REPORT No. CDOH-P&R-R&SS-76-5

EROSION CONTROL AND REVEGETATION ON VAIL PASS: Final Report"

HERB SWANSON
COLORADO DIVISION OF HIGHWAYS
PLANNING AND RESEARCH DIVISION
4201 E. ARKANSAS AVENUE
DENVER, COLORADO 80222

NOVEMBER 1976
FINAL REPORT

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ACKNOWLEDGMENTS

Many people in District I of the Colorado Division of Highways were instrumental in the initiation of this study. The author expresses appreciation for their efforts.

Particular appreciation for their work in the field and input for this report is expressed to the following:

District #1 Personnel
Frisco Residency

W. Goff ..... Resident Engineer

R. Yowell ..... Project Engineer

Environmental Resource Analysis Division

M. Tupa ..... Staff Landscape Architect

EROSION CONTROL AND REVEGETATION
ON VAIL PASS

A B S T R A C T

Fourteen different treatments were applied to a side slope of an embankment east of Vail Pass. Analyses of these test areas indicates a possible economical slope treatment to aid in the design of future high altitude projects.

The fourteen sections, from one-half to one acre, adjoin each other on the same south facing slope.

Periodic evaluations were made during the growing seasons of the two year study.

The major conclusion from this research is that vegetative growth is restricted by thick, heavy cover materials, and there is a tendency for plant development to be inversely proportional to the thickness of the cover materials used to control erosion.

A recommendation is made that one or more test areas using straw only should be set up on steeper slopes.

INTRODUCTION

District and Project personnel on the Vail Pass East project (I 70-2(41)197) expressed interest regarding the effectiveness of chemical soil binders and Hydromulch as alternative erosion control measures. Fourteen experimental sections were established on this project to test erosion control of side slopes until sufficient plant growth is established.

The test area is located about two miles east of Vail Pass and extends from Station 915+00 to Station 925+00. This embankment is immediately east of the proposed Smith Gulch structure. (See map Appendix A.) The entire test was supervised through the cooperative efforts of the Project Engineer, the Project Landscape Architect and the Physical Research Unit of the Planning and Research Division. The materials and the work involved in the installation and the observation of the placement was made by all the above mentioned personnel. The test sections are adjacent to each other, on a south facing embankment of the future driving lane.

The embankment was constructed during the late summer of 1974. Top soil was placed in early October and all the seeding and erosion control materials were placed in the test sections during the week of October 10, 1974.

Field inspections and ratings were made periodically during the 1975 and 1976 growing seasons. A summary of the field ratings is given in Table 3.

The environmental variables were constant for all application combinations.

These variables are as follows:

Slope Ratio	6:1
Slope Exposure	Southwest
Soil Type	A-7(6)
Moisture Content (soil)	8 - 10%
Fertilizer	100 #/A. Nitrogen 200 #/A. Super Phosphate
Seed Mix Quantities	40 PLS #/Acre
Elevation	10,240'
Topsoil Depth	4"
Slope Preparation	Placed and Leveled
Season (time of application)	October 1974
Weather Conditions	Temperature 40^{o} F. Partly Cloudy

DESCRIPTION OF EROSION CONTROL MEASURES

The following table shows the location of erosion control measures for each section and the cost per acre of each combination.

TABLE 1

Section	Stations	Materials	Cost/Acre
Control	915 + 00 916 + 00	Seed & Fert. Straw & Jute	$ 4,480
1	916 + 00 916 + 50	Seed & Fert. Jute	4,280
2	916 + 50 917 + 00	Seed & Fert. Hydro. Mulch II Jute	4,490
3	917 + 00 917 + 50	Seed & Fert. Hydro. Mulch III	550
4	917 + 50 918 + 00	Seed & Fert. Hydro. Mulch II	490
5	918 + 00 918 + 50	Seed & Fert. Hydro. Mulch I	430
6	918 + 50 919 + 00	Seed & Fert. Hydro. Mulch II Petroset III	865
7	919 + 00 919 + 50	Seed & Fert. Hydro. Mulch II Petroset I	615
8	919 + 50 920 + 00	Seed & Fert. Petroset III	655
9	920 + 00 920 + 50	Seed & Fert. Petroset II	530
10	920 + 50 921 + 00	Seed & Fert. Petroset I	405
11	921 + 00 921 + 50	Seed & Fert. Straw Petroset III	855
12	921 + 50 922 + 00	Seed & Fert. Straw Petroset I	605
13	922 + 00 923 + 00	Seed & Fert. Straw	480
14	923 + 00 925 + 00	Seed & Fert.	280

The following table shows individual materials, rates of application and costs per acre.

