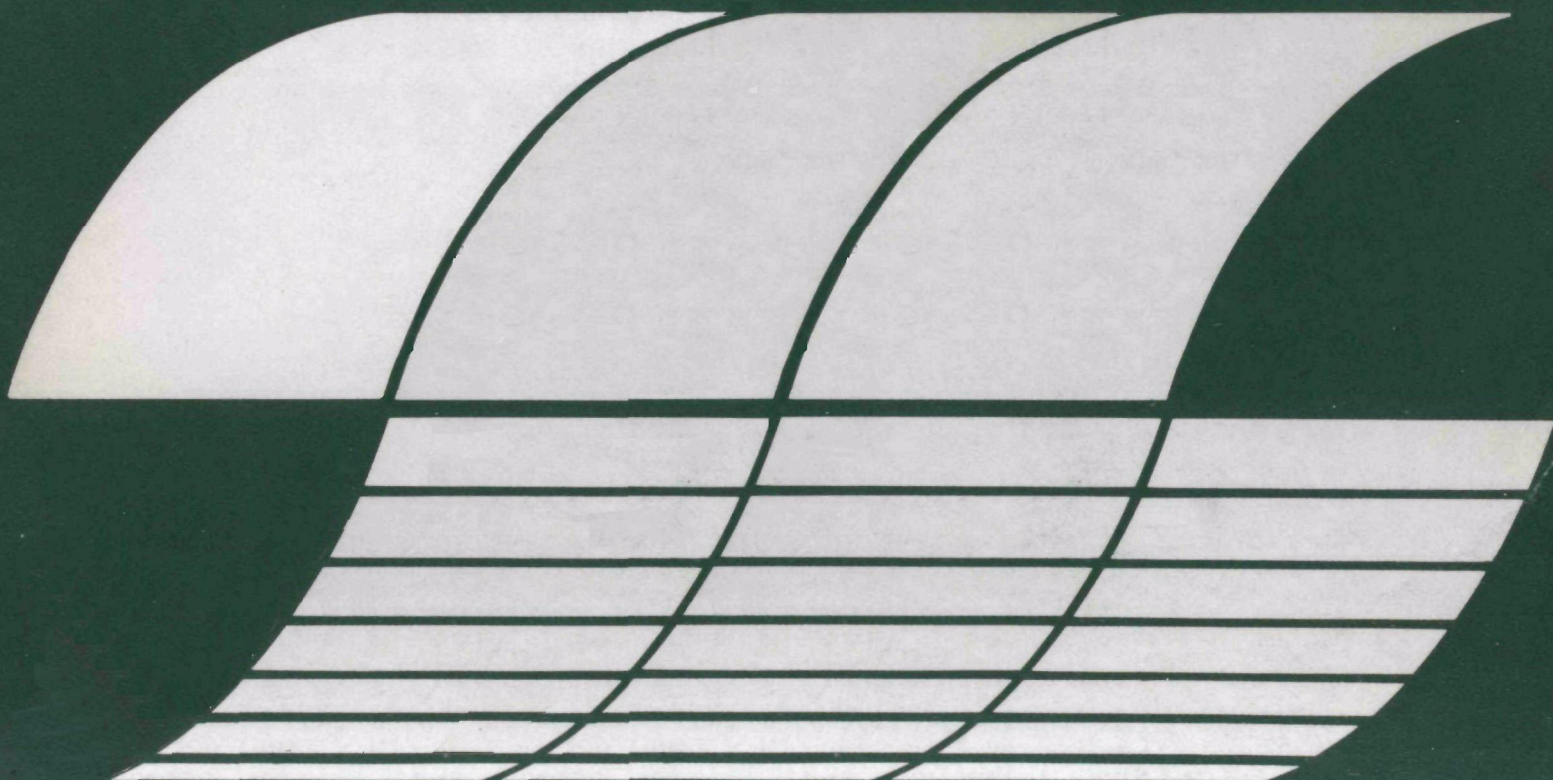


VEGETATIVE STABILIZATION OF SPENT OIL SHALES: Vegetation Moisture Salinity & Runoff 1973-1976

Interagency
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VEGETATIVE STABILIZATION OF SPENT OIL SHALES
Vegetation, Moisture, Salinity, and Runoff - 1973-1976.

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FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutorial impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory - Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

The data presented in this study will aid government and private companies to evaluate the potential for establishing vegetation on areas used for the disposal of retorted oil shale. The Extraction Technology Branch, Resource Extraction and Handling Division, may be contacted for further information.

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PREFACE

Presently, there is no commercial development of the western oil shales. However, the magnitude of this petroleum resource indicates that development will eventually occur.

When development does occur a major problem will be the disposal of massive amounts of spent shale. However, a major problem faced by those working with spent shale disposal today is that only a very limited amount of spent shale is available. This limited the size and configuration of the spent shale plots in this study. Another limitation of the study is that the spent shales used were produced under experimental conditions in which the main objective was to test retorting methodology. Thus the spent shales used in the study may not be representative of commercial operations. The study includes a fine-textured and coarse-texture spent shale. Both of these spent shales have pH's within the acceptable range for growth of adapted plant species. Some higher-temperature retorting processes produce spent shales that have very high pH's (11-12) and some have cementing properties. These spent shales are not represented in this study but are being investigated in other studies.

A large amount of data has been collected on this study since initiation in 1973. The text covers only the highlights - even then we feel it is too long but lacking in detail. For those requiring more in-depth information all data gathered is in the appendix.

ABSTRACT

Disposal of massive amounts of spent shale will be required if an oil shale industry using surface retorting is developed. Field studies were initiated in 1973 on two types of spent oil shale -- coarse-textured (USBM), and fine-textured (TOSCO). The objectives of these studies were to investigate surface stability of and salt movement in spent shales and spent shales covered with soil after vegetation has been established by intensive treatment and then left under natural precipitation conditions. The plots were established at low-elevation (1,700 m) and high-elevation (2,220 m) study sites in northwestern Colorado.

A good cover of native species was established on all plots by leaching, N and P fertilization, seeding, mulching, and irrigation. The plots have not been irrigated since establishment and now support an adequate cover of vegetation dominated by perennial grasses with the exception of the low-elevation TOSCO plots which are dominated by a mixture of annuals and perennial grasses. High levels of Mo were in plants grown in the spent shales when compared to plants grown in soil.

Water applied during leaching and establishment was being used by plants during the third growing season. Thus, only one year's information is available for growth under seasonal precipitation. Resalinization occurred following leaching of the fine-textured TOSCO spent shale and salt moved up into 15 cm of soil cover over leached TOSCO spent shale. The USBM spent shale was resalinized at the high-elevation site following inadequate leaching but was not resalinized at the low-elevation site. The 30 cm of soil cover over the unleached spent shale was not salinized at either study site.

The greatest runoff was from the TOSCO spent shale. Runoff was moderately to highly saline. The sodium adsorption ratio was low for all runoff. Sediment yields were very low reflecting the use of mulch and establishment of adequate plant cover.

CONTENTS

FOREWORD	iii
PREFACE	iv
ABSTRACT	v
FIGURES	viii
TABLES	x
ABBREVIATIONS, SYMBOLS, AND PLANT NAMES	xii
ACKNOWLEDGEMENTS	xiv
1. INTRODUCTION	1
2. FINDINGS AND CONCLUSIONS	3
3. RECOMMENDATIONS	7
4. STUDY DESIGN, INSTRUMENTATION, AND METHODS	9
5. RESULTS AND DISCUSSION	21
Low-Elevation Study Site	21
High-Elevation Study Site	46
REFERENCES	68
APPENDICES	70
A. Low-Elevation Study Site	70
B. High-Elevation Study Site	125

FIGURES

<u>Number</u>		<u>Page</u>
1	Schematic of spent shale and soil-covered spent shale plots . .	11
2	Location of the low and high-elevation vegetative stabilization of spent oil shale study site. Federal oil shale lease tracts Ca and Cb are also shown	12
3	Construction of the USBM spent shale plots at the low-elevation study site	13
4	Nearly completed construction of the low-elevation spent shale soil plots	14
5	Surface runoff and sediment collection system for an individual plot	15
6	Vegetation cover on north-aspect, low-elevation spent shale study site, July 1976	21
7	Vegetation dominated by perennial grasses but with substantial amounts of winterfat (small white shrub) and fourwing saltbush on south-aspect, low-elevation USBM spent shale plots, July 1976	26
8	Volumetric moisture profiles for TOSCO spent shale and soil treatments. Low-elevation study site, north-aspect	29
9	Volumetric moisture profiles for TOSCO spent shale and soil treatments. Low-elevation study site, south-aspect.	30
10	Volumetric moisture profiles for USBM spent shale and soil treatments. Low-elevation study site, north-aspect	32
11	Volumetric moisture profiles for USBM spent shale and soil treatments. Low-elevation study site, south-aspect	33
12	Soluble salt profiles in TOSCO spent shale and soil treatments. North-aspect, low-elevation study site	35
13	Soluble salt profiles in TOSCO spent shale and soil treatments. South-aspect, low-elevation study site	36

<u>Number</u>		<u>Page</u>
14	Soluble salt profiles in USBM spent shale and soil treatments, North-aspect, low-elevation study site	38
15	Soluble salt profiles in USBM spent shale and soil treatments, South-aspect, low-elevation study site	39
16	Maximum temperatures at depths of 1 cm on TOSCO spent shale and soil plots, low-elevation study site	45
17	North-aspect moisture measurements for TOSCO spent shale and soil-covered TOSCO spent shale treatments. High-elevation study site	51
18	South-aspect moisture measurements for TOSCO spent shale and soil-covered TOSCO spent shale treatments. High-elevation study site	52
19	North-aspect moisture measurements for USBM spent shale and soil-covered USBM spent shale treatments. High-elevation study site	53
20	South-aspect moisture measurements for USBM spent shale and soil-covered USBM spent shale treatments. High-elevation study site	54
21	Soluble salt profiles in TOSCO spent shale and soil treatments. North-aspect, high-elevation study site	57
22	Soluble salt profiles in TOSCO spent shale and soil treatments. South-aspect, high-elevation study site	58
23	Soluble salt profiles in USBM spent shale and soil treatments. North-aspect, high-elevation study site	60
24	Soluble salt profiles in USBM spent shale and soil treatments. South-aspect, high-elevation study site	61

TABLES

<u>Number</u>		<u>Page</u>
1	Physical and chemical characteristics of TOSCO II and USBM spent shales	9
2	Species seeded and rate of seeding on the oil shale research plots at the low-elevation study site on June 11, 1973	17
3	Species and rates seeded on June 10, 1975 on the high-elevation study site	18
4	Summary of vegetation cover values (%) for all treatments of years and aspects. Low-elevation study site	22
5	Percent vegetation cover for each treatment by year. Low-elevation study site	23
6	Relative composition in percent by species categories for each treatment. North-aspect, low-elevation study site, 1976	24
7	Relative composition in percent by species categories for each treatment. South-aspect, low-elevation study site, 1976	25
8	Summer storm surface runoff and water quality data for TOSCO spent shale, soil-covered TOSCO spent shale, and soil control plots. Low-elevation study site. 1974-1975	40
9	Snowmelt runoff data and water quality for TOSCO spent shale, soil-covered TOSCO spent shale, and soil control plots. Low-elevation study site. 1975-1976	41
10	Surface runoff and water quality data for USBM spent shale, soil-covered USBM spent shale, and soil control plots. Low-elevation study site. 1974-1975	42
11	Snowmelt runoff data and water quality for USBM spent shale, soil-covered USBM spent shale, and soil control plots. Low-elevation study site. 1975-1976	43
12	Percent vegetation cover for each treatment by year. High-elevation study site	47

<u>Number</u>		<u>Page</u>
13	Relative composition in percent by species categories for each treatment. North-aspect, high-elevation study site, 1976	48
14	Relative composition in percent by species categories for each treatment. South-aspect, high-elevation study site, 1976	49
15	Surface runoff and water quality data for TOSCO and USBM spent shale, soil-covered spent shale, and soil control plots following a 12.7 mm storm on August 14, 1974. High-elevation study site average of two replications	63
16	Snowmelt runoff and water quality for TOSCO and USBM spent shale, soil-covered TOSCO and USBM spent shale, and soil control plots. High-elevation study site. 1975, average of two replications . .	63
17	Snowmelt runoff and water quality samples for TOSCO spent shale, soil-covered TOSCO spent shale, and soil control plots. High-elevation study site, 1976	65
18	Snowmelt runoff and water quality samples for USBM spent shale, soil-covered USBM spent shale, and soil control plots. High-elevation study site, 1976	67

LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

BLM	-- Bureau of Land Management
C	-- celsius
Ca	-- calcium
Cl	-- chlorine
cm	-- centimeter
CO ₃	-- carbonate
EC	-- electrical conductivity
mmhos/cm	-- millimhos per centimeter
μmhos/cm	-- micromhos per centimeter
ERDA	-- Energy Research and Development Administration
F	-- fahrenheit
g	-- grams
HCO ₃	-- bicarbonate
ha	-- hectare
ha/m	-- hectare per meter
K	-- potassium
kg/ha	-- kilogram per hectare
km ²	-- square kilometer
m	-- meter
m ³	-- square meter
Mg	-- magnesium
Mo	-- molybdenum
mm	-- millimeter
N	-- nitrogen
Na	-- sodium
NO ₃	-- nitrate
P	-- phosphorus
pH	-- negative log of hydrogen ion concentration
ppm	-- parts per million
SAR	-- sodium adsorption ratio
SD	-- standard deviation
SO ₄	-- sulfate
TOSCO	-- The Oil Shale Corporation
USBM	-- United States Bureau of Mines
\bar{x}	-- mean

COMMON AND SCIENTIFIC NAMES OF PLANT SPECIES
Mentioned in this Report

Common Name	Scientific Nomenclature
Antelope bitterbrush	<i>Purshia tridentata</i>
Arrowleaf balsamroot	<i>Balsamorhiza sagittata</i>
Basin wildrye	<i>Elymus cinereus</i>
Beardless wheatgrass	<i>Agropyron inerme</i>
Big sagebrush	<i>Artemisia tridentata</i>
Bitterbrush	<i>Purshia tridentata</i>
Bluebunch wheatgrass	<i>Agropyron spicatum</i>
Cheatgrass	<i>Bromus tectorum</i>
Crested wheatgrass	<i>Agropyron desertorum</i>
Fourwing saltbush	<i>Atriplex canescens</i>
Galleta	<i>Hilaria jamesii</i>
Globe mallow	<i>Sphaeralcea grossulariaefolia</i>
Indian ricegrass	<i>Oryzopsis hymenoides</i>
James penstemon	<i>Penstemon jamesii</i>
Lupine	<i>Lupine spp.</i>
Mint	<i>Mint spp.</i>
Mountain mahogany	<i>Cercocarpus montanus</i>
Mustard	<i>Malcolmia spp.</i>
Penstemon	<i>Penstemon spp.</i>
Rabbitbrush	<i>Chrysothamnus spp.</i>
Rocky Mountain penstemon	<i>Penstemon montanus</i>
Russian thistle	<i>Salsola kali tenuifolia</i>
Serviceberry	<i>Amelanchier spp.</i>
Timothy	<i>Phleum pratense</i>
Utah sweetvetch	<i>Hedysarum boreale utahensis</i>
Western wheatgrass	<i>Agropyron smithii</i>
Wild barley	<i>Hordeum jubatum</i>
Wild lettuce	<i>Lactuca</i>
Winterfat	<i>Ceratoides lanata</i>

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SECTION I

INTRODUCTION

Limited domestic oil and natural gas reserves and the increased price of imported oil have renewed interest in developing the nation's western oil shale reserves. These reserves are located with a 6,500 km² (25,000 square mile) area of Colorado, Utah, and Wyoming and are estimated to contain 96 billion m³ (600 billion barrels) of recoverable crude oil with present day technology (U.S. Department of Interior, 1973). Six hundred billion barrels of oil is about 100 years petroleum supply at the 1977 consumption rates. If an oil shale industry is to develop, many environmental as well as technical problems must be resolved. One of the major environmental problems is the long-term stabilization of the massive amounts of waste material (spent or retorted shale) which will be produced.

A mature oil shale industry could produce an estimated one million barrels of oil per day (U.S. Department of Interior, 1973). If surface retorted, approximately 2,200 ha/m (18,000 acre/feet) of spent shale waste, would be generated each year. Part of this spent shale might be disposed of in the mined out areas but a large portion, maybe over half, would require surface disposal as either canyon fills or built-up into mesas. Thus, from 200-400 ha (500-1,000 acres) of land per year would be required for disposal sites. The spent shale would have to be managed to avoid air and water pollution not only in the immediate future (the 20-30 year life expectancy of an individual plant) but also on a long-term basis. Stabilization of the exposed surfaces could be attempted by establishing vegetation directly on spent shales or by covering the spent shales with soil material and then establishing vegetation.

The physical and chemical characteristics of spent shale are a function of the origin of the raw shale, the particle size when crushed, and the retorting temperatures.

The degree to which the raw shale is crushed prior to retorting directly affects the texture of the spent shale. If the materials are finely crushed, such as the TOSCO material, then a fine silty spent shale is produced. However, if the raw shale is coarsely crushed as in the gas combustion processes, then a coarse-textured spent shale is produced.

Spent shales retorted at temperatures of about 500 C have pH's in the 8-9 range, while retorting at 750-800 C results in spent shales with pH's of 11-12. The pH of the high-temperature processed spent shale must be reduced before it can be considered as a plant growth media.

Previous research has shown that spent shales retorted at lower temperatures were extremely salty for plant growth and deficient in plant-available nitrogen and phosphorus (Schmehl and McCaslin, 1973). Good stands of vegetation were established on low-temperature, fine-textured, highly saline spent shales after leaching, N and P fertilization, and sprinkling for seedling establishment (Block and Kilburn, 1973).

The study reported here is the first field research on coarse-textured spent shale as a plant growth medium.

The objectives of this study were to investigate surface stability and salt movement in spent shales and spent shales covered with soil after vegetation was established by intensive treatment and then left under natural precipitation conditions.

SECTION 2

FINDINGS AND CONCLUSIONS

LOW-ELEVATION STUDY SITE

Vegetation

1. A good cover of native perennial grasses and shrubs was established with intensive management, including irrigation and fertilization, on both TOSCO and USBM spent shales and soil-covered spent shales in 1973. The plots have not been irrigated since 1973.
2. The vegetation cover has increased each year since 1974 on all treatments. However, in 1976, the TOSCO treatment was dominated by a combination of perennial grass (western and bluebunch wheatgrass) and annual species (mustards and cheatgrass), whereas all the other treatments were dominated by perennial grasses or a combination of perennial grasses and shrubs.
3. The abundance of annuals on the TOSCO spent shale is apparently a reflection of the loss in perennial vegetation in 1974 as a result of resalinization.
4. North-aspect treatments have more vegetation cover (88%) than south-facing treatments (69%).

Moisture

1. Water stored in the profiles by the 1973 leaching was still being used by the vegetation in 1975. Thus, 1976 was apparently the first year the vegetation depended entirely on seasonal precipitation.
2. Moisture recharge to a depth of 90 to 140 cm in all treatments has occurred each spring as the result of normal to above-normal precipitation in 1974-1976.

Salinity

1. Soluble salts were leached to depths of 120 cm to over 180 cm by application of 100 cm of leach water in 1973.

2. Salts moved up into the leached zone and accumulated on the surface of the fine-textured TOSCO spent shale and the 15 cm soil cover over TOSCO spent shale as the result of capillary water movement from the nearly-saturated subsurface spent shale.
3. Salt did not move up into the 30 cm soil cover over TOSCO spent shale which was unleached and thus did not have a reservoir of water subject to capillary rise.
4. Resalinization of the leached coarse-textured USBM spent shale did not occur.
5. Salts that accumulated on the surface of the TOSCO spent shale and 15 cm of soil cover over TOSCO spent shale in 1974 were leached to depths of 30-60 cm in 1975 by winter and spring precipitation.
6. The soluble salts have remained at the 30-60 cm depths through the 1975 and 1976 growing seasons, apparently maintained at this depth by a balance between precipitation and evapotranspiration.

Surface Runoff and Sediment Yield

1. Two summer storms in three years produced runoff. Runoff was greater from the TOSCO treatment (0.13 cm) than the USBM spent shale (0.005 cm) and the soil control (0.04 cm).
2. Water quality of the rather limited amount of summer storm runoff from the spent shales was rated as having a high salinity hazard for irrigation.
3. Runoff from snowmelt in 1975 and 1976 was much greater than from summer storms. The TOSCO spent shale had the greatest amount of runoff with 1.0 cm in 1976 and the lowest water quality (EC 195 to 1300 $\mu\text{mhos/cm}$). The USBM had only a trace of runoff in 1976 with an EC of 400 $\mu\text{mhos/cm}$ while the soil control had 0.06 cm of runoff with an EC of 130 to 500 $\mu\text{mhos/cm}$.
4. Sediment yields from both summer storms and spring runoff were very low for all treatments, this is a reflection of the initial mulching treatment and the large amount of vegetation cover maintained on each treatment.
5. The sodium adsorption ratio was low for all runoff water.

Surface Temperatures

1. Surface temperatures of 50-60 C were recorded in late June and July each year on the south-aspect TOSCO spent shale and on the soil control plots.

2. These high mid-summer temperatures do not appear to be influencing the mature vegetation already established except that the south-aspect is more xeric as reflected by less vegetation cover.

HIGH-ELEVATION STUDY SITE

Vegetation

1. The initial vegetation stand established by seeding in 1974 was unsatisfactory because of (a) perennial grasses were seeded at a very low rate; (b) a dense population of big sagebrush was established; and (c) inadequately leached TOSCO and USBM spent shales which resalinized.
2. The study site was releached, rototilled, and reseeded in June 1975. A good stand of native perennial plants was established on all treatments in 1975 with ground cover ranging from 43-90 percent.
3. Perennial grasses dominated all treatments in 1976 although forbs and shrubs were prominent on most treatments.
4. The 30 cm of soil cover over USBM spent shale had the least vegetation cover in 1976 as the result of pocket gopher activity which resulted in the loss of some vegetation and considerable surface disturbance.
5. A major contrast in the vegetation at the two sites is that in 1976 annuals were a major component of the vegetation on the TOSCO spent shale at the low-elevation site, whereas annuals were only a minor component at the high-elevation site.

Moisture

1. Moisture profiles taken in 1974 showed that the water penetrated only to a depth of 30 cm and that most of the 150 cm of water applied for leaching in 1974 and 1975 was lost to evaporation. This shows that the leaching technique of applying 2.5 cm of water every two days was a very ineffective leaching procedure.

Salinity

1. Salinity measurements on core samples taken in 1974 showed that the TOSCO and USBM spent shale treatments were only leached to 30 cm under the alternate day irrigation schedule and that the leached layer was resalinized by fall 1974.
2. These results differed with the low-elevation site where the USBM was not resalinized.

3. Both the TOSCO and USBM spent shales were releached in 1975 with 100 cm of water applied continuously over a 10-day period in May. This method proved to be effective and resalinization did not occur on any treatments in 1975 or 1976.
4. Soluble salts did not move upward through the 15 cm of soil cover over TOSCO spent shale as occurred at the low-elevation site. This is probably because leaching through the silt loam soil cover was more effective in moving the salt to greater depths as there was less surface evaporation than on the black TOSCO spent shale.
5. There was no evidence of salt movement upward into the 30 cm of soil covering unleached TOSCO spent shale.

Surface Runoff and Sediment Yield.

1. A small (12.7 mm) summer storm in August 1974 produced 0.02 to 0.05 cm of runoff from the TOSCO spent shale and 0.002 to 0.004 cm from the USBM spent shale. The water quality for all runoff (EC 1200-2900 $\mu\text{mhos/cm}$) was rated as posing a high salinity hazard for irrigation. The control had 0.002 cm of runoff with an EC of 730 $\mu\text{mhos/cm}$.
2. The runoff and sediment yields from summer storms for the high-elevation site are similar to those on the low-elevation site.
3. Runoff from snowmelt in 1975 and 1976 was much greater from the high-elevation plots than from snowmelt runoff from the low-elevation site.
4. The 1976 snowmelt runoff from the TOSCO spent shale had an EC range of 400-1500 $\mu\text{mhos/cm}$ while the USBM spent shale was 200-700 $\mu\text{mhos/cm}$. The SAR (Sodium Adsorption Ratio) was low on all runoff.
5. Sediment yield for all treatments for both the summer storm and snowmelt runoff was very low.

SECTION 3

RECOMMENDATIONS

1. If highly-saline, lower pH (8-9) spent oil shales such as the ones used in this study are to be quickly stabilized with native vegetation they will require very intensive management including leaching, N and P fertilization and irrigation for establishment. Nitrogen application will be required for a number of years after establishment.
2. The infiltration rate on the fine-textured spent shale is very slow, thus the erosion potential is high when this material is subjected to high-intensity summer storms. Although no major summer storms occurred during this study, the slow infiltration rate must be considered when planning stabilization of this spent shale.
3. Resalinization of leached fine-textured spent shale occurred in this study. Application of more leach water than the 100 cm used in this study would move the salt further and decrease the resalinization potential. It should be noted that applications of additional leach water should be under continuous application at slightly less than the infiltration rate of the fine-textured spent shale. The disposition of the leach water within the spent shale disposal pile has not been addressed in this study but must be considered in large-scale operations.
4. A surface stabilization alternative indicated by this study would be to use a minimum of 30 cm of soil over unleached spent shale. This will work only for lower pH spent shales in which roots of adapted species can grow into and thus utilize water stored there. High pH (11-12) spent shales which the roots will not grow into would require thicker soil cover. Even with soil cover, irrigation and fertilization the first year would still be required for fast cover establishment.
5. An initial survey of vegetation grown on spent shale and soil-covered spent shales showed higher levels of Mo and Zn than on vegetation grown on the soil control. Studies are recommended and are currently underway by other investigators on trace elements in vegetation grown on these plots.
6. Deer and domestic livestock use of the revegetated disposal areas must be carefully controlled, this may initially require exclusion by fencing.

7. Pocket gophers and other burrowing animals can be expected to move into the revegetated areas. Control is difficult or impossible, thus the site stabilization scheme must be sufficiently resilient to allow for disturbances such as pocket gophers pushing spent shale up through 30 cm of soil cover as happened in this study.
8. Disposal sites on south-aspects at the lower elevations ($<2,000$ m) have xeric microclimatic conditions and would require more intensive management than most moist locations.
9. Erosion is a continuous natural process. Thus soil cover or spent shale modified for plant growth will eventually erode, particularly from steep upper slopes. This eventuality must be considered and addressed in future waste stabilization research and planning.
10. Up to now stabilization of spent shales has been thought of in terms of plans that might work with the spent shales produced by a given retorting process. Consideration needs to be given to spent shale disposal when designing the retorting process. It may be that spent shale which has cementing properties will pose fewer long-term environmental problems.
11. It is recommended that both study sites continue to be monitored for the following reasons:
 - (a) 1973 leach water was still being depleted from the profile in 1975, thus, only one year's data under natural precipitation is available. Information is needed on vegetation persistence through several years with below-normal precipitation.
 - (b) Additional data is needed on the runoff, sediment yield, and water quality from both spring runoff and high intensity summer storms.

SECTION 4

STUDY DESIGN, INSTRUMENTATION, AND METHODS

STUDY DESIGN

Spent Shales

The two spent shales used in this study were products of retorting processes developed by The Oil Shale Corporation (TOSCO II), and the U.S. Bureau of Mines (USBM). Certain chemical and physical characteristics of these spent shales have been determined by Schmehl and McCaslin (1973, Table 1) and Ward, Margheim, and Lof (1971). In addition, Striffler et al. (1974) reviewed the literature on spent oil shales as plant growth media.

TABLE 1. PHYSICAL AND CHEMICAL CHARACTERISTICS OF TOSCO II AND USBM SPENT SHALES. DATA FROM SCHMEHL AND MCCASLIN, 1973

	TOSCO II	USBM
pH	9.2	8.6
EC (mmhos/cm on saturation extract)	17.7	16.6
Sodium Adsorption Ratio	29.0	14.1
Texture	silt loam	gravely silt loam
>2 mm	14%	62%
<2 mm	86%	38%
Field Moisture Capacity % H ₂ O (<2 mm material)	20.9%	19.8%

The TOSCO II (shortened to TOSCO in the rest of the report) spent shale is black, silt loam material retorted at the Colony Development Operation near Grand Valley, Colorado. A description of the design and mechanical operations of TOSCO retort is given by Lenhart (1969). The USBM spent shale is black to gray and contains about 60% coarse particles (>2 mm in diameter) and 40% soil-size particles (<2 mm in diameter). The USBM spent shale was retorted by the

gas-combustion method as described by Matzick et al. (1966) and was obtained from the waste pile at the USBM (now Energy Research and Development Administration) Anvil Points oil shale research facility near Rifle, Colorado.

The reader is cautioned that the spent shales were retorted under experimental conditions in which the main objective was to test retorting methodology. Therefore, the spent shales may not be representative of material produced by commercial operations. Several years had elapsed between retorting and the initiation of these field studies, thus some physical and chemical changes may have occurred in the spent shales. The TOSCO spent shale was retorted in the period 1970 to 1972 whereas the USBM spent shale was retorted earlier and may initially have had a higher pH. This field study was initiated in 1973.

The soils used were a calcareous silty clay loam on the low-elevation site and a non-calcareous silt loam on the high-elevation site.

Treatments

The study design consists of two spent shale types at two different elevations (study sites). The seven spent shale and/or soil treatments at each site are:

1. leached TOSCO spent shale
2. leached TOSCO spent shale with 15 cm soil cover
3. unleached TOSCO spent shale with 30 cm soil cover
4. leached USBM spent shales
5. leached USBM spent shale with 15 cm soil cover
6. unleached USBM spent shale with 30 or 60 cm soil cover
7. soil control

Each treatment has a north and a south exposure on a 4:1 (25%) slope and is replicated. Thus, there are a total of twenty-eight individual 3.3 x 6.6 m plots at each site. A schematic of the study design and plot layout is given in Figure 1.

Study Sites

The study sites were at Anvil Points 1,700 m (5,700 feet) in elevation and within Piceance Basin at 2,200 m (7,200 feet). The Anvil Points study site is located on the Energy Research and Development Administration research facility 13 km (8 miles) west of Rifle, Colorado (Figure 2). The site has a hot, dry summer climate and sparse natural vegetation and is representative of one of the more difficult areas to revegetate within the Colorado oil shale region. The mean annual precipitation is estimated as 30 cm. The adjacent vegetation is low-elevation pinyon-juniper woodland as described by Ward et al. (1974). Throughout this report, the Anvil Points location will be referred to as the low-elevation study site.

The Piceance Basin study site is located on Bureau of Land Management land within the Piceance Basin (Figure 2). The access to the site is up Black Sulfur Creek from Piceance Creek. The site has an estimated average annual precipitation of 40-45 cm and a hot, dry summer climate. The study site is

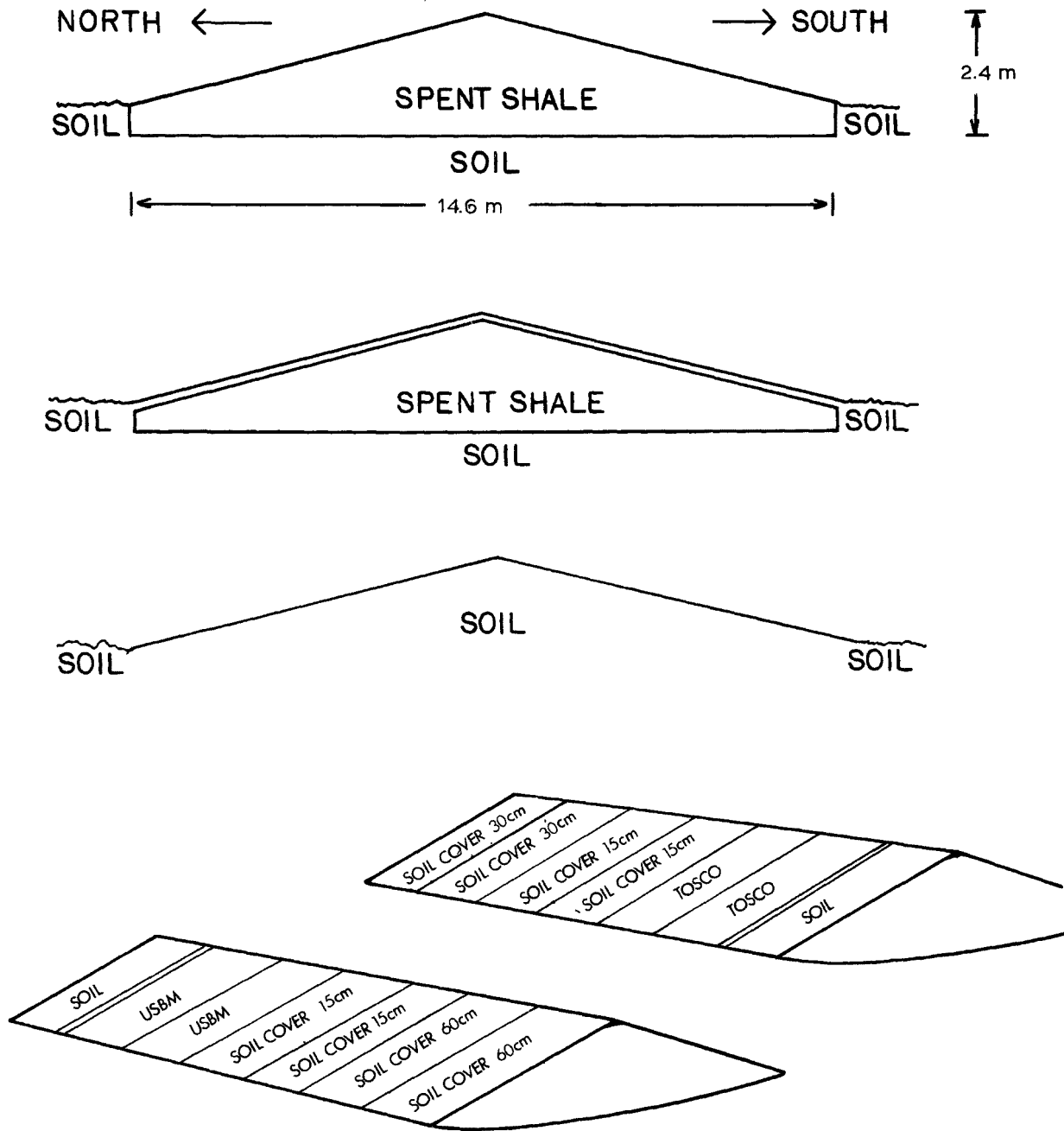


Figure 1. Schematic of spent shale and soil-covered spent shale plots. Top - Side view of cross section through plots. Bottom - Overview of north aspect of TOSCO (upper) and USBM (lower) spent shale plots showing treatments and replications.

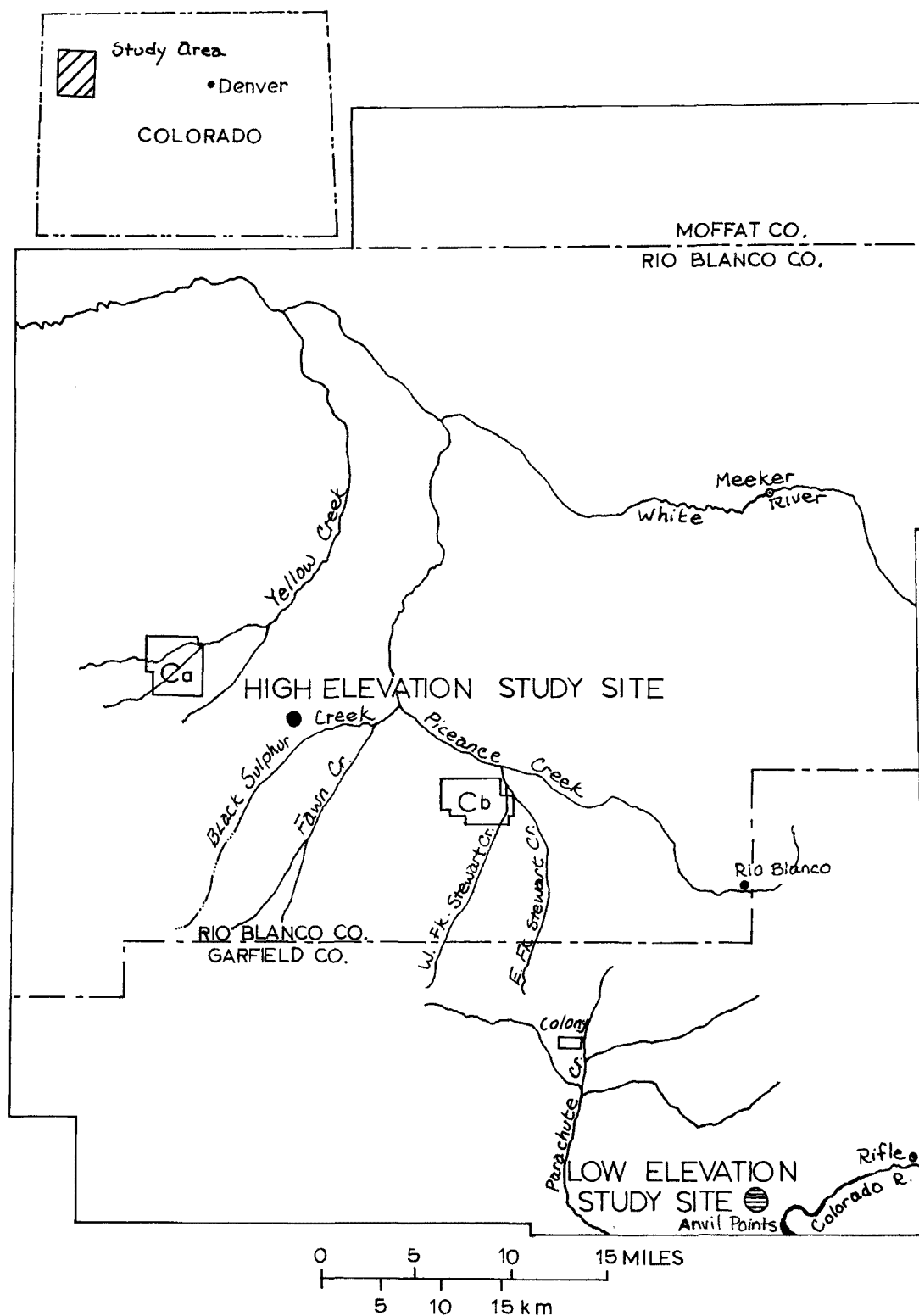


Figure 2. Location of the low and high-elevation vegetative stabilization of spent oil shale study sites. Federal oil shale lease tracts Ca and Cb are also shown.

indicative of the climate, elevation, and vegetation type associated with the federal oil shale lease tracts, Ca and Cb. The natural vegetation around the study site is high-elevation, big sagebrush, and low-elevation pinyon-juniper woodland as described by Ward et al. (1974). In this report, the Piceance Basin study site will be referred to as the high-elevation study site.

Construction Procedures

Construction at each study site was initiated by excavating two areas 15 m wide x 20 m long and 0.6 m deep along an east-west axis. The excavated areas were located side by side and 30 m apart. The excavated soil material was stockpiled adjacent to the study site. The spent shale was dumped into the excavated area and piled to a height of 2-2.7 m at the center, the height depending on the depth of soil cover. The spent shale was then shaped to a 4:1 slope (Figure 3). The excavated soil was then used to construct the soil cover-over-spent shale and soil control plots (Figure 4).

A plywood divider was placed between the 15 cm soil cover treatments and the 30 or 60 cm of soil cover treatments. This divider was used to separate the leached treatments (15 cm soil cover) from the unleached treatments (30 or 60 cm soil cover).

