST LOCATION
- • FIELD TEST DATA LOCATION REFERENCED FROM OLD US ENGINEER DEPARTMENT DATED JANUARY 18, 1944
- ▨ NOT EVALUATED

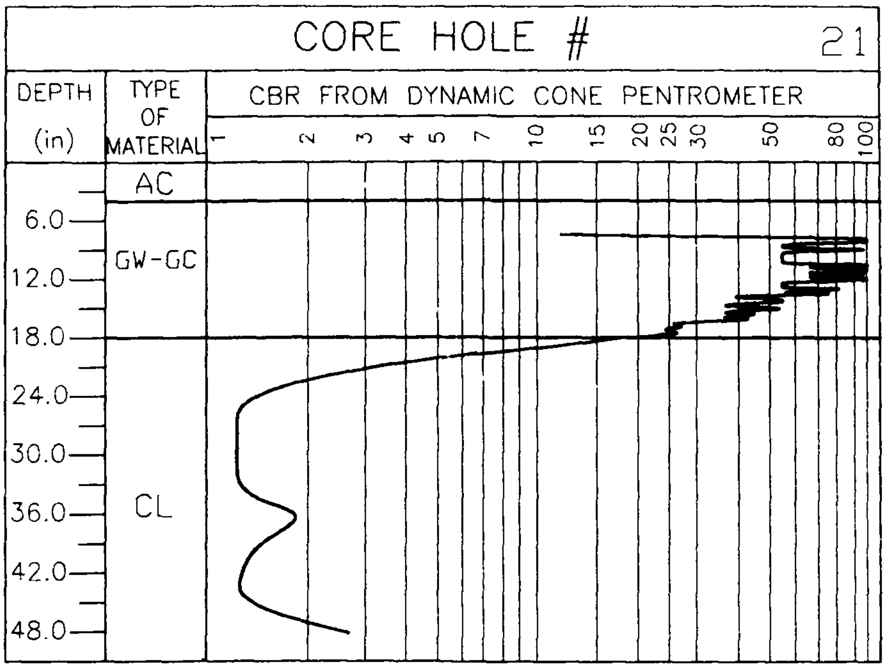
UNITED STATES AIR FORCE
CIVIL ENGINEER SUPPORT AGENCY
TYNDALL AIR FORCE BASE, FLORIDA

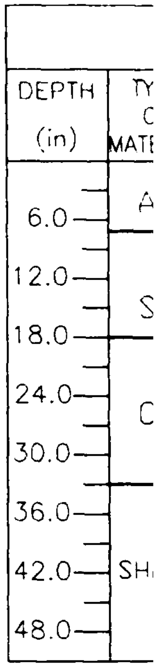
TEST LOCATIONS

PUEBLO, COLORADO

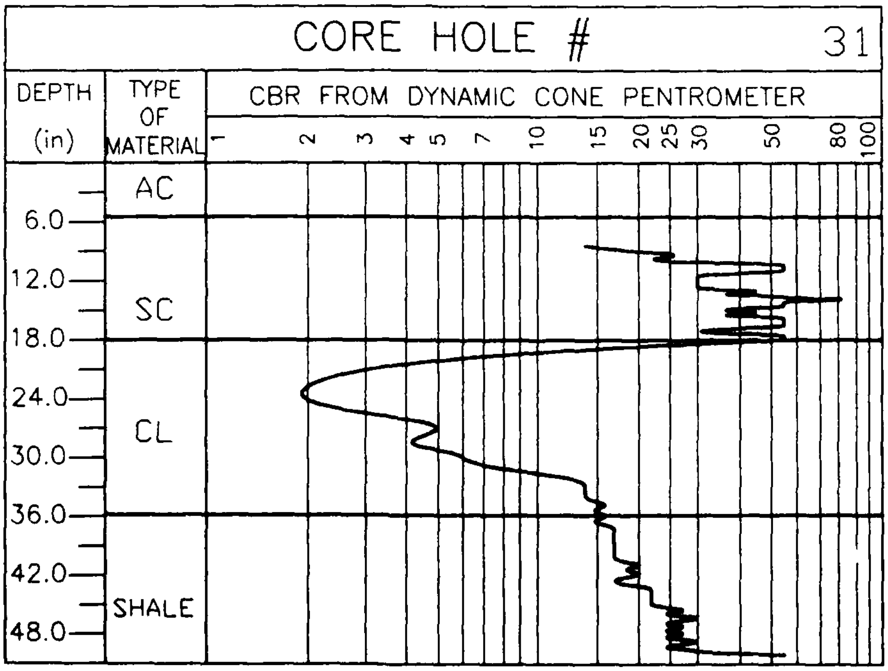
ENGINEER	DATE	DRAWING NUMBER
WALROND	MAY 1994	APPENDIX C
DRAWN: LEE	SCALE: GRAPHIC	SHEET 2 OF 3

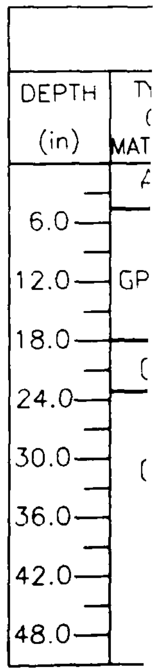
R 03 C


CORE HOLE # 21
DEPTH (in)
TYPE OF MATERIAL
CBR FROM DYNAMIC CONE PENTROMETER
1 2 3 4 5 7 10 15 20 25 30 50 80 100
6.0
12.0
18.0
24.0
30.0
36.0
42.0
48.0
AC
GW-GC
CL