TABLE 2

Material	PLS% by Weight	Rate: Quantity/Acre	Cost/Acre
Seed:			
Slender Wheatgrass	5		
Meadow Foxtail	21		
Timothy	10		
Pubescent Wheatgrass	11		
Smooth Brome (Manchar)	27	40 lbs	$ 280.00
Ladak Alfalfa	5		
Kentucky Bluegrass	5		
Impurities	16		
Total	100%		
Fertilizer:			
Nitrogen		100 lbs	Included in price of seed
Super Phosphate		200 lbs	
Straw Mulch		2 Tons	$ 200.00
Hydromulch I		1000 lbs	$ 150.00*
Hydromulch II		1400 lbs	$ 210.00*
Hydromulch III		1800 lbs	$ 270.00*
Petroset I		50 gal	$ 125.00*
Petroset II		100 gal	$ 250.00*
Petroset III		150 gal	$ 375.00*
Jute Mat		5,000 yds^2	$4000.00

*Estimated. These costs may vary with the quantity.

Table 3

Summary of Field Ratings

Date	7-31-75		8-27-75		10-22-75		6-24-76		8-11-76		
Section	Height of Vegetation	Density	Height of Vegetation	Density	Vigor	Density	Vigor	Density	Vigor	Density	Final Ranking
Control	4	10	6	20	3	30	3	50	4	70	4
1	1.75	10	4	10	2	15	3	50	3	60	13
2	5	20	4	18	2	15	2	40	2.5	50	15
3	4.5	20	5	20	3	25	3	25	3	55	12
4	4.5	20	6	20	3	20	3	20	3	50	14
5	4.5	20	6.5	20	3	20	3	40	3	60	8
6	4.5	20	6.5	20	3	20	3	40	3	60	9
7	4	20	5.5	20	4	35	4	45	4	55-	6
8	4	20	6	20	3	30	3	50	3	60	7
9	4	20	8	20	3	30	3	50	3	65	5
10	4	10	5.5	10	2	15	2	50	2.5	65	11
11	4.5	10	5.5	10	3	25	3	55	3	60	10
12	5	20	8.5	20	4	35	4	55	4	65-	3
13	6.5	35	12.5	45	4+	50	4	60	4.5	75-	1
14	3.5	30	8	25	3	25	3	60	4	70-	2

Height is average inches.
Density shows the % of ground shaded at high noon.

Vigor, 5 = excellent; 4 = good; 3 = average; 2 = fair; 1 = poor

The following is a field inspection and rating which was done on October 22, 1975

Section Number	Cover	Vigor	Density	Erosion Control	Species
Control	Straw	3	30%	4	Ky bluegrass, brome, yarrow
1	Jute	2	15%	3	Ky bluegrass, brome, slender wheatgrass
2	Hyd. Mulch II, Jute	2	15%	3	Ky bluegrass, slender wheatgrass
3	Hyd. Mulch III	3	25%	2+	Meadow foxtail, smooth brome, Ky bluegrass, pubescent wheatgrass
4	Hyd. Mulch II	3	20%	2-	Smooth brome, meadow foxtail, slender wheatgrass, Ky bluegrass
5	Hyd. Mulch I	3	20%	2-	Smooth brome, meadow foxtail, pubescent wheatgrass, slender wheatgrass, Ky bluegrass
6	Hyd. Mulch II, Petroset III	3	20%	2-	Smooth brome (cheatgrass), Ky bluegrass, meadow foxtail, pubescent wheatgrass, slender wheatgrass
7	Hyd. Mulch II, Petroset I	4	35%	3	Meadow foxtail, slender, pubescent (cheatgrass), Ky bluegrass, smooth brome
8	Petroset III	3	30%	3	Meadow foxtail, pubescent, Ky bluegrass, slender brome
9	Petroset II	3	30%	3	Foxtail, brome, Ky bluegrass, pubescent
10	Petroset I	2	15%	2-	Foxtail, Ky bluegrass, pubescent
11	Straw Petroset III	3	25%	3	Foxtail, slender, timothy, brome, Ky bluegrass, pubescent
12	Straw Petroset I	4	35%	4 (Shade)	Foxtail, timothy, brome, pubescent, Ky bluegrass, slender
13	Straw	4+	50%	4 (Shade)	Brome, Ky bluegrass, foxtail, slender, pubescent
14	None	3	25%	3 (Shade)	Ky bluegrass, pubescent, foxtail, brome

Key: For Vigor and Erosion, 5 = excellent; 4 = good; 3 = average; 2 = fair; 1 = poor. Density shows % of ground shaded at high noon. Some native cheatgrass was found throughout the test sections.