During the construction and filling operation, no attempt was made to compact the spent shale, however, some compaction resulted from the small-tracked loader which was used for shaping. The fine-textured TOSCO spent shale at the low-elevation site settled when the plots were leached. Therefore, when the high-elevation plots were constructed, the TOSCO material was lightly compacted with a D4 caterpillar.



Figure 3. Construction of the USBM spent shale plots at the low-elevation study site. The excavation for the TOSCO spent shale plots is to the left center of the photo. April 1973.

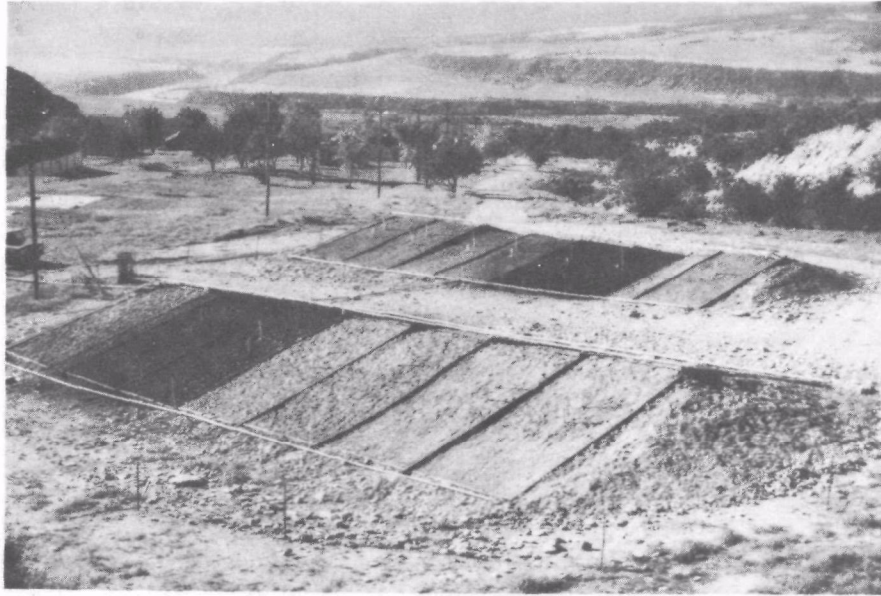


Figure 4. Nearly completed construction of the low-elevation spent shale-soil plots. The USBM spent shale-soil plots are in the foreground and the TOSCO soil plots are in the center of the photograph. The plot treatments are shown in Figure 1.

Construction of the low-elevation plots was completed in April 1973, and the high-elevation plots was completed in August 1973.

INSTRUMENTATION

Salinity Sensors

Salinity sensors, model 5100 manufactured by the Soil Moisture Equipment Company, were installed in each replication. The sensors were buried in the middle of each plot at 20 and 50 cm. Sixty cm leads were left above the soil surface and were attached to wooden stakes.

Moisture Probe Access Tubes

Moisture probe access tubes were placed in the upper 1/3 of each plot for monitoring the in-place moisture content of the spent shale and soil treatments throughout the growing season. The moisture probe access tubes are 3.8 cm diameter steel electrical conduit placed to a depth of 180 cm. Each tube was capped with a #9 rubber stopper. All moisture measurements were made with a Troxler model S6A neutron probe and a model G100 rate meter.

Surface Runoff Collection Systems

Surface runoff collection systems were installed in 1974 on all 28 plots at each study site. The runoff collection system consists of surface plot dividers and sills, sheet metal runoff collectors, and metal storage cisterns. Each plot was divided with redwood boards extending 5 cm below the surface. At the toe of each slope, a redwood sill was set lengthwise across the plot to hold the 3.3 m wide sheet metal collector in place. The collector was then connected with a 5 cm metal pipe to a 106 cm diameter culvert set on end. The bottom of the 1 m deep culvert was sealed with 10 cm of concrete and then the interior was sealed with Farbertite, a water-proofing compound. Finally, the metal culvert was fitted with a sheet metal lid (Figure 5). A 120 l plastic container was placed inside each culvert as the primary runoff and sediment collector.



Figure 5. Surface runoff and sediment collection system for an individual plot.

Meteorological Equipment

Each study site was instrumented in 1974 with a Weather Measure Corporation model P501 tipping bucket remote-recording rain/snow gauge and a model H311 31-day recording hydrothermograph. Snowfall measurements were also made at the high-elevation site with a 20.8 cm diameter standard U.S. Weather Bureau gauge. The precipitation measurements for each study site, for each year are listed in Appendix Table 1.

Spent Shale and Soil Temperatures

Spent shale and soil temperatures were measured only at the low-elevation study site and only on the TOSCO spent shale and soil control plots. Temperatures were measured using Lambrecht 30-day recording thermographs with 16-foot capillary tube sensor leads. Two recorders with three sensors each were used. The following treatments were measured:

1. North-aspect TOSCO
2. North-aspect soil
3. South-aspect TOSCO
4. South-aspect TOSCO (duplicate)
5. South-aspect soil
6. Air temperature in the box

Sensors were buried 1 cm beneath the soil or spent shale surface following construction in June 1973. Temperatures were recorded continuously until September 1973 and starting again in April and continuing through September of 1974, 1975, and 1976.

METHODS

Leaching

The irrigation system at both study sites was a solid-set sprinkler system using Rainbird model 14 TNT VLA sprinkler heads operated at 2-3 kg/cm². The sprinklers were set on 60 cm risers and spaced 6 m apart along laterals. A total of three laterals spaced 8 m apart were used per each spent shale pile. The application rate of this system was measured at 0.4 cm per hour. The application rate was designed to be slightly less than the infiltration rate of the fine-textured TOSCO spent shale and thus avoid surface runoff. Each system was automated with a 7-day time clock and solenoid valves.

Although the systems were identical, the leaching procedure used at each study site was different. The low-elevation plots were leached with a total of 100 cm of water in May 1973. The leach water from the water system at Anvil Points had a conductivity of 200 to 300 micromhos per cm at 25 C. The plots were leached by running the sprinkler continuously for two 5-day periods separated by a 4-day rest period.

In contrast, the high-elevation plots were leached at three separate times. The first leaching was in fall 1973 when 50 cm of water was applied, the second was the following May 1974 when 100 cm of water was applied, and finally, in April 1975, when an additional 100 cm of water was applied. In the first two applications, the irrigation system was operated to apply 2.5 cm of water every other day. This application technique proved to be ineffective as the evaporation rate was high. Hauling water 4.8 km to the high-elevation plots was a problem and contributed to the first two ineffective leaching attempts.

In May 1975, 100 cm of water was applied by continuous sprinkling over a 10-day period. The leach water was from Black Sulfur Creek and had a conductivity of 1,000 micromhos/cm.

The 30 cm of soil cover over the spent shale treatments at both study sites were covered with plastic and not leached.

Fertilization

Nitrogen and phosphorus fertilizers were applied to all treatments at both study sites. Phosphorus was applied following construction at the rate of 400 kg P/ha in the form of triple superphosphate. The P was then rototilled into each plot to a depth of 10 cm.

Nitrogen was applied as ammonium nitrate at the rate of 66 kg N/ha following germination, and an additional 66 kg N/ha was applied later in the growing season. In subsequent years, 66 kg/ha was applied in April just as regrowth was starting. We anticipate nitrogen fertilizer applications will be required for several more years.

Seeding and Mulching

The low-elevation study site was seeded on June 11, 1973 with the mixture of native grasses and shrubs listed in Table 2. The plots were then raked lightly and mulched with grass hay at the rate of 1680 kg/ha. The hay mulch was held in place with a cotton netting.

TABLE 2. SPECIES SEEDED AND RATE OF SEEDING ON THE OIL SHALE RESEARCH PLOTS AT THE LOW-ELEVATION STUDY SITE JUNE 11, 1973.

Species	Rate (kg/ha)
<u>GRASSES</u>	
Bluebunch wheatgrass (<u>Agropyron spicatum</u>)	2.2
Indian ricegrass (<u>Oryzopsis hymenoides</u>)	2.2
Western wheatgrass (<u>Agropyron smithii</u>)	1.1
<u>SHRUBS</u>	
Big sagebrush (<u>Artemisia tridentata</u>)	0.5
Fourwing saltbush (<u>Atriplex canescens</u>)	1.1
Rabbitbrush (<u>Chyrsothamnus</u> spp.)	0.5
Winterfat (<u>Ceratoides lanata</u>)	1.1

The high-elevation study site was initially seeded on June 26, 1974 with a mixture of native grasses, shrubs, and forbs and mulched with barley straw. The high-elevation study site was reseeded on June 10, 1975 with the mixture of native grasses, shrubs, and forbs listed in Table 3. Prior to seeding, these plots were rototilled to the depth of approximately 10 cm. Following seeding, the plots were raked lightly and then mulched with wheat straw at a rate of 1680 kg/ha. The wheat straw was held in place with cotton netting to prevent the straw mulch from blowing.

TABLE 3. SPECIES AND RATES SEEDED ON JUNE 10, 1975
ON THE HIGH-ELEVATION STUDY SITE

Species	Rate (kg/ha)
<u>GRASSES</u>	
Bluebunch wheatgrass (<u>Agropyron spicatum</u>)	0.5
Western wheatgrass (<u>Agropyron smithii</u>)	1.1 [†]
Galleta (<u>Hilaria jamesii</u>)	0.5
Basin wildrye (<u>Elymus cinereus</u>)	0.5
Indian ricegrass (<u>Oryzopsis hymenoides</u>)	2.2
<u>FORBS</u>	
Lupine spp. (<u>Lupine</u> spp.)	0.5
Utah sweetvetch (<u>Hedysarum boreale utahensis</u>)	1.7
Arrowleaf balsamroot (<u>Balsamorhiza sagittata</u>)	0.5
James penstemon (<u>Penstemon jamesii</u>)	1.1
Penstemon spp. "Bandera" (<u>Penstemon</u> spp.)	0.2
<u>SHRUBS</u>	
Antelope bitterbrush (<u>Purshia tridentata</u>)	2.2
Fourwing saltbush (<u>Atriplex canescens</u>)	2.2
Rabbitbrush (<u>Chrysothamnus</u> spp.)	2.2
Winterfat (<u>Ceratoides lanata</u>)	2.2

[†] This rate was doubled on both the TOSCO and USBM spent shale plots.

Moisture Measurements

Neutron probe moisture measurements were made approximately monthly or bimonthly on each plot during the growing season. The count ratios were converted to percent moisture by volume (cm³/cm³) using the standard soil moisture curve provided by the probe manufacturer as differences in moisture content with time are of major interest. However, comparison of gravimetric samples collected during core sampling and neutron probe measurements at the same time indicate that there is a 6-7% higher reading from the probe than the actual volumetric moisture content in the spent shales.

Salinity Measurements

Salinity measurements consisted of both salinity sensor readings and laboratory analysis of core samples taken from each plot. The salinity sensors were read periodically at both study sites during each growing season (April through August).

Core samples were collected at the beginning and the end of each growing season between 1973 and 1975. In 1976 the plots were core sampled only in the fall. The cores were taken in the upper 1/3 of each plot and were collected in 15 cm increments to a depth of 180 cm using a soil coring tube with a 2 cm diameter bit. The samples were then placed in either metal cans or plastic bags and returned to CSU for laboratory analysis. The samples were dried and screened through a 2-mm sieve. Ten grams of the <2-mm fraction was mixed with 10 ml of distilled water in a 50 ml beaker and allowed to stand for 1 hour. The sample was then remixed and filtered. Electrical conductivity was determined on the solution. The soils in the soil-cover treatments and soil-controls were also analysed using a 1:1 soil-water ratio. The reason the 1:1 ratio was used rather than a saturated paste was that the latter requires a much larger sample and only a limited amount of sample was taken in order to minimize plot destruction.

Stand Establishment

The irrigation system used for leaching was also used to ensure stand establishment. The system was automated and irrigation was scheduled to apply 0.4 cm of water per hour. The low-elevation study site was irrigated with 46 cm of water between June 12, 1973 and August 14, 1973. The water was applied daily for approximately two hours with the exception of several days during this period when water was not available or the timing mechanism malfunctioned. The water application rate was calculated to be slightly in excess of the evapotranspiration demand at the study site (Wymore et al., 1974).

The high-elevation study site was irrigated, following the 1975 seeding, from June 10 through July 21 with about 1.5 cm of water applied approximately every third day, however, some days were missed due to water hauling problems. A total of 20 cm of water was applied for stand establishment.

Vegetation Measurements

Two different methods were used to analyze the vegetation. The quadrat method was used the first two years after seeding to provide an estimate of germination and establishment. The line-intercept method was used the last two years, since it proved a more quantitative measurement on the mature bunch grass vegetation.

The quadrat method consisted of randomly placing four 20 x 40 cm quadrats on each plot and counting the number of individual plants found within the quadrat. Ground covered by living vegetation was also estimated for each quadrat.

The procedure for the line-intercept method was to divide each plot into thirds or fourths moving vertically up the slope. A steel tape was then placed along the transect lines. The total cm of vegetative cover was then measured for each species along the tape. In addition, the blank areas were also recorded to calculate the total vegetation cover for each line. These lines were laid in approximately the same location each year, however, in 1975, four lines were used at the low-elevation study site as opposed to 3 lines in 1976.

The low-elevation study site was analyzed in 1976 for total above-ground standing biomass. The procedure was to randomly place three 20 x 40 cm quadrates in the upper, middle, and lower 1/3 of each plot and clip all the above-ground standing vegetation. The samples were placed in paper bags and returned to CSU where they were oven-dried and total dry matter determined.

Total vegetation cover for all years and the species composition for 1976 were statistically analyzed using a split plot factorial design and a Control Data 6400 computer. Significant mean values were separated using Tukey's Q mean separation test at the 5% level.

Surface Runoff Measurements

Surface runoff measurements were made each spring during and following snowmelt and during the growing season following runoff producing thunderstorms. The procedure for collecting runoff data was as follows:

1. The total runoff collected was measured directly in the collectors using a meter stick and then converting this value to total liters of water.
2. The water collected in the plastic container was thoroughly mixed to suspend the sediment and a 500 ml sample was taken.
3. The samples were returned to CSU for water quality analyses by the CSU Soil and Water Testing Laboratory.
4. Sediment yields consisted of evaporating the water samples and weighing the remaining sediment. This figure was then used to calculate the total sediment within each plastic can, which was assumed to be the total sediment yield per plot. No correction was made for soluble salt content of the sediment.

SECTION 5

RESULTS AND DISCUSSION

LOW-ELEVATION STUDY SITE

Vegetation

Overall vegetation establishment and growth was satisfactory on the low-elevation study site (Figure 6). A fairly uniform cover of the species seeded was obtained on the USBM and soil-covered USBM spent shales. However, timothy brought in inadvertently as seed in the hay mulch was a major species on most of the TOSCO and soil-covered TOSCO treatments in 1973 (Appendix Tables 2-5). Without irrigation in 1974, the amount of timothy dropped drastically (Appendix Tables 6 & 7). Vegetation cover increased in 1975 and remained constant in 1976 compared to 1975 (Table 4 Appendix Tables 8-15). Precipitation was estimated to be near to above normal for 1974 through 1976 (Appendix Table 1). As might be expected, the north-aspect plots have more vegetation cover than the south-aspect plots (Table 4), this effect was even



Figure 6. Vegetation cover on north-aspect, low-elevation spent shale study site, July 1976. Treatments are in the positions sketched in Figure 1.

TABLE 4. SUMMARY OF VEGETATION COVER VALUES (%) FOR ALL TREATMENTS BY YEARS AND ASPECTS. LOW-ELEVATION STUDY SITE

Year		Aspect	
1973	67.4 b [†]	North	74.2
1974	58.5 c	South	67.5
1975	77.8a	F	**
1976	80.1a		
F	**		

† Values with a common letter within columns are not significantly different as tested by Tukey's Q mean separation test at 5% level.

** Significantly different at 1.0% level.

more obvious in 1976 when the south-facing plots averaged 69% vegetation cover compared to 88% for the north-facing plots (Table 5). The standing crop of vegetation was also greater in 1976 on the north-aspect than on the south-aspect treatments (Appendix Table 16).

There are some differences in total vegetation cover and even greater differences in cover by species categories among spent shale and soil treatments, these are discussed below:

TOSCO Spent Shale --

Vegetation cover established by irrigation in 1973 was somewhat less on the TOSCO spent shale than on the soil-cover treatments (Table 5). After three growing seasons without irrigation the vegetation cover on the TOSCO spent shale was still significantly less than on the soil-cover and soil treatments on the south-aspect and comparable to all other treatments on the north-aspect (Table 5).

Of much greater magnitude and importance than total vegetation cover are differences in relative cover by species categories. In 1976 the TOSCO treatments were dominated by a combination of perennial grasses and annual species, whereas all the other treatments were dominated by perennial grasses or a combination of perennial grasses and shrubs (Tables 6 & 7). The abundance of annuals (largely cheatgrass and mustard, Appendix Tables 12 & 13) on the TOSCO spent shale plots is apparently a reflection of the loss in perennial vegetation in 1974 as a result of resalinization (see salinity section). In 1975 and 1976 the annuals filled in the bare areas to give a total ground cover comparable to that on the other treatments. Since abundance and productivity of annuals within a stand of perennials is usually a function of annual precipitation it will be of interest to observe the plots through a below-normal precipitation cycle.

TABLE 5. PERCENT VEGETATION COVER FOR EACH TREATMENT BY YEAR LOW-ELEVATION STUDY SITE

Treatment	NORTH ASPECT				SOUTH ASPECT			
	1973	1974	1975	1976	1973	1974	1975	1976
1 TOSCO Spent Shale	52 c [†]	42 c	67	85ab	47 c	42 b	67	60 b
2 15 cm Soil Cover/TOSCO	80a	62ab	70	87ab	80a	57ab	85	72a
3 30 cm Soil Cover/TOSCO	80a	62ab	72	75 b	80a	60a	77	75a
4 USBM Spent Shale	55 bc	55 bc	87	87ab	57 bc	55ab	77	67ab
5 15 cm Soil Cover/USBM	72a	75a	92	97a	67ab	62a	75	77a
6 60 cm Soil Cover/USBM	72a	67ab	87	90a	67ab	60a	70	77a
7 Soil Control	65abc	62ab	80	95a	62 bc	55ab	80	75a
F	**	**	NS	*	**	*	NS	**

† Values with a common letter within columns are not significantly different as tested by Tukey's Q mean separation test at 5% level.

* Significant at 5% level; ** Significant at 1% level; NS No significant difference.

TABLE 6. RELATIVE COMPOSITION IN PERCENT BY SPECIES CATEGORIES FOR EACH TREATMENT NORTH-ASPECT, LOW-ELEVATION STUDY SITE, 1976.

Treatment		Perennial Grasses	Forbs	Shrubs	Annuals	F
1	TOSCO Spent Shale	AB [†] 29 <i>b</i> [§]	B 0	B 15	A 56 <i>a</i>	*
2	15 cm Soil Cover/TOSCO	A 79 <i>a</i>	C 0	BC 4	B 17 <i>b</i>	**
3	30 cm Soil Cover/TOSCO	A 61 <i>ab</i>	B 0	B 20	B 19 <i>b</i>	**
4	USBM Spent Shale	A 66 <i>a</i>	B 0	B 16	B 18 <i>b</i>	**
5	15 cm Soil Cover/USBM	A 83 <i>a</i>	C 0	B 15	C 2 <i>b</i>	**
6	60 cm Soil Cover/USBM	A 69 <i>a</i>	B 0	B 24	B 7 <i>b</i>	**
7	Soil Control	A 79 <i>a</i>	C 1	B 18	C 2 <i>b</i>	**
F		*	NS	NS	**	

† Values with common letters (ABC) within rows (comparing species category within a treatment) are not significantly different by Tukey's test at the 5% level.

§ Values with common italicized letters (*abc*) within columns (comparing spent shale treatments within species categories) are not significantly different by Tukey's test at the 5% level.

* Significant at 5% level; ** Significant at 1% level.

NS No significant difference.

TABLE 7. RELATIVE COMPOSITION IN PERCENT BY SPECIES CATEGORIES FOR EACH TREATMENT. SOUTH-ASPECT, LOW-ELEVATION STUDY SITE, 1976.

Treatment		Perennial Grasses	Forbs	Shrubs	Annuals	F
1	TOSCO Spent Shale	A [†] 35	B 0	A 32	A 33a [§]	*
2	15 cm Soil Cover/TOSCO	A 85	B 0	B 6	B 9 <i>b</i>	**
3	30 cm Soil Cover/TOSCO	A 52	B 0	A 42	B 6 <i>b</i>	**
4	USBM Spent Shale	A 56	C 0	AB 29	BC 15 <i>ab</i>	**
5	15 cm Soil Cover/USBM	A 64	C 0	B 28	BC 8 <i>b</i>	**
6	60 cm Soil Cover/USBM	A 66	B 0	AB 30	B 4 <i>b</i>	*
7	Soil Control	A 79	B 2	B 13	B 6 <i>b</i>	**
F		NS	NS	NS	*	

+ Values with common letters (ABC) within rows (comparing species category within a treatment) are not significantly different by Tukey's test at the 5% level.

§ Values with common italicized letters (*abc*) within columns (comparing spent shale treatments within species categories) are not significantly different by Tukey's test at the 5% level.

* Significant at 5% level; ** Significant at 1% level.

NS No significant difference.

15 cm Soil Over TOSCO --

After four growing seasons this treatment has a total vegetation cover (87%) comparable to all other treatments on the north-aspect and significantly greater (72%) than the TOSCO (60%) on the south-aspect (Table 5). This treatment is dominated by perennial grasses and generally contains less shrubs than any other treatment (Tables 6 & 7). Fewer annuals are found on this treatment than the TOSCO treatment.

30 cm Soil Over TOSCO --

Total vegetation cover on this treatment is similar to the 15 cm of soil cover over TOSCO spent shale (Table 5). However, this treatment has more shrubs on it than the 15 cm soil cover over TOSCO.

USBM Spent Shale --

In 1973, total vegetation cover established on this treatment was comparable to that on the TOSCO treatments and tended to be less than that on the soil-covered treatments (Table 5). By 1976, total vegetation cover was not significantly different on this treatment than any other treatment. Perennial grasses dominated this treatment in 1976 although shrubs and annuals were also obvious (Figure 7, Tables 6 & 7).



Figure 7. Vegetation dominated by perennial grasses but with substantial amounts of winterfat (small white shrub) and fourwing saltbush on south-aspect, low-elevation USBM spent shale plots, July 1976.

15 cm Soil Over USBM --

This treatment tends to have greater vegetation cover than the USBM treatment, however, the difference is not statistically different (Table 5). The relative composition by species categories is also similar for this treatment to the USBM treatment except for a trend to more annuals and less perennial grasses on the USBM (Tables 6 & 7).

60 cm Soil Over USBM --

Total vegetation cover and species categories tend to be the same for this treatment as for the 15 cm of soil-cover over USBM spent shale.

Soil --

Total vegetation cover on this treatment in 1973 was statistically less than on some of the soil-cover treatments (Table 5). These results are difficult to explain except that the soil-cover over the shaped spent shales may have been a firmer and better seedbed than the soils. By 1976 vegetation cover had increased on the soil treatments to one of the highest cover values for any of the treatments (Table 5). The soil treatments were dominated by perennial grasses but included a number of shrubs and few annuals (Tables 6 & 7).

In summary, a rather large amount of vegetation cover was maintained on all the treatments during the 1974-1976 growing seasons. However, a substantial amount of the vegetation on the TOSCO treatment was annuals which might be expected to produce considerably less cover under below-average precipitation conditions. The south-facing plots had less standing crop and less ground cover than the north-facing plots.

Moisture in Spent Shale and Soil Treatments

Plant available moisture is usually the most limiting factor which determines the amount and type of vegetation which can be maintained in the semiarid oil shale area. Thus, moisture was monitored at least monthly in each plot throughout each growing season (Appendix Tables 17 thru 32).

To summarize this large amount of moisture data, early spring and fall moisture profiles were plotted by years for each treatment (Figures 8-11). The spring moisture profiles are reflections of spring snowmelt recharge, while the fall profiles show soil moisture late in the growing season. The soil moisture readings (Figure 8-11) for each year were made on the following dates:

	Spring	Fall
1973	June 27	September 13
1974	April 18	September 9
1975	April 9-10	October 13
1976	March 10 or April 1	August 8

In the discussion to follow all moisture is in percent by volume. It also must be noted that the neutron probe gives quite low moisture values at the 15 cm depth under dry conditions. This is apparently because the 15 cm layer of dry soil material is not thick enough to moderate the neutron flux and some neutron loss to the atmosphere occurs.

TOSCO Spent Shale --

The profiles of the TOSCO spent shale treatment were filled to saturation (about 40%) as the result of leaching in June 1973 (Figures 8 & 9). By the fall of 1973, moisture in the top 60 cm had been reduced to 20-30% and moisture at greater depths was reduced to about 30%. The water loss in the upper 60 cm was probably primarily lost to evapotranspiration, the water loss below 60 cm was probably due to gravitational loss and possibly some transpiration.

Irrigation with 50 mm of water in the fall of 1973 and 127 mm of over-winter precipitation resulted in the TOSCO profiles containing about 35% moisture in the spring of 1974. Thirty to 35% moisture appears to be near field capacity for the TOSCO spent shale. By the fall of 1974 soil moisture was reduced to about 20%.

In 1975, there was moisture recharge to depths of 130 cm on the TOSCO plots from a total of 137 mm of precipitation received between March 1 and July 1, 1975. By fall 1975, moisture was again depleted throughout the profile to about 20% (Figures 8 & 9).

Recharge in 1976 was much less than in 1975 (Figures 8 & 9) even though the site received 190 mm of precipitation between March 1 and July 1. Note that in 1976 moisture recharge and depletion was only from the upper 90 cm of the profile as compared to about 130 cm of the profile in 1975. An explanation for the limited recharge on the north-aspect is that there was 28 mm of surface runoff from snowmelt.

15 cm of Soil Over TOSCO --

Moisture recharge and depletion patterns for the 15 cm soil cover over TOSCO spent shale were similar to the TOSCO spent shale treatments as just discussed.

30 cm Soil Over TOSCO --

The 30 cm of soil cover over TOSCO treatment was not leached, this resulted in considerably less moisture in the profile in the spring of 1973 than in the TOSCO, 15 cm of soil over TOSCO, or soil treatments (Figures 8 & 9). Recharge in 1974 and 1975 appears to be less for this treatment than the other treatments mentioned above. This may be because there was less moisture left at the end of the 1973 and 1974 growing seasons in the 30 cm of soil over TOSCO treatment than the other treatments. This in turn is thought to be a reflection of less moisture in the profile to start with and implies that some water stored in 1973 was used in 1974 and 1975 by plants growing on the leached treatments. Note that by 1976 the moisture extraction patterns were similar for all treatments. This indicates that all of the residual moisture from leaching had been depleted. The moisture available and extracted in 1976 from the north-aspect 30 cm soil-covered TOSCO and soil control treatments (Figure 8) are greater than the TOSCO spent shale and 15 cm soil-cover

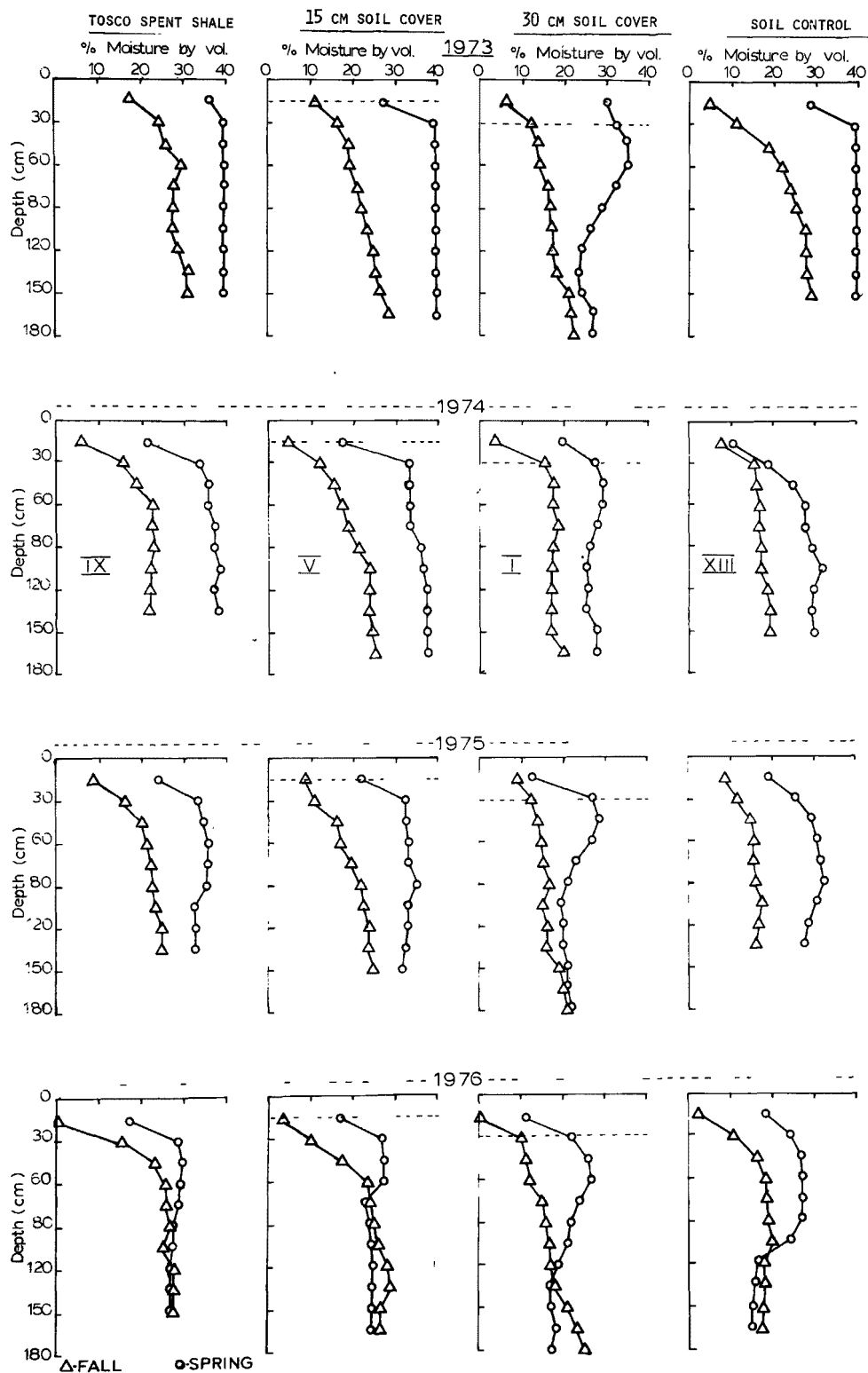


Figure 8. Volumetric moisture profiles for TOSCO spent shale and soil treatments. Low-elevation study site, north-aspect.

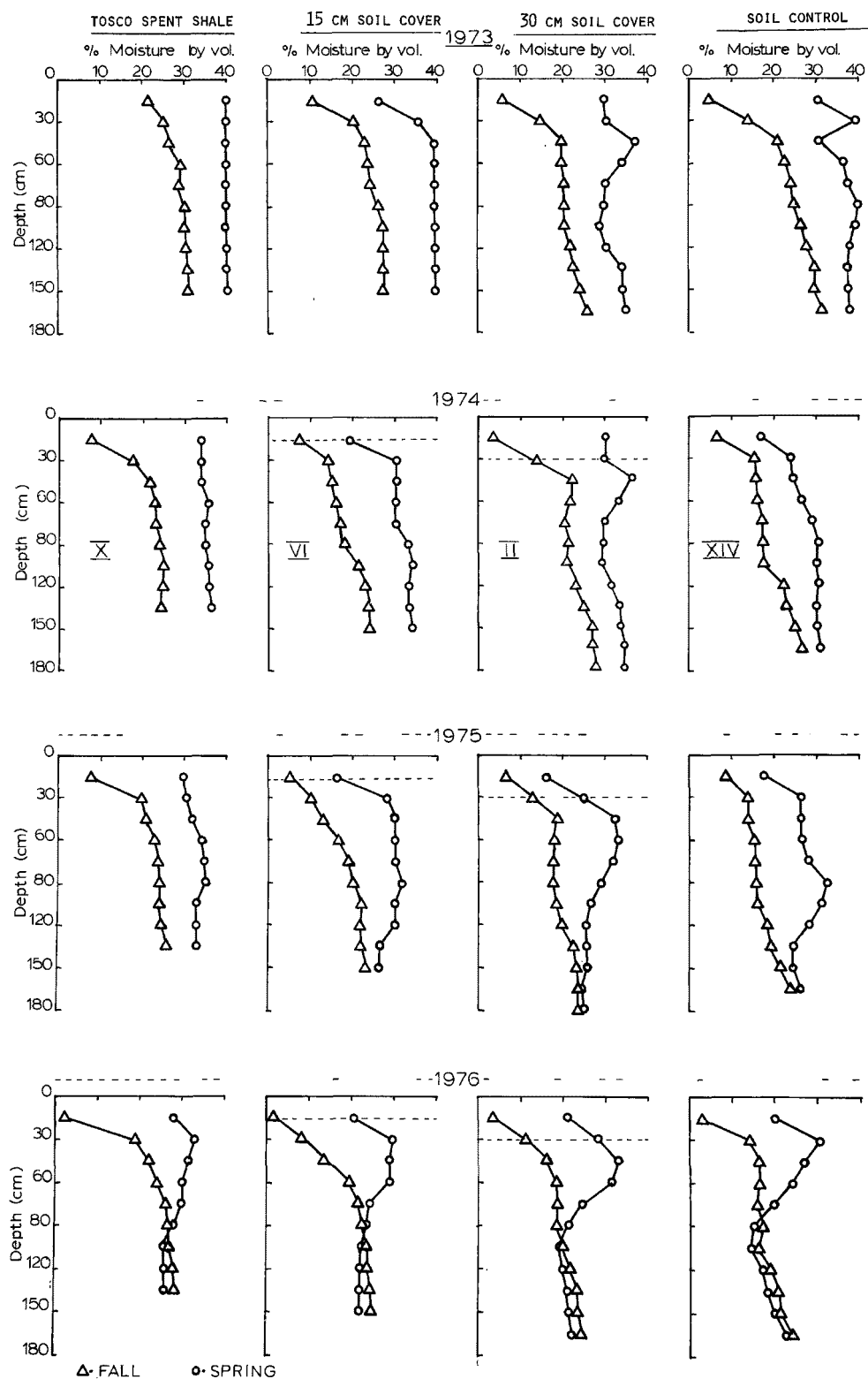


Figure 9. Volumetric moisture profiles for TOSCO spent shale and soil treatments. Low-elevation study site, south-aspect.

treatments. This appears to be the result of considerably more surface runoff from the latter two treatments, and thus less recharge (see the surface runoff section).

USBM Spent Shale --

Leaching in 1973 resulted in saturation of the profile of this treatment. By the fall of 1973, the moisture had been depleted somewhat but considerable plant-available water was left in the profile as indicated by the fact that the moisture content was about 25% as compared to fall moisture content of 15-20% in later years (Figures 10 & 11).

Recharge in the springs of 1974 and 1975 appears to have returned the profiles of this treatment on the north-aspect to field capacity (Figure 10). In contrast, recharge on the south-aspect in 1975 was only to a depth of 120 cm (Figure 11). Moisture appears to be depleted to lower levels in 1975 than in 1974, indicating use of water stored in 1973 by transpiration in 1975.

In 1976, recharge occurred to a depth of about 140 cm on the north-aspect and only to 90 cm on the south-aspect. This reduced plant-available water (the area between the spring and fall moisture profiles) rather dramatically on the south-aspect plots.

No major differences are evident in the moisture patterns between the USBM spent shale treatments and the TOSCO spent shale treatments.

15 cm Soil Over USBM --

Moisture recharge and depletion patterns for this treatment were similar to the USBM spent shale treatment discussed above.

60 cm Soil Over USBM --

This treatment was not leached in 1973 and thus does not show quite as much water in the profile in spring 1973 as the USBM spent shale and 15 cm soil cover over USBM treatments. In 1974-1976 the moisture patterns appeared similar for all USBM and soil-covered over USBM spent shale treatments.

Soil Control --

No major differences in moisture profiles among the spent shale treatments and the soil treatments were evident except that recharge in the soil was greater in the spring in 1976 on the north-aspect than in the TOSCO and 15 cm soil cover over TOSCO treatments. This was apparently a reflection of greater runoff from the latter treatments.

In summary, there is evidence of use in 1974 and 1975 of moisture stored in 1973 from the leaching treatment. This means that 1976 was apparently the first year the vegetation had to depend entirely on seasonal precipitation. In 1976 recharge occurred to maximum depths of 140 cm on the north-aspects and only 90 cm on the south aspects. Recharge in 1976 on the north-aspect TOSCO treatment and 15 cm of soil cover over TOSCO was less than on the other treatments, this was apparently because of greater runoff from snowmelt.

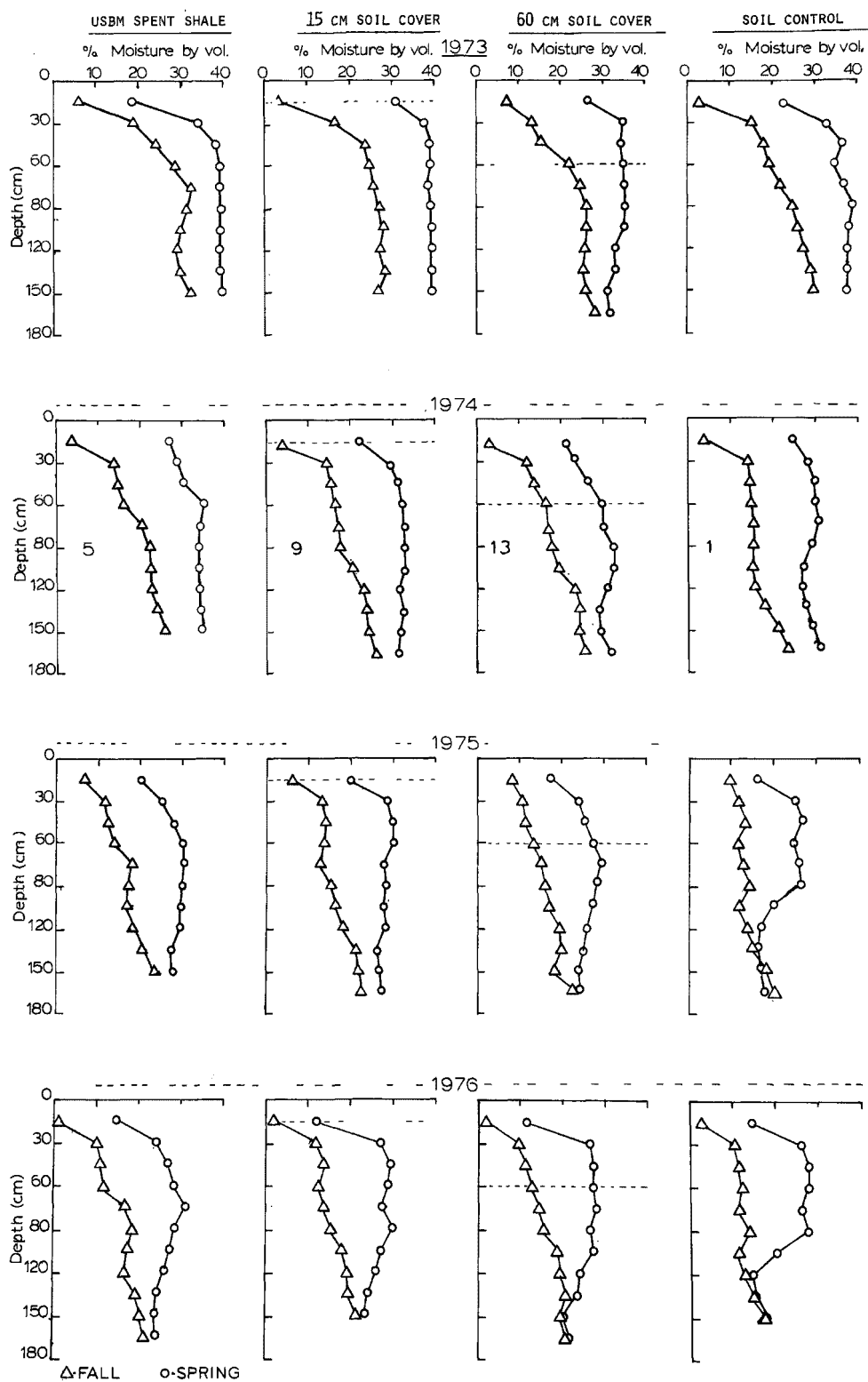


Figure 10. Volumetric moisture profiles for USBM spent shale and soil treatments. Low-elevation study site, north-aspect.