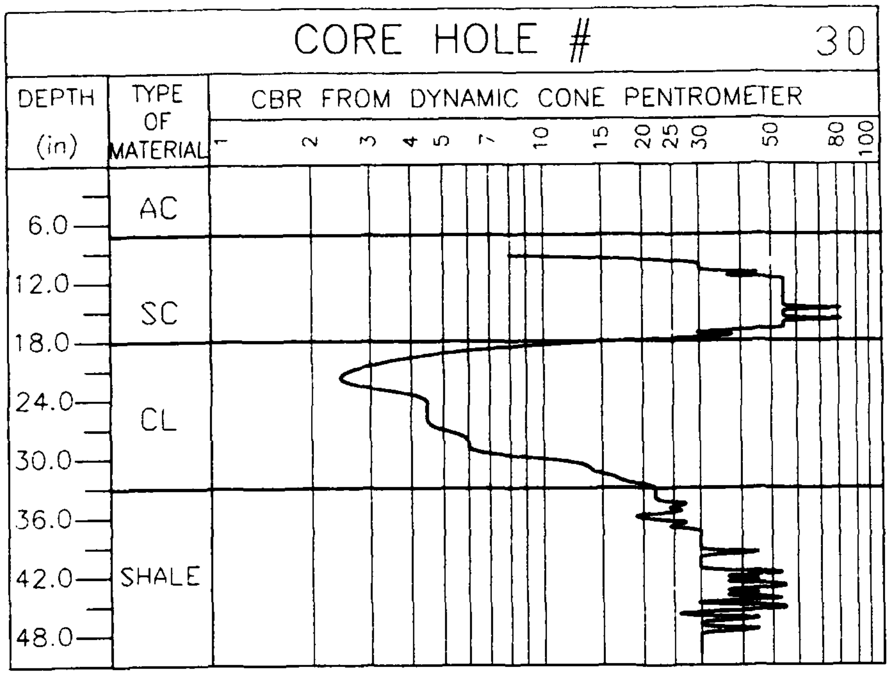


R 08 A

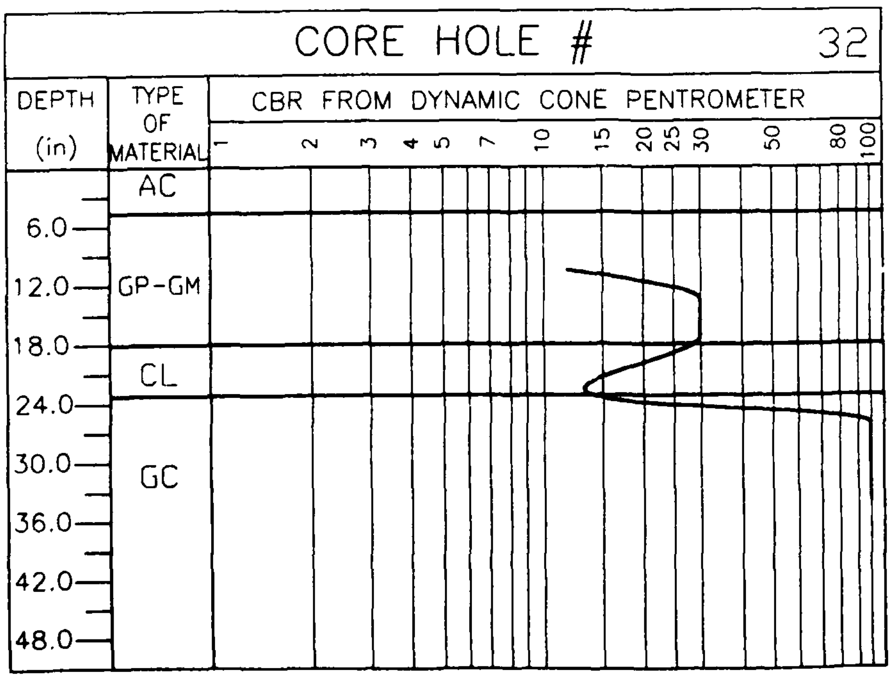

CORE HOLE # 31
DEPTH (in)
TYPE OF MATERIAL
CBR FROM DYNAMIC CONE PENTROMETER
1 2 3 4 5 7 10 15 20 25 30 50 80 100
6.0
12.0
18.0
24.0
30.0
36.0
42.0
48.0
AC
SC
CL
SHALE



R 10 A



R 05 A



NOTES:

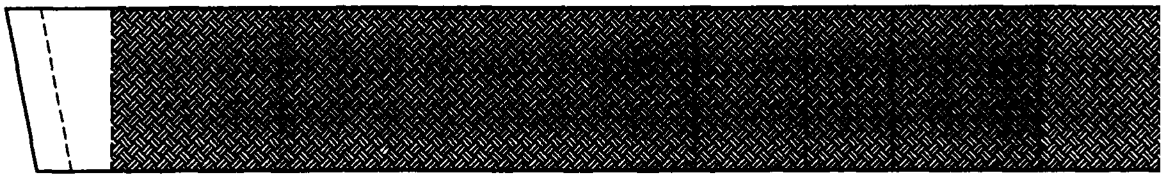
1. MAXIMUM CORE PENETRATION IS 48 INCHES BELOW PAVEMENT SURFACE.

UNITED STATES AIR FORCE
CIVIL ENGINEER SUPPORT AGENCY
TYNDALL AIR FORCE BASE, FLORIDA

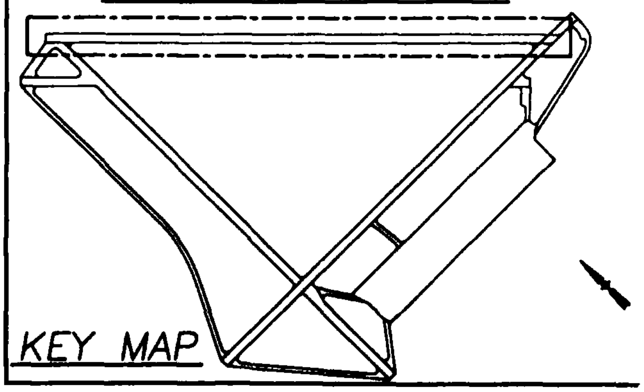
CORE HOLE/TEST LOCATION CROSS SECTIONS

PUEBLO, COLORADO

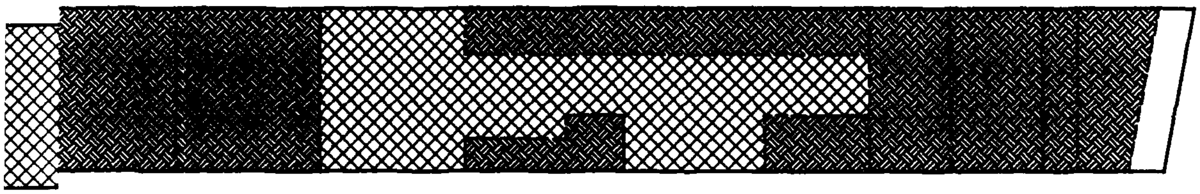
ENGINEER WALROND	DATE MAY 1994	DRAWING NUMBER APPENDIX C
DRAWN TIDWELL	SCALE NONE	SHEET 3 OF 3

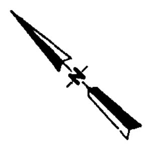


SITE LOCATION



KEY MAP





HORZ:

GRAPHIC SCALE IN FEET

500 0 500 1000 1500

500 0 125 250 375 500

GRAPHIC SCALE IN METERS

VERT:

GRAPHIC SCALE IN FEET

100 0 100 200 300

100 0 25 50 75 100

GRAPHIC SCALE IN METERS

LEGEND

(NOT USED)	EXCELLENT
(NOT USED)	VERY GOOD
(NOT USED)	GOOD
(NOT USED)	FAIR
(NOT USED)	POOR
	VERY POOR
	FAILED
	NOT EVALUATED

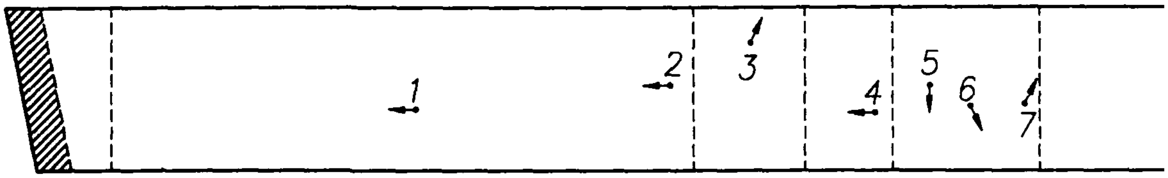
UNITED STATES AIR FORCE
CIVIL ENGINEER SUPPORT AGENCY
TYNDALL AIR FORCE BASE, FLORIDA

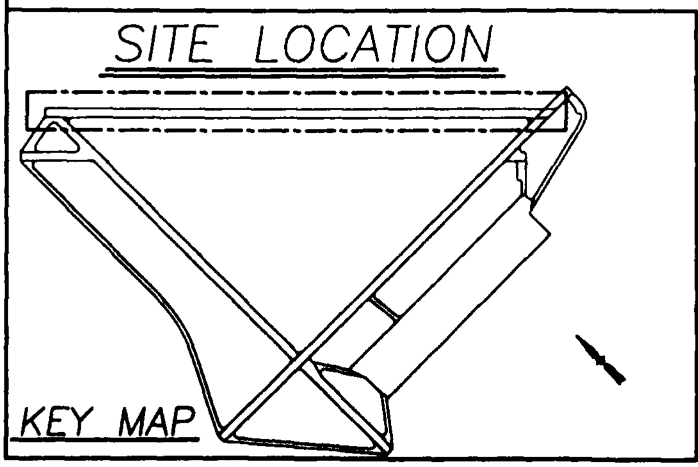
CONDITION SURVEY

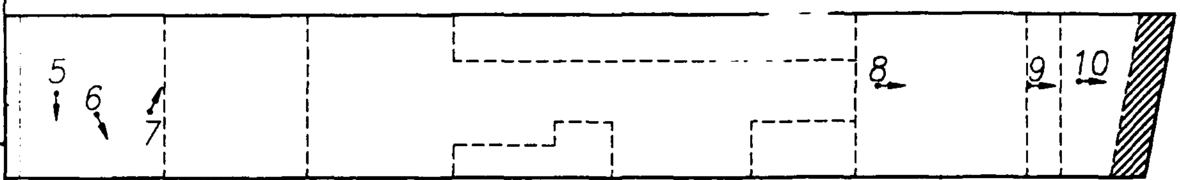
PUEBLO, COLORADO

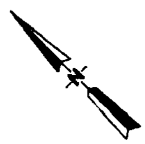
ENGINEER	DATE	DRAWING NUMBER
WALROND	MAY 1994	APPENDIX D
DRAWN TIDWELL	SCALE GRAPHIC	SHEET 1 OF 5

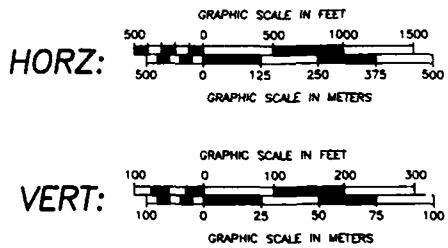
D-1


1
2
3
4
5
6
7


SITE LOCATION
KEY MAP







LEGEND

25 PHOTOGRAPH LOCATION, DIRECTION AND NUMBER

UNITED STATES AIR FORCE CIVIL ENGINEER SUPPORT AGEN TYNDALL AIR FORCE BASE, FLORI		
PHOTOGRAPH LOCATION PUEBLO, COLORADO		
ENGINEER WALROND	DATE MAY 1994	DRAWING NUMBER APPENDIX
DRAWN TIDWELL	SCALE GRAPHIC	SHEET 2

D-2

PHOTO 1 : GENERAL CONDITION OF FEATURE R03C (DAMAGE CAUSED BY EARTH MOVING EQUIPMENT).