Ratings and Species check made by John Murray, Soil Conservation Service, Box 386, Eagle, Colorado 81637 - Telephone 328-6988, and Jim Kellogg, Soil Conservation Service, Box 1629, Grand Junction, Colorado 81501.

The field inspection on page 4 shows the grass species present at the end of the first growing season. The following is a list of the species in order of their presence in the test sections.

1.	Kentucky Bluegrass	All sections
2.	Brome	All sections except 2 and 10
3.	Meadow Foxtail	Sections 3 through 14
4.	Pubescent Wheatgrass	Section 3 and 5 through 14
5.	Slender Wheatgrass	Sections 1, 2, 4, 5, 6, 7, 11, 12 and 13
6.	Timothy	Sections 11 and 12
7.	Ladak Alfalfa	None

Meadow Foxtail and Pubescent Wheatgrass are conspicuously absent from the sections on which jute mat was used.

Perhaps Timothy and Ladak Alfalfa could be eliminated from the design seed mix for high altitude projects if the listing above truly represents their performance.

COMPARISON OF EROSION CONTROL TREATMENTS

Control Section

This section is composed of seed, fertilizer, straw mulch and jute mat. This section is identical to the project specifications and is used as a comparison for all other test sections. The cost of this type of erosion control is $4,480 per acre. (See Table 1.)

Section 1

Seed, Fertilizer and Jute

This section deviates from project specifications by the elimination of straw. Growth has been somewhat less effective than the control section. The lack of straw mulch may have allowed higher moisture losses causing the difference in growth. Cost = $4,280/acre.

Section 2

Hydromulch was used in place of straw in this section. This design produced vegetation nearly as good as the control. There is no particular advantage in the use of this design since the cost is slightly higher. Cost = $4,490/acre.

Sections 3, 4 and 5

These three sections are a comparison of different rates of application of Hydromulch. Section 5 has produced slightly better vegetation than the other two, but differences are so slight that economics must be the deciding factor. Section 5 had the lightest application (1000 lbs/acre). None of these three application rates of Hydromulch produced vegetation quite as dense or vigorous as the standard control section. Costs = $550/acre, 490/acre and 430/acre respectively.

Sections 6 and 7

Different rates of application of Petroset were compared. The lighter rate of 50 gallons per acre on Section 7 produced the best vegetation. The vegetation on Section 7 is very similar to the control section. Costs = $865/acre for Section 6 and $615/acre on Section 7.

Sections 8, 9 and 10

Petroset is the erosion control agent in these sections and was applied at the rates of 150, 100 and 50 gallons per acre respectively. The light application of 50 gallons/acre did not produce vegetation as good as the same application in Section 7 where Petroset was used in combination with Hydromulch. The vegetation of Sections 8 and 9 is very similar to Section 7 and the control section. Costs = $655/acre, 530/acre and 405/acre respectively.

Sections 11 and 12

These sections represent the standard slope treatment with the substitution of Petroset for jute matting. The vegetation on Section 11 is very similar to the control section and Section 12 is slightly better. This would suggest that the lighter application will produce better vegetation. Costs = $855/acre and 605/acre respectively.

Section 13

The use of crimped straw only provided early and better cover than all other sections including the control which is the project standard specifications. This treatment is also one of the most economical. Cost = $480/acre.

Section 14

No erosion control measure was taken in this section. Vegetation in this section got an earlier start and was considerably better than the control section during 1975. It has been just about the same as the control in 1976. Cost = $280/acre.

The cost figures shown in this section Comparison of Erosion Control Treatments and in Table 1, page 3, were calculated on the quantities used in these small test plots. Projects which specify one design for larger areas would accommodate easier, faster and more economical placement.

CONCLUSIONS

There has been very little erosion of any of the test area. Photograph number 5 shows some minor erosion and photograph number 6 shows the minor sedimentation at the bottom of the slope. Erosion has been insignificant partly because this is not a very steep slope (6:1). Therefore, this study has primarily tested vegetative growth through various materials.

The vegetation on Section 13 (crimped straw only) took an early lead and continued to be the best through the two year study period.

The summary of field ratings on Table 3 and the comparisons above indicate that less cover materials will produce more and better vegetation. The more cover materials that are used, the more seed growth will be retarded.