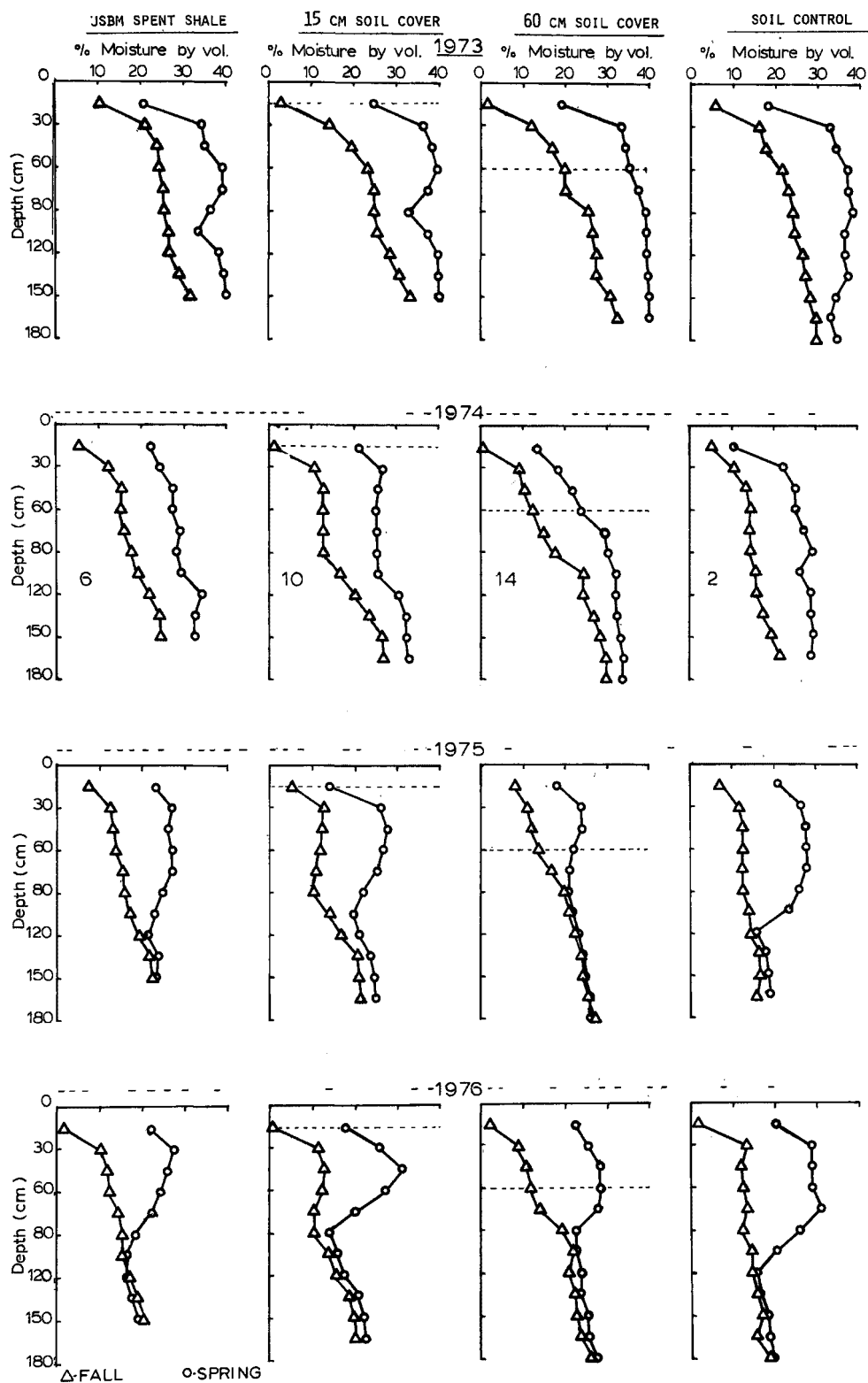


Figure 11. Volumetric moisture profiles for USBM spent shale and soil treatments. Low-elevation study site, south-aspect.

Leaching and Movement of Soluble Salts

The salinity levels of the spent shales were initially too high for the materials to be considered as suitable plant growth media. Thus the spent shale was leached as were the 15 cm of soil cover over spent shale treatments. The 30 cm of soil over TOSCO and 60 cm of soil over USBM spent shale treatments were not leached.

Soluble salts were determined by electrical conductivity (EC) measurements on core samples (Appendix Tables 33-40) and by monitoring in-place salinity sensors (Appendix Tables 41-45). The salinity sensors gave erratic data and appear to be unsuitable for long-term monitoring studies, thus the sensor data was not used in the following discussion.

The EC data used in the following presentation is on the 1:1 soil-water extracts, thus the data are not directly interpretable in terms of plant growth by the common salinity standards for saturation extracts. A rough approximation for plant growth interpretation on the 1:1 extracts can be made by multiplying these EC values by 2. The common interpretations are that soils with saturation extract EC values of 4 mmhos/cm and greater are saline, and that soils with saturation extract EC values of 16 mmhos/cm and greater are extremely saline (Richards, 1954).

TOSCO Spent Shale --

Soluble salts in the TOSCO spent shale were leached in 1973 to depths of greater than 180 cm on the north-aspect plots (Figure 12) and to 150 cm on the south-aspect plots (Figure 13). Initially, these spent shales had saturation extract conductivities of about 18 mmhos/cm. By the fall of 1974, the TOSCO spent shales had resalinized, somewhat throughout the profile, but particularly at the surface where conductivities were 15-17 mmhos/cm on the 1:1 extract (Figures 12 & 13). This resalinization was the result of water and the dissolved salts moving upward by capillary action in the silty-textured TOSCO spent shale.

In the spring of 1975, the salts were moved downward as a result of 127 mm of precipitation received during the winter and spring. By fall of 1975 there was no indication of salt movement upward, a situation which also prevailed in 1976 (Figures 12 & 13). Thus it appears that the soluble salts have reached somewhat of an equilibrium with their environment in that rapid plant utilization of moisture in the spring reduces greatly the potential for upward movement of water and dissolved salt. These are the results that were predicted for semi arid areas when the soil surface is beyond the capillary rise potential from a water table (Striffler et al., 1974).

15 cm Soil Over TOSCO --

Salt movement patterns on the 15 cm soil over TOSCO spent shale treatments are nearly identical to those discussed above for the TOSCO spent shale (Figures 12 & 13). Of particular interest is that by the fall of 1974 soluble salt had moved through the 15 cm of soil cover and concentrated at the surface. But as in the case of the TOSCO treatments the salt was moved down by precipitation in 1975 and did not concentrate on the surface by the fall of 1975 or 1976.

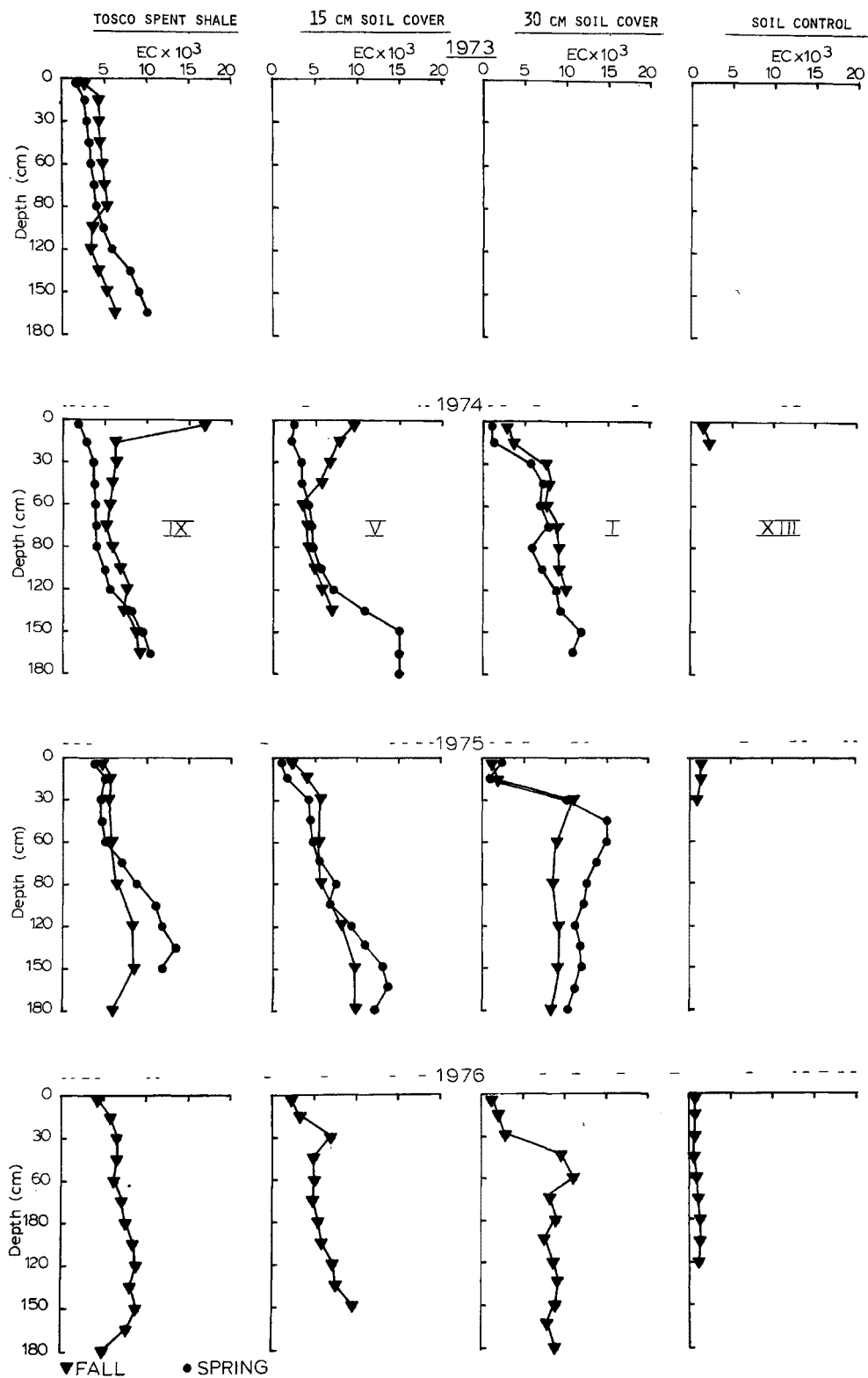


Figure 12. Soluble salt profiles in TOSCO spent shale and soil treatments. North-aspect, low-elevation study site.

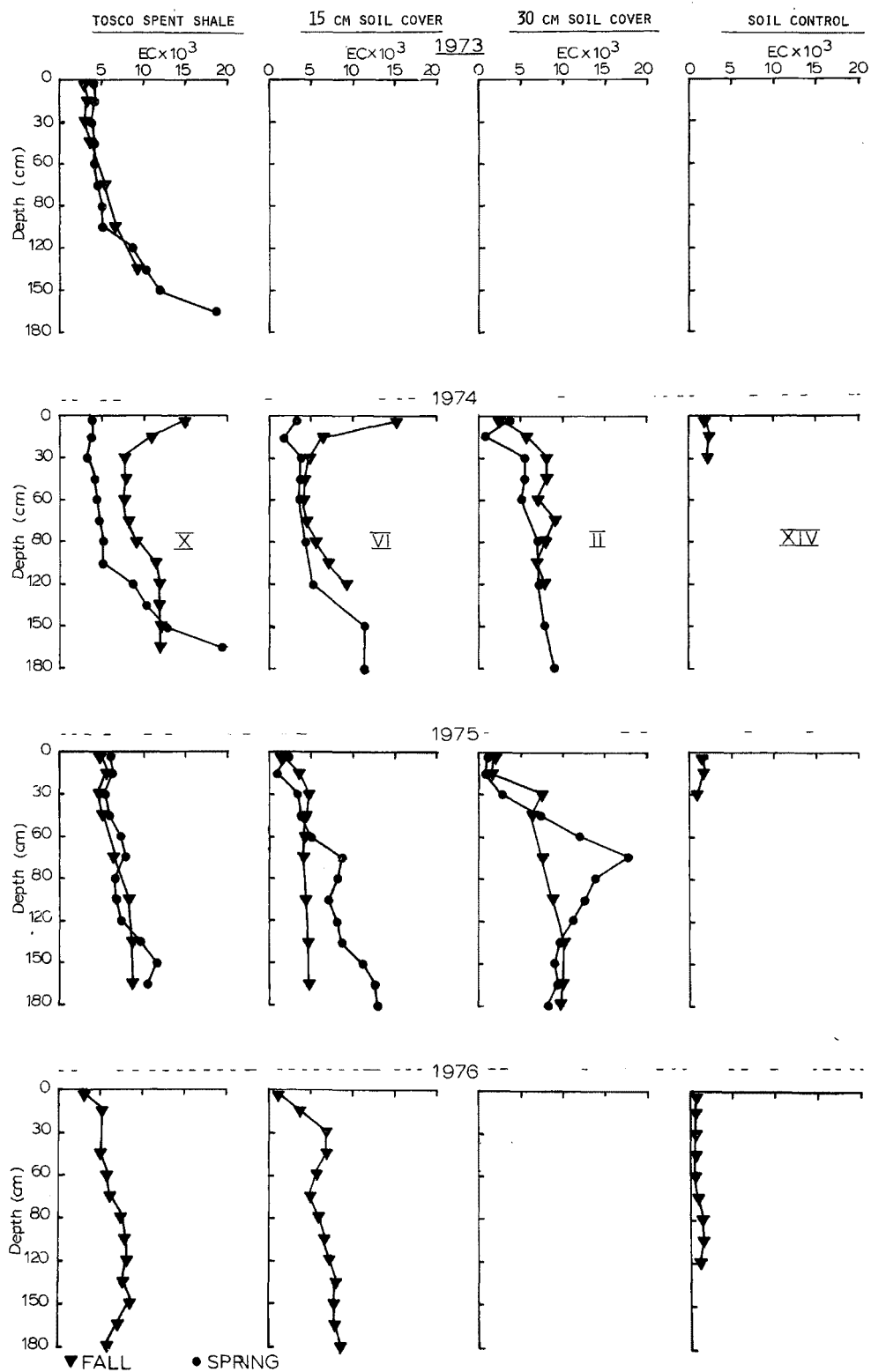


Figure 13. Soluble salt profiles in TOSCO spent shale and soil treatments. South-aspect, low-elevation study site.

30 cm Soil Over TOSCO --

These plots were unleached thus when initially core sampled in the spring of 1974 the soluble salt content in the 30-120 cm zone was considerably greater than in the TOSCO and 15 cm soil cover over TOSCO plots (Figures 12 & 13). Soluble salt did not accumulate on the surface of these unleached treatments by the fall of 1974 (Figures 12 & 13), this is in direct contrast to the TOSCO leached treatments. Salt apparently did not move to or accumulate on the surface because water stored in the profile was less in the unleached treatments (Figures 8 & 9) and thus did not have the potential to move by capillary action to the surface carrying salts with it.

USBM Spent Shale --

The soluble salt content of the 180 cm profile of USBM spent shale was reduced to low levels by the 1973 leaching (Figures 14 & 15). In contrast to the TOSCO spent shale, resalinization of the USBM spent shale surface did not occur by the fall of 1974 (Figures 12-15). This is because the coarse-textured USBM spent shale does not have the potential for capillary movement of water that the fine-textured TOSCO has.

There may be a slight increase in soluble salt levels in the USBM spent shales at depths of 60-180 cm over the 1974-1976 span, this is probably due to salt diffusion out of large particles rather than from salt movement from above or below.

15 cm Soil Over USBM --

Soluble salt movement in this treatment was quite similar to that for the USBM treatment discussed above.

60 cm Soil Over USBM --

The 60 cm soil over USBM spent shale was unleached and thus in 1974 shows a high soluble salt content at 60 cm and below (Figures 14 & 15). There was no tendency for the soluble salt to move upward into the soil cover, on the contrary, the soluble salt appears to be moving downward over the 1974-1976 period (Figures 14 & 15).

Soil --

The soil was initially non-saline and there was no indication of salt accumulation or movement over the 1974-1976 period.

In summary, these patterns of salt movement in the spent shales and soil cover over spent shale treatments are probably the most important findings of the study. The soluble salts were leached to depths of 120 to 180 cm by application of 100 cm of leach water. On the fine-textured TOSCO spent shale the salt moved back into the leached zone and accumulated on the surface as a result of capillary water movement from rather high subsurface moisture accumulations. Resalinization did not occur on the 30 cm of soil cover over TOSCO spent shale which was unleached and thus did not have a reservoir of water subject to capillary rise. Resalinization of the coarse-textured USBM spent shale did not occur.

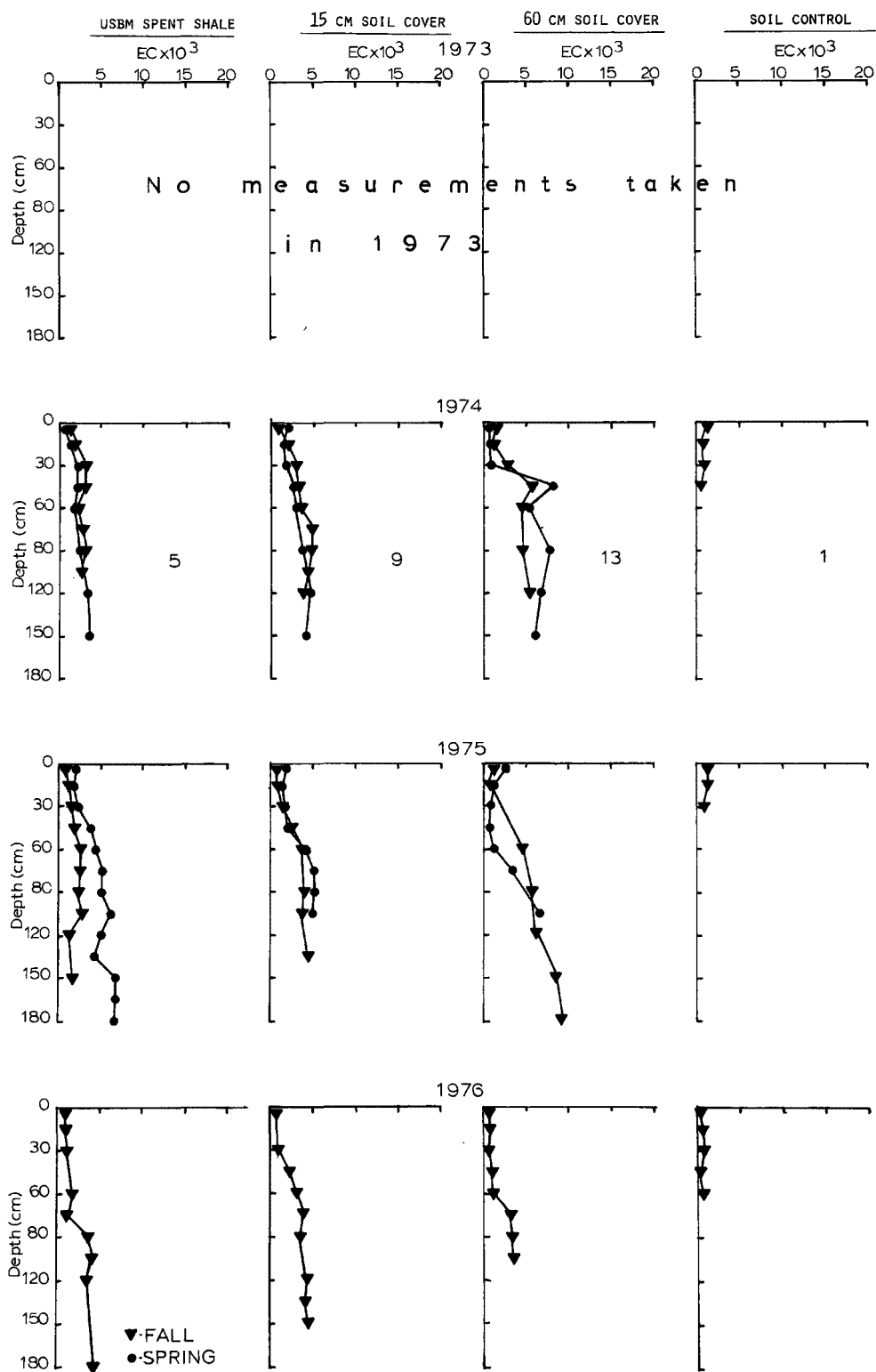


Figure 14. Soluble salt profiles in USBM spent shale and soil treatments. North-aspect, low-elevation study site.

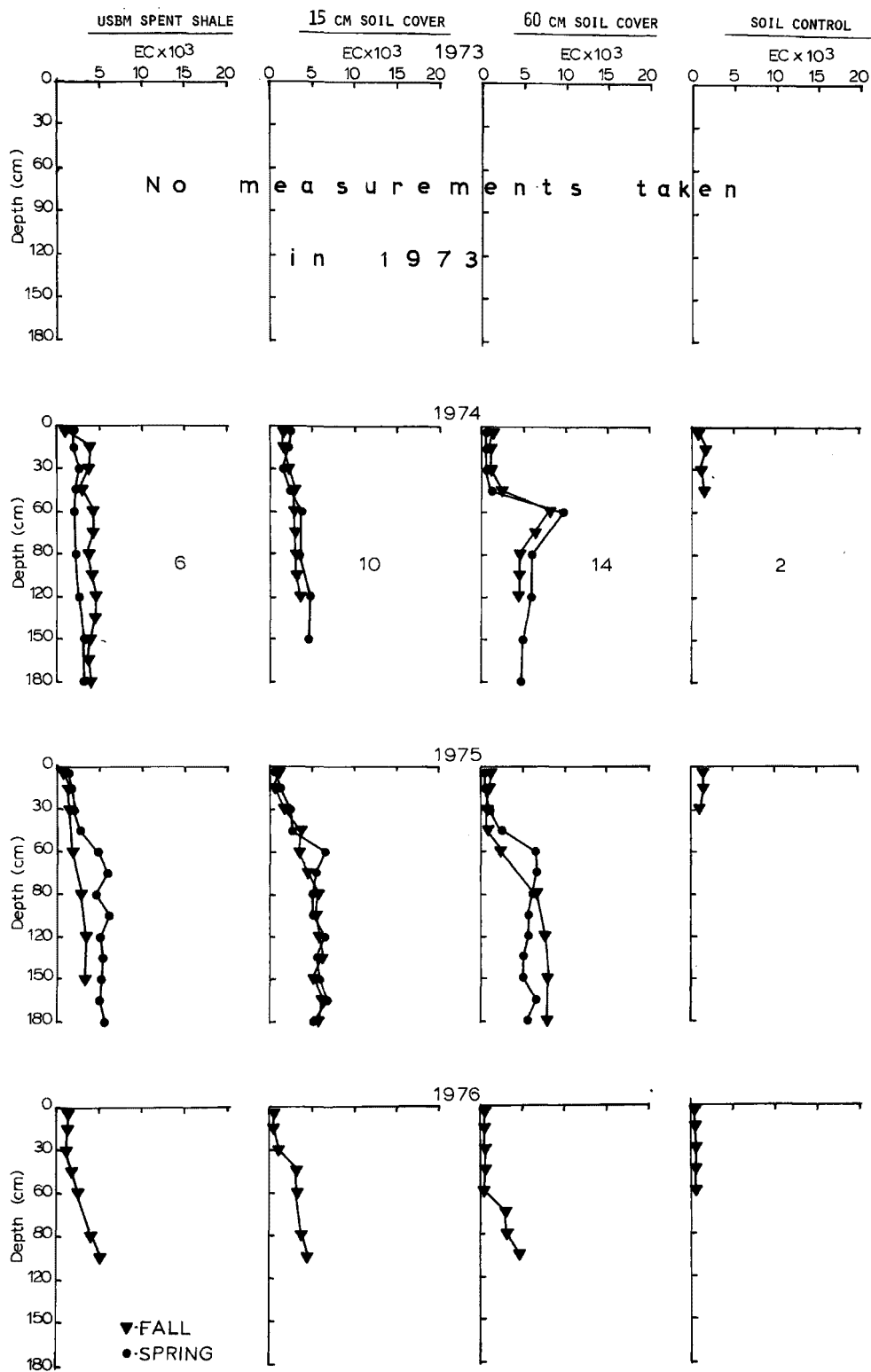


Figure 15. Soluble salt profiles in USBM spent shale and soil treatments. South-aspect, low-elevation study site.

Of even more interest is that the accumulation of salt on the surface of the TOSCO spent shales was leached to depths of 30-60 cm in 1975 by winter and spring precipitation. The soluble salts have remained at this depth through the 1975 and 1976 growing seasons, apparently maintained at about this depth by a balance among precipitation, evaporation, and transpiration.

Surface Runoff and Sediment Yields

The runoff and sediment collection system was completed in June 1974. Measureable amounts occurred from one summer storm in 1974, snowmelt runoff in spring 1975, one summer storm in 1975, and snowmelt runoff in the spring of 1976. The amounts of runoff, sediment yields, conductivity, and chemical analysis for common ions are reported in Appendix Tables 47-54. The data is summarized in the body of this report in Tables 8-11.

TOSCO Spent Shale --

The 19 mm of rainfall which fell in 30 minutes in July 1974 was about a 10-year maximum probable storm for the low-elevation study site. The storm resulted in an average of 36 liters of runoff from the TOSCO north-aspect treatment (Table 8) this is 1.6 mm or about 8% of the rainfall. There was no runoff from the north-aspect soil treatments and only a small amount of runoff from the south-aspect treatments including the TOSCO spent shale (Table 9). The limited amount of runoff water presents a high salinity hazard if used for irrigation (Richards, 1954).

TABLE 8. SUMMER STORM SURFACE RUNOFF AND WATER QUALITY DATA FOR TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. LOW-ELEVATION STUDY SITE. 1974-1976.

1974, 19 mm rain in 30 minutes on August 14								
	North Aspect				South Aspect			
	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	36	0	0	0	9	3	0	2
Sediment/plot (g)	505	0	0	0	369	63	0	32
EC μ mhos/cm @ 25 C	1450	0	0	0	1130	1320	0	1100
Sodium Adsorption Ratio	1.0	0	0	0	0.5	0.8	0	0.8
1975, 10.6 mm rain over three 30-minute periods on July 16								
	North Aspect				South Aspect			
	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	39	30	0	2	23	2	22	22
Sediment/plot (g)	10	6	0	2	11	6	6	3
EC μ mhos/cm @ 25 C	2400	350	0	1300	3150	8200	1200	700
Sodium Adsorption Ratio	1.6	0.2	0	0.2	1.2	7.0	0.6	0.5

TABLE 9. SNOWMELT RUNOFF DATA AND WATER QUALITY FOR TOSCO SPENT SHALE SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. LOW-ELEVATION STUDY SITE. 1975-1976.

	1975							
	North Aspect				South Aspect			
	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	94	106	120 [†]	3.5	120 [†]	165 [†]	112	20
Sediment/plot (g)	76	89	91	3	94	98	105	18
EC μ mhos/cm @ 25 C	265	105	100	310	195	230	265	150
Sodium Adsorption Ratio	0.3	0.2	0.3	0.4	0.4	0.2	0.6	0.2

	1976							
	North Aspect				South Aspect			
	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	622	495	71	36	92	73	61	14
Sediment/plot (g)	3	8	1	0.4	2	6	4	1
EC μ mhos/cm @ 25 C	350	150	150	200	1300	250	300	200
Sodium Adsorption Ratio	0.2	0.1	0.1	0.3	0.1	0.2	0.3	0.2

[†] Total runoff was not accurately measured because of leaks in the collection basins.

The sediment yield for the TOSCO spent shale plots for the August 1974 storm (Table 8) calculates out to about 200 kg/ha (200 pounds/acre) which is quite low by agricultural standards.

The sodium adsorption ratio which is an indication of the possible hazard posed by sodium in causing soil dispersion was low for this and all other runoff events for all spent shale and soil treatments.

The summer storm on July 16, 1975 (Table 8) produced some runoff from the TOSCO spent shale treatments. The quality of this runoff for irrigation was poor. Sediment yields and the sodium adsorption ratio were low for runoff from this storm.

The amount of runoff and its quality are difficult to interpret for the 1975 snowmelt (Table 9) because the total amount of runoff was unknown due to leaking collection basins. The basins were sealed in the summer of 1975. The north-aspect TOSCO plots yielded an average of 622 liters of runoff or nearly 3 cm from snowmelt in 1976 (Table 9). Runoff on the south-aspect was much less. Water quality of the north slope runoff was high for irrigation, whereas on the south slope water quality was marginal. Note that the lesser amounts of runoff produce higher quantities of dissolved salts, which is what

is expected for salts accumulated on the surface which are dissolved and moved by the initial water flow. The snowmelt produced very little sediment and the sodium adsorption ratio of the runoff was low.

15 cm Soil Over TOSCO---

In general, runoff and water quality for this treatment were similar to that of the TOSCO spent shale discussed above. There are some differences but the results are quite variable between replications.

30 cm Soil Over TOSCO --

Runoff was less from this treatment than for the TOSCO spent shale for the summer storms except for the south-aspect treatment on the July 1975 storm. Runoff from snowmelt in 1976 was much less from this treatment than from the TOSCO spent shale and 15 cm of soil cover TOSCO spent shale - this may be because the latter two treatments were frozen resulting in more runoff. The water quality of spring runoff for the 30 cm of soil over TOSCO spent shale was high.

USBM Spent Shale --

Runoff from the two summer storms was very little for the USBM spent shale treatments (Table 10) and considerably less than the runoff from the TOSCO spent shale (Table 8). These results are consistent with the textures of the spent shales. The conductivities of the runoff water was rather high, but what might be expected from such a small amount of runoff.

TABLE 10. SURFACE RUNOFF AND WATER QUALITY DATA FROM USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. LOW-ELEVATION STUDY SITE. 1974-1975.

1974, 19 mm rain in 30 minutes on August 14								
	North Aspect				South Aspect			
	USBM	15 cm Soil Cover	60 cm Soil Cover	Soil Control	USBM	15 cm Soil Cover	60 cm Soil Cover	Soil Control
Runoff/plot (l)	1.2	ff	ff	ff	1.2	ff	1.2	ff
Sediment/plot (g)	30	no	no	no	131	no	21.2	no
EC μ mhos/cm @ 25 C	1880	r	r	r	1400	r	1640	r
Sodium Adsorption Ratio	3.3	no	no	no	1.3	no	0.8	no
1975, 10.6 mm rain over three 30-minute periods on July 16								
	North Aspect				South Aspect			
	USBM	15 cm Soil Cover	60 cm Soil Cover	Soil Control	USBM	15 cm Soil Cover	60 cm Soil Cover	Soil Control
Runoff/plot (l)	2.0	1.8	2.6	ff	ff	1.5	2.0	ff
Sediment/plot (g)	5	7	5	no	no	6	10	no
EC μ mhos/cm @ 25 C	2300	2600	1000	r	r	4100	2300	r
Sodium Adsorption Ratio	1.5	2.3	0.6	no	no	3.2	1.5	no

Snowmelt runoff from USBM plots was low in 1976 (Table 11) and much less than from the TOSCO plots (Table 9). The conductivity of the runoff water was relatively low when the small amount of runoff is considered.

TABLE 11. SNOWMELT RUNOFF DATA AND WATER QUALITY FOR USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. LOW-ELEVATION STUDY SITE. 1975-1976.

	1975							
	North Aspect				South Aspect			
	USBM	15 cm Soil Cover	60 cm Soil Cover	Soil Control	USBM	15 cm Soil Cover	60 cm Soil Cover	Soil Control
Runoff/plot (l)	83	8	29	49	137 [†]	120 [†]	144 [†]	25
Sediment/plot (g)	49	6	22	23	103	94	92	17
EC μ mhos/cm @ 25 C	115	205	100	150	230	190	160	130
Sodium Adsorption Ratio	0.2	0.4	0.2	0.2	0.2	0.2	0.4	0.2

	1976							
	North Aspect				South Aspect			
	USBM	15 cm Soil Cover	60 cm Soil Cover	Soil Control	USBM	15 cm Soil Cover	60 cm Soil Cover	Soil Control
Runoff/plot (l)	7	10	16	22	1	2	2	13
Sediment/plot (g)	0.2	0.6	0.3	0.9	0.7	0.2	0.2	2.1
EC μ mhos/cm @ 25 C	450	350	300	400	400	900	750	500
Sodium Adsorption Ratio	0.3	0.3	0.2	0.3	0.3	0.4	0.3	0.2

[†] Total runoff was not accurately measured because of leaks in the collection basins.

15 cm of Soil and 60 cm of Soil Over USBM --

The runoff and water quality of these treatments are about the same as for the USBM plots discussed above.

Soil --

The runoff on the soil plots tended to be less than from the TOSCO plots (Tables 8 & 9) and similar to the runoff from the USBM plots (Tables 10 & 11).

In summary, only two summer storm events over three years produced runoff. The runoff was greater for the TOSCO plots than for the USBM or soil plots. Water quality of the rather limited amount of summer storm runoff was rated as having a medium to high salinity hazard for irrigation.

Runoff from snowmelt was much greater than from the summer storms. Quality of the snowmelt runoff was rated as posing a low salinity hazard for irrigation with the exception of the TOSCO south-aspect treatment which was rated as posing a high salinity hazard. Caution has to be used in interpreting the water quality for irrigation as large amounts of runoff tend to

produce water low in soluble salts whereas small amounts of runoff are high in soluble salts.

Sediment yield on all treatments was very low - this is a reflection of the initial mulching treatments and then the rather large amount of vegetation cover maintained on the plots.

The sodium adsorption ratio was low for runoff water from all treatments.

Near-Surface Temperatures

Temperatures 1 cm below the surface of TOSCO spent shale and soil plots were continuously recorded during the 1973-1976 growing seasons. Maximum temperatures were plotted along with the air temperatures (Figure 16) and are used in the following discussion.

In 1973, the near-surface temperatures were approximately the same for both aspects and treatments (Figure 16). The temperatures never exceeded 35 C during the growing season as the result of daily irrigation during most of June and July. The low temperature probably contributed to the successful plant establishment on the black-colored TOSCO spent shale.

In 1974-1976 the near-surface temperatures for all treatments showed a gradual rise during April and May, but increased greatly in June and early July (Figure 16). The rise in temperature is directly related to the maturity of the vegetation cover. In April and May, the cool-season grasses are growing rapidly and the surface is being cooled by both the green transpiring plants and moisture evaporation from the spent shale surface. When the moisture was depleted and the vegetation reached senescence or maturity, the rapid rise in temperatures occurred for all treatments and aspects.

The temperatures on the south-aspect treatments have exceeded those on the north-aspect by an average of 10-15 C during April and May, and by as much as 20 C in late June, July, and August. These temperature differences with aspects are what were expected but do indicate one of the major problems in vegetation establishment on south-facing slopes.

In 1975 and 1976, the north-aspect TOSCO spent shale treatments were 10-15 C warmer than the north-aspect soil, this is a reflection of less vegetation cover and decomposition of the mulch thereby exposing some black surface of the shale. There was little difference in the near-surface temperatures when comparing south-aspect TOSCO spent shale and soil in 1975 and 1976.

The difference between the air temperature in the instrument box in 1973-1974 as compared to 1975-1976 is result of moving the instrument box, which housed the recorders, approximately 20 cm off the ground surface in 1975. This resulted in a cooler air temperature in the box in 1975 and 1976.

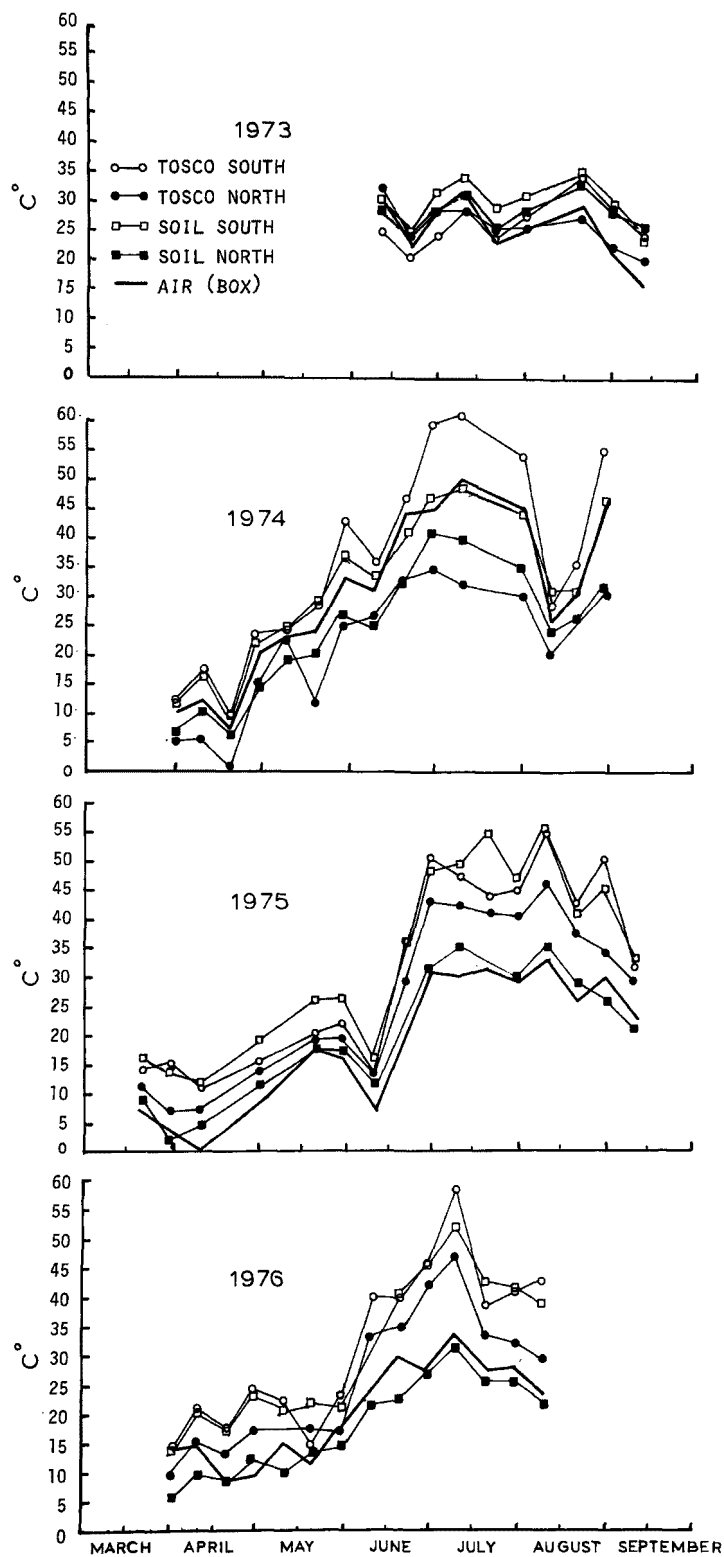


Figure 16. Maximum temperatures at depths of 1 cm on TOSCO spent shale and soil plots. Low-elevation study site.