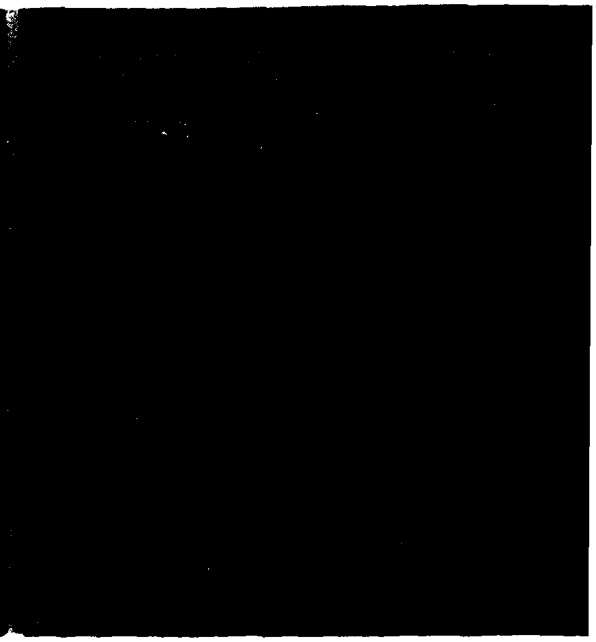


PHOTO 2 : TYPICAL VIEW OF CLEARED PORTION OF FE

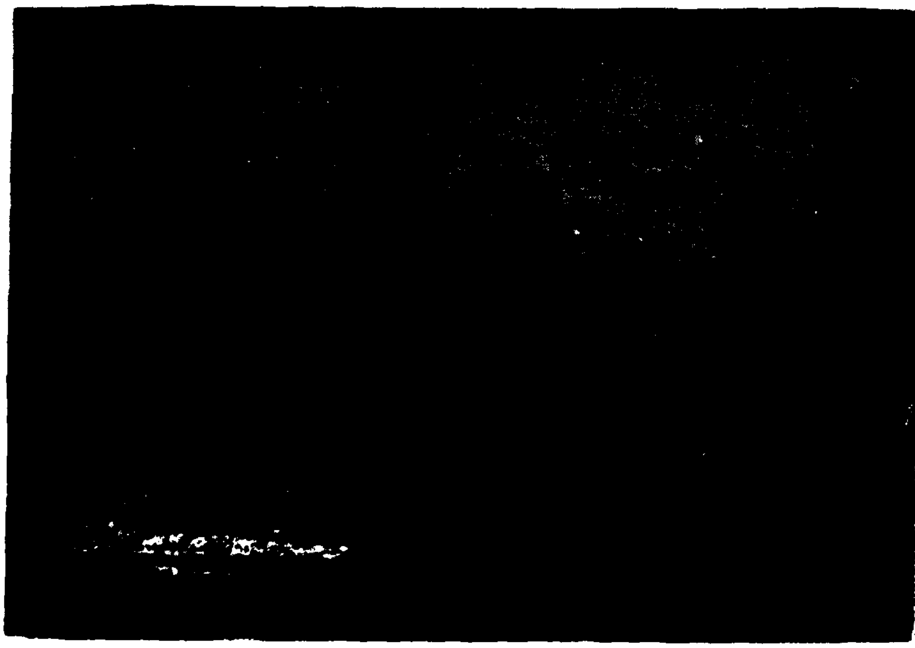


PHOTO 4 : HIGH SEVERITY ALLIGATOR CRACKING (FEATURE R05A).

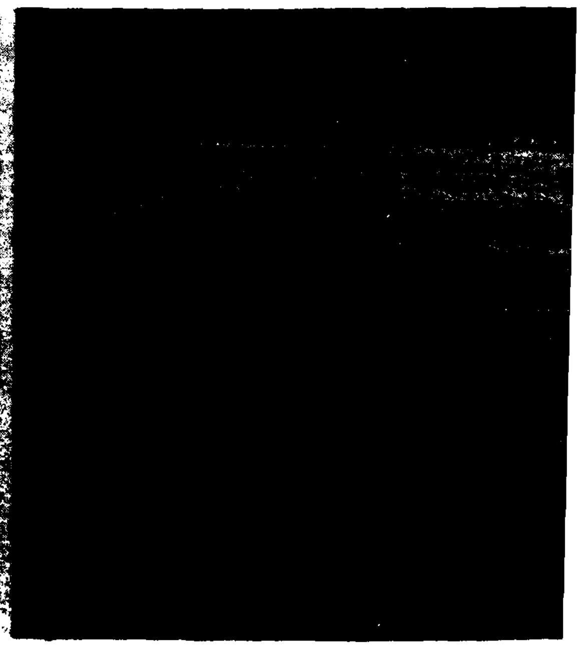
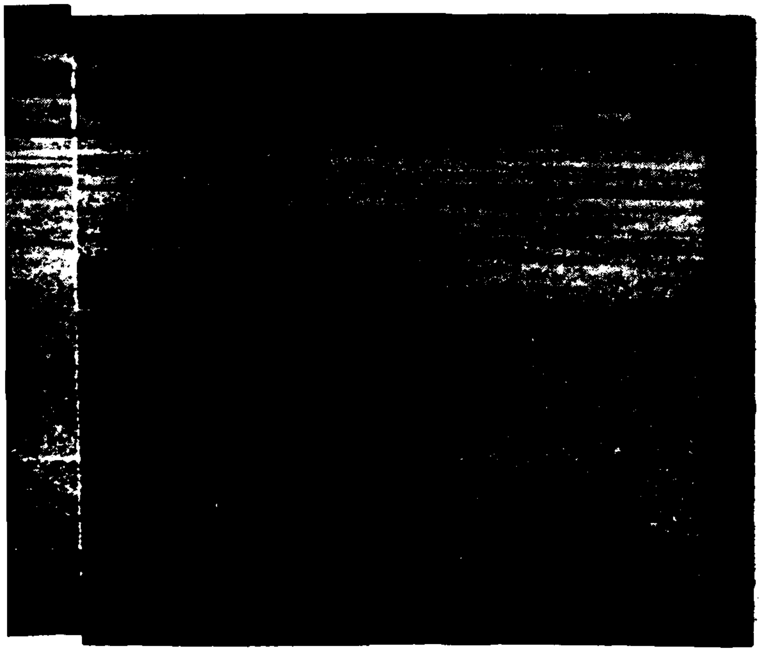


PHOTO 5 : FOUR INCH SWELL ACCROSS ENTIRE WID

'E R03C CAL VIEW OF CLEARED PORTION OF FEATURE R03C.

PHOTO 3 : HIGH SEVERITY RUTTING IN FEATURE R04A.



IF PAVEM INCH SWELL ACCROSS ENTIRE WIDTH OF PAVEMENT (FEATURE R06A).