The question remains. Will crimped straw only, effectively control erosion on steeper slopes?

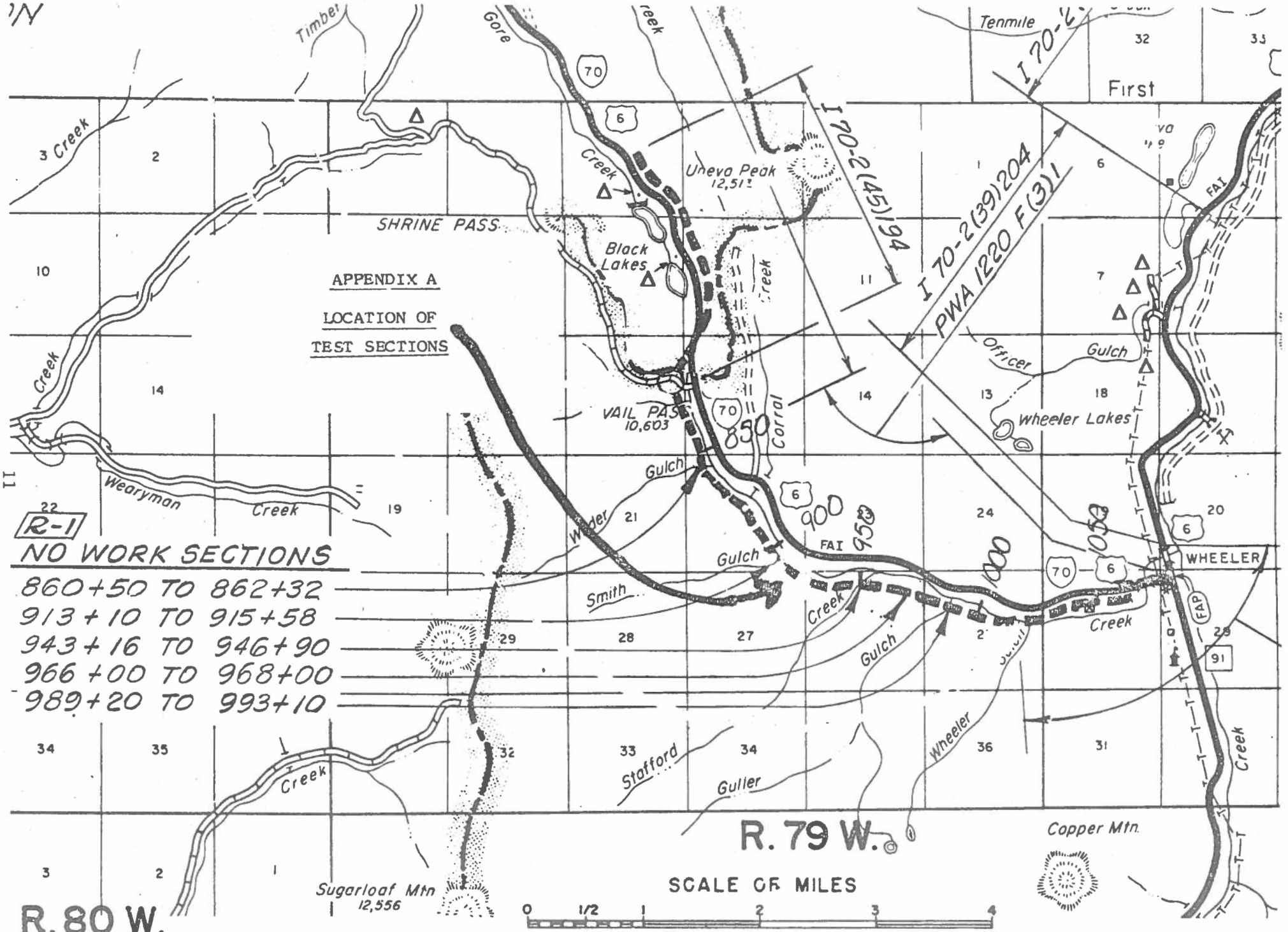
If isolated areas should erode, they could be replanted and straw mulched nine times for the same cost as the standard project specifications of straw and jute mat.

The Petroset used in Sections 11 and 12 produced vegetation as good or better than the control section. Petroset treatments at 50 gallons per acre cost about one seventh as much as the jute mat treatment.