In summary, surface temperatures are sufficiently high in late June and July on the south-aspect TOSCO spent shale and soil control plots to limit seedling establishment. This does not appear to be directly influencing the mature vegetation cover already established except that the south-aspect is more xeric as reflected by less vegetation cover.

HIGH-ELEVATION STUDY SITE

The high-elevation study site is 80 km from Rifle which serves as our base of operations. Water for leaching and irrigation was hauled 4.8 kilometers to the plots. Because of the remoteness of the site and the difficult water hauling logistics, these plots did not get the intensive and timely management that the low-elevation plots received. The initial stand established by seeding in 1974 was unsatisfactory so the plots were reseeded in 1975. Thus only one year's results (1976) for vegetation growth without irrigation are available. Because of the shorter time span since the high-elevation plots were established, the following discussion is more limited than for the low-elevation plots.

Vegetation

A thin stand of vegetation dominated by big sage resulted from seeding the high-elevation plots in June of 1974. The thin stand was due to: 1. too low of a seeding rate of perennial grasses; 2. inadequate leaching of the spent shales and subsequent resalinization. The low seeding rate for the perennial grasses (2.5 kg/ha, Appendix Table 55) was used in an effort to reduced competition thereby encouraging establishment of forbs and shrubs. The results of the 1974 seeding are included in this report (Appendix Tables 56-59) for documentation and also to raise the question if big sage should be included in seed mixes for similar sites. This species dominated the 1974 seeding. Incontrast, only several plants were established in 1973 on the low-elevation plots. Viability of this species varies greatly among seed lots. As there are about 8 million seeds per kilogram, there appears to be no way to adjust the seeding rate to obtain a desirable mix of big sage with other species.

Barley straw was used as a mulch for the 1974 seeding. As a result some barley grew on the plots, this was sampled and certain trace elements determined in the foliage by Ward and Nagey (1977). Molybdenum and zinc were higher in the barley grown on the spent shales than in the soil.

Due to the thin stand of vegetation established by the 1974 seeding, the plots were rototilled and reseeded on June 10, 1975, irrigation was used for establishment. A good stand of native perennial plants was established on all treatments in 1975 with ground cover ranging from 43-90 percent (Table 12). In 1976 the vegetation cover on all north-aspect treatments was similar except for the 30 cm soil cover over USBM spent shale. The latter treatment was invaded by pocket gophers which resulted in a loss of some vegetation and considerable surface disturbance, including pushing piles of spent shale up through the soil cover. On the south-aspect treatments there was no difference in cover among the treatments.

TABLE 12. PERCENT VEGETATION COVER FOR EACH TREATMENT BY YEAR. HIGH-ELEVATION STUDY SITE.

Treatment	North Aspect		South Aspect	
	1975	1976	1975	1976
1 TOSCO Spent Shale	63a [†]	91a	53	77
2 15 cm Soil Cover/TOSCO	44 b	89a	43	76
3 30 cm Soil Cover/TOSCO	58ab	75ab	54	77
4 USBM Spent Shale	53ab	78ab	54	83
5 15 cm Soil Cover/USBM	54ab	73ab	54	73
6 30 cm Soil Cover/USBM	43 b	60 b	52	70
7 Soil	49ab	83a	50	74
F	*	**	NS	NS

[†] Values with a common letter within columns are not significantly different as tested by Tukey's Q mean separation test at 5% level.

* Significant at 5% level; ** Significant at 1% level;

NS No significant difference.

Perennial grasses tended to dominate all treatments in 1976 (Tables 13 & 14) although forbs and shrubs were prominent on most treatments. There appears to be a tendency for fewer forbs to be established on the TOSCO and USBM plots, this is probably a reflection of the higher seeding rate of western wheatgrass (Table 3) seeded on these plots. The higher seeding rate of this species was used to ensure a stand, and in retrospect should have been used on all treatments.

Fourwing saltbrush is by far the dominant shrub on the high-elevation site (Appendix Tables 64-67). If it continues to increase in size comparable to that grown on the low-elevation site it will eventually dominate the plots, and probably should be thinned.

As the high-elevation plots have only gone through one growing season without irrigation it is difficult to make comparisons with the low-elevation plots which have gone through 3 growing seasons without irrigation. Overall, the amount of vegetation cover is similar for both sites. A major contrast between the two sites is that annuals make up a major component of the vegetation on the TOSCO low-elevation plots whereas they are a minor component on the TOSCO high-elevation plots. The difference is due to partial loss of the perennial vegetation stand on the low-elevation study site. Thus salt leaching management had a great influence upon the type of vegetation established.

TABLE 13. RELATIVE COMPOSITION IN PERCENT BY SPECIES CATEGORIES FOR EACH TREATMENT. NORTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1976.

Treatment	Perennial Grasses	Forbs	Shrubs	Annuals	F
1. TOSCO Spent Shale	A [†] 70a [§]	C 2ab	B 22	C 6	**
2. 15 cm Soil Cover/TOSCO	A 51ab	AB 27a	B 15	B 7	**
3. 30 cm Soil Cover/TOSCO	A 55ab	B 24ab	B 11	B 10	**
4. USBM Spent Shale	A 72a	B 1 b	B 24	B 3	**
5. 15 cm Soil Cover/USBM	A 61ab	B 16ab	B 9	B 14	**
6. 30 cm Soil Cover/USBM	42 b	15ab	18	25	NS
7. Soil	49ab	16ab	19	16	NS
F	*	*	NS	NS	

[†] Values with common letters (ABC) within rows (comparing species category within a treatment) are not significantly different by Tukey's test at the 5% level.

[§] Values with common italicized letters (*abc*) within columns (comparing spent shale treatments within species categories) are not significantly different by Tukey's test at the 5% level.

* Significant at 5% level; ** Significant at 1% level;

NS No significant difference.

TABLE 14. RELATIVE COMPOSITION IN PERCENT BY SPECIES CATEGORIES FOR EACH TREATMENT. SOUTH-ASPECT, HIGH-ELEVATION STUDY SITE, 1976.

Treatment	Perennial Grasses	Forbs	Shrubs	Annuals	F
1. TOSCO Spent Shale	A [†] 76	C 1 <i>b</i> [§]	B 20	C 3	**
2. 15 cm Soil Cover/TOSCO	A 56	B 24 <i>a</i>	B 15	B 5	**
3. 30 cm Soil Cover/TOSCO	A 51	A 12 <i>b</i>	A 28	A 9	*
4. USBM Spent Shale	A 48	B 3 <i>b</i>	A 38	B 11	**
5. 15 cm Soil Cover/USBM	A 50	B 8 <i>b</i>	AB 21	AB 21	**
6. 30 cm Soil Cover/USBM	A 37	B 7 <i>b</i>	A 31	AB 25	*
7. Soil	37	11 <i>b</i>	29	23	NS
F	NS	**	NS	NS	

[†] Values with common letters (ABC) within rows (comparing species category within a treatment) are not significantly different by Tukey's test at the 5% level.

[§] Values with common italicized letters (*aba*) within columns (comparing spent shale treatments within species categories) are not significantly different by Tukey's test at the 5% level.

* Significant at 5% level; ** Significant at 1% level;

NS No significant difference.

Moisture in Spent Shale and Soil Treatments

TOSCO Spent Shale --

Neutron probe readings taken on May 24, 1974 after the application of approximately 50 cm of leach water in the fall of 1973 indicate the water had moved to a depth of only 60 cm in the profile (Figures 17 & 18). Below 60 cm, the moisture content was only 15% by volume. By the September 10, 1974 sampling date, the moisture content below 60 cm in the profile had increased to greater than 20% by volume, thus indicating that water had moved through the profile as a result of the applications of an additional 100 cm of leach water and irrigation water during the summer. The profiles for the TOSCO spent shale treatments in fall 1974 indicate that moisture used by the seedlings was only from the upper 15 cm of the profiles.

In 1975, the TOSCO spent shale treatment was releached with 100 cm of irrigation water. Approximately 20 cm of irrigation was applied for plant establishment in June and July; however, by the fall moisture reading date, moisture had been depleted to approximately 20-25% by volume throughout the profile (Figures 17 & 18).

The spring 1976 moisture reading shows that the moisture content was greater than 20% by volume in the profile indicating that there was moisture recharge from snowmelt on the north-aspect. Supplemental irrigation was not applied in 1976. The fall 1976 reading shows that moisture was depleted to less than 10% by volume to a depth of 90 cm and to less than 20% by volume throughout the remainder of the profile. This shows that moisture was extracted throughout the profile in 1976 by the large amount of vegetation established on these plots in 1975.

15 cm Soil Over TOSCO --

In the spring of 1974 there was more moisture in the 15 cm soil cover over TOSCO than in the TOSCO treatments (Figures 17 & 18). In 1975 and 1976, moisture patterns for the 15 cm soil cover TOSCO were very similar to the TOSCO treatments.

30 cm Soil Over TOSCO --

These plots were unleached and tend to show a lower moisture content in 1974 than the TOSCO plots and the 15 cm soil over TOSCO plots (Figures 17 & 18). By fall 1976 the moisture profile for the 30 cm soil over TOSCO treatments was very similar to that for the other TOSCO treatments.

USBM Spent Shale --

Spring moisture profiles for the north and south-aspect USBM spent shales in 1974 (Figures 19 & 20) indicate that more water moved into the profile than in the corresponding TOSCO spent shale treatments (Figures 17 & 18). The moisture content is about 25% by volume for the USBM spent shale as compared to 15% for the TOSCO at depths greater than 60 cm. The fall 1974 moisture curves indicate that moisture was only extracted to a depth of 30-45 cm from the USBM spent shale.

The spring 1975 moisture profiles (Figures 19 & 20) show that moisture was 30-40% by volume throughout the profile following leaching.

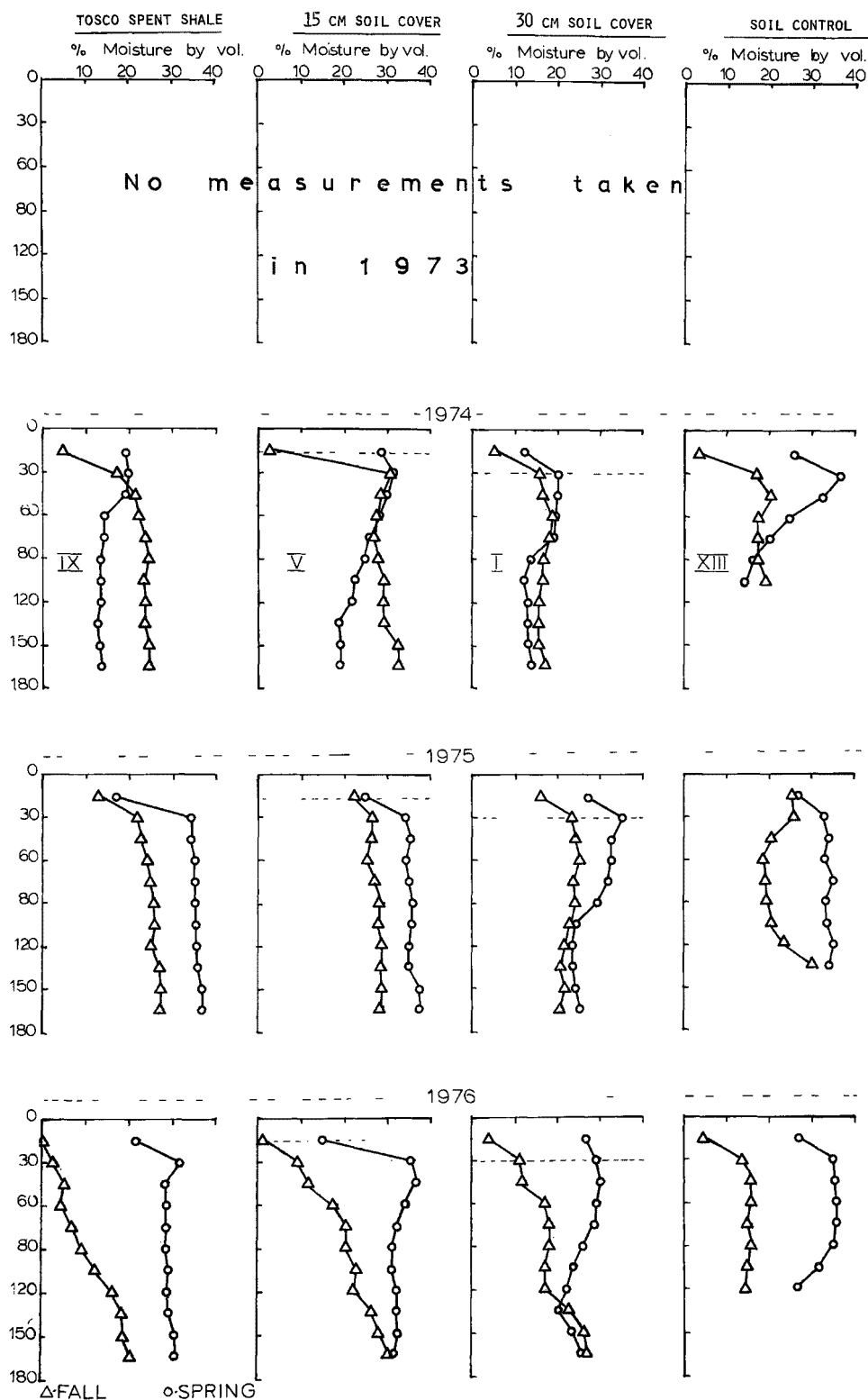


Figure 17. North-aspect moisture measurements for TOSCO spent shale and soil-covered TOSCO spent shale treatments. High-elevation study site.

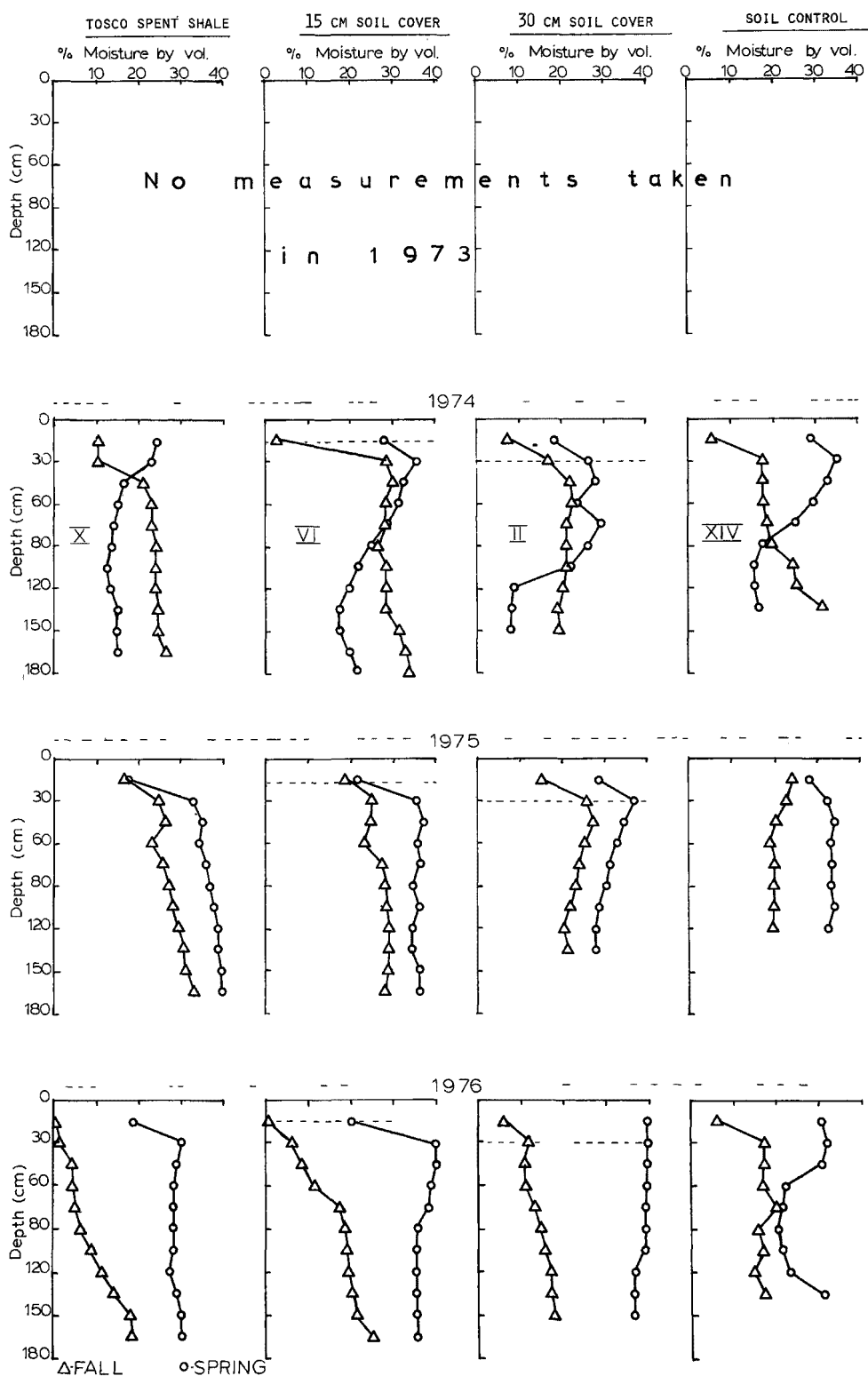


Figure 18. South-aspect moisture measurements for TOSCO spent shale and soil-covered TOSCO spent shale treatments. High-elevation study site.

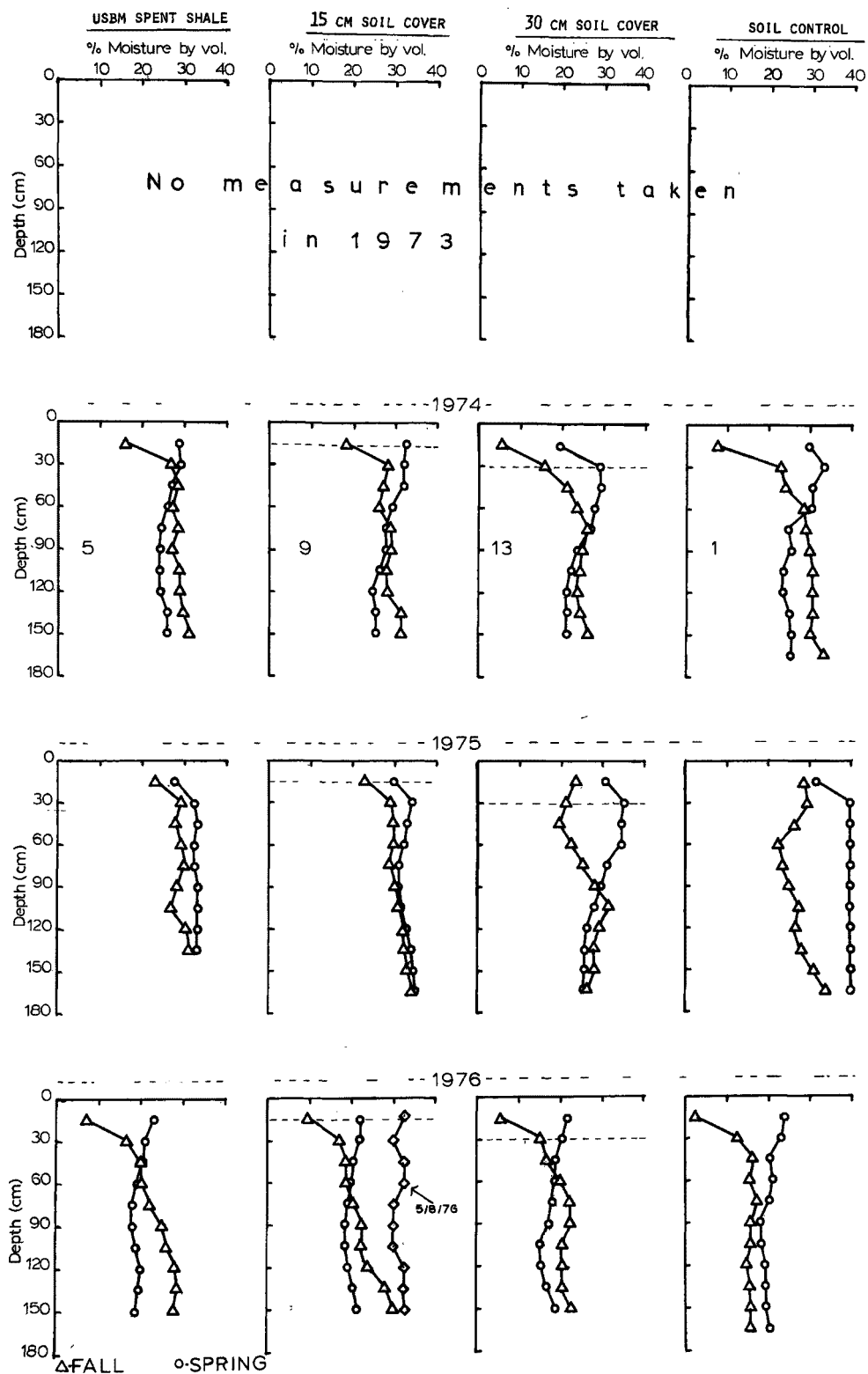


Figure 19. North-aspect moisture measurements USBM spent shale and soil-covered USBM spent shale treatments. High-elevation study site.

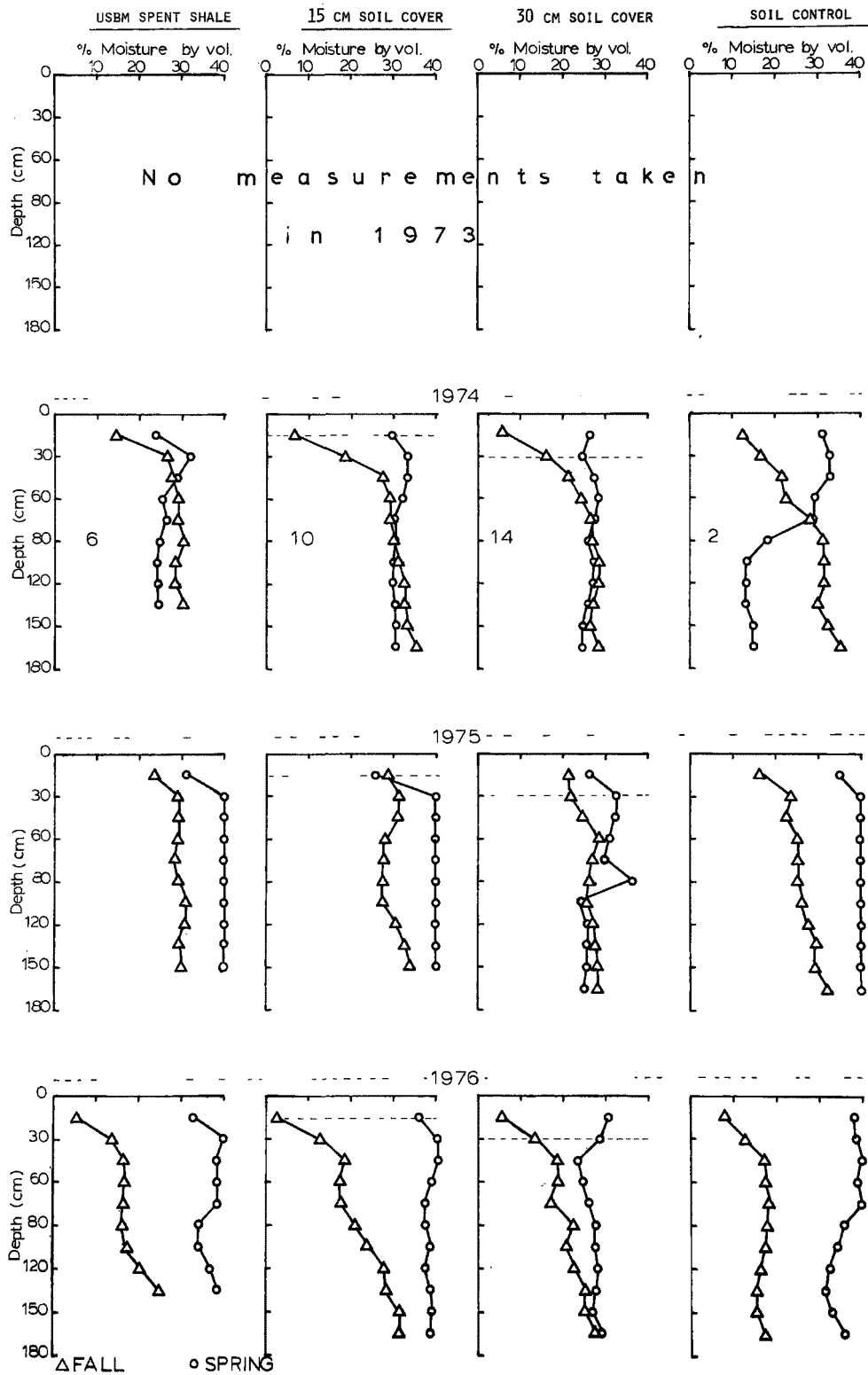


Figure 20. South-aspect moisture measurements USBM spent shale and soil-covered USBM spent shale treatments. High-elevation study site.

Recharge from snowmelt in 1976 was greater on the south-aspect USBM spent shale treatment (Figure 20) than on the north-aspect treatment (Figure 19). Note that the moisture content on the south-aspect treatment is approximately 40% by volume while the moisture content on the north-aspect treatment for the same reading date was approximately 21% by volume. The moisture extraction patterns for 1976 show that on the south-aspect treatment moisture was extracted from throughout the entire profile and that the moisture content was less than 20% by volume by the fall reading date. However, on the north-aspect treatment, moisture was only used to a depth of 45 cm and that the moisture content was greater than 20% by volume below 60 cm in the profile. The differences between the north and south-aspect recharge patterns for the USBM spent shale in 1976 are the direct result of surface runoff following snowmelt. The north-aspect treatments had approximately 4 times more surface runoff than the south-aspect, this will be discussed in more detail on the surface runoff sections. The lack of moisture recharge in 1976 may also be evident on the total vegetation cover in 1976. Note that there is a slightly greater vegetation cover on the USBM south-aspect treatments than on the north-aspect treatments in 1976 (see the vegetation section). The fall 1976 curves show that moisture was extracted from 120 cm in the profile from the south-aspect treatments and only to 60 cm in the north-aspect treatments (Figures 19 & 20).

15 cm Soil Over USBM --

The 1974 spring and fall moisture curves are similar to those of USBM spent shale treatment (Figures 19 & 20). The 1975 and 1976 moisture recharge and extraction curves for the 15 cm soil cover treatment are similar to the USBM spent shale treatment and they also show the same effect of a greater recharge on the south-aspect treatment than on the north-aspect treatment in 1976 (Figures 19 & 20).

30 cm Soil Over USBM --

The spring of 1974 moisture readings indicate that there was moisture recharge following snowmelt in 1974 on both the north and south-aspect treatments (Figures 19 & 20). The 1974 fall moisture reading shows that moisture was extracted to a depth of 60 cm in both the north and south-aspect plots. In 1976 the spring moisture recharge was somewhat less on the north-aspect plots than on the south-aspect plots.

Soil --

In 1974, the spring moisture readings show that moisture had moved into the soil profiles to a depth of 60 cm. By fall 1974 the moisture had moved deeper and had also been extracted to a depth of 90 cm (Figures 17-20).

The spring 1975 reading for both the north and south-aspects showed the moisture content was greater than 40% by volume throughout the profiles.

The results for 1976 soil recharge are variable. One north-aspect soil plot (Figure 17) was recharged to a depth of 120 cm, the other north-aspect soil plot (Figure 19) did not show this much recharge. This difference can be explained by much more runoff from the soil plots shown in Figure 19 (Appendix Tables 92 & 93).

On the south-aspect a similar situation existed where recharge was greater for one soil plots (Figure 20) than the other (Figure 18). By the fall of 1976 moisture had been depleted to 10-15 percent for all soil plots.

In summary, moisture had penetrated only 60 cm into the TOSCO spent shale by May 1974, this despite application of 50 cm of water in the fall of 1973. This data indicates that much of the water applied was lost to surface evaporation. Water penetration into the USBM and soil-cover treatments was deeper. Recharge in the spring of 1976 varied for the various treatments, this was apparently a reflection of considerable snowmelt runoff from some of the plots.

Leaching and Movement of Soluble Salts

TOSCO Spent Shale --

Core samples taken in October 1973 following the application of 50 cm of leach water in August show that the north-aspect TOSCO spent shale treatments had an EC of 10 mmhos/cm below 30 cm and an EC of 5 mmhos/cm in the upper 30 cm (Figure 21). The south-aspect treatment had EC of 10 mmhos/cm below 60 cm, but the EC increased to 20 mmhos/cm at 30 cm and 15 mmhos/cm at the surface (Figure 22). These results indicate that the north-aspect plots were partially leached to a depth of 30 cm. Whereas on the south-aspect, water moved upward as the result of capillary rise carrying soluble salts upward.

These results illustrate the inefficiency of the leaching technique which was to apply 2.5 cm of water every other day. Most of this water was apparently lost to surface evaporation.

Core samples taken in May 1974 indicate that there was leaching of soluble salts in the upper 60 cm of the south-aspect TOSCO spent shale treatment (Figure 22) by the 117 mm of snowmelt water. The results for the north-aspect indicate that leaching did not occur from snowmelt water since the fall 1973 and spring 1974 salinity profiles are similar. There was greater surface runoff from the north-aspect treatment and thus less water on-site for leaching.

The salinity profiles for TOSCO spent shale following application of 100 cm of water in May and June 1974, indicate the salts were moved out of only the top 30-60 cm of the profile on both the north and south-aspect treatments (Figures 21 & 22). This limited amount of salt movement indicates that probably only about one half of the 100 cm of water applied moved into the spent shale. The remainder of the water was evaporated.

The fall 1974 core samples show resalinization of the TOSCO spent shale surface but moderate salt contents at depths of 15-45 cm (Figures 21 & 22). The concentration of salt at the surface was similar to the resalinization of the low-elevation site TOSCO treatments in 1974. Resalinization at both sites was due to upward movement of salt in water moving upward by capillary action from high-moisture spent shale at depths of greater than 60 cm.

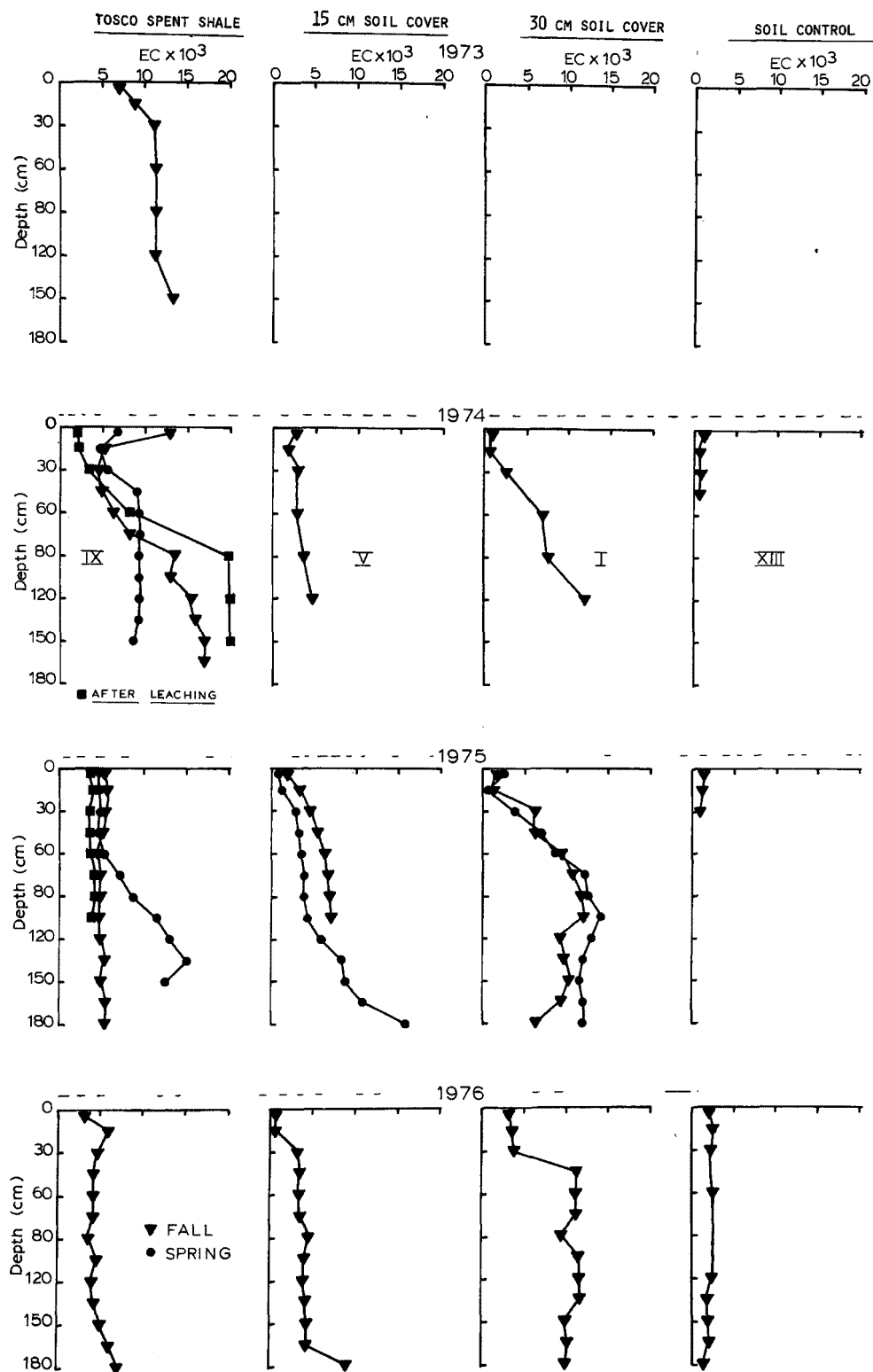


Figure 21. Soluble salt profiles in TOSCO spent shale and soil treatments. North-aspect, high-elevation study site.

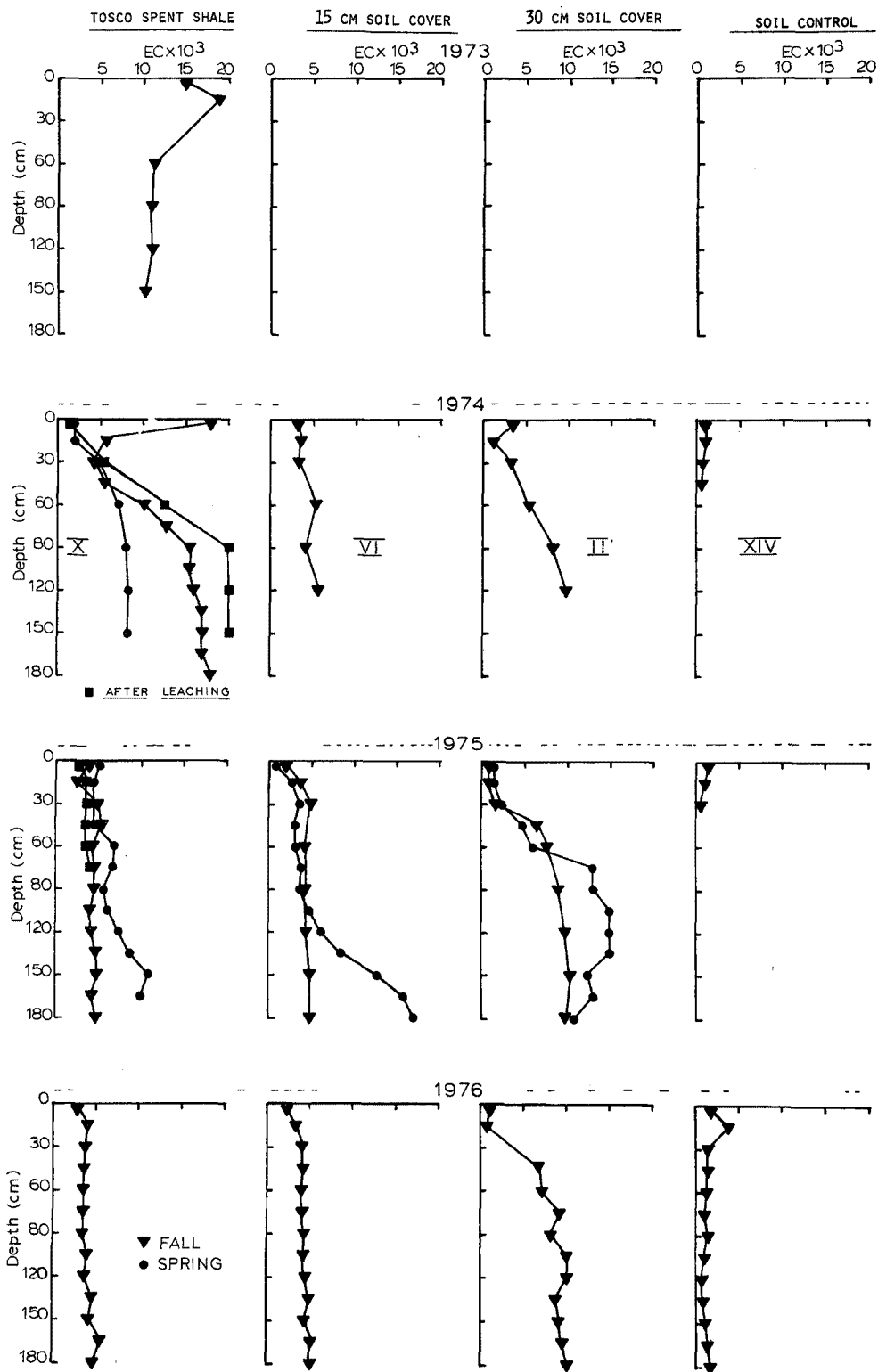


Figure 22. Soluble salt profiles in TOSCO spent shale and soil treatments. South-aspect, high-elevation study site.

The resalinized profiles were leached over the winter of 1974-1975 with approximately 59 mm of snowmelt water (Figures 21 & 22). Note, however, that the profile below 60 cm had an EC of 10 mmhos/cm or greater on both aspects. The TOSCO spent shale plots were releached with 100 cm of irrigation water during May 1975 which reduced the EC to less than 5 mmhos/cm throughout both the north and south-aspect treatments. Results of the fall 1975 and fall 1976 core sample analyses show no indication of resalinization or increased salinity levels in either the north or south-aspect profiles (Figures 21 & 22).

15 cm Soil Over TOSCO --

This treatment was initially core sampled in fall of 1974, these core analyses showed no resalinization on either aspect (Figures 21 & 22).

In 1975, the spring core samples taken following snowmelt showed that the EC was 2-3 mmhos/cm lower than the fall 1974 core analyses in the upper 120 cm of the profile. Leaching in May 1975 with 100 cm of water reduced soluble salts to low levels which persisted through fall 1976.

30 Soil Over TOSCO (unleached) --

This treatment was not leached in either 1974 or 1975, and the salinity levels of the spent shale below the soil-cover are 10-15 mmhos/cm higher in 1975 and 1976 than either of the leached treatments (Figures 21 & 22). In 1975 and 1976, the salinity levels of the soil cover were between 0.5 and 3.0 mmhos/cm and are within the same range as the soil control. Thus, salinization of the soil cover does not appear to be occurring.