UNITED STATES AIR FORCE
CIVIL ENGINEER SUPPORT AGEN
TYNDALL AIR FORCE BASE, FLORI

PHOTOGRAPHS

PUEBLO, COLORADO

ENGINEER	DATE	DRAWING NUMBER
WALROND	MAY 1994	APPENDIX
DRAWN TIDWELL	SCALE NONE	SHEET 3 (

D-3

PHOTO 6 : AREA OF HEAVED PAVEMENT IN FEATURE R06A.

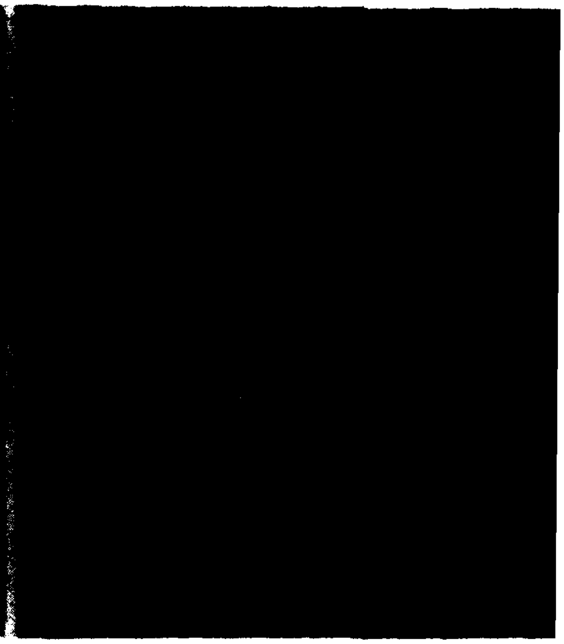


PHOTO 7 : SIX INCH SWELL ACROSS ENTIRE WIDTH
BOUNDARY BETWEEN R06A AND R07A.

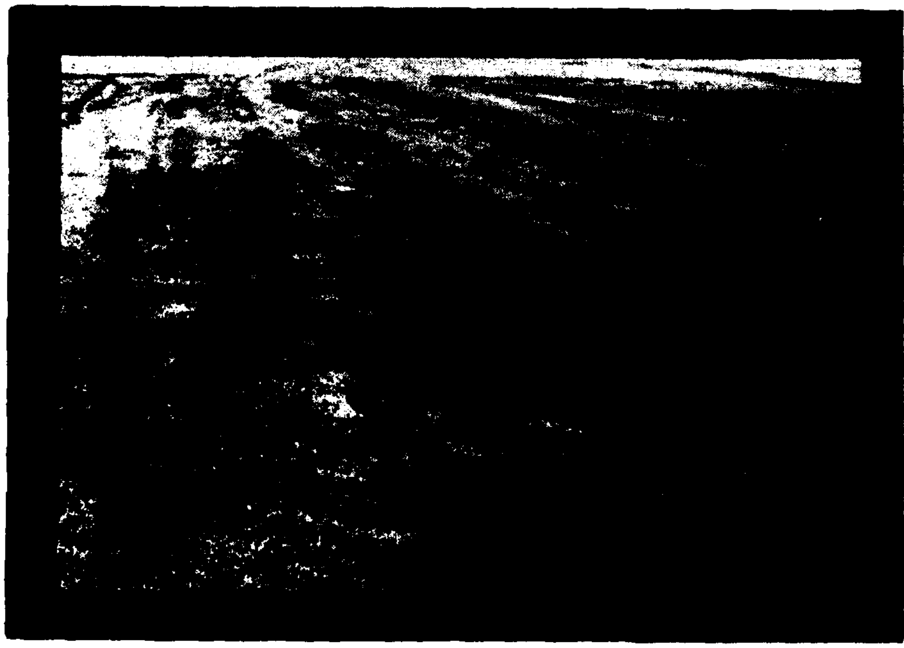


PHOTO 9 : FAILED PAVEMENT IN FEATURE R11A.

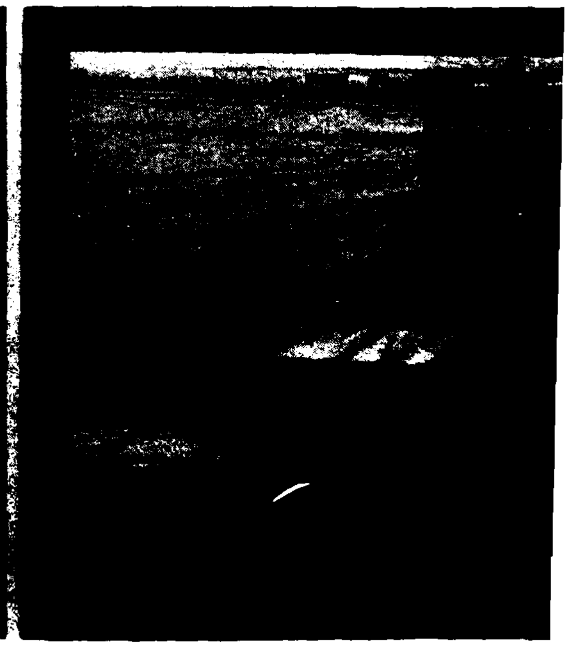
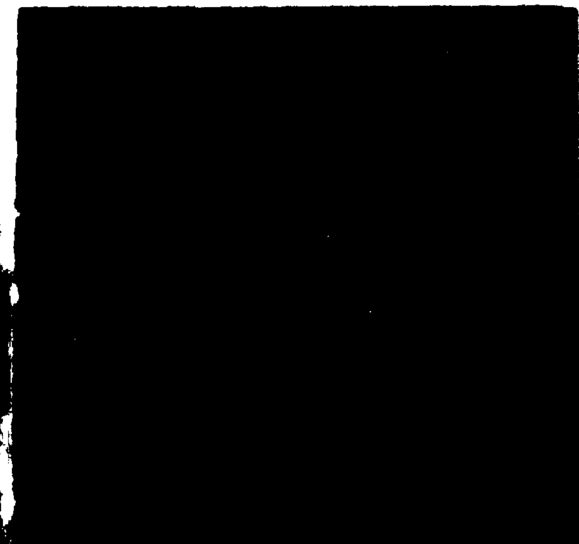


PHOTO 10 : JOINT REFLECTION CRACKING AND BL(
FEATURE R12A.