RECOMMENDATIONS

Seed fertilizer and crimped straw, as was used in Section 13, should be placed on several limited areas on steeper slopes to further test the conclusions of this study. Petroset should also be tested on some steeper slopes since it produces vegetation as good as the standard, jute mat. Project engineers on high altitude projects are encouraged to use crimped straw only or Petroset, especially if provisions can be made to reseed small areas which may be eroded during the first high run off season. Engineering judgment is to be exercised in the selection of these sites as even jute mat does not provide immunity to erosion under severe conditions.

The results of this study should be used with care since they are based on a constant set of environmental variables, shown on page 2.

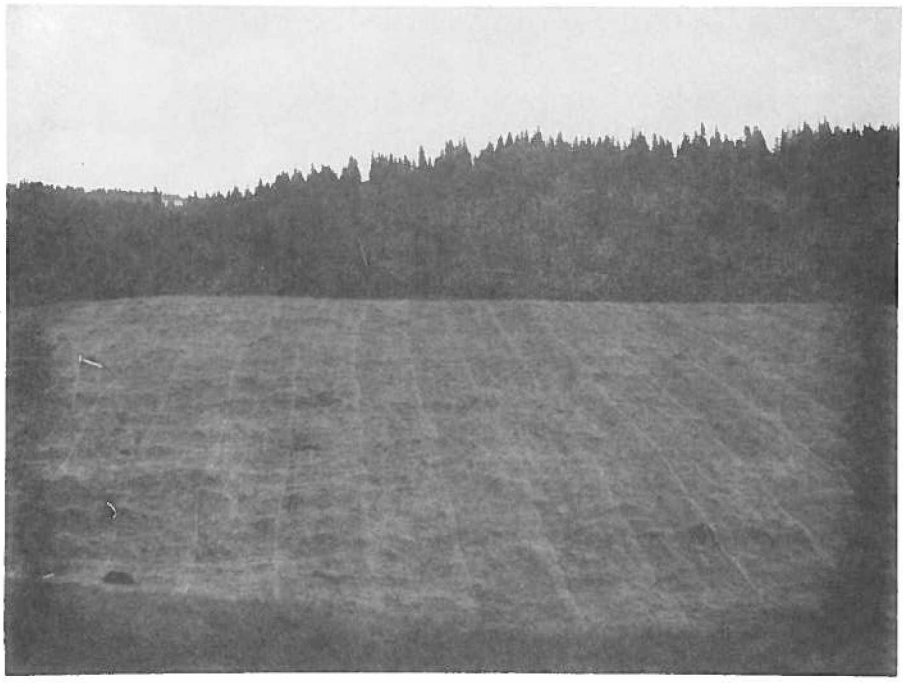

APPENDIX A
LOCATION OF
TEST SECTIONS
R-1
NO WORK SECTIONS
860+50 TO 862+32
913+10 TO 915+58
943+16 TO 946+90
966+00 TO 968+00
989+20 TO 993+10
SHRINE PASS
VAIL PASS
10,603
Unevo Peak
12,511
Black Lakes
Timber Creek
Gore Creek
Tenmile
I 70-2(45)194
I 70-2(39)204
PWA 1220 F(31)
Officer Gulch
Wheeler Lakes
Corral Gulch
Wearyman Creek
Smith Gulch
Stafford Gulch
Guller
Wheeler Creek
Sugarloaf Mtn
12,556
Copper Mtn.
WHEELER
FAI
FAP
R. 79 W.
R. 80 W.
SCALE OF MILES
0 1/2 1 2 3 4

APPENDIX B

Erosion Control and Revegetation on Vail Pass
Project I 70-2(41)