USBM Spent Shale --

The 50 cm of water applied in the fall of 1973 and the 100 cm of leach water applied in the spring of 1974 reduced the salt content only in the surface 45 cm of the USBM spent shale plots (Figures 23 & 24). As pointed out for the TOSCO plots, this leach water was applied at the rate of 2.5 cm every two days. The limited downward movement of the soluble salts indicates that this was an ineffective leaching method. The surface of the USBM plots were resalinized by fall 1974.

Leaching with 100 cm of water applied continuously over a 10-day period in May 1975 leached the soluble salts out of the profile and no resalinization occurred in 1975 or 1976.

15 cm Soil Over USBM --

The surface soil on this treatment did not become salinized as did the USBM spent shale treatment in the fall of 1974. In 1975 and 1976, the salinity profile of this treatment was similar to that of the USBM shale treatment.

30 cm Soil Over USBM --

This treatment was unleached in 1974 and 1975. There was no indication of salt movement upward into the soil cover (Figures 23 & 24). In 1976, the north-aspect treatment (Figure 23) shows soluble salt on the surface, no explanation is offered for this except that it may have been an experimental error. The replication that was not plotted on Figure 23 shows no soluble salt on the surface (Appendix Table 85).

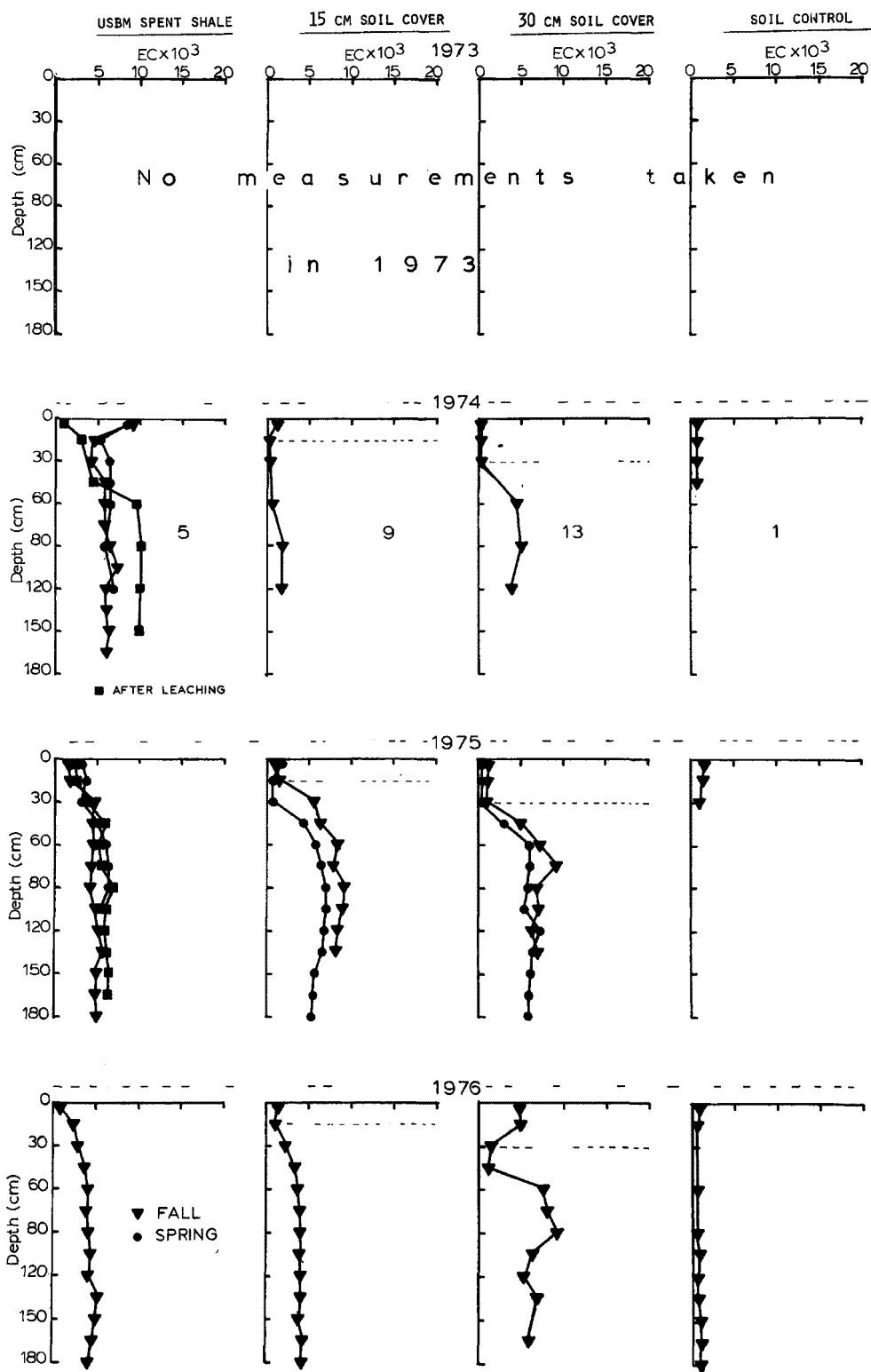


Figure 23. Soluble salt profiles in USBM spent shale and soil treatments. North-aspect, high-elevation study site.

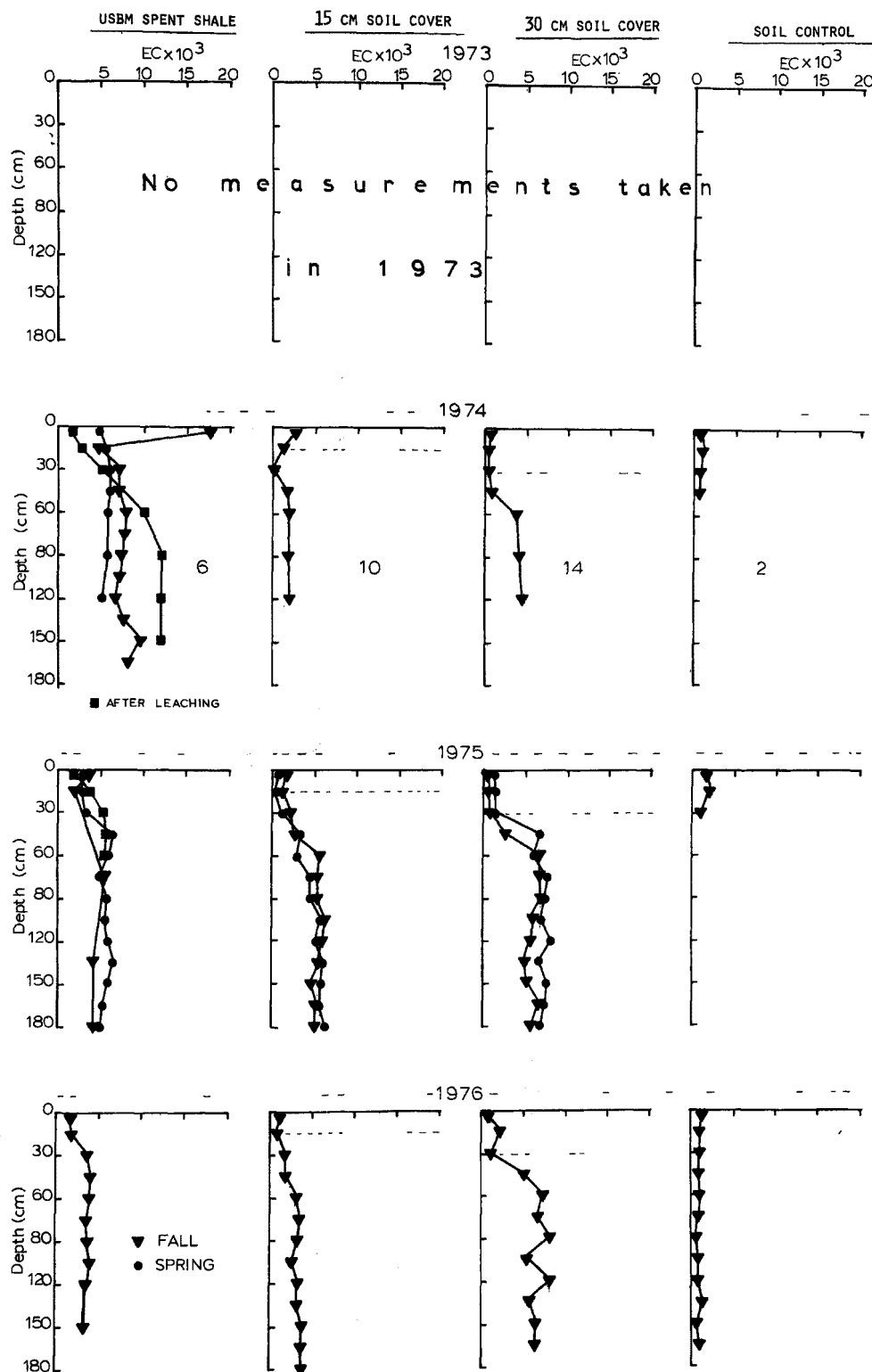


Figure 24. Soluble salt profiles in USBM spent shale and soil treatments. South-aspect, high-elevation study site.

Soil --

The soil was non-saline to start with. There was little or no change in the soluble salt profile of soil as a result of the irrigation treatments (Figures 21 & 22).

In summary, leaching the spent shales by applying 2.5 cm of water every two days for a total of 150 cm of water was very inefficient. The soluble salts were only moved down a short distance and the surface of both the fine-textured TOSCO spent shale and coarse-textured USBM spent shale later resalinized. In contrast, only the TOSCO spent shale was resalinized at the low-elevation study site, however, the initial leaching had moved the soluble salts deeper.

Leaching with another 100 cm of water applied continuously over 10 days leached the soluble salts to depths below 180 cm, after this leaching resalinization did not occur.

The soluble salts did not move upward through the 15 cm of soil cover over the leached spent shales. This is probably because leaching through the silt loam soil cover appears to be more effective in moving the salt to greater depths.

There was no evidence of salt movement upward into the 30 cm of soil covering the unleached TOSCO spent shale.

Surface Runoff and Sediment Yields

The runoff and sediment collection system was installed in July 1974. However, the culverts acting as overflow catchments from the 120 liter plastic containers were not water-proofed until the summer of 1975, thus an accurate total snowmelt runoff in 1975 was not measured. Measureable runoff occurred from a summer rainstorm on 14 August 1974 and from snowmelt in 1975 and 1976. The amounts of runoff, sediment yields, conductivity, and chemical analysis are reported in Appendix Tables 85-95. The data is summarized in the body of this report in Tables 15-18.

TOSCO Spent Shale --

A small 12.7 mm thunderstorm on 14 August 1974 produced 10 l of runoff from the south-aspect TOSCO spent shale and 28 l from the north-aspect. The EC was quite high, 2900 $\mu\text{mhos/cm}$ and 2200 $\mu\text{mhos/cm}$, respectively. The sediment yield ranged from 60 g on the south-aspect to 410 g on the north-aspect. The SAR ranged from 1.4 to 0.9 and indicates sodium should not pose a soil dispersion hazard (Table 15).

A total of 200 plus liters of runoff was measured from the TOSCO spent shale treatments following snowmelt in 1975 (Table 16). Total runoff, that in excess of the plastic collection containers was not accurately measured because of leaks. The EC of water was 725 $\mu\text{mhos/cm}$ on the north-aspect and 375 $\mu\text{mhos/cm}$ on the south-aspects which poses only a medium salinity hazard (Richards, 1954). The total sediment yields was 126 to 175 g on the TOSCO treatment in 1975 which was higher than in 1976. This was apparently the

TABLE 15. SURFACE RUNOFF AND WATER QUALITY DATA FOR TOSCO AND USBM SPENT SHALE, SOIL-COVERED SPENT SHALE, AND SOIL CONTROL PLOTS FOLLOWING A 12.7 mm STORM ON AUGUST 14, 1974. HIGH-ELEVATION STUDY SITE AVERAGE OF TWO REPLICATIONS.

	North Aspect				South Aspect			
	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	10	2	+	+	28	+	+	1.5
Sediment/plot (g)	68	30	+	+	410	+	+	22
EC μ mhgs/cm @ 25° C	2900	850	+	+	2200	+	+	730
Sodium Adsorption Ratio	1.4	1.5	NO	NO	0.9	NO	NO	0.6

	North Aspect				South Aspect			
	USBM	15 cm Soil Cover	30 cm Soil Cover	Soil Control	USBM	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	1.1	1.7	+	+	2.8	2.1	+	+
Sediment/plot (g)	1.7	6	+	+	22	14	+	+
EC μ mhgs/cm @ 25° C	1210	1210	+	+	1900	920	+	+
Sodium Adsorption Ratio	1.3	2.0	NO	NO	2.3	1.6	NO	NO

TABLE 16. SNOWMELT RUNOFF AND WATER QUALITY FOR TOSCO AND USBM SPENT SHALE, SOIL-COVERED TOSCO AND USBM SPENT SHALE, AND SOIL CONTROL PLOTS. HIGH-ELEVATION STUDY SITE. 1975 AVERAGE OF TWO REPLICATIONS.

	North Aspect				South Aspect			
	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	200+ ⁺	200+ ⁺	200+ ⁺	200+ ⁺	200+ ⁺	200+ ⁺	200+ ⁺	200+ ⁺
Sediment/plot (g)	175	140	89	70	126	135	146	87
EC μ mhgs/cm @ 25° C	725	240	135	160	375	160	95	80
Sodium Adsorption Ratio	0.3	0.3	0.3	0.3	0.8	0.4	0.2	0.2

	North Aspect				South Aspect			
	USBM	15 cm Soil Cover	30 cm Soil Cover	Soil Control	USBM	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	200+ ⁺	200+ ⁺	200+ ⁺	200+ ⁺	200+ ⁺	200+ ⁺	200+ ⁺	200+ ⁺
Sediment/plot (g)	86	84	76	76	79	84	83	92
EC μ mhgs/cm @ 25° C	1190	1020	750	80	180	110	80	80
Sodium Adsorption Ratio	0.8	0.5	0.3	0.2	0.3	0.4	0.2	0.2

+ Total runoff was not accurately measured because of leaks in the collection basins.

result of compacting soil and shale behind the collectors following installation. The SAR of all runoff water was very low (0.3 to 0.8).

In 1976, surface runoff following snowmelt was measured on 3 separate dates during March at the high-elevation study site (Table 17). The TOSCO spent shale south-aspect treatment had 431 l of runoff by the March 10 sampling date. The conductivity of this water was high at 1500 $\mu\text{mhos/cm}$, the total amount of sediment was very low 21.6 g per plot (Table 17). No surface runoff was measured for the north-aspect treatment since there was approximately 30 cm of snow on this treatment at this date. Total runoff was again measured on March 17 and samples were collected. At this time the north-aspect treatment had 311 l of runoff while the south-aspect treatment only had 12.7 l. The conductivity of the north-aspect runoff was 250 $\mu\text{mhos/cm}$ while the south-aspect had a conductivity of 900 $\mu\text{mhos/cm}$, sediment yield was again quite low. Note that the conductivity of the south-aspect treatment is still high which suggests that soluble salts were still being washed off of this treatment. At the time of sampling on March 17, the north-aspect treatment still had approximately 10 cm of snow and water running off the plots. Both aspects were again sampled on March 31 and 287 liters had runoff the north-aspect treatment while only 1 liter had runoff the south-aspect treatment. The conductivity of the north-aspect water was 400 $\mu\text{mhos/cm}$ while the conductivity of the south-aspect was 850 $\mu\text{mhos/cm}$ the sediment yield was quite low on all treatments (Table 17).

15 cm Soil Over TOSCO --

In 1976, a total of 2.72 cm of runoff was measured from the south-aspect soil-covered treatment for the three measuring dates in March, while only 1.76 cm of runoff water was recorded from the north-aspect treatment. This total runoff was similar to that from the TOSCO spent shale treatment, however, the conductivity of this water (200-300 $\mu\text{mhos/cm}$) was considerably less than from the TOSCO spent shale treatment and approximately the same as the soil control (Table 17).

30 cm Soil Over TOSCO (unleached) --

The total runoff, sediment yield, EC, and SAR for the 30 cm soil over TOSCO spent shale treatments in 1975 and 1976 will approximately be the same as for the 15 cm soil cover and soil control treatments (Table 16 & 17).

USBM Spent Shale --

Total surface runoff water, following a 12.7 mm storm in August 1974, from the USBM spent shale was less than from the TOSCO spent shale, the EC of the runoff and total sediment were also lower (Table 15). The differences in runoff between the two spent shales is a reflection of the textural difference and its effect on infiltration rates.

In 1976, the total snowmelt runoff from the north-aspect USBM spent shale treatments was 4.3 cm while the south-aspect had 1.1 cm. These results correspond directly with the moisture readings taken at the same time, which show that the majority of the snowmelt water moved into the south-aspect profile while very little of it moved into the north-aspect profile. However, the north-aspect profile was later filled by April and May precipitation. The EC of runoff from USBM spent shale was considerably lower (200-700 $\mu\text{mhos/cm}$)

TABLE 17. SNOWMELT RUNOFF AND WATER QUALITY SAMPLES FOR TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. HIGH-ELEVATION STUDY SITE, 1976.

	March 10							
	North Aspect				South Aspect			
	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	no runoff	no runoff	no runoff	no runoff	430	516	459	505
Sediment/plot (g)	no runoff	no runoff	no runoff	no runoff	22	18	17	11
EC $\mu\text{mhos/cm}$ @ 25°C	no runoff	no runoff	no runoff	no runoff	1500	350	350	200
Sodium Adsorption Ratio	no runoff	no runoff	no runoff	no runoff	0.4	0.6	0.4	0.4
	March 17							
	North Aspect				South Aspect			
	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	311	22	163	22	13	83	31	1.0
Sediment/plot (g)	1.2	1.2	1.6	0.2	0.4	6.0	4.0	0.1
EC $\mu\text{mhos/cm}$ @ 25°C	650	250	250	300	900	200	200	200
Sodium Adsorption Ratio	0.2	0.4	0.4	0.3	0.2	0.4	0.3	0.2
	March 31							
	North Aspect				South Aspect			
	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control	TOSCO	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	487	370	244	83	1.0	9.0	2.0	1.0
Sediment/plot (g)	6.7	6.7	6.8	6.9	6.9	6.7	7.2	6.7
EC $\mu\text{mhos/cm}$ @ 25°C	400	95	85	100	850	200	200	200
Sodium Adsorption Ratio	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.3

than from the TOSCO spent shale (400-1500 $\mu\text{mhos/cm}$) in 1976. The runoff water from the USBM would pose a low to medium salinity hazard for irrigation (Table 18).

15 cm Soil Over USBM --

In 1976, the total runoff from snowmelt on this soil-cover treatment was approximately the same as from the USBM and TOSCO spent shale (Tables 17 & 18). However, the EC of the runoff was 2 to 3 times lower than for runoff from either spent shale treatment. The north-aspect soil-cover treatment was apparently frozen and thus had greater runoff than the south-aspect treatment (Table 18).

30 cm Soil Over USBM (unleached) --

In 1976, the snowmelt runoff was less from the 30 cm of soil-cover (121-525 ℓ) than from USBM spent shale (257-960 ℓ) or 15 cm of soil-cover (258-1061 ℓ). The EC of runoff water ranged from 150 to 400 $\mu\text{mhos/cm}$ approximately the same as the 15 cm soil-cover and soil control (Table 18).

Soil Control --

In 1976, the north-aspect soil control treatments adjacent to the TOSCO spent shale treatments had only 0.18 cm of snowmelt runoff as compared to 3.69 cm of runoff from the north-aspect soil control plots attached to the USBM treatments. The south-aspect soil control treatments showed a reversed effect with the soil treatment on the TOSCO spent shale pile (the south pile) yielding 2.27 cm of runoff water while the soil on the USBM spent shale pile had 0.56 cm of runoff (Tables 17 & 18). The moisture results also show the same effect in that those soil plots with large amounts of runoff had very little moisture recharge while those plots with little runoff show a greater moisture recharge. The differences are probably explained by the fact that soil plots are located on the end of each spent shale pile and the differences are due to snow drifting. In the future, more intensive data on snow depth and distribution will have to be obtained in order to explain runoff results.

In summary, runoff from a summer thunderstorm in 1974 was greater from the fine-textured TOSCO spent shale than from the coarse-textured USBM, soil-covered spent shale treatments, and soil control. The EC of the limited amount of runoff was 1200 to 2900 $\mu\text{mhos/cm}$ for the spent shales, but was lower for the soil-covered treatments and soil control.

Runoff in 1975 from snowmelt was not accurately measured because of leaks in the secondary collector. Snowmelt in 1976 produced greater runoff from the north-aspect than from the south-aspect treatments apparently because of frozen surface layers on the north-aspect.

Sediment yields were very low for all treatments in all years when compared to sediment yields from agricultural soils. SAR values were also very low and indicate that sodium would not present a dispersion problem if the water was used for irrigation.

TABLE 18. SNOWMELT RUNOFF AND WATER QUALITY SAMPLES FOR USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. HIGH-ELEVATION STUDY SITE, 1976.

	March 10							
	North Aspect				South Aspect			
	USBM	15 cm Soil Cover	30 cm Soil Cover	Soil Control	USBM	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	r u n o f f	r u n o f f	r u n o f f	r u n o f f	255	2 252	105	320
Sediment/plot (g)					7.8	11.4	9.2	7.2
EC μ mhgs/cm @ 25° C	r u n o f f	r u n o f f	r u n o f f	r u n o f f	300	500	400	300
Sodium Adsorption Ratio	N o	N o	N o	N o	0.8	1.0	0.5	0.8
	March 17							
	North Aspect				South Aspect			
	USBM	15 cm Soil Cover	30 cm Soil Cover	Soil Control	USBM	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	480	531	290	415	1.0	4.0	8.0	r u n o f f
Sediment/plot (g)	26	8.4	2.4	24	1.1	0.1	0.2	r u n o f f
EC μ mhgs/cm @ 25° C	500	250	250	200	700	200	200	r u n o f f
Sodium Adsorption Ratio	0.5	0.4	0.4	0.2	0.9	0.6	0.5	N o
	March 31							
	North Aspect				South Aspect			
	USBM	15 cm Soil Cover	30 cm Soil Cover	Soil Control	USBM	15 cm Soil Cover	30 cm Soil Cover	Soil Control
Runoff/plot (l)	480	530	235	410	1.0	2.0	8.0	1.0
Sediment/plot (g)	7.3	6.9	7.0	7.1	6.6	6.9	7.0	7.2
EC μ mhgs/cm @ 25° C	200	150	150	200	250	200	200	300
Sodium Adsorption Ratio	0.1	0.3	0.1	0.2	0.3	0.4	0.5	0.4

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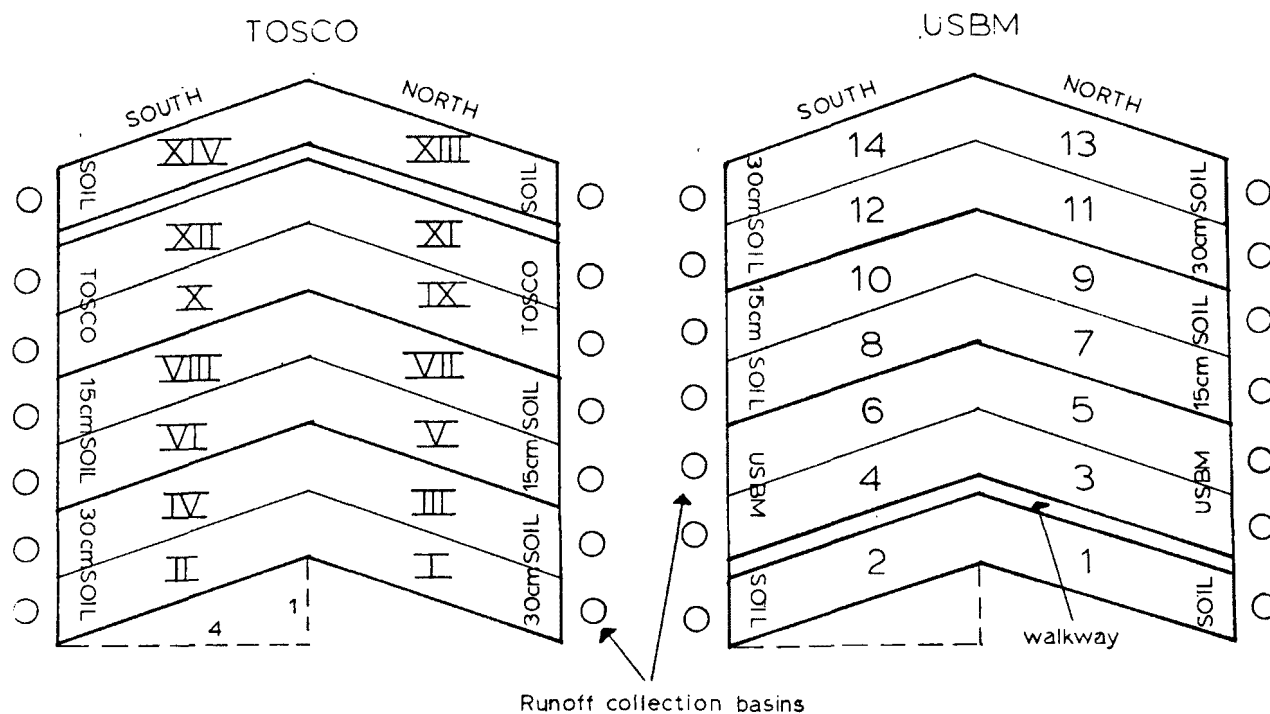
APPENDIX TABLES

LOW-ELEVATION STUDY SITE

The following Appendix Tables (1-54) are a complete tabulation of all data collected for each treatment and replication between 1973 and 1976.

A guide to the plot layout and number system for the appendix tables is given below:

Plot Plan and Numbering System (Low elevation and High elevation study sites)



<u>Appendix Number</u>		<u>Page</u>
1	Precipitation measurements - Anvil Points and Piceance Basin, 1973-1976	73
2 - 5	Vegetation density and ground cover - 1973	
	2 - TOSCO - north-aspect	74
	3 - TOSCO - south-aspect	75
	4 - USBM - north-aspect	76
	5 - USBM - south-aspect	77
6 - 7	Vegetation density and ground cover - 1974	
	6 - TOSCO - north and south-aspects	78
	7 - USBM - north and south-aspects	79
8 - 11	Vegetation analysis (transect method) - 1975	
	8 - TOSCO - north-aspect	80
	9 - TOSCO - south-aspect	81
	10 - USBM - north-aspect	82
	11 - USBM - south-aspect	83
12 - 15	Vegetation analysis (transect method) - 1976	
	12 - TOSCO - north-aspect	84
	13 - TOSCO - south-aspect	85
	14 - USBM - north-aspect	86
	15 - USBM - south-aspect	87
16	Above ground standing bio-mass clipping data TOSCO & USBM 1976	88
17 - 20	Moisture measurements (neutron probe) - 1973	
	17 - TOSCO - north-aspect	89
	18 - TOSCO - south-aspect	90
	19 - USBM - north-aspect	91
	20 - USBM - south-aspect	92
21 - 24	Moisture measurements (neutron probe) - 1974	
	21 - TOSCO - north-aspect	93
	22 - TOSCO - south-aspect	94
	23 - USBM - north-aspect	95
	24 - USBM - south-aspect	96
25 - 28	Moisture measurements (neutron probe) - 1975	
	25 - TOSCO - north-aspect	97
	26 - TOSCO - south-aspect	98
	27 - USBM - north-aspect	99
	28 - USBM - south-aspect	100

<u>Appendix Number</u>		<u>Page</u>
29 - 32	Moisture measurements (neutron probe) - 1976	
	29 - TOSCO - north-aspect	101
	30 - TOSCO - south-aspect	102
	31 - USBM - north-aspect	103
	32 - USBM - south-aspect	104
33 - 40	Salinity measurements (EC)	
	33 - TOSCO - north and south-aspects (1973 & 1974) . .	105
	34 - USBM - north and south-aspects (1974)	106
	35 - TOSCO - north-aspect (1975)	107
	36 - TOSCO - south-aspect (1975)	108
	37 - USBM - north-aspect (1975)	109
	38 - USBM - south-aspect (1975)	110
	39 - TOSCO - north and south-aspects (1976)	111
	40 - USBM - north and south-aspects (1976)	112
41 - 46	Salinity sensor measurements	
	41 - TOSCO - north and south-aspects (1973-1974) . . .	113
	42 - USBM - north and south-aspects (1973-1974) . . .	114
	43 - TOSCO - north-aspect (1975-1976)	115
	44 - TOSCO - south-aspect (1975-1976)	115
	45 - USBM - north-aspect (1975-1976)	116
	46 - USBM - south-aspect (1975-1976)	116
47 - 48	Surface runoff and water quality data - 1974	
	47 - TOSCO - north and south-aspects	117
	48 - USBM - north and south-aspects	118
49 - 50	Snowmelt runoff and water quality data - 1975	
	49 - TOSCO - north and south-aspects	119
	50 - USBM - north and south-aspects	120
51 - 52	Surface runoff and water quality data - 1975	
	51 - TOSCO - north and south-aspects	121
	52 - USBM - north and south-aspects	122
53 - 54	Snowmelt runoff and water quality samples - 1976	
	53 - TOSCO - north and south-aspects	123
	54 - USBM - north and south-aspects	124

APPENDIX TABLE 1. PRECIPITATION MEASUREMENTS IN mm FOR ANVIL POINTS AND PICEANCE BASIN STUDY SITES. 1973-1976

	January	February	March	April	May	June	July	August	September	October	November	December
<u>ANVIL POINTS</u>												
1973			Plot construction			0	4.5	22.5	6.0	5		
1974							46.9 mm			32.6 mm		
1975	61.3 mm		16.7	41.9	49.0	29.4	18.7	7.3	7.3	12.2	9.3	22.3
1976	3.6	59.1	37.1	33.5	39.8	17.5	11.6	24.8	37.5	13.7	+	+
<u>PICEANCE BASIN</u>												
1973						Plot construction			#			
1974							38.1 mm			41.2 mm		
1975	72.3 mm		6.8	30.7	Irrigation			11.9	19.8	25.1	7.8	6.1
1976	50.6	70.6	6.3	34.3	52.0	24.8	12.1	33.5	21.6	7.3	+	+

* Missing data observation.

+ Observations not completed

§ October 13, 1973 thru April 28, 1974 - 127 mm ppt from snowfall.

October 13, 1973 thru May 10, 1974 - 116.8 mm ppt from snowfall.

APPENDIX TABLE 2. VEGETATION DENSITY AND GROUND COVER (QUADRAT METHOD) ON NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. SEPTEMBER 1973

	30 cm (12") Soil Cover								15 cm (6") Soil Cover								TOSCO Spent Shale								Soil			
	I				III				V				VII				IX				XI				XIII			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
<u>GRASSES</u>																												
Western wheatgrass	6*	4	2	6	3	3	5	3	2	4	2	2	7	3	5	5	1	4	2	2	3	1	5	4	4	5	4	3
Bluebunch wheatgrass	4	4	1	3	1	2	1	1	4	1	2	-	2	2	2	1	3	2	3	1	5	4	3	3	2	2	1	-
Indian ricegrass	-	-	1	1	-	2	1	-	-	-	-	-	-	-	-	-	1	1	-	1	-	1	1	-	-	-	1	-
Timothy	8	6	10	11	2	4	2	6	2	5	7	9	2	16	4	4	10	8	9	3	5	4	3	3	9	6	8	7
Wild barley	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																												
Winterfat	-	4	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>FORBS</u>																												
Globe mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																												
Mustards	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Totals	18	18	14	21	8	12	9	10	8	10	11	11	11	21	11	10	15	16	14	8	13	11	12	11	15	13	14	11
% Cover/plot	85				75				80				80				50				55				65			

* Values are total number of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each plot.

APPENDIX TABLE 3. VEGETATION DENSITY AND GROUND COVER (QUADRAT METHOD) ON SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. SEPTEMBER 1973

	30 cm (12") Soil Cover								15 cm (6") Soil Cover								TOSCO Spent Shale								Soil			
	II				IV				VI				VIII				X				XII				XIV			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
<u>GRASSES</u>																												
Western wheatgrass	2*	3	2	2	6	4	3	5	3	1	1	6	1	2	2	1	1	3	2	2	4	2	3	4	4	5	3	1
Bluebunch wheatgrass	3	7	3	4	3	3	2	4	6	4	4	4	6	4	3	3	3	3	5	3	3	4	4	4	1	3	3	3
Indian ricegrass	1	1	-	2	-	-	-	-	1	2	-	1	1	1	1	-	2	1	1	2	2	2	-	2	-	1	1	-
Timothy	6	1	8	2	-	7	1	1	2	2	-	6	6	2	9	12	4	4	11	1	1	-	4	1	8	5	9	10
Wild barley	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
<u>SHRUBS</u>																												
Winterfat	-	1	2	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>FORBS</u>																												
Globe mallow	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																												
Mustards	1	1	-	-	-	1	1	1	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Totals	13	14	15	10	10	17	7	11	15	9	6	19	16	9	15	16	10	11	19	8	10	8	11	11	14	14	17	15
% Cover/plot	80				80				85				75				45				50				65			

* Values are total number of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each plot.

APPENDIX TABLE 4. VEGETATION DENSITY AND GROUND COVER (QUADRAT METHOD) ON NORTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. SEPTEMBER 1973

	60 cm (24") Soil Cover								15 cm (6") Soil Cover								USBM Spent Shale								Soil				
	13				11				9				7				5				3				1				
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
<u>GRASSES</u>																													
Western wheatgrass	2*	1	2	2	3	4	3	4	3	3	2	4	3	3	2	2	2	3	3	2	2	2	2	1	4	3	4	3	3
Bluebunch wheatgrass	3	4	1	2	4	2	2	4	7	3	4	8	3	5	3	1	2	2	4	4	2	1	2	6	3	5	6	2	
Indian ricegrass	2	3	1	1	1	1	2	1	1	1	1	1	2	1	2	2	3	-	1	3	1	2	1	-	1	2	1	1	
Timothy	10	7	1	2	4	6	4	-	1	-	5	1	2	1	1	2	2	-	1	1	3	9	2	1	2	1	2	2	
Wild barley	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<u>SHRUBS</u>																													
Winterfat	1	2	-	-	-	1	-	-	-	-	2	1	-	-	2	1	1	-	-	-	-	1	2	-	1	1	-	-	
Fourwing saltbush	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	
<u>FORBS</u>																													
Globe mallow	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<u>WEEDY ANNUALS</u>																													
Mustards	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	
TOTALS	18	19	7	7	12	14	11	9	12	8	15	15	10	10	10	8	10	6	9	10	8	15	9	11	11	13	13	8	
% COVER/PLOT	70				75				70				75				55				55				65				

* Values are total number of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each plot.

APPENDIX TABLE 5. VEGETATION DENSITY AND GROUND COVER (QUADRAT METHOD) ON SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. SEPTEMBER 1973

	60 cm (24") Soil Cover								15 cm (6") Soil Cover								USBM Spent Shale								Soil			
	14				12				10				8				6				4				2			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
GRASSES																												
Western wheatgrass	3*	2	2	4	1	3	3	4	2	2	3	3	2	2	3	3	1	4	3	4	5	2	2	3	3	3	7	2
Bluebunch wheatgrass	4	1	1	4	2	5	2	5	3	3	2	4	4	2	5	5	1	5	4	6	6	4	2	5	4	3	5	3
Indian ricegrass	1	1	-	2	1	1	2	1	1	-	-	1	3	1	1	2	-	1	3	4	1	3	3	2	-	1	-	2
Timothy	3	8	7	5	1	-	7	6	2	7	10	6	2	10	-	-	-	-	2	-	1	-	-	-	3	4	1	2
Wild barley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS																												
Winterfat	-	-	1	-	-	1	-	2	-	1	-	-	1	-	1	-	1	-	1	1	-	-	-	-	-	-	1	1
Fourwing salbush	-	1	-	1	-	1	-	-	1	-	-	-	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
FORBS																												
Globe mallow	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WEEDY ANNUALS																												
Mustards	-	-	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
TOTALS	11	14	12	16	5	11	14	19	10	13	16	14	13	15	11	10	4	11	13	15	13	9	7	10	10	12	14	10
% COVER/PLOT	70				65				65				70				60				55				60			

* Values are total number of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each plot.

APPENDIX TABLE 6. VEGETATION DENSITY AND GROUND COVER (QUADRAT METHOD) ON TOSCO SPENT SHALE, SOIL-COVERED SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. SEPTEMBER 1974

NORTH ASPECT																												
30 (12") Soil Cover								15 cm (6") Soil Cover								TOSCO Spent Shale								Soil				
I				III				V				VII				IX				XI				XIII				
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
<u>GRASSES</u>																												
Western wheatgrass	1*	2	4	3	3	3	2	3	1	1	2	1	1	1	3	1	3	1	1	2	2	1	1	1	3	5	1	
Bluebunch wheatgrass	3	3	-	3	2	2	3	5	3	3	2	3	3	2	2	2	3	2	2	1	3	2	2	1	1	1	-	
Indian ricegrass	1	-	-	1	2	1	2	1	1	-	-	2	1	-	1	1	1	-	1	2	2	3	2	2	-	-	-	
Timothy	-	1	-	-	1	-	-	-	-	2	1	1	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	
<u>SHRUBS</u>																												
Winterfat	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	
Fourwing saltbush	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	
<u>WEEDY ANNUALS</u>																												
Cheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	1	2	-	3	2	2	-	-	-	
TOTALS	5	8	4	7	8	7	7	9	5	6	5	7	6	3	7	5	9	6	5	7	7	10	7	6	2	4	6	
% COVER/PLOT	65				60				60				65				45				40				65			

SOUTH ASPECT																												
30 cm (12") Soil Cover								15 cm (6") Soil Cover								TOSCO Spent Shale								Soil				
II				IV				VI				VIII				X				XII				XIV				
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
<u>GRASSES</u>																												
Western wheatgrass	-*	5	-	2	-	1	5	3	1	1	-	1	1	1	-	1	1	1	-	-	1	1	-	3	3	2	1	
Bluebunch wheatgrass	2	3	-	2	3	1	1	2	1	1	2	1	3	3	2	2	-	2	1	-	2	-	-	1	2	1	2	
Indian ricegrass	-	1	-	1	-	-	-	1	2	1	-	-	1	2	1	-	1	-	2	3	2	3	2	-	-	-	-	
Timothy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<u>SHRUBS</u>																												
Winterfat	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	
Fourwing saltbush	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	3	-	1	2	-	2	2	-	-	-	
<u>WEEDY ANNUALS</u>																												
Cheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	2	-	-	-	
TOTALS	2	9	0	5	3	3	6	6	4	3	2	2	5	6	3	3	4	8	4	4	6	5	5	6	4	5	3	
% COVER/PLOT	60				60				60				55				40				45				60			

* Values are total number of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each plot.