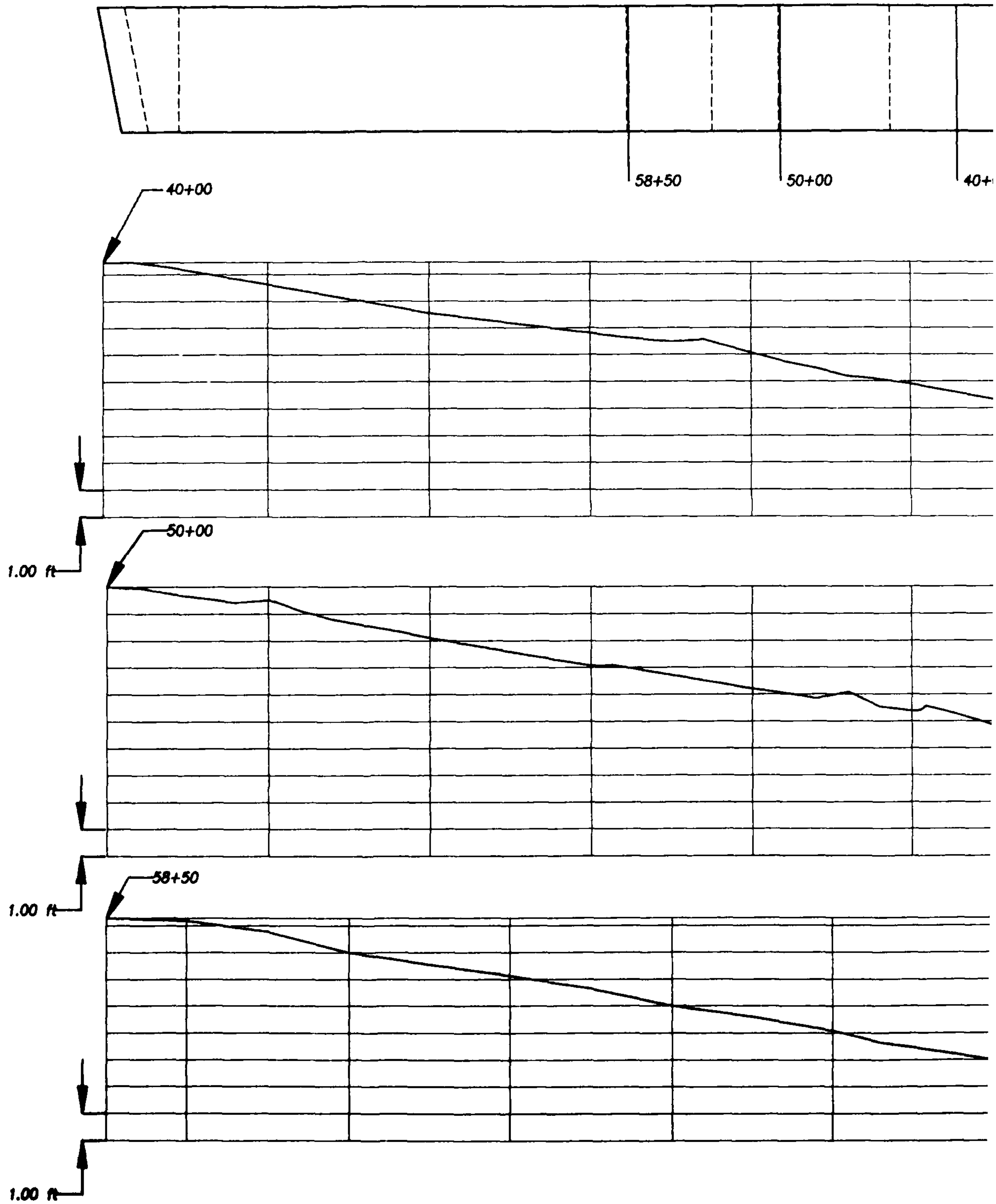


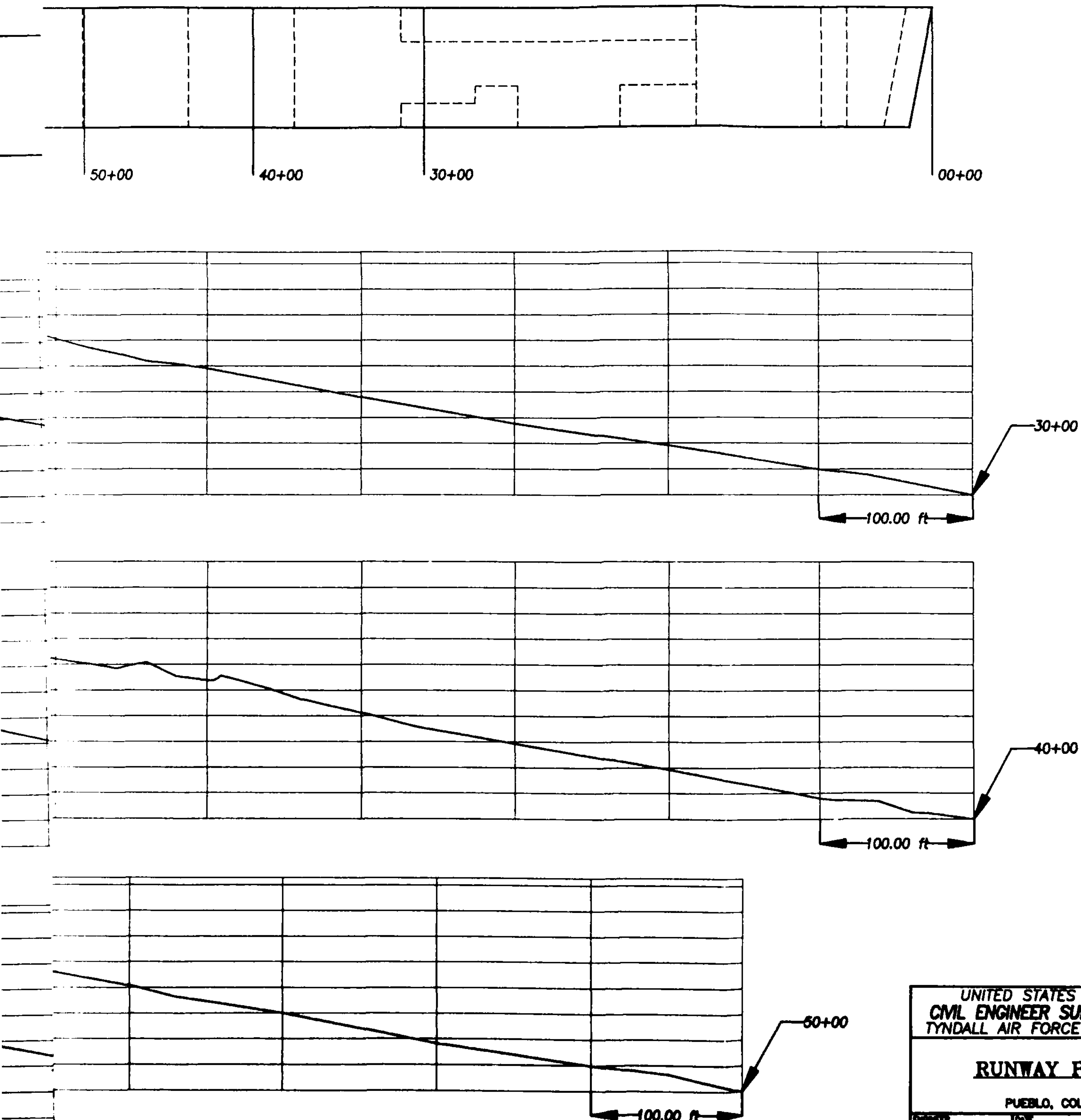
CH SWELL ACROSS ENTIRE WIDTH OF PAVEMENT NEAR
ARY BETWEEN R06A AND R07A.

PHOTO 8 : TYPICAL BLOCK, LONGITUDINAL AND TRANSVERSE CRACKING
(FEATURE R10A).

REFLECTION CRACKING AND BLOCK CRACKING TYPICAL IN
JRE R12A

UNITED STATES AIR FORCE CIVIL ENGINEER SUPPORT AGENCY TYNDALL AIR FORCE BASE, FLORIDA		
PHOTOGRAPHS PUEBLO, COLORADO		
ENGINEER WALROND	DATE MAY 1994	DRAWING NUMBER APPENDIX D
DRAWN TIDWELL	SCALE NONE	SHEET 4 OF