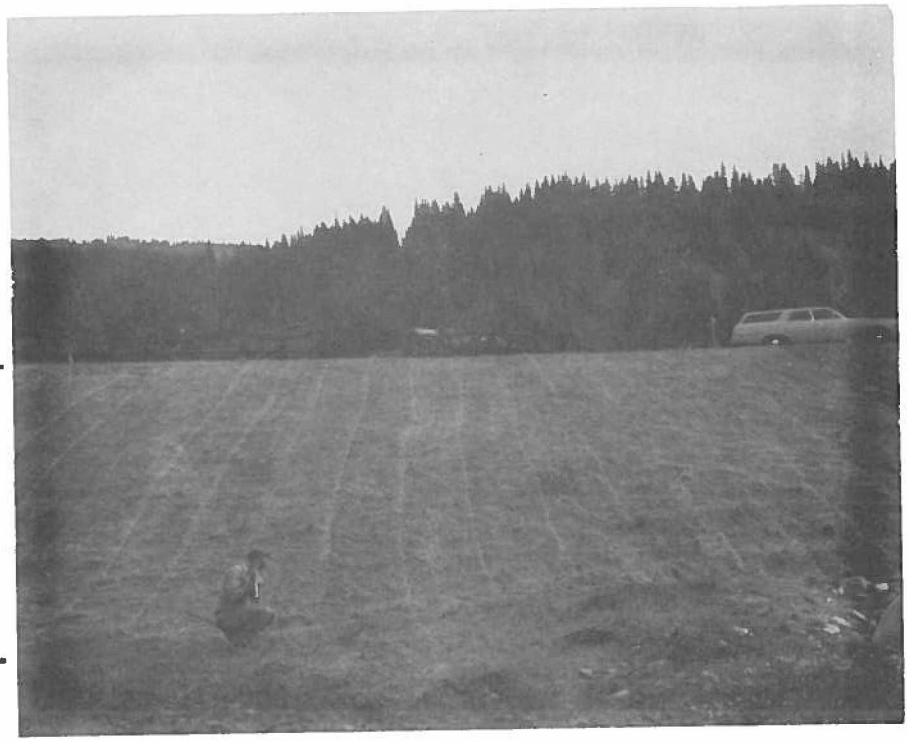
Seed & Fert.
Straw & Jute
First Year

Control Section July 1975



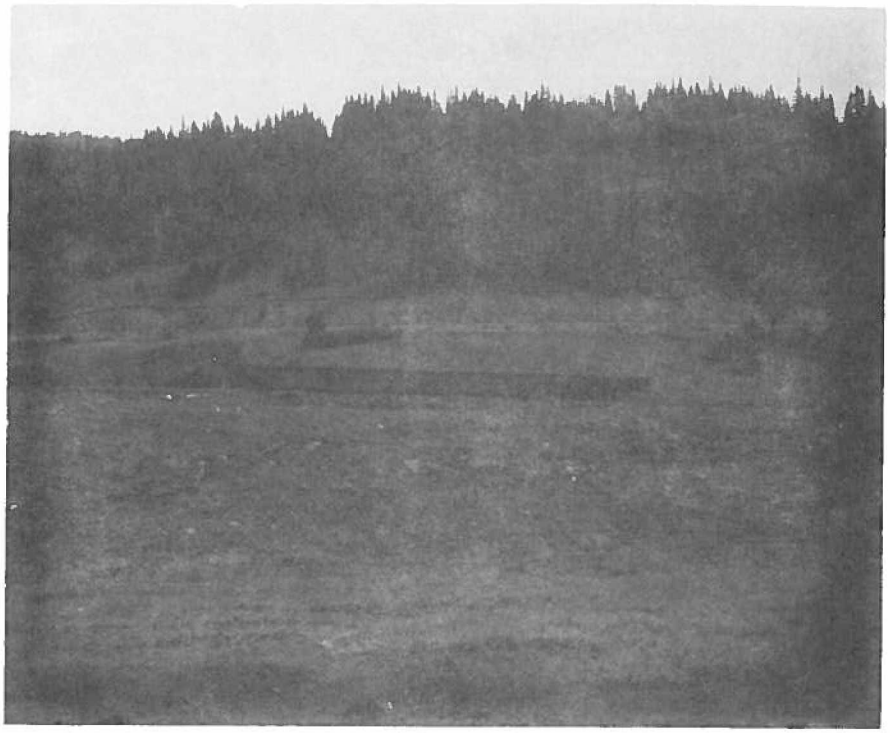
Seed & Fert.
Jute
First Year

Sec. 1 July 1975



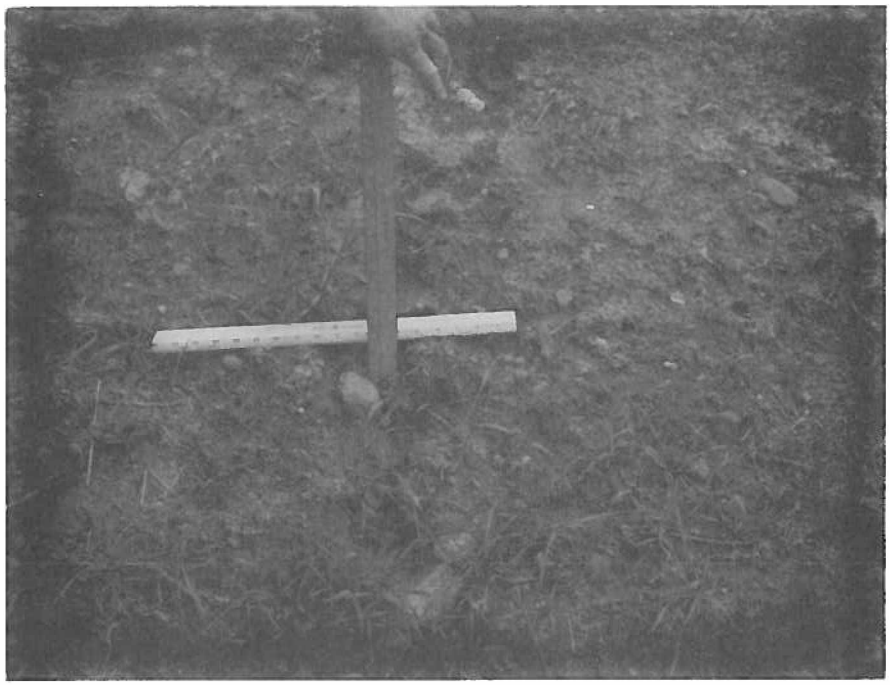
Seed & Fert.
Hyd. Mulch II
1400 lb/Acre
& Jute
First Year

Sec. 2 July 1975



Seed & Fert.
Hyd. Mulch II
First Year

Sec. 4 July 1975



Sec. 4 July 1975
This is the most erosion that has
taken place in the entire test area.

Sec. 4 July 1975
Silt deposition at the bottom of the slope

Seed & Fert.
Crimped Straw
First Year's Growth

Sec. 13 July 1975

Seed & Fert.
only
First Year

Sec. 14 July 1975

Note: More vegetation in these two than in any others at this time.

Seed & Fert.
Straw & Jute
Second Year's
Growth

Control Section August 1976

Seed & Fert.
Jute
Second Year

Sec. 1 August 1976
The bottom of this slope was cut by the
contractor for access to a structure.

Seed & Fert.
Hyd. Mulch II
& Jute
Second Year

Sec. 2 August 1976
Lack of vegetation where a space was
left between the soil and the Jute

Seed & Fert.
Hyd. Mulch II
Second Year

Sec. 4 August 1976

Seed & Fert.
Petroset I
Second Year

Sec. 10 August 1976

Seed & Fert.
Straw
Second Year

Sec. 13 August 1976
Note: Section 13 has continued to produce the most dense and vigorous vegetation.

PUBLICATIONS

State Department of Highways
Division of Highways-State of Colorado

66-1 Final Report - Denver SE Pavement Study I 25-3(20)
66-2 Interim Reports on the Experimental Base Project At Ordway, Colorado #1