APPENDIX TABLE 7. VEGETATION DENSITY AND GROUND COVER (QUADRAT METHOD) ON USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS.
ANVIL POINTS STUDY SITE. SEPTEMBER 1974

NORTH ASPECT																												
60 cm (24") Soil Cover								15 cm (6") Soil Cover								USBM Spent Shale								Soil				
13				11				9				7				5				3				1				
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
<u>GRASSES</u>																												
Western wheatgrass	2*	3	-	1	1	4	3	-	1	1	1	-	3	-	3	-	1	-	-	1	1	-	-	1	3	1	1	4
Bluebunch wheatgrass	-	1	2	3	2	2	2	5	4	3	3	3	1	4	3	3	2	2	3	3	3	2	1	3	3	2	3	1
Indian ricegrass	2	1	-	1	1	-	-	-	-	1	1	1	1	-	-	2	1	-	1	1	-	-	2	-	-	2	-	-
Timothy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																												
Winterfat	-	-	1	-	-	-	-	-	-	-	1	1	-	-	1	1	1	-	-	-	-	2	1	-	-	-	-	-
Fourwing saltbush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																												
Cheatgrass	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	-	-	-	-	-	-
TOTALS	4	5	3	5	4	7	5	5	5	5	6	5	5	4	7	7	6	3	4	5	4	4	6	4	6	5	4	5
% COVER/PLOT	65				70				75				75				55				55				60			

SOUTH ASPECT																												
60 cm (24") Soil Cover								15 cm (6") Soil Cover								USBM Spent Shale								Soil				
14				12				10				8				6				4				2				
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
<u>GRASSES</u>																												
Western wheatgrass	1*	-	-	-	-	1	-	3	3	3	-	-	-	1	-	1	-	1	1	-	2	-	-	-	1	-	3	3
Bluebunch wheatgrass	-	3	2	3	1	2	3	1	-	2	2	3	-	1	3	2	1	3	2	2	1	1	1	2	1	4	-	1
Indian ricegrass	1	1	-	1	2	-	2	-	-	-	-	1	3	2	-	1	-	2	2	2	3	4	3	2	-	-	-	-
Timothy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																												
Winterfat	-	-	1	-	-	-	1	-	-	-	-	-	1	-	-	-	1	-	1	-	-	-	-	-	-	-	1	-
Fourwing saltbush	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																												
Cheatgrass	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
TOTALS	2	3	3	4	3	3	5	5	3	5	2	5	4	4	3	5	3	7	6	4	6	5	4	4	2	4	3	6
% COVER/PLOT	60				60				60				65				55				55				50			

* Values are total number of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each plot.

APPENDIX TABLE 8. VEGETATION DENSITY AND GROUND COVER (QUADRAT METHOD) ON NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. SEPTEMBER 1975

	I				III				V				VII				IX				XI				XIII			
	30 cm (12") Soil Cover				30 cm (12") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover				TOSCO Spent Shale				TOSCO Spent Shale				Soil			
	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4
<u>GRASSES</u>																												
Western wheatgrass	344	237	216	183	231	254	279	234	302	205	300	177	178	265	232	216	74	66	122	20	92	59	49	45	124	221	238	200
Bluebunch wheatgrass	11	-	-	30	5	-	-	-	71	99	37	19	42	24	6	30	-	-	-	65	15	18	15	-	121	33	45	45
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	-	-	-	-	-	-	8	-	-	8	-	5	6	-	8	28	52	37	33	-	9	24	20	-	-	-	-
Timothy	-	-	-	-	62	-	-	-	9	83	9	-	38	51	41	12	17	16	-	26	-	21	11	-	10	-	15	-
Wild barley	-	43	27	40	48	47	-	-	6	24	24	12	-	-	28	7	14	24	-	-	45	26	15	16	10	-	13	-
<u>SHRUBS</u>																												
Winterfat	39	-	-	-	-	18	14	4	-	8	-	-	-	-	8	7	-	11	-	-	-	3	5	-	-	-	11	-
Fourwing saltbush	-	18	34	-	-	-	66	-	-	-	-	-	-	-	-	-	-	5	-	-	29	60	-	5	-	94	25	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	14	-
<u>FORBS</u>																												
Globe mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-
<u>WEEDY ANNUALS</u>																												
Cheatgrass	38	10	15	9	24	10	40	6	15	22	10	85	23	2	27	15	42	126	147	54	7	118	119	128	3	18	-	9
Wild lettuce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russian thistle	-	-	17	-	-	-	-	3	-	-	-	-	-	-	-	-	19	19	-	19	16	-	-	8	-	-	-	-
Mint	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mustards (spp)	-	-	-	-	-	10	3	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	3	-	-	-	-	-
No Vegetative Cover	220	54	77	97	77	79	127	94	144	121	181	127	86	165	108	228	122	98	76	135	146	94	174	234	85	60	85	54

* Values are total centimeters of above ground vegetation cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 and 3 in middle, and line 4 in lower, ¼ of each plot.

APPENDIX TABLE 9. VEGETATION ANALYSIS (TRANSECT METHOD) ON SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE.
AUGUST 1975

	II				IV				VI				VIII				X				XII				XIV			
	30 cm (12") Soil Cover				30 cm (12") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover				TOSCO Spent Shale				TOSCO Spent Shale				Soil			
	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4
<u>GRASSES</u>																												
Western wheatgrass	98*	137	153	124	103	133	143	154	84	151	209	81	105	138	150	102	106	669	14	42	94	64	90	30	75	216	193	219
Bluebunch wheatgrass	13	-	-	-	8	11	15	14	65	56	48	38	26	68	37	70	15	4	34	33	60	50	23	24	21	23	18	11
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	10	9	9	-	-	-	-	-	3	-	-	6	30	5	12	14	52	-	34	51	52	9	48	15	-	-	-	-
Timothy	-	-	-	25	-	-	-	-	-	-	-	-	6	25	27	-	-	8	-	-	-	-	-	12	-	-	-	-
Wild barley	-	-	-	-	-	25	-	4	10	-	-	7	13	18	-	-	16	-	3	35	11	-	-	3	-	-	-	-
<u>SHRUBS</u>																												
Winterfat	27	29	80	11	11	-	25	7	-	-	-	-	-	-	-	-	54	28	24	-	17	18	-	19	-	-	-	-
Fourwing saltbush	172	17	-	52	185	42	-	5	-	9	8	-	-	7	-	-	-	81	-	-	-	-	-	60	-	-	-	-
Rabbitbrush	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37	-	-
<u>FORBS</u>																												
Globe mallow	-	5	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-	-
<u>WEEDY ANNUALS</u>																												
Cheatgrass	-	-	7	4	-	-	53	11	6	30	17	110	21	21	28	129	-	18	54	10	32	71	63	54	76	15	12	17
Wild lettuce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	6	-	23	-	6	-
Russian thistle	-	-	-	15	5	7	8	9	-	8	-	-	2	-	-	-	33	48	34	46	-	-	14	26	-	-	-	-
Mint	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mustard (spp)	-	21	28	-	-	-	-	-	-	-	-	-	7	-	-	-	22	53	8	7	29	71	60	-	77	10	16	26
No Vegetative Cover	42	131	64	93	74	157	140	143	98	121	88	118	129	89	142	169	148	159	184	146	176	196	144	120	124	126	88	115

* Values are total centimeters of above ground vegetation cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 and 3 in middle, and line 4 in lower, ¼ of each plot.

APPENDIX TABLE 10. VEGETATION ANALYSIS (TRANSECT METHOD) ON NORTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE.
AUGUST 1975

	13				11				9				7				5				3				1			
	60 cm (24") Soil Cover				60 cm (24") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover				USBM Spent Shale				USBM Spent Shale				Soil			
	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4
<u>GRASSES</u>																												
Western wheatgrass	115	224	187	210	209	226	115	207	193	266	253	246	258	279	293	209	253	223	259	128	72	125	172	71	241	75	177	261
Bluebunch wheatgrass	67	47	26	26	65	10	33	81	66	87	43	57	78	59	52	42	42	46	44	83	88	66	48	70	70	65	30	24
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	35	9	27	6	8	-	6	14	-	-	5	8	7	-	6	17	3	21	-	19	11	-	10	55	-	-	-	-
Timothy	15	6	12	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-
Wild barley	-	-	-	-	-	-	-	-	-	-	10	16	-	20	-	-	18	20	7	-	-	17	24	15	11	11	-	-
<u>SHRUBS</u>																												
Winterfat	14	32	-	-	41	24	18	-	8	-	8	11	55	7	6	8	-	-	-	-	57	87	7	78	30	58	77	23
Fourwing saltbush	121	-	-	86	-	37	114	-	-	-	37	-	-	-	-	-	7	-	57	-	-	49	26	-	-	-	-	-
Rabbitbrush	12	17	-	-	-	-	21	18	-	-	-	7	8	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-
<u>FORBS</u>																												
Globe mallow	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																												
Cheatgrass	-	-	4	-	-	-	-	-	12	32	-	11	-	-	-	68	-	22	25	94	23	13	21	20	-	-	22	-
Wild lettuce	-	-	14	-	-	6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
Russian thistle	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	-	-	9	-	-	12	3	-	-	-
Mint	-	-	11	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mustards (spp)	-	16	-	-	-	-	17	5	-	-	-	14	-	-	3	5	-	4	-	3	2	-	17	-	-	-	-	-
No Vegetative Cover	187	62	198	94	176	58	62	108	202	94	111	143	123	98	183	207	129	133	131	64	168	168	192	143	54	123	93	48

* Values are total centimeters of above ground vegetation cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 and 3 in middle, and line 4 in lower, ¼ of each plot.

APPENDIX TABLE 11. VEGETATION ANALYSIS (TRANSECT METHOD) ON SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. AUGUST 1975

	14				12				10				8				6				4				2			
	60 cm (24") Soil Cover				60 cm (24") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover				USBM Spent Shale				USBM Spent Shale				Soil			
	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4	line 1	line 2	line 3	line 4
<u>GRASSES</u>																												
Western wheatgrass	157	60	102	91	131	146	160	106	176	97	129	122	124	166	154	92	75	82	90	53	33	103	78	137	126	67	229	163
Bluebunch wheatgrass	57	36	36	44	55	60	12	43	60	38	75	72	60	36	51	77	93	109	132	29	97	93	27	35	46	134	18	86
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	-	-	16	-	-	-	-	-	7	5	-	-	-	-	-	-	8	-	10	5	17	-	11	7	-	-	-
Timothy	14	12	9	8	-	-	7	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
Wild barley	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																												
Winterfat	-	-	25	-	-	-	15	11	52	-	23	14	16	17	32	36	69	20	-	65	37	24	51	54	63	-	28	15
Fourwing saltbush	27	121	-	-	97	-	36	-	10	10	83	-	97	-	11	3	28	52	27	119	67	9	-	-	112	-	-	-
Rabbitbrush	6	-	-	6	-	-	14	-	-	-	13	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>FORBS</u>																												
Globe mallow	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																												
Cheatgrass	-	-	15	77	-	24	19	25	5	32	6	16	5	36	-	44	14	8	21	30	-	12	96	21	-	43	18	13
Wild lettuce	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	3	-	4	4	-	-	-	-
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	11	9	-	3	-	3	-	-
Mint	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mustards (spp)	55	124	42	6	35	147	14	50	-	49	11	10	8	-	-	18	89	16	4	4	54	-	-	-	-	-	-	-
No Vegetative Cover	172	85	122	127	192	162	155	132	123	147	85	140	116	145	160	106	140	126	127	82	140	110	55	171	111	151	88	139

* Values are total centimeters of above ground vegetation cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 and 3 in middle, and line 4 in lower, ¼ of each plot.

APPENDIX TABLE 12. VEGETATION ANALYSIS (TRANSECT METHOD) ON NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. AUGUST 1976

	30 cm (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale						Soil		
	I			III			V			VII			IX			XI			XIII		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
<u>GRASSES</u>																					
Western wheatgrass	37*	147	302	117	124	199	177	221	202	161	193	159	26	23	60	198	94	60	165	200	149
Bluebunch wheatgrass	-	-	22	-	16	49	23	50	55	92	49	69	-	-	-	-	-	-	34	64	138
Crested wheatgrass	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	40	10	-	18	21	-	-	10
Timothy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild barley	-	-	-	-	25	-	-	-	7	-	-	14	-	-	-	3	-	-	-	-	-
<u>SHRUBS</u>																					
Winterfat	-	-	-	-	37	-	5	-	-	-	-	-	16	13	21	19	-	16	-	-	-
Fourwing saltbush	91	-	-	146	20	54	-	-	-	-	26	40	92	-	72	15	-	-	67	14	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	77	12
Bitterbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big sagebrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>FORBS</u>																					
Globe mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utah sweetvetch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																					
Cheatgrass	19	40	16	-	5	3	17	52	56	34	69	73	82	204	169	49	218	163	-	19	15
Mustard (spp)	94	13	-	-	70	-	-	-	-	5	-	-	15	33	3	59	17	-	-	-	-
Russian thistle	25	-	-	-	-	-	-	-	-	-	-	-	6	-	12	4	-	17	-	-	-
Wild lettuce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
No Vegetative Cover	81	130	45	84	53	131	128	22	19	68	28	11	112	37	3	103	13	50	47	30	5

* Values are total centimeters of above ground vegetative cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower, 1/3 of each plot.

APPENDIX TABLE 13. VEGETATION ANALYSIS (TRANSECT METHOD) ON SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. AUGUST 1976

	30 (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale						Soil		
	II			IV			VI			VIII			X			XII			XIV		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
<u>GRASSES</u>																					
Western wheatgrass	138*	140	142	155	123	120	242	188	215	104	223	190	21	123	64	42	94	18	104	227	114
Bluebunch wheatgrass	6	14	-	14	21	7	39	19	14	53	23	5	-	-	-	-	33	11	77	11	49
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	5	-	11	-	-	-	-	5	-	-	11	11	9	9	13	-	14	-	-	-
Timothy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild barley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																					
Winterfat	5	-	28	7	18	7	-	10	-	6	-	-	-	19	13	-	-	-	15	-	-
Fourwing saltbush	-	94	297	69	114	97	8	-	20	-	-	56	-	-	110	80	-	199	-	19	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bitterbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big sagebrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>FORBS</u>																					
Globe mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utah sweetvetch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																					
Cheatgrass	7	-	-	23	14	19	14	-	44	38	-	34	38	29	40	20	39	22	5	33	19
Mustard (spp)	36	8	-	-	-	-	-	-	-	9	-	3	13	25	39	30	11	22	-	17	-
Russian thistle	3	-	-	-	-	-	-	-	-	-	-	-	83	-	5	11	10	-	-	-	-
Wild lettuce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
No Vegetative Cover	153	89	25	71	60	106	47	133	53	138	102	51	169	148	70	154	158	64	149	54	146

* Values are total centimeters of above ground vegetative cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower, 1/3 of each plot.

APPENDIX TABLE 14. VEGETATION ANALYSIS (TRANSECT METHOD) ON NORTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. AUGUST 1976

	60 cm (24") Soil Cover						15 cm (6") Soil Cover						USBM Spent Shale						Soil		
	13			11			9			7			5			3			1		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
<u>GRASSES</u>																					
Western wheatgrass	122 *	170	88	203	138	132	195	158	104	146	158	159	132	192	104	159	115	21	150	70	132
Bluebunch wheatgrass	103	88	75	46	63	97	103	174	92	123	128	163	46	132	89	78	128	49	89	155	207
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-
Timothy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild barley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																					
Winterfat	19	7	14	21	50	39	14	11	32	43	51	28	13	-	-	-	27	47	14	21	11
Fourwing saltbush	39	39	176	6	-	31	-	-	108	12	-	-	18	-	135	25	-	26	36	104	-
Rabbitbrush	11	-	26	-	-	-	-	-	5	-	13	-	-	-	-	-	-	-	-	-	-
Bitterbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big sagebrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>FORBS</u>																					
Globe mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utah sweetvetch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																					
Cheatgrass	8	16	-	7	68	6	11	-	-	-	-	-	62	-	22	22	37	183	-	-	-
Mustard (spp)	8	-	-	14	11	-	10	-	9	-	-	-	6	-	-	6	4	-	-	-	-
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild lettuce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
No Vegetative Cover	48	30	0	53	20	15	17	7	0	26	0	0	73	17	0	60	39	24	18	0	0

* Values are total centimeters of above ground vegetative cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower, 1/3 of each plot.

APPENDIX TABLE 15. VEGETATION ANALYSIS (TRANSECT METHOD) ON SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. AUGUST 1976

	60 cm (24") Soil Cover						15 cm (6") Soil Cover						USBM Spent Shale						Soil		
	14			12			10			8			6			4			2		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
<u>GRASSES</u>																					
Western wheatgrass	72 *	69	63	118	132	154	72	77	106	158	72	88	59	146	50	125	91	8	196	232	104
Bluebunch wheatgrass	42	72	69	91	63	115	98	91	86	56	72	19	22	73	71	30	47	-	86	52	64
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-
Indian ricegrass	-	-	-	-	-	-	20	-	-	-	-	-	10	-	-	30	17	-	-	-	-
Timothy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild barley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																					
Winterfat	41	6	14	26	17	29	9	-	19	33	18	29	15	-	-	7	12	14	16	19	24
Fourwing saltbush	59	130	79	-	15	-	7	84	-	-	94	119	97	23	-	6	-	250	-	-	112
Rabbitbrush	-	-	29	26	-	-	15	24	-	-	-	-	-	-	-	-	-	-	-	-	25
Bitterbrush	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big sagebrush	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-
<u>FORBS</u>																					
Globe mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utah sweetvetch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																					
Cheatgrass	9	11	8	-	-	-	-	-	7	-	18	22	-	10	26	-	12	9	-	10	-
Mustard (spp)	7	5	-	-	19	-	-	5	39	-	-	24	23	11	16	5	18	44	-	-	-
Russian thistle	-	-	-	-	-	-	12	-	-	-	-	-	5	3	19	6	-	14	-	-	-
Wild lettuce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
No Vegetative Cover	120	62	83	88	104	35	117	69	87	93	76	49	119	81	147	141	133	11	52	137	21

* Values are total centimeters of above ground vegetative cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower, 1/3 of each plot.

APPENDIX TABLE 16. ABOVE GROUND STANDING BIO-MASS CLIPPING DATA ON TOSCO AND USBM SPENT SHALES, SOIL-COVERED TOSCO AND USBM SPENT SHALES, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. AUGUST 15, 1976

NORTH ASPECT								SOUTH ASPECT							
Location	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil	Location	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII		II	IV	VI	VIII	X	XII	XIV
upper	17.1*	11.0	13.8	19.2	25.7	9.0	21.5	upper	16.6	16.9	16.4	14.3	5.5	7.7	8.7
middle	23.0	19.0	14.1	25.5	27.9	20.5	69.0	middle	22.1	10.1	24.9	12.0	13.0	21.7	23.2
lower	39.3	29.1	34.9	41.5	35.8	23.0	32.6	lower	36.9	9.2	33.9	14.3	15.0	5.2	18.6
\bar{X}	26.5	19.7	20.9	28.7	29.8	17.5	41.0	\bar{X}	25.2	12.1	25.1	13.5	11.2	11.5	16.8
SD	11.5	9.1	12.1	11.5	5.3	7.5	24.8	SD	10.5	4.2	8.8	1.3	5.0	8.9	7.4

NORTH ASPECT								SOUTH ASPECT							
Location	60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil	Location	60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil
	13	11	9	7	5	3	1		14	12	10	8	6	4	2
upper	39.3	57.1	26.4	87.9	40.8	16.0	67.8	upper	20.9	18.5	14.2	4.2	8.9	4.8	7.4
middle	31.0	10.8	42.7	49.0	60.1	14.5	35.1	middle	15.4	57.2	31.2	4.5	10.1	3.6	45.0
lower	13.8	13.2	71.5	52.8	31.3	15.8	49.4	lower	12.4	12.8	71.9	18.5	4.1	21.1	21.1
\bar{X}	28.0	27.0	46.8	63.2	44.1	15.4	50.7	\bar{X}	16.3	29.5	39.1	9.1	7.7	9.8	24.5
SD	13.0	26.1	22.8	21.4	14.7	0.8	16.4	SD	4.3	24.1	29.6	8.2	3.2	9.7	19.0

* Values are total grams (over dry weight) of above ground standing bio-mass within a 20.3 x 40.6 cm quadrat, randomly placed in upper, middle, and lower, 1/3 of each plot.

APPENDIX TABLE 17. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1973

Depth (cm)	30 cm (12") Soil Cover				30 cm (12") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover			
	I				III				V				VII			
	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13
15	30.0*	17.5	6.0	10.0	36.0	11.2	11.0	1.7	27.2	19.2	11.0	12.0	22.0	21.0	8.2	12.0
30	31.7	29.7	12.5	17.0	33.5	17.5	13.2	17.2	>40.0	32.7	17.5	22.2	>40.0	>40.0	16.2	21.7
45	35.2	37.7	14.0	20.5	31.7	32.0	14.0	26.5	>40.0	>40.0	19.7	22.2	>40.0	>40.0	19.7	23.2
60	35.2	37.7	14.0	21.2	31.7	30.2	15.5	26.5	>40.0	>40.0	19.7	24.0	>40.0	>40.0	20.5	23.2
75	32.5	37.7	16.2	21.2	31.0	28.0	17.0	25.5	>40.0	>40.0	22.0	24.0	>40.0	>40.0	23.5	24.0
90	29.0	35.7	17.0	21.2	27.2	28.0	18.2	25.5	>40.0	>40.0	22.7	25.5	>40.0	>40.0	24.7	24.7
105	26.5	37.7	17.5	21.2	24.0	30.2	19.7	25.5	>40.0	>40.0	24.0	26.5	>40.0	>40.0	24.2	25.5
120	24.7	36.7	17.5	23.0	24.0	28.7	21.2	25.5	>40.0	>40.0	25.5	28.2	>40.0	>40.0	21.2	25.5
135	23.7	36.7	18.2	23.0	23.0	30.2	22.7	26.5	>40.0	>40.0	25.5	28.2	>40.0	>40.0	23.5	26.5
150	24.7	35.7	21.2	24.7	23.0	33.5	23.5	26.5	>40.0	>40.0	27.0	28.2	>40.0	>40.0	24.2	27.2
165	27.2	>40.0	21.2	25.5	23.0	>40.0	24.2	29.0	--	--	--	--	--	--	--	--
180	27.2	>40.0	22.7	25.5	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale				TOSCO Spent Shale				Soil			
	IX				XI				XIII			
	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13
15	36.7	25.5	18.7	4.2	32.7	21.7	18.0	5.0	29.2	6.0	5.5	3.5
30	>40.0	>40.0	25.5	21.5	>40.0	>40.0	26.5	28.0	>40.0	17.7	12.5	11.5
45	>40.0	>40.0	26.5	26.5	>40.0	>40.0	28.2	29.7	>40.0	23.2	19.2	14.0
60	>40.0	>40.0	30.0	27.2	>40.0	>40.0	28.2	29.7	>40.0	25.5	23.0	19.0
75	>40.0	>40.0	28.2	27.2	>40.0	>40.0	29.0	30.5	>40.0	29.5	24.7	19.7
90	>40.0	>40.0	28.2	28.0	>40.0	>40.0	28.2	29.7	>40.0	29.5	26.5	22.2
105	>40.0	>40.0	28.2	28.0	>40.0	>40.0	29.0	29.7	>40.0	28.7	28.2	24.7
120	>40.0	>40.0	30.0	27.2	>40.0	>40.0	29.0	29.7	>40.0	26.5	28.2	25.5
135	>40.0	>40.0	31.7	28.0	>40.0	>40.0	30.7	31.2	>40.0	27.2	28.2	26.5
150	--	--	--	--	--	--	--	--	>40.0	27.2	30.0	26.5
165	--	--	--	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--

* Values in percent moisture by volume as determined from a standard soil moisture curve.

-- No readings.

APPENDIX TABLE 18. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1973

Depth (cm)	30 cm (12") Soil Cover				30 cm (12") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover			
	II				IV				VI				VIII			
	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13
15	30.0 *	12.0	5.2	3.5	23.0	19.0	14.2	0.2	26.5	19.2	10.7	<0.2	36.7	26.5	9.0	1.7
30	30.7	24.0	14.7	13.0	32.5	28.0	20.7	13.0	36.0	33.2	20.5	15.0	>40.0	>40.0	19.5	23.0
45	37.7	34.0	19.7	21.5	36.0	34.5	23.5	20.5	>40.0	>40.0	23.0	18.0	>40.0	>40.0	24.7	28.0
60	34.2	35.0	19.7	22.2	37.0	32.2	23.5	24.0	>40.0	>40.0	24.0	18.0	>40.0	>40.0	25.2	27.2
75	30.7	32.2	20.5	23.0	23.5	31.2	25.5	23.0	>40.0	>40.0	24.7	19.7	>40.0	>40.0	26.5	29.0
90	30.0	31.5	20.5	23.0	32.5	30.5	25.5	22.2	>40.0	>40.0	26.5	21.5	>40.0	>40.0	27.2	29.0
105	29.0	33.2	20.5	23.0	29.0	33.0	27.5	22.2	>40.0	>40.0	27.2	23.0	>40.0	>40.0	30.0	29.0
120	30.7	36.5	22.0	24.0	28.2	34.5	28.5	23.0	>40.0	>40.0	28.2	24.0	>40.0	>40.0	30.7	30.5
135	34.2	>40.0	22.7	25.5	27.2	>40.0	29.5	24.7	>40.0	>40.0	27.2	24.7	>40.0	>40.0	31.7	31.2
150	34.2	>40.0	24.2	27.2	26.5	>40.0	29.5	25.5	>40.0	>40.0	27.2	24.7	>40.0	40.0	31.7	31.2
165	35.2	>40.0	25.5	27.2	--	--	--	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale				TOSCO Spent Shale				Soil			
	X				XII				XIV			
	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13
15	>40.0	28.7	21.2	11.2	>40.0	21.7	13.7	4.7	30.5	6.0	4.5	1.7
30	>40.0	>40.0	25.5	24.0	>40.0	31.0	22.2	24.7	39.7	18.5	13.7	14.0
45	>40.0	>40.0	26.5	25.5	>40.0	>40.0	22.2	26.5	31.7	21.0	21.5	16.5
60	>40.0	>40.0	29.0	26.5	>40.0	>40.0	22.2	26.5	36.7	24.7	22.2	19.7
75	>40.0	>40.0	28.2	26.5	>40.0	>40.0	23.2	26.5	37.7	26.2	24.0	19.7
90	>40.0	>40.0	30.0	27.2	>40.0	>40.0	24.0	26.5	>40.0	31.0	24.7	19.7
105	>40.0	>40.0	30.0	27.2	>40.0	>40.0	26.5	27.2	39.7	28.0	26.6	22.2
120	>40.0	>40.0	30.7	26.5	>40.0	>40.0	28.0	27.2	30.7	27.2	28.2	24.0
135	>40.0	>40.0	30.7	27.2	>40.0	>40.0	28.0	28.0	37.7	26.2	29.7	24.7
150	--	--	--	--	--	--	--	--	37.7	27.2	29.7	28.0
165	--	--	--	--	--	--	--	--	37.7	28.0	31.5	28.0
180	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No readings.

APPENDIX TABLE 19. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM NORTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1973

Depth (cm)	60 cm (24") Soil Cover				60 cm (24") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover			
	13				11				9				7			
	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13
15	26.5*	13.2	7.2	2.7	23.7	13.7	5.5	6.2	30.2	28.2	2.7	3.5	22.7	14.2	4.7	4.2
30	35.7	21.2	13.2	13.7	32.0	20.5	15.0	13.7	38.5	33.2	16.2	17.0	39.5	32.5	18.7	15.0
45	34.7	23.0	16.0	13.7	33.0	23.7	16.0	15.5	39.5	32.2	24.0	21.5	>40.0	36.0	25.5	20.7
60	35.7	31.5	23.0	18.7	34.7	29.0	20.5	16.2	39.5	31.5	24.7	22.2	>40.0	38.7	25.5	24.0
75	35.7	32.5	25.5	22.2	39.5	35.7	25.5	24.0	39.5	34.0	25.5	24.0	>40.0	>40.0	21.5	24.7
90	35.7	32.5	26.5	24.0	>40.0	35.7	26.5	25.5	39.5	34.0	27.2	24.7	39.5	>40.0	26.5	24.7
105	35.7	31.5	26.5	24.0	39.5	31.5	26.5	25.5	>40.0	37.5	28.2	25.5	39.5	>40.0	28.2	24.7
120	33.0	31.5	26.5	25.0	34.0	31.5	26.5	25.5	>40.0	>40.0	27.2	27.2	>40.0	>40.0	29.0	26.5
135	34.0	30.0	26.5	25.0	34.7	33.2	26.5	25.5	>40.0	>40.0	29.0	27.2	>40.0	>40.0	30.0	26.5
150	32.0	31.5	26.5	24.7	39.5	35.0	26.5	26.5	>40.0	>40.0	26.5	27.2	>40.0	>40.0	31.5	28.0
165	32.0	35.2	28.2	27.2	39.5	35.0	28.2	26.5	--	--	--	--	>40.0	>40.0	31.5	28.0
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale				USBM Spent Shale				Soil			
	5				3				1			
	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13
15	17.2	20.5	5.5	7.2	26.5	23.7	6.5	8.5	22.7	23.0	3.0	6.7
30	35.7	30.0	18.7	21.2	37.5	31.5	23.0	21.2	33.0	30.0	16.0	15.0
45	38.5	34.2	24.7	22.0	39.5	35.2	25.5	24.7	37.5	30.0	18.7	16.5
60	39.5	37.7	29.0	24.7	>40.0	36.7	28.2	25.5	34.7	34.2	19.2	18.2
75	>40.0	>40.0	33.5	29.0	>40.0	36.7	30.0	26.5	37.5	37.7	23.0	19.0
90	>40.0	>40.0	31.5	30.0	>40.0	38.7	28.2	27.2	39.5	37.7	25.5	21.5
105	>40.0	>40.0	30.0	29.0	38.5	>40.0	30.0	27.2	37.5	37.0	26.5	22.2
120	>40.0	>40.0	30.0	29.0	>40.0	>40.0	30.0	27.2	38.5	35.2	27.2	22.2
135	>40.0	>40.0	30.0	29.0	>40.0	>40.0	28.2	28.2	37.5	35.2	30.0	24.0
150	>40.0	>40.0	33.5	28.2	>40.0	>40.0	30.0	27.2	37.5	35.2	30.0	26.5
165	--	--	--	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No readings.

APPENDIX TABLE 20. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1973

Depth (cm)	60 cm (24") Soil Cover				60 cm (24") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover			
	14				12				10				8			
	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13
15	19.2*	17.0	1.7	1.7	13.7	19.5	3.0	2.5	24.7	27.2	2.2	2.5	14.5	27.2	4.7	2.5
30	33.7	21.2	12.0	11.5	31.0	24.7	13.2	12.5	36.7	30.0	14.2	15.0	35.7	29.0	15.0	14.0
45	34.7	24.7	17.0	12.5	35.7	26.5	17.7	14.0	38.5	30.7	19.2	18.2	35.7	30.7	20.5	19.0
60	35.7	29.0	19.7	18.2	33.7	34.2	19.2	15.7	39.5	30.0	23.0	19.0	37.5	37.7	24.7	21.5
75	37.5	37.0	20.5	19.7	39.5	35.2	25.5	21.5	37.5	29.0	24.7	21.5	>40.0	37.7	30.0	25.5
90	39.5	37.0	25.5	24.0	38.5	36.0	26.5	23.0	33.0	30.7	24.7	20.7	>40.0	>40.0	30.0	26.5
105	39.5	37.0	26.5	25.5	38.5	36.0	26.5	24.7	37.5	37.0	25.5	23.2	39.5	>40.0	29.0	26.5
120	39.5	>40.0	27.2	26.5	38.5	35.2	26.5	24.7	>40.0	>40.0	28.2	25.5	>40.0	>40.0	31.5	27.2
135	>40.0	>40.0	27.2	27.2	37.5	33.5	26.5	24.0	>40.0	>40.0	30.7	26.5	>40.0	>40.0	31.5	28.0
150	>40.0	>40.0	30.7	28.0	>40.0	37.7	26.5	24.0	>40.0	>40.0	33.2	27.2	>40.0	>40.0	31.5	29.0
165	>40.0	>40.0	32.2	29.0	>40.0	>40.0	26.5	26.5	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale				USBM Spent Shale				Soil			
	6				4				2			
	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13	6/27	8/1	9/19	10/13
15	21.0	24.0	10.7	1.0	21.7	13.2	5.5	1.7	18.2	20.5	5.5	1.7
30	34.7	29.0	21.2	15.7	>40.0	29.0	19.2	17.2	33.0	25.5	16.0	13.7
45	35.7	30.5	24.0	19.7	>40.0	31.2	24.7	21.0	34.7	29.0	17.7	15.5
60	39.5	29.0	24.7	19.7	>40.0	33.0	26.5	22.2	37.5	31.5	21.2	16.2
75	39.5	29.0	25.5	22.2	>40.0	32.2	26.5	24.7	37.5	31.5	23.0	19.7
90	36.7	28.0	25.5	24.0	>40.0	33.0	27.2	25.5	38.5	30.7	24.0	21.2
105	33.7	29.7	26.5	24.7	>40.0	33.0	27.2	25.5	36.7	33.2	24.7	23.0
120	38.5	33.0	26.5	24.7	>40.0	33.7	28.2	27.2	36.7	33.2	26.5	24.7
135	39.5	36.2	29.0	26.5	>40.0	34.5	30.0	27.2	37.5	35.2	27.2	25.5
150	>40.0	>40.0	31.5	27.2	>40.0	36.2	30.7	27.2	34.7	30.0	28.2	28.2
165	--	--	--	--	>40.0	36.2	30.7	26.5	33.0	30.0	30.0	28.2
180	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No readings.

APPENDIX TABLE 21. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1974

Depth (cm)	30 cm (12") Soil Cover				30 cm (12") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover			
	I				III				V				VII			
	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6
15	19.5*	13.5	0.2	3.7	10.7	13.0	<0.2	5.5	7.5	12.0	<0.2	4.7	17.2	9.0	3.7	7.2
30	27.2	20.5	5.0	15.2	24.7	20.0	14.2	17.0	33.5	28.2	12.5	12.5	33.2	28.3	14.2	16.0
45	29.0	24.5	15.7	17.7	31.7	23.5	18.7	17.0	33.5	28.5	16.0	15.2	34.0	28.5	17.7	17.7
60	29.0	26.7	21.2	17.7	30.0	27.3	17.7	16.0	33.5	29.7	19.5	17.7	34.0	29.7	22.2	21.2
75	28.2	27.5	20.2	18.7	30.0	27.2	17.7	17.0	35.2	30.2	20.5	18.7	34.0	30.5	24.0	22.2
90	26.5	23.5	20.2	17.7	30.0	28.6	19.5	19.5	36.0	30.7	23.0	21.2	35.7	30.5	24.7	24.0
105	25.5	24.5	20.2	17.7	29.0	29.0	21.2	21.2	37.0	32.0	24.7	24.7	35.0	31.2	25.5	23.0
120	26.5	24.0	20.2	17.7	29.0	27.5	24.0	23.0	37.0	34.0	28.2	24.7	34.0	32.8	24.7	23.0
135	25.5	24.0	21.2	17.7	29.0	29.0	24.0	24.0	37.0	36.5	26.5	25.5	35.7	31.6	26.5	24.7
150	28.2	27.5	22.0	20.5	31.7	30.3	25.5	24.7	37.0	37.5	28.2	26.5	35.7	33.6	27.2	24.7
165	28.2	27.5	23.7	22.2	35.2	34.7	26.5	25.5	--	--	--	--	--	--	--	--
180	29.0	28.0	24.7	22.2	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale				TOSCO Spent Shale				Soil			
	IX				XI				XIII			
	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6
15	21.2	20.5	5.5	5.5	20.5	19.5	4.0	6.0	10.2	3.5	3.7	7.2
30	33.5	29.0	16.0	16.0	34.0	25.6	14.2	16.7	18.7	3.5	12.5	15.2
45	35.2	29.0	15.2	18.7	35.7	29.2	20.5	21.2	24.7	15.5	15.0	16.0
60	35.2	31.5	23.0	23.0	37.5	31.5	23.0	23.0	28.2	25.5	17.7	17.0
75	37.0	31.5	24.7	23.0	36.5	31.5	24.0	23.7	28.2	25.5	17.7	17.0
90	37.0	32.2	24.7	22.7	35.0	32.2	24.7	23.7	29.0	25.5	19.5	17.7
105	38.7	33.2	26.5	23.0	35.0	32.5	24.7	24.7	31.5	26.5	22.0	17.7
120	37.0	34.0	26.5	23.0	35.7	33.2	25.5	24.7	29.7	27.2	23.0	18.7
135	37.7	34.0	26.5	23.0	37.5	34.0	27.2	24.7	29.0	29.0	25.5	19.5
150	--	--	--	--	37.5	34.0	27.2	24.7	29.7	31.5	25.5	19.5
165	--	--	--	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No readings.

APPENDIX TABLE 22. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1974

Depth (cm)	30 cm (12") Soil Cover				30 cm (12") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover			
	II				IV				VI				VIII			
	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6
15	14.7*	13.0	4.0	6.5	15.5	13.5	10.7	8.2	19.5	3.0	5.5	7.5	26.5	2.0	3.7	7.5
30	17.0	15.2	14.2	15.2	24.0	23.5	14.2	16.0	31.7	27.0	12.5	14.2	34.0	25.5	14.2	14.2
45	29.0	18.6	21.2	22.2	29.7	26.7	16.0	16.0	31.7	28.5	15.2	15.2	35.0	27.3	19.5	17.0
60	28.2	22.5	21.2	23.7	31.5	21.5	17.7	17.0	31.7	29.5	19.5	16.0	34.0	29.0	21.2	17.7
75	25.5	22.0	21.2	19.5	29.5	24.3	18.7	17.7	31.7	30.1	19.5	17.7	33.2	29.5	22.0	20.5
90	24.7	22.5	21.2	21.2	28.2	25.5	19.5	17.7	33.5	30.6	22.2	18.7	34.0	30.7	23.7	21.2
105	24.7	23.2	21.2	21.2	29.0	25.5	21.2	18.7	34.2	30.2	23.0	21.2	35.7	32.6	27.2	22.2
120	27.2	25.5	23.7	23.0	29.5	25.5	24.7	19.5	33.5	32.5	24.7	23.0	37.5	34.0	27.2	25.5
135	28.2	27.6	25.5	24.7	30.7	27.6	24.7	23.0	33.5	33.0	24.7	24.7	36.5	34.5	28.2	26.5
150	29.0	29.0	26.5	24.7	31.5	29.0	24.7	24.7	34.2	33.0	24.7	24.7	36.5	35.0	28.2	26.5
165	28.2	29.0	26.5	26.5	--	--	--	--	--	--	--	--	--	--	--	--
180	29.0	29.1	26.5	26.5	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale				TOSCO Spent Shale				Soil			
	X				XII				XIV			
	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6
15	34.0	3.0	9.0	7.2	30.7	2.0	9.0	7.2	17.0	3.0	4.0	6.5
30	34.0	29.5	20.5	17.7	34.0	29.0	19.5	17.0	24.0	20.6	12.5	15.2
45	34.0	30.2	23.0	21.2	34.0	30.5	21.2	18.7	24.7	22.6	16.0	16.0
60	35.7	32.3	24.7	23.0	35.7	32.2	23.0	21.2	26.5	23.5	16.0	16.0
75	35.0	31.6	26.5	23.0	34.0	32.5	24.0	23.0	29.0	25.6	17.7	17.0
90	35.0	33.3	25.5	24.0	34.0	33.2	24.7	24.0	30.7	28.5	17.7	17.0
105	35.7	33.3	25.5	24.7	35.7	33.2	26.5	24.0	30.0	28.6	18.7	17.0
120	35.7	33.2	25.5	24.7	35.7	33.2	28.2	24.7	30.7	28.6	24.0	22.2
135	36.5	35.7	26.5	24.7	35.7	35.7	28.2	24.7	30.0	28.4	24.7	23.0
150	--	--	--	--	--	--	--	--	30.0	28.3	26.5	24.7
165	--	--	--	--	--	--	--	--	31.0	28.2	28.2	26.5
180	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No readings.