58+50
50+00
40+00
40+00
1.00 ft
50+00
1.00 ft
58+50
1.00 ft



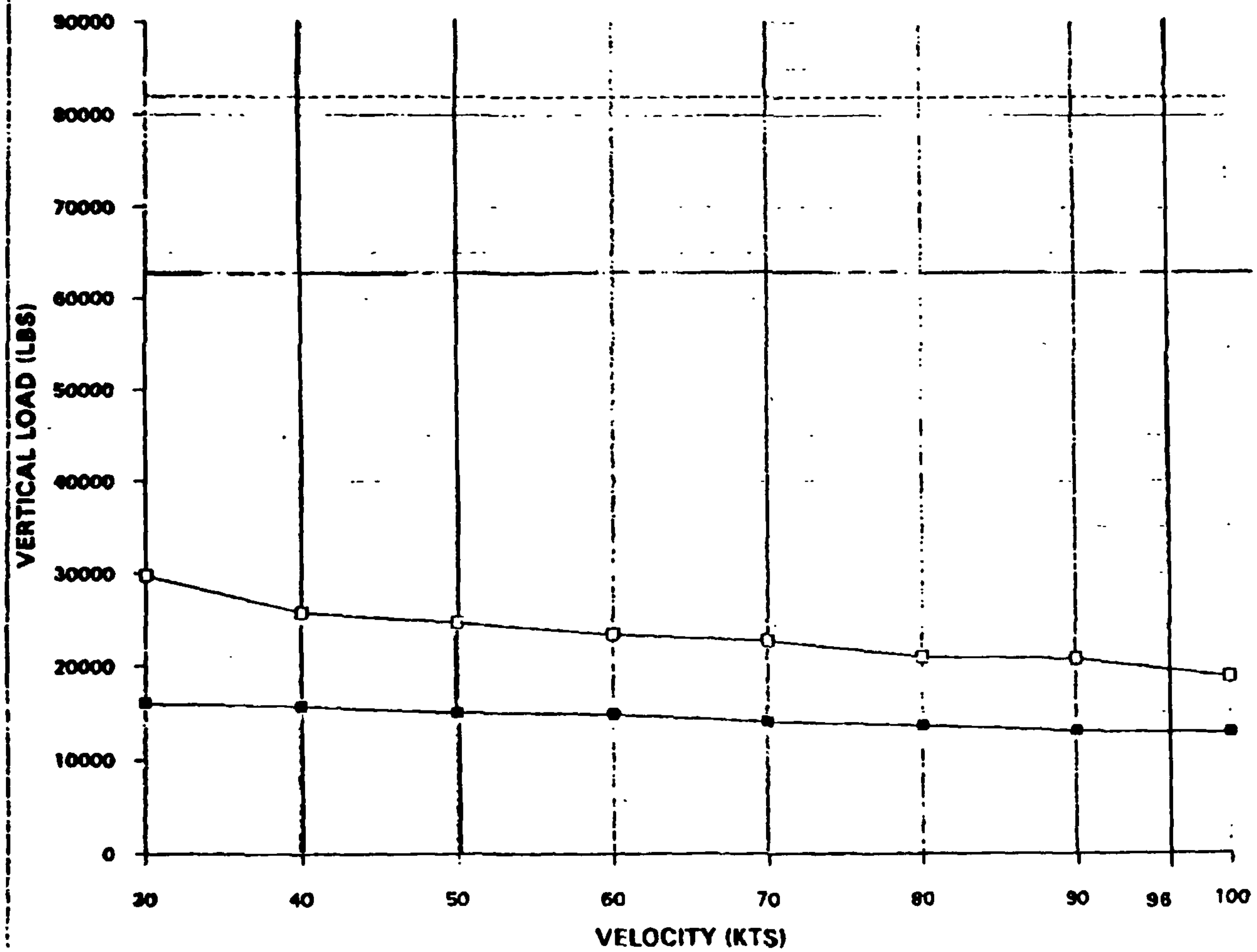
UNITED STATES AIR FORCE
CIVIL ENGINEER SUPPORT AGENCY
TYNDALL AIR FORCE BASE, FLORIDA

RUNWAY PROFILE

PUEBLO, COLORADO

WALROND	MAY 1994	APPENDIX D
TIDWELL	GRAPHIC	SHEET 5 OF

C-130E/H MAX LANDING GEAR LOAD PREDICTIONS
PUEBLO MEMORIAL CO



RUN CONFIGURATION:
AIRCRAFT: C-130E/H
GW: 130,000 LBS
CG: 27% MAC
TAKEOFF VELOCITY: 96 KTS
PROFILE: AS PROVIDED

NLG
MLG
NLG DLL (62850)
MLG DLL (82000)

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SUMMARY OF PHYSICAL PROPERTY DATA

FACILITY					OVERLAY PAVEMENT			PAVEMENT			BASE			SUBBASE			SUBGRADE	
FEAT	IDENT	LGTH (ft)	WDTH (ft)	GEN COND	THICK (in)	DESCRP	1000E FLEX	THICK (in)	DESCRP	1000E FLEX	THICK (in)	DESCRP	1000E K/CBR	THICK (in)	DESCRP	1000E CBR	DESCRP	1000E K/CBR
R02A	NW-SE RUNWAY		140				—	10.75	PCC (ANGLED LENGTH)	753	10	CLAYEY SAND (SC)	75			—	LEAN CLAY (CL)	290
R03A	NW-SE RUNWAY	2500	140	FAIL			—	4.5	AC	—	13.0	W/G GRVL W/CLAY & SAND (GW-GC)	30			—	LEAN CLAY (CL)	1
R04A	NW-SE RUNWAY	480	140	FAIL			—	6.0	AC	—	10.0	GRAVEL W/SILT (GM)	45			—	SANDY CLAY (SC)	1
R05A	NW-SE RUNWAY	385	140	FAIL			—	5.0	AC	—	12.0	P/G GRVL W/SILT & SAND (GP-GM)	27	6.0	LEAN CLAY W/SAND (CL)	2	CLAYEY GRAVEL W/SAND (GC)	30
R06A	NW-SE RUNWAY	625	140	FAIL			—	7.00	AC	—	11.0	P/G SAND W/SILT & GRAVEL (SP-SM)	6	9.0	LEAN CLAY (CL)	2	SHALE	100
R07A	NW-SE RUNWAY	610	140	FAIL			—	4.5	AC	—	12.0	POORLY GRADED GRAVEL (GP)	11	22.0	SANDY SILT (SM)	30	SHALE	100
R08A	NW-SE RUNWAY	630	140	VERY POOR			—	6.0	AC	—	11.0	CLAYEY SAND W/GRAVEL (SC)	24	0-24.0	LEAN CLAY W/SAND (CL)	2.5	SHALE	65
R09A	NW-SE RUNWAY	1745	55	FAIL			—	6.0	AC	—	12.0	POORLY GRADED GRAVEL (GP)	12			—	LEAN CLAY (CL)	2
R10A	NW-SE RUNWAY	1745	140	FAIL			—	7.0	AC	—	7.0	CLAYEY SAND W/GRAVEL (SC)	31	3.0 +	LEAN CLAY W/SAND (CL)	4	SHALE	70
R11A	NW-SE RUNWAY	141	140	FAIL			—	6.5	AC	—	7.0	CLAYEY SAND W/GRAVEL (SC)	31	3.0 +	LEAN CLAY W/SAND (CL)	4	SHALE	70
R12A	NW-SE RUNWAY		140	FAIL	1.25	AC (ANGLED LENGTH)	—	10.0	PCC ALKALINE REACTION TOP 5"	—	5.0	SANDY CLAY (SC)	140			—	LEAN CLAY (CL)	20

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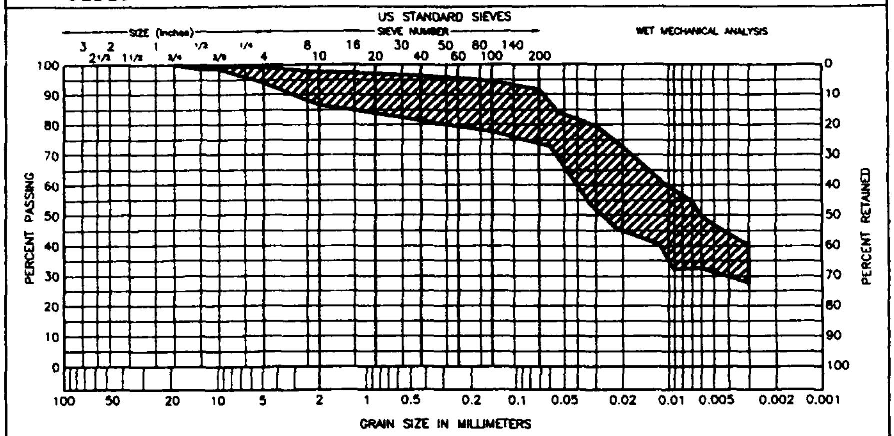
GRAIN SIZE DISTRIBUTION GRAPH – AGGREGATE GRADING CHART

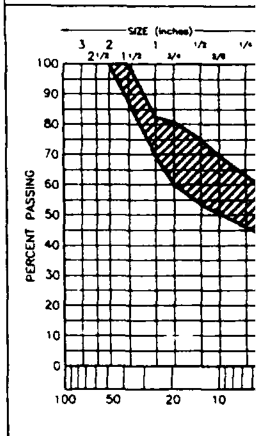
BASE PUEBLO



CORE HOLE	LAYER	DEPTH	Gs	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	FROST GROUP	GROUP SYMBOL	MUNSELL COLOR / REMARKS
21	SG	17.75	2.7	28.9	16.2	12.7	F3	CL	LEAN CLAY W/ SAND
28	SG	21	2.69	39.4	17.8	21.6	F3	CL	LEAN CLAY
29	SG	21	2.81	38.5	19.0	19.5	F3	CL	LEAN CLAY
30	SG	15	2.87	43.4	20.2	23.2	F3	CL	LEAN CLAY
31	SG	17.5	NT	35.7	16.3	19.4	F3	CL	LEAN CLAY W/ SAND
32	SG	26	NT	39.3	20.2	19.1	F3	CL	LEAN CLAY W/ SAND
33	SG	16	NT	32.5	17.3	15.2	F3	CL	LEAN CLAY