66-3 Interim Report on the Clifton-Highline Canal Experimental Project I 70-1(14)33 #1
66-4 Final Report on Statistical Research Project - Quality Control Study on Asphalt Pavement
66-5 Final Report on the Automatic "Icy Road" Sign Study
66-6 Interim Report on Crawford-South Experimental Project S 0125(9) #1
66-7 Final Report on the Strasburg E & W Pavement Study I 70-4(30)
66-8 ASCE Report on High Altitude Multiple Vehicle Emission Tests
66-9 Final Report on Photo and Engineering Geology Along Interstate Route 70 from Dotsero to Rifle, Colorado
66-10 Interim Report on the Reflective Traffic Bead Study #1
66-11 Rock Slope Stability in the Precambrian Metamorphic Rocks of the Front Range, Colorado

67-1 Interim Report on Experimental Base Project at Ordway, Colorado #2
67-2 Second Interim Report on Crawford-South Experimental Project S 0125(9)
67-3 Interim Report on Clifton-Highline Canal Experimental Project I 70-1(14)33 #2
67-4 Reflective Traffic Bead Study #2
67-5 Density-Temperature-Roller Data from Asphalt Paving Projects in Colorado
67-6 Skid Resistance in Colorado
67-7 Swelling Soils Study at Cedar Point, Colorado
67-8 Lime Shaft and Lime Till Stabilization of Subgrades on Colorado Highways
67-9 Embankment Construction Without Moisture-Density Control
67-10 Study of Preformed Open Cell Neoprene Joint Sealer
67-11 Dielectric Measurements of Asphalt Content
67-12 Revision of Colorado CHLOE Profilometer
67-13 Performance of Box Beam Guard Rail Having Vertical Post Mounted in Sand
67-14 Scaling on Concrete Bridge Decks