APPENDIX TABLE 23. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM NORTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1974

Depth (cm)	60 cm (24") Soil Cover				60 cm (24") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover			
	13				11				9				7			
	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6
15	20.5*	3.5	6.0	3.7	17.2	4.0	2.2	5.5	22.2	2.0	2.2	3.7	27.2	4.0	4.2	2.2
30	24.7	7.0	11.2	12.5	24.7	8.0	12.2	12.5	29.0	5.2	13.0	15.0	31.5	6.0	14.0	15.0
45	26.5	11.2	13.0	13.5	25.5	12.0	12.2	13.5	31.5	14.6	15.7	16.0	33.2	18.5	16.7	16.0
60	31.5	15.5	16.7	16.0	32.2	15.5	14.7	16.0	32.2	24.0	16.7	16.0	34.0	24.5	18.5	16.0
75	30.7	20.5	18.5	17.0	34.0	20.5	18.5	17.7	33.2	25.0	18.5	17.0	32.5	25.0	19.5	17.0
90	32.2	25.5	21.2	17.7	34.0	22.5	21.2	20.5	34.0	26.5	21.2	17.7	32.5	26.5	22.0	19.5
105	29.7	26.5	22.0	19.5	32.2	25.5	22.0	21.2	34.0	27.7	22.0	21.2	33.2	23.5	23.0	22.2
120	31.5	27.2	23.7	23.0	32.2	26.0	23.7	23.0	32.2	29.0	24.7	24.0	34.0	29.0	24.7	24.0
135	29.7	27.2	23.7	24.0	32.2	26.5	24.7	23.0	33.2	31.5	26.5	24.7	34.0	31.0	25.5	24.7
150	29.7	28.2	25.5	24.0	32.2	27.3	25.5	24.7	33.2	32.2	25.5	24.7	34.0	33.0	26.5	26.5
165	32.2	28.2	27.5	24.7	32.2	28.3	25.5	24.7	33.2	32.2	27.2	26.5	34.0	33.0	26.5	28.2
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale				USBM Spent Shale				Soil			
	5				3				1			
	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6
15	27.2	2.0	4.0	4.0	28.2	5.0	6.0	2.2	24.0	14.7	3.7	3.7
30	29.0	15.5	11.2	14.2	30.0	15.9	12.2	14.2	28.2	22.2	11.2	14.2
45	30.7	23.0	14.0	15.0	33.5	22.5	17.5	16.0	29.7	23.5	13.7	15.0
60	35.7	30.7	17.5	16.0	31.7	31.3	21.2	18.7	29.0	24.7	13.7	15.0
75	34.0	31.5	23.0	21.2	34.2	31.5	23.7	22.2	30.7	24.5	13.7	16.0
90	34.0	32.2	25.5	23.0	33.0	32.0	25.5	23.0	29.7	24.0	15.5	16.0
105	34.0	31.2	25.5	23.0	33.0	32.0	25.5	24.0	27.2	24.0	15.5	16.0
120	34.0	30.7	26.5	23.0	33.0	31.0	25.5	25.5	26.5	24.0	15.5	16.0
135	35.0	32.0	27.2	24.7	33.0	32.0	25.5	24.7	27.2	24.0	18.0	17.7
150	35.0	32.2	30.0	26.5	33.0	33.0	27.2	24.7	29.0	24.7	22.2	21.2
165	--	--	--	--	--	--	--	--	29.0	29.0	24.0	23.0
180	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No readings.

APPENDIX TABLE 24. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1974

Depth (cm)	60 cm (24") Soil Cover				60 cm (24") Soil Cover				15 cm (6") Soil Cover				15 cm (6") Soil Cover			
	14				12				10				8			
	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6
15	13.7*	3.5	0.5	3.7	17.2	3.5	2.2	4.7	23.0	4.0	2.2	3.7	23.0	3.5	2.2	3.7
30	18.7	5.2	9.0	13.5	24.0	5.3	9.5	12.5	28.2	19.0	12.2	14.2	25.5	18.7	11.7	14.2
45	22.0	10.3	10.7	14.2	24.0	10.4	12.0	13.5	27.2	21.0	14.7	16.0	30.7	22.1	14.2	16.0
60	24.0	15.5	12.5	15.2	29.7	15.6	13.0	16.0	27.2	23.0	14.7	15.2	30.7	25.5	15.2	16.0
75	29.7	20.5	15.0	16.0	32.5	20.6	18.5	17.7	27.2	24.7	14.7	15.2	30.7	27.2	21.2	17.7
90	30.7	25.5	17.7	21.2	32.5	25.6	20.2	19.5	27.2	26.5	14.7	16.0	30.7	29.0	22.2	23.0
105	32.5	26.3	24.7	24.7	30.7	25.3	22.0	22.2	27.2	29.5	18.5	17.7	32.5	30.5	24.7	24.0
120	32.5	26.8	24.7	26.5	31.5	26.7	23.7	21.2	32.5	32.5	22.0	23.0	32.5	32.5	25.5	24.7
135	32.5	27.2	27.2	26.5	30.7	27.3	23.0	21.2	34.0	32.9	25.5	24.7	32.5	32.5	26.5	26.5
150	33.2	28.1	28.2	27.2	32.5	27.3	23.7	23.0	34.0	33.0	28.2	25.5	32.5	32.5	26.5	26.5
165	34.0	28.5	30.0	28.2	32.5	29.5	27.5	24.7	34.0	33.0	28.2	26.5	--	--	--	--
180	34.0	29.0	30.0	30.0	32.5	30.0	27.5	24.7	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale				USBM Spent Shale				Soil			
	6				4				2			
	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6	4/18	5/16	7/12	9/6
15	22.2	5.0	3.7	5.5	27.2	5.5	0.5	7.2	10.5	3.0	0.2	5.5
30	24.7	18.5	11.2	12.5	31.0	19.0	10.7	14.2	22.2	3.5	10.7	12.5
45	27.2	19.5	13.0	15.2	30.0	20.3	12.5	15.2	25.5	14.0	13.5	14.2
60	27.2	21.5	14.7	15.2	30.0	23.3	14.2	16.0	25.5	20.5	14.2	15.2
75	29.0	25.6	18.5	16.0	31.0	26.6	19.5	21.2	27.2	23.5	14.2	15.2
90	28.2	26.0	20.2	17.7	31.0	26.6	21.2	23.0	29.7	25.5	14.2	15.2
105	29.0	26.7	22.0	19.5	31.7	26.7	24.0	24.7	26.5	27.0	15.2	16.0
120	34.0	28.5	23.7	22.0	33.5	28.9	24.0	24.7	29.0	28.2	16.0	16.0
135	32.5	30.5	27.2	24.7	33.5	31.2	26.5	25.5	29.0	29.0	17.7	17.0
150	32.5	30.5	27.2	24.7	33.5	33.5	26.5	25.5	29.7	29.0	19.5	17.7
165	--	--	--	--	33.5	33.5	26.5	25.5	29.0	29.0	21.2	21.2
180	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No readings.

APPENDIX TABLE 25. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE, 1975

Depth (cm)	30 cm (12") Soil Cover						30 cm (12") Soil Cover						15 cm (6") Soil Cover						15 cm (6") Soil Cover					
	I						III						V						VII					
	4/10	5/12	5/20	6/20	7/16	10/13	4/10	5/12	5/20	6/20	7/16	10/13	4/10	5/12	5/20	6/20	7/16	10/13	4/10	5/12	5/20	6/20	7/16	10/13
15	19.8*	5.0	12.5	5.5	6.5	9.0	15.8	6.3	12.5	4.8	5.0	9.0	24.0	17.3	22.0	7.5	5.8	8.5	24.8	17.5	21.3	8.0	5.8	7.8
30	24.0	16.5	27.3	12.8	10.0	12.8	24.0	19.3	25.5	16.0	13.3	14.8	30.5	27.3	32.5	17.8	10.8	11.3	29.3	28.0	32.5	18.3	13.3	13.0
45	27.0	23.0	28.3	18.3	13.3	13.8	27.0	26.3	32.5	22.3	17.3	16.3	31.3	29.8	32.5	21.0	15.8	16.0	30.3	28.0	32.5	22.3	18.3	17.8
60	26.3	24.8	27.3	18.3	14.8	14.5	25.5	24.8	28.3	21.5	17.3	15.5	33.0	33.0	33.3	22.5	18.3	17.3	28.5	30.3	31.8	24.0	21.5	19.5
75	24.0	24.0	23.8	19.3	16.5	15.0	23.3	24.8	25.5	20.8	17.3	15.5	32.3	33.0	33.3	24.8	21.5	19.5	29.3	32.0	32.5	24.8	23.0	21.5
90	22.5	22.3	21.3	20.8	17.3	16.5	23.3	24.0	25.5	21.5	18.3	16.3	33.0	33.8	35.3	26.3	23.0	21.8	30.3	32.8	32.5	28.0	24.8	21.5
105	21.0	21.5	19.5	20.8	18.3	15.3	23.3	25.5	24.8	23.3	19.8	17.8	32.3	33.8	33.3	26.3	24.8	22.5	29.3	32.8	31.8	27.3	24.0	21.5
120	18.5	20.5	20.3	20.8	18.3	16.0	23.3	26.3	24.8	25.5	21.5	20.0	33.0	34.5	33.3	34.3	27.3	23.5	29.3	32.8	32.5	27.3	24.8	21.8
135	18.5	21.5	20.3	20.0	18.3	16.0	24.8	26.3	24.8	25.5	24.0	20.8	32.3	34.5	32.5	34.3	26.3	23.5	29.3	34.3	31.8	28.0	25.5	25.3
150	18.5	20.5	21.3	22.3	20.5	19.0	24.8	29.5	25.5	27.3	24.8	21.5	32.3	34.5	31.8	34.3	26.3	25.0	29.3	34.3	31.8	28.0	25.5	26.8
165	19.3	21.5	21.3	22.3	21.5	20.0	26.3	29.5	25.5	35.3	24.8	22.8	--	--	--	--	--	--	--	--	--	--	--	--
180	19.3	23.0	21.3	24.0	22.3	20.8	26.3	29.5	26.5	35.3	24.8	23.5	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale						TOSCO Spent Shale						Soil					
	IX						XI						XIII					
	4/10	5/12	5/20	6/20	7/16	10/13	4/10	5/12	5/20	6/20	7/16	10/13	4/10	5/12	5/20	6/20	7/16	10/13
15	25.5*	17.5	24.8	6.8	5.8	9.3	27.0	20.8	17.8	7.5	5.8	7.5	22.5	10.8	19.5	6.5	6.8	8.8
30	30.3	28.8	34.3	18.5	14.8	16.5	31.8	30.3	35.3	21.0	16.5	14.8	24.8	20.5	26.5	12.0	24.8	12.0
45	31.0	32.8	35.3	22.5	22.3	20.5	32.5	32.0	35.3	24.0	21.5	18.3	27.0	24.0	30.0	16.5	28.0	15.0
60	31.0	32.0	36.8	24.8	23.0	21.8	32.5	32.8	36.8	25.5	23.0	19.3	27.0	26.3	30.8	18.0	28.8	15.8
75	31.0	32.8	36.0	26.3	24.0	23.3	30.3	31.3	35.3	28.0	23.0	19.5	28.8	27.3	31.8	19.5	29.8	16.0
90	30.3	33.5	36.0	26.3	24.8	23.3	30.3	31.3	32.5	26.3	24.8	20.3	28.8	28.8	33.3	22.5	31.3	16.5
105	30.3	32.8	33.3	27.0	26.3	23.5	30.3	32.8	31.8	27.0	26.3	21.0	28.0	29.8	30.8	24.0	28.8	17.8
120	31.0	33.5	33.3	28.8	27.3	25.3	30.3	32.8	30.8	28.0	26.3	21.5	27.0	27.3	29.0	24.0	27.3	16.8
135	31.0	33.5	33.3	28.8	27.3	25.3	31.0	32.8	31.8	28.0	26.3	21.8	26.3	27.3	28.3	24.0	26.3	16.8
150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 26. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1975

Depth (cm)	30 cm (12") Soil Cover						30 cm (12") Soil Cover						15 cm (6") Soil Cover						15 cm (6") Soil Cover					
	II						IV						VI						VIII					
	4/10	5/12	5/20	6/20	7/16	10/13	4/10	5/12	5/20	6/20	7/16	10/13	4/10	5/12	5/20	6/20	7/16	10/13	4/10	5/12	5/20	6/20	7/16	10/13
15	19.3 *	8.8	16.0	7.5	5.8	6.8	21.0	10.8	23.3	7.3	6.8	10.3	19.5	10.0	16.0	6.3	4.3	5.3	10.3	13.5	17.8	5.5	4.3	6.8
30	24.0	16.8	24.8	13.8	12.3	13.3	24.0	17.3	26.5	13.5	11.5	11.5	25.5	23.0	28.3	16.0	10.0	10.3	28.5	25.5	31.8	13.5	9.0	10.3
45	28.8	31.3	32.5	21.5	18.3	19.0	27.0	27.3	33.3	14.3	10.8	12.3	26.3	24.8	30.0	18.3	14.0	13.0	28.5	26.3	33.3	20.8	15.8	16.0
60	29.5	32.8	33.3	22.5	19.0	18.3	27.0	26.3	31.8	17.3	13.3	15.8	26.3	24.8	30.0	20.8	18.3	16.5	27.8	27.3	31.8	22.3	17.3	18.0
75	27.0	27.3	31.8	21.5	19.8	17.8	26.3	25.5	31.8	18.8	15.8	16.0	27.0	25.5	30.0	23.3	19.8	19.3	27.8	28.0	31.8	23.3	20.5	19.3
90	25.5	25.5	29.0	22.5	20.5	17.8	25.5	24.8	28.3	19.5	16.5	17.5	26.3	27.3	31.8	24.8	22.3	20.3	27.8	29.5	31.8	24.8	23.0	21.5
105	24.0	24.8	26.5	21.5	20.5	18.8	24.0	24.8	28.3	20.3	19.0	18.8	27.0	27.3	30.0	25.5	23.0	22.3	29.3	31.3	32.5	25.5	24.8	23.5
120	25.5	26.3	25.5	23.3	23.0	20.3	25.5	27.3	26.5	21.8	20.5	20.0	26.3	28.8	30.0	25.5	24.0	21.8	28.5	32.0	33.3	28.0	27.3	25.8
135	26.3	28.8	26.5	26.3	24.8	22.5	26.3	28.8	27.3	24.0	23.0	19.5	24.8	28.8	26.5	24.8	24.0	22.3	29.3	31.3	33.3	29.5	27.3	26.5
150	27.0	29.5	25.5	26.3	24.8	23.8	26.3	29.8	26.5	25.5	24.0	21.8	24.0	28.8	26.5	25.5	24.0	23.0	29.3	31.3	33.3	29.5	27.3	26.5
165	26.3	32.0	23.8	26.3	26.3	24.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	TOSCO Spent Shale						TOSCO Spent Shale						Soil					
	X						XII						XIV					
	4/10	5/12	5/20	6/20	7/16	10/13	4/10	5/12	5/20	6/20	7/16	10/13	4/10	5/12	5/20	6/20	7/16	10/13
15	28.8 *	19.3	28.3	8.0	4.3	8.0	26.3	19.8	30.8	9.3	8.3	12.0	21.0	9.5	17.8	7.3	6.8	8.8
30	29.5	26.3	30.8	20.8	16.5	20.0	31.0	28.8	33.3	20.0	16.5	18.5	25.5	17.5	27.3	12.5	13.3	14.3
45	30.3	27.3	31.8	24.0	20.5	21.3	30.3	28.8	33.3	23.3	20.5	19.5	24.0	20.8	27.3	15.0	14.8	14.8
60	31.8	30.3	34.3	25.5	23.0	22.8	29.3	28.8	32.5	24.0	21.5	20.8	24.0	21.5	27.3	15.8	14.8	15.8
75	31.8	32.0	35.3	35.3	25.5	24.0	28.5	28.8	32.5	24.0	22.3	21.5	24.0	23.3	28.3	17.3	16.5	15.8
90	31.0	30.3	35.3	29.5	27.3	24.3	28.5	31.3	33.3	26.3	24.8	23.5	27.0	27.3	33.3	18.0	16.5	16.5
105	30.3	30.3	33.3	27.3	26.3	24.3	29.3	31.3	35.3	27.0	26.3	23.5	26.0	26.3	31.8	19.5	16.5	16.5
120	29.5	29.5	33.3	28.0	25.5	24.8	30.3	32.3	33.3	28.0	27.3	25.3	24.0	26.3	29.0	21.0	19.8	18.8
135	31.0	32.0	33.3	27.3	27.3	26.0	--	--	--	--	--	--	22.5	24.0	24.8	22.5	21.5	19.5
150	--	--	--	--	--	--	--	--	--	--	--	--	21.8	24.0	24.8	22.5	23.0	22.8
165	--	--	--	--	--	--	--	--	--	--	--	--	23.3	25.5	26.5	24.0	23.0	22.8
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 27. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM NORTH-ASPECT USBM SPENT SHALE, SOIL-
COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1975

Depth (cm)	60 cm (24") Soil Cover						60 cm (24") Soil Cover						15 cm (6") Soil Cover						15 cm (6") Soil Cover					
	13						11						9						7					
	4/9	5/12	5/20	6/20	7/16	10/13	4/9	5/12	5/20	6/20	7/16	10/13	4/9	5/12	5/20	6/20	7/16	10/13	4/9	5/12	5/20	6/20	7/16	10/13
15	19.5*	8.0	17.8	5.5	4.3	8.8	21.8	11.3	9.0	7.5	6.8	7.5	21.0	10.3	19.5	7.5	5.8	6.0	18.8	7.5	16.0	8.3	5.0	9.0
30	25.5	19.3	24.8	11.3	10.8	11.3	24.0	20.0	24.8	12.3	11.5	11.0	27.0	25.5	29.0	17.8	14.0	13.5	28.5	25.5	29.8	19.0	13.3	15.5
45	24.8	21.5	25.5	14.3	11.5	12.3	27.0	22.3	25.5	14.8	13.3	11.3	29.5	26.5	30.0	19.3	14.8	14.5	30.3	27.3	30.8	20.5	14.8	15.3
60	26.3	24.0	28.3	16.8	14.0	13.8	27.8	26.3	27.3	17.8	14.0	14.0	27.5	26.5	30.8	20.0	15.8	13.8	29.5	28.8	30.8	29.8	15.8	16.0
75	27.0	27.3	30.0	22.3	15.8	15.8	28.5	29.5	30.0	23.3	15.8	17.5	27.0	26.5	28.3	21.8	15.8	13.0	29.5	28.8	29.8	25.5	17.3	15.5
90	27.0	26.3	29.0	23.3	19.0	16.8	25.5	28.8	30.8	24.0	19.8	17.8	27.5	27.3	29.0	24.0	19.0	15.8	27.8	29.8	28.3	28.0	19.0	18.0
105	25.5	26.3	28.3	24.8	20.5	18.0	27.0	27.3	25.5	23.3	21.5	17.8	28.5	28.0	28.3	26.3	21.5	17.0	27.0	28.0	28.3	27.3	22.3	19.8
120	26.3	25.5	26.5	24.8	22.3	20.0	25.5	29.5	26.52	23.3	22.3	18.8	29.5	29.5	29.0	27.0	23.0	19.3	27.0	28.8	28.3	28.0	22.3	21.0
135	26.3	26.3	26.5	25.5	23.0	20.	27.0	28.0	26.5	24.0	23.0	18.8	27.5	28.0	27.3	27.0	24.0	22.0	30.3	29.0	28.3	28.0	24.8	22.3
150	25.5	27.3	24.8	24.8	22.3	19.3	27.0	28.8	26.5	24.8	24.0	19.8	27.5	28.0	27.3	26.3	24.8	22.3	31.0	30.5	28.3	29.8	26.5	25.8
165	26.3	28.0	27.3	27.3	23.0	23.0	--	--	--	--	--	--	27.5	26.5	27.3	26.3	24.8	23.0	31.0	31.3	28.3	34.5	26.5	26.8
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale						USBM Spent Shale						Soil					
	5						3						1					
	4/9	5/12	5/20	6/20	7/16	10/13	4/9	5/12	5/20	6/20	7/16	10/13	4/9	5/12	5/20	6/20	7/16	10/13
15	22.5*	14.8	19.5	10.0	6.5	7.0	21.8	14.3	21.3	10.3	5.8	8.5	20.0	11.3	16.0	8.5	5.0	9.8
30	25.5	24.0	25.5	18.5	11.5	12.0	27.8	24.8	28.3	19.3	13.3	12.5	26.3	20.5	25.5	13.3	10.8	11.8
45	27.8	28.0	28.3	20.0	13.3	12.5	27.8	27.0	29.8	24.0	16.5	13.8	27.0	27.3	27.3	15.8	12.5	13.3
60	28.5	28.8	30.8	24.8	14.8	14.3	28.5	27.0	28.3	25.5	19.0	15.0	28.8	24.8	24.8	18.3	12.5	11.5
75	30.3	33.0	30.8	27.3	21.5	18.8	29.5	28.8	29.8	27.0	21.5	17.0	22.5	27.3	26.5	19.0	13.3	13.0
90	30.3	31.3	30.8	29.5	23.0	17.5	29.5	29.5	30.8	27.0	23.0	18.5	18.5	28.0	26.5	20.8	14.8	14.5
105	31.0	31.3	30.0	28.3	22.3	17.3	29.5	29.5	28.3	28.8	24.0	19.8	17.8	27.3	19.5	19.8	14.0	12.0
120	31.0	31.3	30.0	27.8	22.3	18.8	29.5	30.5	28.3	28.0	24.0	19.5	18.5	24.8	17.0	20.8	15.8	14.3
135	31.0	32.0	28.3	27.8	26.5	20.5	27.8	28.8	26.5	27.0	24.8	19.5	17.8	19.5	16.0	20.8	17.3	14.8
150	31.0	32.0	28.3	27.8	26.5	24.0	27.8	29.5	26.5	28.8	24.8	22.3	18.5	22.3	17.8	21.5	17.3	18.3
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 28. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1975

Depth (cm)	60 cm (24") Soil Cover						60 cm (24") Soil Cover						15 cm (6") Soil Cover						15 cm (6") Soil Cover					
	14						12						10						8					
	4/9	5/12	5/20	6/20	7/16	10/13	4/9	5/12	5/20	6/20	7/16	10/13	4/9	5/12	5/20	6/20	7/16	10/13	4/9	5/12	5/20	6/20	7/16	10/13
15	18.8*	6.3	17.8	6.3	6.5	8.3	21.0	8.3	19.5	8.0	6.8	7.5	17.3	6.3	14.3	4.8	2.5	5.3	16.5	6.3	14.3	6.3	4.3	6.8
30	23.3	15.0	23.8	12.8	10.0	11.0	24.8	14.5	22.0	12.0	11.5	11.0	25.5	18.3	26.5	11.3	11.5	13.0	24.8	19.3	25.5	13.5	11.5	13.3
45	22.5	16.8	24.8	14.5	11.5	12.3	24.8	16.3	25.5	12.8	13.3	11.3	24.8	22.3	28.3	11.3	13.3	12.5	25.5	21.5	26.5	18.3	14.8	15.0
60	21.8	16.8	22.0	14.5	12.5	13.5	23.3	20.0	24.8	13.5	14.0	13.5	24.0	22.3	27.3	16.0	13.3	12.3	25.5	24.8	28.3	19.3	14.8	15.0
75	21.8	16.8	21.3	19.3	16.5	17.0	25.5	25.5	26.5	19.3	15.8	17.0	22.5	21.5	25.5	16.8	13.3	11.3	27.8	28.8	29.0	24.0	19.0	18.0
90	24.3	26.5	21.3	27.8	22.3	20.3	24.8	25.5	26.5	23.3	19.8	18.3	23.3	20.8	22.0	18.3	13.3	10.5	27.8	28.0	29.8	26.3	21.5	20.5
105	24.32	27.0	21.3	25.5	24.8	22.0	24.8	24.0	23.0	23.3	22.3	18.0	21.0	23.3	20.3	19.3	16.5	14.5	26.3	27.3	27.3	27.3	23.0	22.0
120	24.8	27.0	23.8	25.5	24.8	22.5	22.5	23.3	21.3	22.3	23.0	17.0	22.5	24.8	21.3	23.3	19.0	16.8	27.8	28.0	27.3	28.0	24.8	23.8
135	25.5	28.8	24.9	27.0	25.5	24.3	21.8	23.3	21.3	23.3	24.0	17.5	23.3	26.5	23.8	27.3	24.0	20.8	26.3	28.0	26.5	28.0	25.5	24.8
150	25.5	27.0	24.9	28.0	26.5	24.8	22.5	27.0	22.0	24.0	24.0	18.3	23.3	26.5	24.8	27.3	23.0	21.0	26.3	28.8	26.5	28.8	26.5	25.5
165	27.0	28.0	26.5	28.8	25.5	26.0	25.5	27.0	21.3	25.5	24.0	21.5	--	--	--	--	--	--	--	--	--	--	--	--
180	26.5	27.0	26.5	28.8	27.3	26.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	USBM Spent Shale						USBM Spent Shale						Soil					
	6						4						2					
	4/9	5/12	5/20	6/20	7/16	10/13	4/9	5/12	5/20	6/20	7/16	10/13	4/9	5/12	5/20	6/20	7/16	10/13
15	21.8*	14.0	23.0	8.3	6.5	7.5	23.3	15.3	23.0	27.5	5.8	8.3	20.3	10.3	21.3	8.5	5.5	7.5
30	24.0	23.0	27.3	16.5	11.5	12.5	27.8	24.0	29.8	17.8	11.5	12.3	24.0	17.0	26.5	11.5	10.8	12.0
45	26.3	25.5	26.5	19.8	13.3	13.0	27.8	25.5	29.0	21.0	15.8	13.8	24.0	19.8	28.3	14.0	12.5	12.5
60	25.5	24.8	27.3	19.8	14.0	13.8	27.8	26.3	29.0	21.8	19.0	16.8	27.0	20.5	28.3	14.8	13.5	13.0
75	24.8	24.8	27.3	21.5	15.8	15.5	27.8	26.3	29.0	25.5	20.8	18.8	25.5	23.0	28.3	17.8	13.5	13.0
90	23.3	24.0	24.8	22.5	16.5	16.3	26.3	27.0	29.8	26.5	23.0	19.8	24.0	23.0	26.5	17.8	14.3	13.0
105	22.5	23.0	23.0	22.5	18.0	17.3	26.3	26.3	26.5	26.5	24.0	21.0	21.8	23.0	23.8	18.5	15.3	14.5
120	22.5	25.5	21.3	23.0	20.5	19.5	26.3	28.0	26.5	26.5	24.8	23.0	18.0	21.3	16.8	18.5	16.0	14.8
135	24.0	28.0	23.8	28.0	25.5	21.8	26.3	27.0	25.5	26.5	24.8	23.8	18.0	20.5	17.8	18.5	16.8	16.5
150	24.0	28.0	23.0	28.0	24.8	22.5	25.5	28.0	23.0	26.0	25.5	24.0	18.8	20.5	19.5	19.3	18.5	17.0
165	--	--	--	--	--	--	--	--	--	--	--	--	18.8	20.5	19.5	18.5	17.8	16.5
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 29. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM NORTH-ASPECT TOSCO SPENT SHALE, SOIL-
COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1976

Depth (cm)	I 30 cm (12") Soil Cover						III 30 cm (12") Soil Cover						V 15 cm (6") Soil Cover					
	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4
15	--	11.5*	8.3	5.3	1.0	0.8	--	2.3	9.5	6.5	1.0	2.0	--	17.0	15.8	8.0	2.8	3.5
30	--	22.3	13.8	12.0	9.5	10.5	--	22.3	16.8	15.8	11.3	12.3	--	27.3	23.0	14.3	7.8	10.0
45	--	26.5	20.0	16.3	11.3	11.8	--	27.3	22.3	20.5	14.5	15.3	--	27.3	23.0	20.8	14.5	17.5
60	--	27.3	21.8	17.0	11.3	12.5	--	26.0	22.3	20.5	15.5	16.3	--	27.3	24.0	22.3	20.5	23.3
75	--	24.8	20.8	18.0	13.8	15.3	--	24.3	20.8	20.5	16.3	17.5	--	24.3	24.8	24.0	20.5	24.3
90	--	22.3	18.5	19.5	16.3	16.3	--	22.3	20.8	22.3	18.0	18.3	--	24.8	26.3	24.8	22.3	25.0
105	--	21.3	18.5	19.5	17.0	17.3	--	21.8	21.5	23.0	19.5	20.0	--	24.3	26.3	24.8	24.0	26.0
120	--	19.3	18.5	21.3	18.8	17.3	--	21.8	23.3	24.0	21.3	21.8	--	24.8	28.0	28.0	26.3	28.0
135	--	17.5	17.0	20.5	18.8	18.3	--	21.3	22.3	26.3	22.3	23.8	--	24.3	27.3	27.3	27.3	28.8
150	--	17.5	17.8	21.3	18.0	21.0	--	21.8	24.8	25.5	24.0	23.8	--	24.3	28.0	26.3	28.0	28.8
165	--	18.8	17.8	21.3	20.5	23.8	--	21.8	25.5	25.5	25.5	24.8	--	--	--	--	--	--
180	--	17.5	18.5	21.3	21.3	25.5	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	VII 15 cm (6") Soil Cover						IX TOSCO Spent Shale						XI TOSCO Spent Shale						XIII Soil					
	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4
15	--	16.3*	12.8	5.5	0.25	2.5	--	17.5	19.3	6.3	< .25	0.5	--	19.3	19.3	8.3	.25	0.8	--	18.8	12.0	7.3	1.8	2.5
30	--	26.5	21.5	16.0	7.8	10.0	--	29.0	24.8	19.3	13.3	15.8	--	29.8	25.5	19.8	14.5	15.8	--	24.8	15.3	11.3	10.0	10.8
45	--	27.3	22.3	19.3	15.5	17.5	--	29.8	26.3	24.0	21.5	23.3	--	29.8	27.0	24.8	21.3	22.3	--	27.3	22.0	17.5	14.8	16.3
60	--	27.3	24.0	22.3	21.3	22.3	--	29.8	27.0	26.3	23.0	26.0	--	30.3	27.0	26.3	24.0	23.8	--	27.8	23.8	19.3	15.8	18.3
75	--	27.3	24.0	24.8	23.0	24.3	--	29.0	27.0	27.3	24.8	26.0	--	29.0	28.0	26.3	25.5	25.5	--	27.8	25.5	19.3	16.5	18.3
90	--	26.0	25.5	24.8	24.8	25.0	--	27.8	28.0	27.3	26.3	27.0	--	27.8	27.0	28.0	27.3	25.5	--	27.3	25.5	19.3	16.5	19.3
105	--	24.8	24.0	25.5	26.3	26.0	--	27.3	26.3	25.5	27.3	28.0	--	27.3	28.8	28.0	28.0	28.3	--	24.8	24.8	20.8	16.5	20.0
120	--	24.3	24.8	24.8	25.5	26.0	--	27.3	28.0	28.0	27.3	28.0	--	27.8	27.0	29.8	28.0	28.3	--	17.0	18.8	17.5	17.3	18.3
135	--	24.3	25.5	26.3	25.5	28.0	--	27.3	28.0	28.0	27.3	28.0	--	27.8	27.0	28.0	29.8	28.3	--	16.3	17.0	16.8	16.5	18.3
150	--	24.3	25.5	27.3	29.0	28.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 30. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1976

Depth (cm)	II 30 cm (12") Soil Cover						IV 30 cm (12") Soil Cover						VI 15 cm (6") Soil Cover					
	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4
15	21.3*	10.8	7.5	6.5	1.0	3.5	22.3	16.3	11.0	8.5	2.8	3.5	20.5	10.8	10.3	6.5	1.3	1.5
30	28.5	21.8	13.3	12.3	11.3	11.8	26.0	21.8	14.3	12.0	10.3	10.8	29.8	24.3	16.8	11.5	6.5	8.0
45	33.3	27.3	22.3	19.0	15.5	16.3	29.0	27.3	16.8	12.8	10.3	10.8	29.0	26.5	19.3	17.3	13.3	13.5
60	32.0	27.3	22.3	20.5	17.0	18.3	27.3	24.8	18.3	15.5	13.8	13.5	29.0	26.5	20.8	21.5	18.5	19.3
75	24.8	26.0	21.5	19.8	18.0	18.3	18.8	22.3	19.3	17.0	15.5	16.3	24.8	26.5	22.3	22.3	21.3	21.8
90	21.3	23.5	21.5	20.5	18.8	18.3	16.3	21.3	19.3	19.5	17.0	18.3	24.3	26.5	23.3	23.0	24.8	23.8
105	20.0	21.3	19.8	20.5	19.5	20.0	16.3	19.3	18.3	19.5	17.0	19.3	23.0	26.0	23.3	24.0	25.5	23.8
120	20.0	20.0	20.5	22.3	19.5	21.8	17.5	19.3	19.3	19.5	19.5	20.0	22.3	24.3	22.3	24.8	26.5	23.8
135	21.3	21.3	22.3	22.3	20.5	23.8	18.8	18.8	20.8	21.5	20.5	20.0	22.3	23.5	22.3	24.8	26.5	24.8
150	21.3	21.8	24.0	23.0	23.0	23.8	20.0	18.8	20.8	15.5	21.3	20.0	22.3	22.3	22.3	24.0	27.3	25.0
165	22.3	21.3	21.5	22.3	24.0	24.5	--	--	--	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	VIII 15 cm (6") Soil Cover						X TOSCO Spent Shale						XII TOSCO Spent Shale						XIV Soil					
	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4
15	20.0*	13.8	10.8	3.3	0.25	.25	28.5	20.0	10.8	6.5	0.25	2.5	29.0	21.8	12.8	7.5	1.0	2.5	20.5	14.5	11.5	7.3	2.0	3.5
30	31.5	26.5	16.5	10.0	6.0	6.3	33.3	26.5	19.8	19.8	15.5	19.3	31.0	27.3	20.8	18.3	14.5	17.3	31.0	24.3	15.8	12.8	12.0	14.5
45	31.5	27.8	20.5	18.3	13.8	13.5	32.0	26.5	23.0	21.5	21.3	22.8	31.0	27.3	22.3	23.0	18.8	21.0	27.3	24.3	17.3	16.8	13.8	16.3
60	29.0	27.3	22.3	21.5	20.5	20.0	30.3	26.5	24.0	23.0	24.0	24.8	31.0	27.3	23.3	23.0	22.3	21.8	24.3	24.3	17.3	16.8	15.5	16.3
75	26.0	26.0	22.3	22.3	18.8	21.8	30.3	27.8	24.8	24.0	25.5	26.5	28.5	27.3	24.0	23.0	22.3	22.8	20.0	21.8	19.0	16.0	15.5	16.3
90	24.3	26.0	24.8	23.0	20.5	21.8	28.5	27.8	26.3	26.3	26.3	27.5	26.0	27.8	24.0	24.8	24.0	25.5	15.8	18.8	19.0	16.0	15.5	17.3
105	24.8	26.0	25.5	25.5	22.3	24.8	26.5	27.3	26.3	24.8	25.5	27.5	27.3	27.8	25.5	26.3	26.3	26.5	15.8	13.8	15.8	15.0	15.5	16.3
120	26.0	27.8	28.0	28.0	24.8	26.5	26.5	26.0	24.8	26.3	27.3	28.5	26.0	27.8	25.5	27.3	27.3	27.5	17.5	16.3	17.3	17.5	14.5	19.3
135	26.0	27.3	26.3	28.0	25.5	27.5	26.5	27.3	26.3	25.5	27.3	28.5	27.3	27.8	25.5	27.3	27.3	27.5	18.8	19.3	18.0	16.8	18.8	21.0
150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	21.8	20.0	19.0	19.3	18.8	21.8
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	24.3	20.0	21.5	21.5	20.5	21.8
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 31. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM NORTH-ASEPCT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1976

Depth (cm)	13						11						9						7					
	60 cm (24") Soil Cover						60 cm (24") Soil Cover						15 cm (6") Soil Cover						15 cm (6") Soil Cover					
	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4
15	--	11.5*	9.5	8.3	1.0	2.0	--	18.8	12.8	9.0	2.0	2.8	--	12.0	15.0	10.8	2.0	2.0	--	11.5	11.5	7.3	< .2	< .2
30	--	26.5	17.5	14.3	9.5	9.5	--	24.8	17.5	17.3	10.3	10.3	--	27.3	21.5	16.5	12.5	12.0	--	27.8	21.5	14.3	11.5	11.3
45	--	27.3	17.5	17.0	12.0	11.3	--	26.0	19.3	21.5	12.0	11.3	--	29.8	24.0	21.5	16.0	13.8	--	30.3	26.3	17.5	14.8	13.8
60	--	27.3	23.3	17.0	14.5	12.8	--	26.0	23.3	24.0	12.8	12.0	--	29.0	24.0	23.0	15.0	12.8	--	29.8	27.3	22.3	15.8	14.5
75	--	27.8	25.5	17.8	16.3	14.5	--	30.3	27.3	24.8	18.8	16.3	--	27.3	24.0	28.0	17.0	13.8	--	27.8	24.8	22.3	16.5	14.5
90	--	26.5	24.0	18.5	18.8	15.5	--	29.0	27.3	26.3	20.5	18.0	--	29.8	25.5	28.0	19.5	15.5	--	27.3	26.3	23.3	18.3	18.0
105	--	27.3	24.0	17.0	21.3	18.8	--	24.8	24.8	26.3	20.5	18.8	--	27.3	25.5	26.3	22.0	18.0	--	24.8	26.3	23.3	19.8	19.5
120	--	24.3	24.0	17.8	22.3	19.5	--	23.5	24.8	25.5	23.0	18.8	--	26.0	26.3	26.3	24.8	18.8	--	26.0	26.3	24.8	22.3	19.5
135	--	23.5	24.8	17.0	24.0	20.5	--	20.0	24.8	24.0	22.3	18.8	--	24.3	25.5	27.3	24.8	19.5	--	24.3	28.0	24.8	21.5	20.5
150	--	20.0	24.0	18.5	23.0	19.5	--	19.3	24.8	28.8	22.3	18.8	--	23.5	25.5	28.0	27.3	21.3	--	24.3	29.8	28.0	24.0	23.0
165	--	21.3	24.0	21.3	24.8	20.5	--	--	--	--	--	--	--	--	--	--	--	--	--	24.3	29.8	29.0	25.5	23.0
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Depth (cm)	5						3						1					
	USBM Spent Shale						USBM Spent Shale						Soil					
	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4	3/10	4/1	5/10	6/4	7/9	8/4
15	--	15.0*	20.5	6.3	2.5	1.0	--	15.0	19.8	8.8	3.5	1.0	--	14.5	14.8	8.3	2.0	2.8
30	--	24.8	23.0	16.0	12.3	10.3	--	27.8	16.5	13.5	9.5	7.8	--	26.0	18.3	14.0	10.3	10.3
45	--	27.3	24.8	19.3	12.3	11.3	--	27.8	25.5	14.3	13.8	11.3	--	27.8	21.5	14.8	13.8	11.3
60	--	29.0	27.3	20.0	14.8	12.0	--	29.0	26.3	16.8	25.5	13.8	--	27.8	21.5	17.3	13.8	12.0
75	--	31.5	29.8	20.8	12.3	17.0	--	29.0	26.3	23.3	21.3	16.3	--	26.0	22.3	21.5	13.8	11.3
90	--	29.0	28.0	22.3	22.3	18.8	--	29.0	28.0	24.0	24.0	18.8	--	27.3	23.0	22.3	14.5	13.8
105	--	27.8	28.0	24.0	21.5	18.0	--	27.8	27.3	23.3	24.0	19.5	--	20.0	19.0	24.0	13.8	11.3
120	--	26.5	27.3	24.8	24.8	17.0	--	27.3	28.0	23.3	24.0	18.8	--	14.5	15.8	24.0	13.8	12.8
135	--	24.8	28.0	25.5	25.5	19.5	--	26.5	28.0	23.3	24.0	18.8	--	15.0	15.8	24.0	15.5	14.5
150	--	24.8	28.8	25.5	26.3	20.5	--	26.5	28.0	24.8	25.5	18.8	--	17.5	16.5	24.0	18.8	17.0
165	--	--	--	--	--	--	--	--	--	--	--	--	--	17.5	20.5	24.8	20.5	17.0
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 32. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1976