GRAIN SIZE DIS

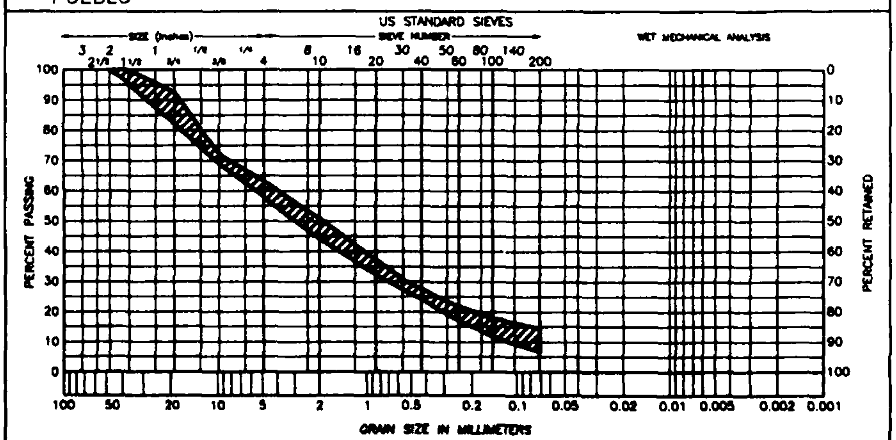
BASE PUEBLO



CORE HOLE	LAYER	DEPTH	Gs
31	BC	5.5	2.73
32	BC	4.75	NT
33	BC	4 25	NT

GRAIN SIZE DISTRIBUTION GRAPH – AGGREGATE GRADING CHART

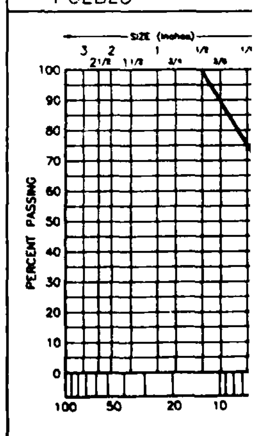
BASE PUEBLO



CORE HOLE	LAYER	DEPTH	Gs	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	FROST GROUP	GROUP SYMBOL	MUNSELL COLOR / REMARKS
28	BC	5.5	NT	NP	NP	NP	S2	SW-SM	WELL GRAD SAND W/SILT/GRAVEL
29	BC	9.25	NT	NP	NP	NP	S2	SP-SM	POOR GRAD SAND W/SILT/GRAVEL
30	BC	7.0	NT	26.2	15.2	11.0	F2	SC	CLAYEY SAND W/ GRAVEL

GRAIN SIZE DI

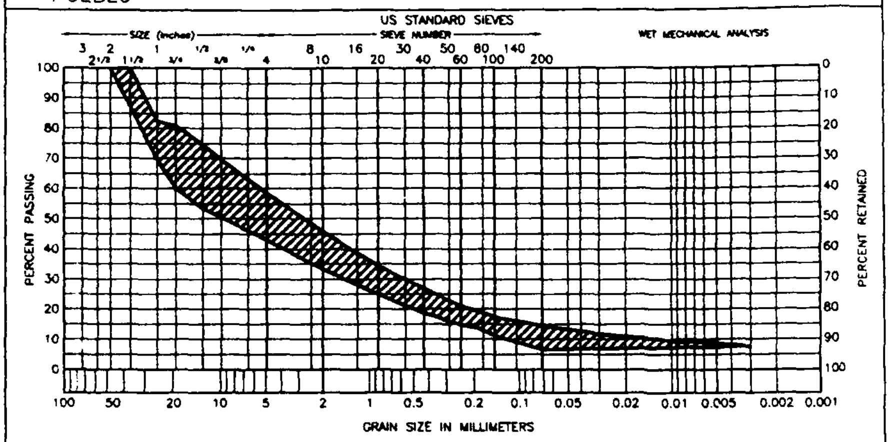
BASE PUEBLO



CORE HOLE	LAYER	DEPTH	Gs
32	SG	32	NT

GRAIN SIZE DISTRIBUTION GRAPH – AGGREGATE GRADING CHART

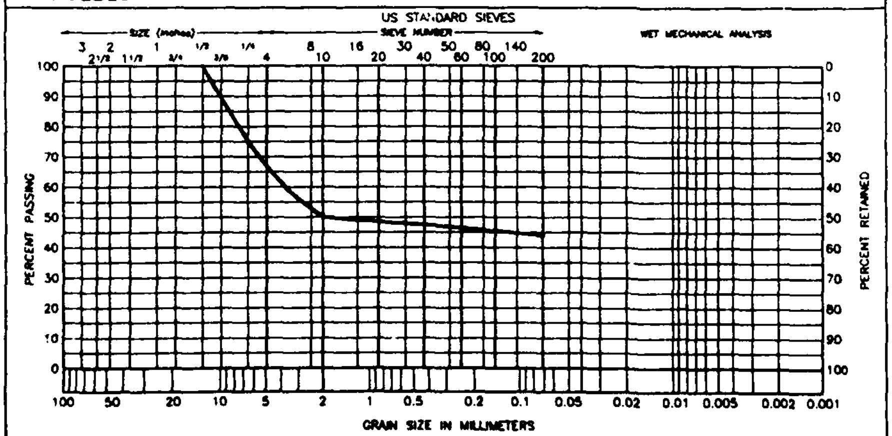
BASE PUEBLO



CORE HOLE	LAYER	DEPTH	Gs	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	FROST GROUP	GROUP SYMBOL	MUNSELL COLOR / REMARKS
31	BC	5.5	2.73	2.72	14.5	12.6	F2	SC	CLAYEY SAND W/ GRAVEL
32	BC	4.75	NT	NP	NP	NP	S1	GP–GM	POOR GRAD GRAVL W/SILT/SAND
33	BC	4.25	NT	31.3	15.8	15.5	F1	GW–GC	WELL GRAD GRAVL W/CLAY/SAND

GRAIN SIZE DISTRIBUTION GRAPH – AGGREGATE GRADING CHART

BASE PUEBLO



CORE HOLE	LAYER	DEPTH	Gs	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	FROST GROUP	GROUP SYMBOL	MUNSELL COLOR / REMARKS
32	SG	32	NT	35.9	19.5	16.4	F3	GC	CLAYEY GRAVEL W/ SAND

UNITED STATES AIR FORCE
CIVIL ENGINEER SUPPORT AGE
TYNDALL AIR FORCE BASE, FLO

LABORATORY TEST RES

PUEBLO, COLORADO

ENGINEER	DATE	DRAWING NO.
WALRONO	MAY 1994	APPEND
DRAWN: TIDWELL	SCALE: NONE	SHEET

E–2

TAB A

PUEBLO MEMORIAL AIRPORT

TOPOGRAPHY: Pueblo Memorial Airport is located 6 miles east of town, having moved to this location June 1, 1954. Pueblo is located at the junction of the Arkansas and Fountain Rivers, about 40 miles east-southeast of the point where the Arkansas River leaves the mountains through the Royal Gorge. The mountains extend to within 25 miles of the city to the southwest and within about 35 miles to the northwest. The surrounding country consists of rolling plains, broken by arroyos (usually dry); it is generally treeless and is covered sparsely with bunchgrass and cacti. The Arkansas River flows eastward about 2 miles south of the airport, which is approximately 45 feet above the river bed on rolling table land.

The mountain ranges to the west run generally north and south; about 60 miles north of Pueblo the Palmer Lake Divide extends east from the main range (this range has altitudes above 8000 feet). The ground slopes upward from Pueblo in every direction except the east and southeast.

VISIBILITY: Most of the smoke sources are in the western quadrant, thus all reductions in visibility occur with winds from that direction. Light and moderate fogs are most frequent during December. Radiation fog seldom occurs and when it does it is of short duration. The most likely time for it to form is between midnight and sunrise following precipitation on the previous day; it usually dissipates 2 or 3 hours after sunrise.