68-1 Rock Rippability Study
68-2 Equilibrium Moisture and Density Study of Subgrades in Colorado
68-3 Grooving of Concrete Pavement Surfaces in Colorado to Prevent Hydroplaning
68-4 A Statistical Study of Rock Slopes in Jointed Gneiss with Reference to Highway Rock Slope Design
68-5 Reflective Traffic Bead Study -Interim #3
68-6 Use of a Microwave Oven for Rapid Drying of Aggregate Samples
68-7 Means for Measuring Surface Smoothness
68-8 Culvert Performance at Test Sites in Colorado
68-9 Colorado's Reflective Bead Study
68-10 Dielectric Measurements of Asphalt Content - Final Report

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Division of Highways-State of Colorado

69-1 Treatment of Swelling Soils, West of Agate, Colorado
69-2 The Whitewater Experimental Project - First Interim Report
69-3 Evaluation of Dielectric Measurement Apparatus for Determining Pavement Density
69-4 Pavement Marking Materials Tested in Colorado
69-5 Study of Preformed Open Cell Neoprene Joint Sealer for Use in Transverse Weakened Plane Sawed Joints - Final Report
69-6 Use of Microwave Oven for Rapid Drying of Aggregate Samples - Final Report
69-7 Follow Up Report, Colorado's Reflective Bead Study
69-8 Rock Rippability Study - Final Report
69-9 Ordway Experimental Project, Post Construction Field Measurements - Interim Report

70-1 State-of-the-Art - Automatic Controls on Construction Equipment
70-2 Action Program to Promote Highway Safety
70-3 Reflective Traffic Bead Study - Final Report
70-4 Asphalt Membrane Project at Elk Springs - First Interim Report
70-5 Evaluation of Colorado's Flexible Pavement Base Design Methods - Final Report
70-6 The Effect of Vibration on the Durability of Concrete Pavement - First Interim Report
70-7 Crawford - South Experimental Project S 0125(9) - Third Interim Report
70-8 The Whitewater Experimental Project: An Instrumented Roadway Test Section to Study Hydrogenesis - Final Report
70-9 Clifton-Highline Canal Experimental Project - Third Interim Report

71-1 The Effect of Good Vibration on the Durability of Concrete Pavement #2
71-2 Effect of Vibration on Durability of Concrete
71-3 Lighted Deer Crossing Signs and Vehicular Speed

72-1 Reflection Cracking in Bituminous Overlays - Interim Report
72-2 Evaluation of Dielectric Measurement Apparatus for Determining Pavement Density
72-3 Skid Testing in Colorado
72-4 Development of Dwarf Ground Cover for Erosion Control in Colorado
72-5 Corrugated Metal Arch Barrier, Phase 1, Scale Model Study
72-6 Styrofoam Highway Insulation on Colorado Mountain Passes
72-7 Colorado Tunnel Ventilation Study - Interim Report
72-8 Effectiveness of Absorptive Form Liner for Horizontal Surfaces
72-9 Partially Beaded Centerline Markings
72-10 Field Study of Erosion Control Agents in Colorado
72-11 Soil Modification Highway Projects in Colorado
72-12 Calibration of Colorado's Texturemeter - Final Report
72-13 Air Pollution at High Altitude Construction Sites

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State Department of Highways
Division of Highways-State of Colorado

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73-2 The Ordway Colorado Experimental Base Project
73-3 Noise Levels Associated with Plant Mix Seals
73-4 Accelerated Concrete Strength Study
73-5 Colorado Tunnel Ventilation Study
73-6 Clifton-Highline Canal Experimental Report
73-7 Seibert Experimental Project

74-1 Implementation Package for Swelling Soils in Colorado
74-2 Embankments With and Without Moisture Density Control

75-1 Erosion Control and Revegetation on Vail Pass
75-2 The Effects of Vibration on Durability of Concrete Pavement
75-3 Infrared Heating to Prevent Preferential Icing of Concrete Box Girder Bridges
75-4 Asphalt Membrane Project at Elk Springs, Colorado
75-5 Treatment of Swelling Soils - West of Agate, Colorado, Project I 70-4(48)347

76-1 Examination of Noise Prediction Methods
76-2 Bridge Deck Deterioration in Colorado
76-3 Absorptive Form Liner and Burlap and Cement and Sand To Assist Bridge Deck Cure
76-4 Low Profile Markers For Wet/Night Visibility
76-5 Erosion Control and Revegetation on Vail Pass
76-6 Reflection Cracking in Bituminous Overlays