Dust storms cause visibility restrictions primarily during January, February and March. They are caused by high winds from the western quadrant which pick up dry surface soil and fine sand. Before January and after March there is normally enough surface vegetation to protect the soil and dust storms do not occur except with the most severe winds.

SEVERE WEATHER: The thunderstorm season is from late April through September. Practically all thunderstorms occur during the afternoon hours, thunderstoms occurring at night are rare and thunderstoms occurring after midnight are extremely rare. Thunderstorms usually form over the mountains during the morning hours and move over the plains during the afternoon. Hail may accompany these storms during any month, but is much more frequent during the early part of the thunderstom season (the maximum likelihood of hail occurrence is May). The area north of the Arkansas River and the section just east of the city seem far more likely to get severe hail in such storms than the southwest part of the city. Thunderstorms that form over the mountains to the northwest of Pueblo are more likely to move into the vicinity of Pueblo than those that form in the southwest.

CLIMATOLOGICAL DATA

	J	F	M	A	M	J	J	A	S	O	N	D	ANN	YRS REC
TEMPERATURE (°F)														
HIGHEST	78	81	84	90	98	106	106	104	99	92	84	82	106	41
MEAN DAILY MAX	45	51	56	67	76	87	92	90	81	70	56	48	68	41
MEAN DAILY MIN	14	20	25	36	46	55	61	59	50	37	24	17	37	41
LOWEST	-29	-31	-20	2	25	38	48	40	27	14	-14	-28	-31	41
MEAN NO. OF DAYS														
MAX TEMP ≥ 90 °F	0	0	0	#	2	13	22	18	7	#	0	0	62	41
MIN TEMP ≤ 32 °F	30	26	25	9	1	0	0	0	#	8	25	30	154	41
PRECIPITATION														
MEAN (INCHES)	.3	.3	.7	1.0	1.5	1.2	2.0	1.8	.8	.8	.4	.4	11.2	41
MEAN NO. OF DAYS ≥ 0.5 IN.	0	#	#	#	1	1	1	1	#	#	#	#	4	41
SNOWFALL														
MEAN (INCHES)	6	4	7	3	#	0	0	0	1	1	4	5	31	41
MEAN NO. OF DAYS ≥ 6 IN	#	#	#	0	0	0	0	0	0	0	0	#	#	41
RELATIVE HUMIDITY (%)														
MEAN	47	55	47	48	53	51	48	55	54	49	49	55	51	41

MAXIMUM 24 HOUR PRECIPITATION

3.0 INCHES 41 YEARS OF RECORD

MAXIMUM 24 HOUR SNOWFALL

16 INCHES 41 YEARS OF RECORD

FLYING WEATHER - ANNUAL PERCENTAGES FOR VARIOUS CATEGORIES

A. CEILING ≥ 1000 FEET AND VISIBILITY ≥ 3 MILES 93.1 %

B. CEILING 500-900 FEET AND VISIBILITY ≥ 1 MILE, OR VISIBILITY ≥ 1 MILE BUT < 3 MILES AND CEILING ≥ 1000' 2.7 %

C. CEILING < 500 FEET AND/OR VISIBILITY < 1 MILE 2.8 %

D. INSTRUMENT: CEILING ≥ 200 FEET AND VISIBILITY ≥ 1/2 MILE, AND EITHER CEILING < 1500 FEET OR VISIBILITY < 3 MILES 1.4 %

SOURCE OF DATA: RUSSWO, CLIMSUM

# DENOTES LESS THAN 0.05 INCH, LESS THAN .5 DAY

ANNUAL WIND COVERAGE TABULATION

RUNWAYS OR COMBINATIONS FOR CROSSWIND COMPONENT 10 KNOTS OR LESS

RUNWAY DIAGRAM	MAGNETIC MARK	TRUE BEARING	LENGTH IN FEET	(1)	(2)
08-26			10,496		
17-35			8,308		

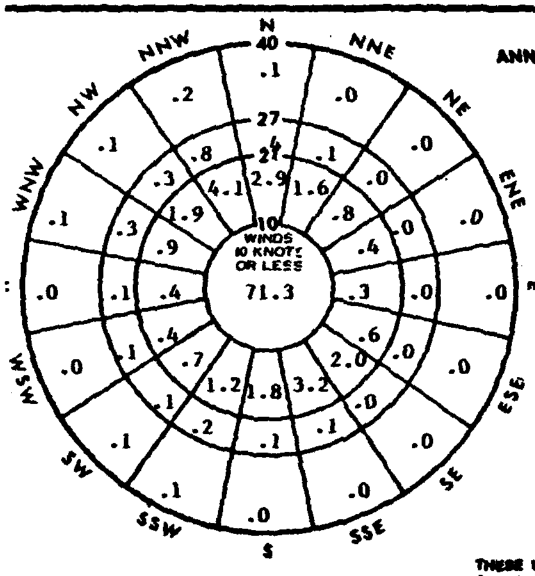
INSTRUMENT RUNWAY
(1) WIND COVERAGE (%) - ALL WEATHER
(2) WIND COVERAGE (%) - INSTRUMENT

ADDITIONAL DATA

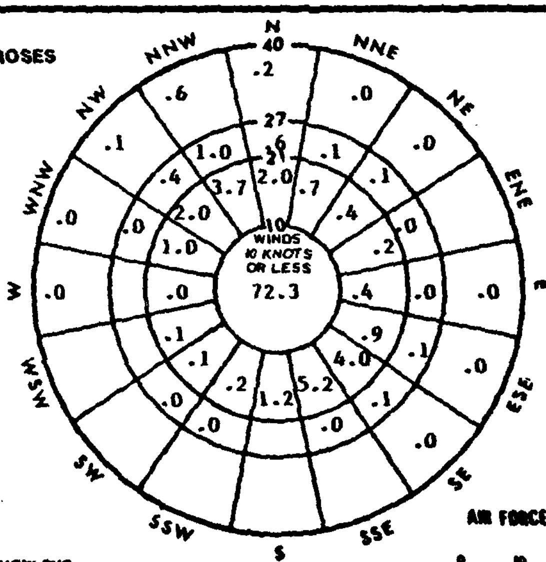
FIELD ELEVATION 4726 FEET MSL
MAGNETIC VARIATION ______
SOURCE US DOD FLIP
YEAR 1994

G-2

ANNUAL WIND ROSES



ALL WEATHER



INSTRUMENT

NOTE:
THESE WIND ROSES SHOW THE TOTAL % OF WINDS BY SPEED GROUP AND DIRECTION BASED ON TRUE BEARING.

AIR FORCE RUNWAY WIND COMPUTER
(SEE AFM 86-6)

0 10 21 27 40 KNOTS
12 24 31 46 MPH

ENGINEERING WEATHER DATA

AIR CONDITIONING DESIGN AND CRITERIA DATA (SEE AFM 88-8, CHAP 6)
WINTER HEATING DESIGN TEMPERATURE (SEE AFM 88-8, CHAP 6)
MEAN WINTER WIND SPEED 7.3 KNOTS
MEAN ANNUAL NUMBER OF HEATING DEGREE DAYS 6183 (SEE AFR 91-7)
PRESSURE ALTITUDE AND TEMPERATURE DATA FOR DETERMINING REQUIRED RUNWAY LENGTHS (SEE AFM 86-2)
EXTREME WIND DATA FOR CONSTRUCTION DESIGN (SEE AFM 88-3, CHAP 1)
SNOW LOAD DATA FOR ROOF CONSTRUCTION (SEE AFM 88-3, CHAP 1)
MAXIMUM FROST PENETRATION (SEE AFM 88-3, CHAP 1)
MEAN ANNUAL NUMBER OF COOLING DEGREE DAYS = 1228

NOTICE: WHEN NECESSARY, INTERPRETATIONS OF THESE DATA SHOULD BE SECURED THROUGH THE LOCAL STAFF WEATHER OFFICER.

PUEBLO MEMORIAL ARPT, CO
38°17'N 104°30'W
FIELD ELEVATION 4726 FT
PREPARED BY USAFETAC
JUNE 1994

TAB D