Depth (cm)	14							12							10							8						
	60 cm (24") Soil Cover							60 cm (24") Soil Cover							15 cm (6") Soil Cover							15 cm (6") Soil Cover						
	3/10	4/1	5/10	6/4	7/9	8/4		3/10	4/1	5/10	6/4	7/9	8/4		3/10	4/1	5/10	6/4	7/9	8/4		3/10	4/1	5/10	6/4	7/9	8/4	
15	23.0*	12.5	9.3	7.5	.2	2.0		20.0	12.0	10.3	7.8	2.8	2.8		17.5	8.3	6.3	5.3	3.0	.2		16.3	9.0	6.3	7.0	.5	.2	
30	26.0	23.5	12.3	12.3	10.3	9.5		26.0	22.3	13.5	11.3	11.3	7.8		26.0	22.3	14.3	12.8	10.8	11.3		29.0	23.5	16.0	13.8	13.0	10.3	
45	29.0	26.0	14.5	13.3	11.3	11.3		27.3	24.3	15.0	12.0	13.8	11.3		31.0	26.0	17.5	14.5	12.5	12.8		27.8	23.5	17.5	17.0	14.0	13.8	
60	29.0	24.8	16.3	14.0	13.8	12.0		27.8	23.5	16.0	13.5	14.5	11.3		27.3	24.3	17.5	15.5	12.5	12.0		26.5	24.3	20.8	18.0	13.0	13.8	
75	28.5	24.8	20.0	19.0	15.5	14.5		27.8	27.3	20.8	18.3	16.3	14.5		20.0	23.5	17.5	14.5	17.0	10.3		24.8	27.8	23.3	22.3	13.0	15.5	
90	23.0	26.5	23.3	21.5	20.5	19.5		26.0	27.3	22.3	19.3	17.0	17.0		13.3	20.0	17.5	13.8	19.5	10.3		24.8	26.5	24.0	24.8	12.0	18.8	
105	22.3	26.0	23.3	24.0	24.0	22.3		21.3	24.8	22.3	20.8	15.5	18.8		14.5	18.8	17.5	15.5	21.3	13.8		21.3	24.8	24.0	24.8	12.0	19.5	
120	23.0	24.3	23.3	24.8	24.0	21.3		17.5	21.8	20.8	20.0	15.5	18.8		16.3	17.0	16.8	17.0	21.3	15.5		21.8	24.3	24.0	24.0	13.0	19.5	
135	23.0	24.3	23.3	24.0	24.0	23.0		18.8	19.3	20.0	20.0	22.3	18.0		28.5	18.8	19.3	20.5	20.3	18.8		22.3	24.8	23.3	24.0	14.8	21.3	
150	24.3	24.3	23.3	25.5	25.5	23.0		19.3	19.3	19.3	20.0	22.3	18.8		21.8	20.0	20.0	22.3	21.3	19.5		21.8	24.8	23.3	24.0	17.5	22.3	
165	26.0	24.3	24.0	26.3	27.3	24.0		21.3	21.3	21.5	21.5	22.3	20.5		22.3	20.0	20.0	22.3	21.3	19.5		--	--	--	--	--	--	
180	26.5	27.8	25.5	28.0	29.8	26.3		--	--	--	--	--	--		--	--	--	--	--	--		--	--	--	--	--	--	

Depth (cm)	6							4							2						
	USBM Spent Shale							USBM Spent Shale							Soil						
	3/10	4/1	5/10	6/4	7/9	8/4		3/10	4/1	5/10	6/4	7/9	8/4		3/10	4/1	5/10	6/4	7/9	8/4	
15	22.3*	17.0	11.5	8.8	.2	2.0		24.2	14.5	12.8	8.3	1.0	2.0		20.5	13.8	11.8	7.5	2.0	2.0	
30	27.8	24.8	18.3	14.5	12.0	10.3		31.5	26.0	21.5	18.3	11.3	11.3		29.0	24.3	17.0	13.3	11.3	10.3	
45	26.0	24.8	20.5	18.0	13.8	12.0		29.8	27.3	22.3	21.5	15.5	13.8		29.0	24.3	17.8	14.8	12.8	12.0	
60	24.3	24.3	21.5	18.8	15.5	12.8		29.8	26.0	22.3	22.3	18.8	17.0		29.0	27.3	19.5	14.8	13.8	12.8	
75	22.3	22.3	22.3	19.5	17.0	14.5		27.3	26.0	24.0	24.0	20.5	19.5		31.0	26.0	21.3	15.8	13.8	13.8	
90	18.8	21.8	21.5	20.5	19.5	15.5		26.0	26.5	24.0	24.8	23.0	21.3		26.0	24.3	21.3	16.5	13.8	12.8	
105	16.3	19.0	20.5	20.5	22.3	15.5		24.3	24.8	24.8	24.8	24.8	21.3		20.5	23.5	21.3	16.5	14.5	14.5	
120	17.5	18.8	20.5	19.5	22.3	17.0		23.0	24.8	24.0	24.8	26.3	22.3		15.8	17.5	20.3	16.5	15.5	14.5	
135	19.0	21.3	22.3	24.0	24.8	18.8		22.3	24.5	24.0	25.5	26.3	23.0		15.8	17.0	17.8	16.5	16.4	15.5	
150	20.0	21.3	22.3	23.0	25.5	19.5		23.0	24.5	24.3	24.8	26.3	22.3		18.3	17.0	19.5	18.3	17.0	17.0	
165	--	--	--	--	--	--		24.8	24.5	24.8	24.8	26.3	22.3		18.8	16.3	17.8	16.5	16.3	15.5	
180	--	--	--	--	--	--		--	--	--	--	--	--		18.8	16.3	18.5	18.3	18.8	15.5	

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 33. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES OF TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1973 AND 1974

NORTH ASPECT																					
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale								Soil
	I			III			V			VII			IX				XI				XIII
	10/73	5/74	9/74	10/73	5/74	9/74	10/73	5/74	9/74	10/73	5/74	9/74	6/73	10/73	5/74	9/74	6/73	10/73	5/74	9/74	9/74
5	--	0.95*	2.0	--	1.1	1.5	--	2.3	10.0	--	4.6	11.0	2.0	2.1	2.0	17.0	2.3	2.1	2.3	16.6	1.3
15	--	1.1	3.1	--	6.9	8.1	--	2.0	7.7	--	3.1	8.0	3.0	4.6	3.1	6.5	4.2	3.9	4.3	7.2	2.1
30	--	5.6	7.5	--	5.5	8.5	--	3.0	5.6	--	3.5	5.1	3.8	--	3.8	6.7	3.5	--	3.5	5.5	--
45	--	8.2	8.0	--	7.0	8.5	--	3.1	3.4	--	3.6	4.3	3.8	4.6	3.9	5.6	3.9	4.3	4.0	5.1	--
60	--	6.9	7.9	--	9.1	8.5	--	3.8	4.0	--	4.0	4.9	3.9	--	4.0	5.8	3.9	--	3.9	5.1	--
75	--	8.1	8.1	--	--	8.5	--	--	4.0	--	--	4.9	3.9	5.3	3.9	5.1	3.9	4.1	3.9	6.3	--
90	--	5.9	9.0	--	9.0	11.5	--	3.8	4.7	--	4.0	5.5	4.0	--	4.3	5.9	3.9	--	4.0	7.2	--
105	--	6.8	9.0	--	--	11.5	--	--	5.8	--	--	6.3	5.0	3.3	5.0	6.9	5.1	4.9	5.4	9.3	--
120	--	8.6	9.9	--	9.1	11.5	--	6.7	7.1	--	5.3	7.6	5.6	--	5.6	7.6	7.5	--	7.5	8.0	--
135	--	9.3	--	--	--	--	--	--	--	--	--	--	8.0	4.6	8.3	7.3	8.6	4.6	8.9	9.7	--
150	--	12.0	--	--	9.1	--	--	15.0	--	--	8.8	--	9.1	--	9.2	8.8	10.1	--	10.4	10.0	--
165	--	11.0	--	--	--	--	--	--	--	--	--	--	10.0	6.3	10.5	9.2	11.5	7.1	11.5	11.5	--
180	--	--	--	--	9.1	--	--	15.0	--	--	13.0	--	11.0	--	11.5	7.2	12.5	--	12.5	--	--
SOUTH ASPECT																					
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale								Soil
	II			IV			VI			VIII			X				XII				XIV
	10/73	5/74	9/74	10/73	5/74	9/74	10/73	5/74	9/74	10/73	5/74	9/74	4/73	10/73	5/74	9/74	4/73	10/73	5/74	9/74	9/74
5	--	3.7*	2.8	--	5.6	2.4	--	3.5	15.0	--	3.1	10.0	3.6	3.3	3.6	15.0	3.2	2.1	3.2	17.0	1.9
15	--	0.95	5.6	--	0.95	2.5	--	1.8	6.2	--	3.0	6.1	3.6	3.7	3.6	11.0	3.9	2.8	3.7	16.7	2.4
30	--	5.5	8.1	--	10.0	8.6	--	4.4	4.7	--	3.4	4.1	3.4	--	3.4	7.9	3.9	--	3.9	8.3	1.4
45	--	5.5	8.1	--	5.8	11.5	--	4.1	4.1	--	3.4	4.1	3.9	3.6	4.0	7.8	4.6	4.0	4.7	5.0	2.2
60	--	5.1	7.1	--	5.6	11.5	--	4.2	4.0	--	3.4	4.1	4.4	--	4.4	7.7	4.6	--	4.6	5.0	--
75	--	--	9.4	--	--	10.8	--	--	4.2	--	--	4.1	4.6	5.5	4.8	8.4	5.1	6.3	5.3	5.6	--
90	--	7.1	8.0	--	4.4	10.5	--	4.5	5.3	--	3.8	4.1	5.0	--	5.2	9.4	7.4	--	7.4	7.4	--
105	--	--	7.1	--	--	10.5	--	--	7.0	--	--	3.9	5.1	6.8	5.1	11.5	8.8	6.5	8.9	8.4	--
120	--	7.9	7.9	--	7.8	10.5	--	5.5	9.2	--	3.9	5.1	8.8	--	8.9	12.0	10.2	--	10.2	9.7	--
135	--	--	--	--	--	--	--	--	--	--	--	--	10.4	9.4	10.5	12.0	11.5	7.7	11.5	10.3	--
150	--	8.0	--	--	9.0	--	--	11.2	--	--	6.3	--	12.0	--	12.4	12.0	14.0	9.5	14.7	10.3	--
165	--	--	--	--	--	--	--	--	--	--	--	--	19.0	--	19.5	12.0	14.0	9.8	14.5	12.0	--
180	--	9.0	--	--	9.9	--	--	11.3	--	--	11.0	--	--	--	--	--	--	--	--	--	--

* EC Values are in mmhos/cm @ 25° C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 34. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES OF
 USBM SPENT SHALE, SOIL COVERED USBM SPENT SHALE, AND SOIL CONTROL
 PLOTS ANVIL POINTS STUDY SITE, 1974

NORTH ASPECT														
Depth (cm)	60 cm (24") Soil Cover				15 cm (6") Soil Cover				USBM Spent Shale					
	13		11		9		7		5			3		
	5/74	9/74	5/74	9/74	5/74	9/74	5/74	9/74	5/74	6/74	9/74	5/74	6/74	9/74
5	0.73*	1.4	0.7	2.1	2.2	0.9	2.1	1.5	1.2	--	1.2	1.0	--	1.1
15	0.7	1.1	0.6	1.4	1.5	1.7	1.6	1.2	1.5	--	1.9	1.5	--	1.8
30	0.9	2.9	0.9	1.0	1.8	3.0	1.8	3.4	2.4	--	3.1	2.3	--	1.7
45	8.3	6.1	6.6	1.7	3.0	3.8	2.9	3.8	2.3	--	3.0	2.3	--	2.5
60	5.2	4.4	2.2	3.8	3.1	3.6	3.1	2.7	2.4	--	2.4	2.4	--	2.5
75	--	--	--	8.0	--	4.8	--	2.1	--	--	2.9	--	--	3.5
90	7.9	4.5	7.7	7.0	3.8	4.8	3.9	2.1	2.7	--	3.1	2.5	--	3.7
105	--	--	--	7.0	--	4.2	--	3.1	--	--	2.8	--	--	3.5
120	6.9	5.5	6.5	6.9	4.5	3.9	4.3	3.5	3.5	--	--	3.2	--	3.7
135	--	--	--	--	--	--	--	--	--	--	--	--	--	3.5
150	6.1	--	6.1	--	4.2	--	4.1	--	3.9	--	--	3.8	--	--
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--

SOUTH ASPECT														
Depth (cm)	60 cm (24") Soil Cover				15 cm (6") Soil Cover				USBM Spent Shale					
	14		12		10		8		6			4		
	5/74	9/74	5/74	9/74	5/74	9/74	5/74	9/74	5/74	6/74	9/74	5/74	6/74	9/74
5	0.8*	0.9	0.7	1.3	2.2	1.6	2.1	1.6	1.7	--	1.1	1.7	--	1.5
15	0.8	0.9	1.0	1.1	2.0	1.7	1.1	1.6	2.0	--	3.7	2.0	--	3.9
30	1.2	0.9	1.7	1.1	1.8	2.1	1.9	2.5	2.5	--	3.7	2.5	--	2.7
45	1.3	2.2	2.2	2.7	2.5	2.7	2.6	3.5	2.3	--	2.9	2.2	--	2.7
60	9.9	8.3	4.7	2.9	3.0	3.0	2.9	3.7	2.0	--	4.3	2.0	--	2.7
75	--	6.4	--	4.7	--	3.0	--	3.9	--	--	4.3	--	--	2.8
90	6.1	4.5	5.6	4.5	3.4	3.0	3.2	3.9	2.3	--	3.7	2.5	--	3.7
105	--	4.5	--	5.0	--	3.2	--	3.9	--	--	4.0	--	--	4.7
120	6.0	4.5	5.6	4.2	4.8	4.0	4.6	4.1	2.5	--	4.5	2.5	--	4.6
135	--	--	--	--	--	--	--	--	--	--	4.4	--	--	3.5
150	5.0	--	5.2	--	4.7	--	4.6	--	3.2	--	3.9	3.1	--	3.7
165	--	--	--	--	--	--	--	--	--	--	3.7	--	--	4.6
180	4.9	--	4.5	--	--	--	--	--	3.2	--	3.9	3.1	--	4.5

* EC Values are in mmhos/cm @ 25° C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 35. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES ON NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. SPRING AND FALL 1975

Depth (cm)	30 cm (12") Soil Cover				15 cm (6") Soil Cover				TOSCO Spent Shale				Soil
	I		III		V		VII		IX		XI		XIII
	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	11/75
S	2.4*	1.2	1.5	1.9	1.0	1.9	2.0	4.2	4.4	4.5	5.2	3.2	1.3
15	1.1	1.4	1.5	1.0	1.6	4.2	4.9	5.8	5.6	5.7	5.2	6.1	1.5
30	9.8	11.0	6.2	11.0	4.3	5.8	4.7	6.2	4.5	5.4	5.3	5.7	0.8
45	15.0	--	7.3	--	4.5	--	4.8	--	4.8	--	7.0	--	--
60	15.0	9.0	9.8	10.0	5.0	5.3	7.3	6.6	5.4	5.8	7.4	4.9	--
75	13.6	--	14.4	--	5.5	--	7.1	--	7.0	--	7.0	--	--
90	12.6	8.4	10.4	10.0	7.5	5.6	6.0	7.9	8.8	6.4	7.4	6.5	--
105	12.2	--	10.2	--	6.9	--	5.9	--	11.0	--	8.8	--	--
120	11.2	9.2	9.8	9.2	9.2	8.1	8.8	9.4	11.9	8.3	10.0	8.8	--
135	11.8	--	11.0	--	10.8	--	10.8	--	13.6	--	11.2	--	--
150	12.0	9.2	10.4	12.0	13.0	9.7	12.2	8.2	11.9	8.4	11.2	8.6	--
165	11.3	--	10.2	--	13.6	--	12.8	--	--	--	7.3	--	--
180	10.4	8.2	10.2	10.7	12.1	9.8	10.2	8.2	--	5.8	--	8.1	--
195	--	--	9.0	--	--	--	6.0	--	--	--	--	--	--
210	--	--	--	--	--	--	--	--	--	--	--	--	--

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 36. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES ON SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS.
ANVIL POINTS STUDY SITE. SPRING AND FALL 1975

Depth (cm)	30 cm (12") Soil Cover				15 cm (6") Soil Cover				TOSCO Spent Shale				Soil
	II		IV		VI		VIII		X		XII		XIV
	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	11/75
S	1.4*	1.5	2.3	1.0	2.1	1.7	1.5	1.9	6.1	4.7	5.4	4.6	1.2
15	0.9	0.6	1.1	7.2	1.1	3.6	0.9	5.3	5.7	5.5	5.6	6.5	1.5
30	2.9	7.5	3.1	8.6	3.9	4.9	--	4.4	5.0	4.6	4.8	7.8	0.9
45	7.4	6.5	4.9	9.5	4.3	4.1	4.0	4.0	5.8	5.1	5.7	7.1	--
60	12.2	--	4.3	--	4.6	--	4.8	--	7.2	--	8.9	--	--
75	18.0	7.6	5.2	8.5	8.9	4.1	5.8	4.1	8.0	6.5	7.8	6.9	--
90	14.2	--	7.0	--	8.4	--	5.6	--	6.6	--	7.8	--	--
105	12.7	8.8	12.6	9.4	7.3	4.4	6.2	4.5	6.8	8.1	8.7	8.9	--
120	11.4	--	13.4	--	8.4	--	6.5	--	7.5	--	10.5	--	--
135	10.0	9.9	12.5	11.0	8.9	4.8	7.4	5.9	9.7	8.6	12.2	9.0	--
150	9.1	--	13.3	--	11.2	--	7.7	--	11.6	--	13.6	--	--
165	9.6	10.3	12.8	9.0	12.7	4.9	9.5	9.3	10.5	8.6	11.9	8.2	--
180	8.6	9.9	9.8	--	12.8	--	10.4	--	--	--	--	--	--
195	6.9	--	6.1	--	9.7	--	--	--	--	--	--	--	--
210	4.6	--	--	--	--	--	--	--	--	--	--	--	--

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 37. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES ON NORTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS.
ANVIL POINTS STUDY SITE. SPRING AND FALL 1975

Depth (cm)	60 cm (24") Soil Cover				15 cm (6") Soil Cover				USBM Spent Shale				Soil
	13		11		9		7		5		3		1
	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	11/75
5	2.7*	1.2	2.7	0.9	1.8	0.8	1.7	1.1	1.8	0.7	1.5	0.8	1.2
15	0.9	0.7	1.2	0.6	1.0	0.9	0.9	1.0	1.4	1.0	1.2	1.1	1.3
30	0.9	--	1.3	0.5	1.3	--	1.2	1.5	1.7	1.4	1.7	1.3	0.8
45	0.8	--	1.0	0.5	2.4	2.3	2.1	1.9	3.8	1.7	3.6	1.6	--
60	1.3	4.5	0.8	4.8	3.9	4.0	3.8	2.9	4.4	2.5	4.2	4.1	--
75	3.4	--	4.2	--	5.2	--	4.6	3.8	5.0	2.4	4.4	3.5	--
90	6.6	5.6	5.2	4.9	5.3	4.0	5.1	4.0	5.0	2.3	4.7	3.3	--
105	--	--	6.6	--	4.9	3.7	4.8	4.4	6.2	2.9	4.6	4.1	--
120	--	6.2	9.0	5.6	--	--	--	4.2	5.0	1.3	4.6	4.5	--
135	--	--	8.2	--	--	4.5	--	4.0	4.2	--	4.6	4.0	--
150	--	8.5	--	5.9	--	--	--	--	6.8	1.7	5.4	--	--
165	--	--	--	--	--	--	--	--	6.8	--	6.8	--	--
180	--	9.0	7.6	5.1	--	--	--	--	6.6	--	6.9	--	--
195	--	--	4.2	--	--	--	--	--	5.1	--	4.3	--	--
210	--	--	--	--	--	--	--	--	--	--	2.8	--	--

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 38. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES ON SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS.
ANVIL POINTS STUDY SITE. SPRING AND FALL 1975

Depth (cm)	60 cm (24") Soil Cover				15 cm (6") Soil Cover				USBM Spent Shale				Soil
	14		12		10		8		6		4		2
	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	11/75
5	0.4 *	0.9	1.9	0.9	1.2	1.2	0.8	0.5	1.2	0.7	0.9	1.2	1.3
15	0.5	0.7	1.3	0.5	1.1	0.4	0.9	0.7	1.4	1.3	1.4	1.8	1.4
30	0.6	0.7	0.7	0.6	2.2	1.5	1.7	1.1	1.7	--	2.4	1.8	0.9
45	2.5	0.7	1.0	0.5	2.7	3.6	2.8	--	2.7	--	4.7	--	--
60	6.6	2.1	1.2	0.7	6.5	3.5	5.0	3.7	4.7	2.0	6.2	2.4	--
75	6.8	--	5.7	--	5.5	4.5	4.7	--	6.0	--	4.3	--	--
90	6.7	6.8	7.3	3.0	5.2	5.7	5.0	3.7	4.8	2.9	4.4	3.9	--
105	5.9	--	--	--	5.2	5.4	5.5	--	6.0	--	5.2	--	--
120	5.7	7.5	6.8	4.5	6.4	5.8	5.5	4.1	5.1	3.7	5.6	4.1	--
135	5.1	--	6.6	--	5.9	5.6	5.6	--	5.4	--	5.7	--	--
150	5.1	8.0	7.0	7.2	5.7	5.3	4.8	5.0	5.2	3.5	6.4	4.5	--
165	6.6	--	6.8	--	6.7	6.5	5.5	--	5.1	--	4.9	--	--
180	5.6	8.0	6.8	8.0	5.4	5.6	2.7	--	5.8	--	4.7	--	--
195	--	--	6.0	--	--	--	--	--	6.5	--	2.8	--	--
210	--	--	--	--	--	--	--	--	--	--	--	--	--

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 39. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES OF TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. AUGUST 1976

Depth (cm)	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VIII	X	XII	XIV
5	1.3 *	2.6	2.4	1.5	4.3	1.6	0.7	Missing Data	0.8	--	0.9	3.0	2.4	0.5
15	2.1	1.8	3.3	3.2	5.9	5.1	0.7		0.9	1.1	2.7	5.3	6.8	0.5
30	2.9	5.7	7.1	5.3	6.6	6.5	0.6		2.5	3.9	4.8	--	5.3	0.5
45	9.5	8.1	5.0	6.6	6.6	7.2	0.5	Missing Data	2.6	7.0	5.2	5.0	8.1	0.5
60	11.1	10.0	5.0	6.6	6.2	5.3	0.7		3.0	7.1	5.8	5.7	5.2	0.6
75	8.8	10.1	4.9	4.8	7.3	5.0	1.1		4.4	5.8	4.6	6.1	5.7	0.9
90	9.0	10.1	5.6	4.7	7.7	5.6	1.2		4.4	5.0	4.2	7.6	5.9	1.4
105	7.5	10.1	5.9	5.1	8.6	7.1	1.2		5.0	5.9	4.5	8.1	7.1	1.5
120	8.6	10.1	7.2	5.2	9.0	7.3	1.1		5.9	6.9	5.2	8.3	7.9	1.2
135	9.1	8.9	8.0	7.5	8.1	8.2	--		5.5	7.4	--	7.9	8.5	--
150	8.8	6.9	9.5	8.6	8.8	8.1	--		6.5	8.3	9.1	8.7	8.6	--
165	7.8	9.6	--	9.1	7.9	--	--		7.6	7.9	7.7	7.4	8.7	--
180	8.7	8.1	--	8.4	4.9	8.0	--		4.2	8.1	7.6	6.0	7.4	--
195	7.6	6.9	--	7.9	--	--	--		4.3	8.8	1.9	--	--	--
210	--	5.0	--	--	--	--	--		--	--	--	--	--	--

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 40. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES OF USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. AUGUST 1976

Depth (cm)	NORTH ASPECT							SOUTH ASPECT						
	60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil	60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
5	0.7 *	0.6	0.7	0.7	--	0.4	0.4	0.5	0.7	0.5	0.4	--	0.6	0.3
15	0.8	0.8	--	0.7	1.1	1.2	0.6	0.6	0.9	0.5	0.9	1.4	0.8	0.5
30	0.7	0.6	0.8	1.0	1.2	1.3	0.6	0.6	0.9	1.1	1.1	1.3	1.4	0.6
45	1.0	0.7	2.1	--	--	2.2	0.2	0.6	0.6	3.3	1.8	1.9	2.6	0.6
60	1.1	0.6	3.0	3.1	1.8	1.7	0.5	0.5	1.3	3.4	4.0	2.6	3.8	0.5
75	5.7	5.3	3.7	3.3	1.3	4.3	--	3.1	4.0	--	5.6	--	7.6	--
90	5.8	9.1	3.5	3.8	3.7	3.2	--	3.2	3.1	3.9	5.5	4.2	7.1	--
105	6.0	7.2	--	3.4	4.4	3.3	--	4.7	3.9	4.5	4.3	5.4	4.7	--
120	--	8.4	4.4	--	3.6	4.2	--	--	5.8	--	--	--	4.8	--
135	--	--	4.0	--	--	3.6	--	--	--	--	--	--	5.1	--
150	--	6.7	4.3	--	--	4.8	--	--	6.2	--	--	--	5.2	--
165	--	--	--	--	--	--	--	--	--	--	--	--	4.3	--
180	--	7.5	--	--	4.5	5.3	--	--	--	--	--	--	3.7	--
195	--	7.0	--	--	--	5.4	--	--	--	--	--	--	3.2	--
210	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 41. SALINITY SENSOR MEASUREMENTS FOR TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1973-1974

				NORTH ASPECT															
Plot No.		Depth (cm)	Serial No.	1973								1974							
				5/13	5/16	5/25	6/5	6/20	7/18	8/13	9/18	4/18	4/30	5/16	5/23	7/15	8/19		
I	30 cm (12") Soil Cover	18	1970	--	--	--	<1.5	1.6	1.9	6.4	11.3	3.6*	4.2	7.3	13.8	14.2	15.1		
		50	1952	--	--	--	3.3	4.4	4.4	5.6	7.2	8.0	8.9	10.1	11.5	10.7	11.4		
III	30 cm (12") Soil Cover	18	1962	--	--	--	2.6	1.5	2.7	5.8	30.2	5.8	8.6	15.1	25.0	25.0	26.7		
		50	1712	--	--	--	30.0	32.0	6.9	14.2	40.0	35.0	38.0	35.0	40.0	40.0	40.0		
V	15 cm (6") Soil Cover	18	1752	2.0*	2.5	<1.5	<1.5	<1.5	2.3	5.3	8.2	5.5	6.2	7.3	11.2	11.3	14.2		
		50	1941	5.4	5.8	5.6	4.9	4.7	4.4	5.2	5.6	9.2	9.7	9.7	10.3	9.7	10.5		
VII	15 cm (6") Soil Cover	18	1751	<1.5	<1.5	<1.5	<1.5	<1.5	3.8	4.9	10.5	3.2	3.6	5.6	14.0	14.2	14.9		
		50	1969	5.5	6.8	5.1	4.9	4.9	5.1	5.7	7.3	20.0	19.0	14.2	13.0	13.6	20.1		
IX	TOSCO Spent Shale	18	1943	3.1	3.3	2.0	3.1	4.1	5.4	6.4	7.2	4.5	5.0	7.8	10.3	10.4	12.2		
		50	1965	8.1	8.3	5.8	5.6	5.5	5.5	6.2	9.6	13.0	12.5	12.0	12.5	12.6	13.5		
XI	TOSCO Spent Shale	18	1981	4.2	5.3	4.0	4.2	4.7	5.3	6.2	5.8	6.0	6.5	7.9	9.4	9.9	10.2		
		50	1975	9.3	9.6	5.4	5.2	5.2	5.3	5.7	4.9	6.8	6.6	6.7	6.5	6.7	6.5		
XII	Soil Control	18	1954	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		
				SOUTH ASPECT															
Plot No.		Depth (cm)	Serial No.	1973								1974							
				5/13	5/16	5/25	6/5	6/20	7/18	8/13	9/18	4/18	4/30	5/16	5/23	7/15	8/19		
II	30 cm (12") Soil Cover	18	1447	--	--	--	<1.5	<1.5	1.6	3.5	3.6	<1.5*	<1.5	2.3	2.7	3.0	3.5		
		50	1967	--	--	--	2.7	4.2	5.0	6.0	9.0	5.9	10.1	11.1	15.0	15.1	14.9		
IV	30 cm (12") Soil Cover	18	1715	--	--	--	<1.5	<1.5	<1.5	<1.5	3.3	<1.5	<1.5	<1.5	1.9	1.9	2.0		
		50	1541	--	--	--	22.0	3.9	4.0	5.7	18.5	11.5	12.8	15.0	17.0	18.0	17.5		
VI	15 cm (6") Soil Cover	18	1968	2.1*	1.9	<1.5	1.6	2.2	2.8	4.7	7.3	7.2	7.4	8.5	12.0	12.6	13.0		
		50	1753	4.1	3.8	3.2	3.3	3.5	4.0	2.7	3.4	6.2	6.4	5.4	5.9	5.7	5.9		
VIII	15 cm (6") Soil Cover	18	1448	<1.5	<1.5	<1.5	<1.5	<1.5	2.7	6.1	20.0	<5.3	7.6	9.2	13.0	13.2	13.6		
		50	1394	1.5	1.5	3.3	3.5	3.5	3.5	3.5	7.2	8.4	9.0	10.1	11.5	11.9	12.4		
X	TOSCO Spent Shale	18	1971	4.0	3.7	2.2	3.4	4.0	5.5	5.6	7.2	5.1	6.0	12.3	14.0	14.3	14.7		
		50	1580	13.4	16.5	10.8	10.8	11.0	7.1	7.3	7.2	11.0	10.8	10.5	10.7	10.8	11.3		
XII	TOSCO Spent Shale	18	1980	3.5	3.5	3.3	3.3	3.7	4.7	5.1	5.1	5.8	5.4	6.7	7.3	7.9	8.2		
		50	1608	3.6	3.5	2.0	2.1	2.3	4.0	4.8	5.3	8.8	9.2	7.8	8.2	8.9	9.2		
XIV	Soil Control	18	1958	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	1.8	1.9	<1.5	<1.5	<1.5		

* Values are EC in mmhos/cm @ 25°C.

-- No reading.

APPENDIX TABLE 42. SALINITY SENSOR MEASUREMENTS FOR USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1973-1974

NORTH ASPECT																	
Plot No.		Depth (cm)	Serial No.	1973								1974					
				5/13	5/16	5/25	6/5	6/20	7/18	8/13	9/18	4/18	4/30	5/16	5/23	7/15	8/19
13	30 cm (12") Soil Cover	18	1955	--	--	--	2.1	2.35	2.2	2.7	0	<1.5	<1.5	<1.5	--	<1.5	<1.5
		50	1931	--	--	--	<1.5	1.75	2.5	3.1	6.3	3.8	4.0	5.1	6.5	7.2	6.7
11	30 cm (12") Soil Cover	18	1959	--	--	--	<1.5	<1.5	2.2	2.9	0	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
		50	1754	--	--	--	1.8	1.9	2.6	3.3	30.1	3.3	3.85	6.32	10.0	9.7	10.5
9	15 cm (6") Soil Cover	18	1936	--	--	<1.5	<1.5	<1.5	<1.5	2.0	4.5	3.50	5.4	8.3	10.0	10.1	10.0
		50	1637	--	--	<1.5	<1.5	2.75	3.1	3.9	3.1	4.0	3.95	4.6	5.2	5.9	6.0
7	15 cm (6") Soil Cover	18	1679	--	--	<1.5	<1.5	<1.5	<1.5	2.1	4.1	2.80	5.98	7.9	11.0	11.5	12.3
		50	1767	--	--	3.66	3.4	3.65	3.8	4.0	3.5	7.20	7.20	7.5	7.8	7.9	7.5
5	USBM Spent Shale	18	1757	2.1	2.65	<1.5	<1.5	<1.5	2.18	3.2	9.5	3.20	3.6	8.3	14.0	14.2	15.0
		50	1646	7.05	7.56	3.85	3.9	4.0	4.1	4.8	3.65	6.20	6.3	6.1	6.0	6.5	7.8
3	USBM Spent Shale	18	1678	3.25	3.8	<1.5	2.0	2.35	3.25	4.2	3.6	3.60	3.95	4.25	5.2	5.2	4.6
		50	1713	13.3	11.5	6.4	5.4	5.5	5.5	5.9	4.8	4.8	5.8	6.7	7.5	7.5	7.9
1	Soil Control	118	1958	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5

SOUTH ASPECT																	
Plot No.		Depth (cm)	Serial No.	1973								1974					
				5/13	5/16	5/25	6/5	6/20	7/18	8/13	9/18	4/18	4/30	5/16	5/23	7/15	8/19
14	30 cm (12") Soil Cover	18	1720	--	--	--	<1.5	<1.5	<1.5	<1.5	0	<1.5	<1.5	--	--	--	--
		50	1717	--	--	--	<1.5	<1.5	<1.5	<1.5	0	<1.5	<1.5	--	--	--	--
12	30 cm (12") Soil Cover	18	1445	--	--	--	<1.5	<1.5	<1.5	<1.5	0	<1.5	<1.5	<1.5	--	--	--
		50	1716	--	--	--	<1.5	<1.5	<1.5	<1.5	10.0	<1.5	<1.5	--	--	--	--
10	15 cm (6") Soil Cover	18	1949	--	--	<1.5	<1.5	<1.5	<1.5	7.1	10.0	2.6	4.75	4.5	3.8	4.0	3.9
		50	1681	--	--	2.59	2.8	2.83	3.0	3.2	2.75	2.90	2.95	2.95	2.85	2.75	3.2
8	15 cm (6") Soil Cover	18	1938	--	--	<1.5	<1.5	<1.5	<1.5	2.1	5.9	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
		50	1673	--	--	2.7	2.8	3.05	3.3	3.5	3.4	3.50	3.45	3.5	3.7	3.8	3.9
6	USBM Spent Shale	18	1675	2.05	3.16	1.7	2.2	2.87	2.78	3.75	6.5	3.30	4.2	4.4	4.8	4.9	5.4
		50	1724	6.48	6.80	3.9	4.0	4.0	3.9	4.0	3.8	3.70	4.2	4.4	4.4	4.9	5.0
4	USBM Spent Shale	18	1683	4.85	5.6	2.8	3.0	3.35	3.7	4.3	4.9	3.50	3.78	4.1	4.4	4.6	5.7
		50	1934	10.6	10.6	5.2	5.1	5.1	4.8	5.2	5.3	4.90	5.0	5.0	5.2	5.2	5.2
2	Soil Control	18	1954	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	2.10	2.18	2.2	2.18	2.1	22.0

* Values are EC in mmhos/cm @ 25° C.

-- No reading.

APPENDIX TABLE 43. SALINITY SENSOR MEASUREMENTS FROM NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1975-1976

Plot No.		Depth (cm)	Serial No.	1975				1976			
				4/9	5/12	6/4	8/21				
I	30 cm Soil Cover	18	1970	5.52*	6.1	11.1	<1.5	Data Missing			
		50	1952	13.0	11.75	13.0	25.0				
III	30 cm Soil Cover	18	1962	5.35	6.80	15.9	<1.5				
		50	1712	30.0	34.0	<1	>40.0				
V	15 cm Soil Cover	18	1752	3.28	6.6	12.2	40.0				
		50	1941	13.0	11.5	12.8	40.0				
VII	15 cm Soil Cover	18	1751	3.96	5.0	8.4	33.0				
		50	1969	18.0	12.3	18.5	30.0				
IX	TOSCO Spent Shale	18	1943	2.15	4.35	5.62	28.0				
		50	1965	10.7	12.7	20.0	27.0				
XI	TOSCO Spent Shale	18	1981	4.10	4.20	7.8	21.0				
		50	1975	14.0	17.0	16.0	11.5				
XIII	Soil Control	18		No sensor							
		50									

* Values are EC in mmhos/cm @ 25° C.

-- No reading.

APPENDIX TABLE 44. SALINITY SENSOR MEASUREMENTS FROM SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1975-1976

Plot No.		Depth (cm)	Serial No.	1975				1976			
				4/9	5/12	6/4	8/21				
II	30 cm Soil Cover	18	1447	<1*	<1	<1	-	Data Missing			
		50	1967	7.4	11.3	19.5	35.0				
IV	30 cm Soil Cover	18	1715	<1	<1	<1	-				
		50	1541	2.85	3.05	4.45	20.5				
VI	15 cm Soil Cover	18	1968	6.0	12.5	16.5	22.0				
		50	1753	5.32	7.1	6.75	10.2				
VIII	15 cm Soil Cover	18	1448	2.04	6.1	6.55	<1.5				
		50	1394	6.50	9.8	16.0	40.0				
X	TOSCO Spent Shale	18	1971	2.30	4.13	8.2	20.0				
		50	1580	23	23.5	20.2	18.0				
XII	TOSCO Spent Shale	18	1980	3.2	4.7	7.5	20.0				
		50	1608	10.6	13.5	15.0	14.5				
XIV	Soil Control	18		No sensor							
		50									

* Values are EC in mmhos/cm @ 25° C.

-- No reading.

APPENDIX TABLE 45. SALINITY SENSOR MEASUREMENTS FROM NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1975-1976

Plot No.		Depth (cm)	Serial No.	1975				1976			
				4/9	5/12	6/4	8/21				
I	30 cm Soil Cover	18 50	1958	2.06*	1.6	<1	<1.5	Data Missing			
III	30 cm Soil Cover	18 50	1678 1713	<1 3.4	<1 5.3	1.5 7.4	<1.5 10.0				
V	15 cm Soil Cover	18 50	1757 1646	<1 3.76	<1 4.8	<1 5.8	<1.5 6.8				
VII	15 cm Soil Cover	18 50	1679 1767	<1 4.55	2.15 4.85	6.3 6.1	<1.5 10.3				
IX	USBM Spent Shale	18 50	1936 1637	1.58 6.40	2.45 5.90	7.2 6.3	<1.5 <1.5				
XI	USBM Spent Shale	18 50	1959 1754	<1 2.56	<1 2.47	<1 5.6	- 8.0				
XIII	Soil Control	18 50	1955 1931	<1 2.06	<1 2.42	<1 2.95	- <1.5				

* Values are EC in mmhos/cm @ 25° C.

-- No reading.

APPENDIX TABLE 46. SALINITY SENSOR MEASUREMENTS FROM NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. 1975-1976

Plot No.		Depth (cm)	Serial No.	1975				1976			
				4/9	5/12	6/4	8/21				
II	30 cm Soil Cover	18 50	1954	4.10*	3.67	4.55	<1.5	Data Missing			
IV	30 cm Soil Cover	18 50	1683 1934	<1 7.4	3.5 8.4	7.25 13.0	6.7 31.0				
VI	15 cm Soil Cover	18 50	1675 1724	1.63 5.91	3.05 7.6	5.55 9.2	<1.5 6.7				
VIII	15 cm Soil Cover	18 50	1938 1673	<1 3.10	<1 3.3	<1 3.6	- <1.5				
X	USBM Spent Shale	18 50	1949 1681	<1 5.02	2.38 4.4	5.85 4.2	- 1.9				
XII	USBM Spent Shale	18 50	1445 1716	<1 <1	<1 <1	<1 <1	- -				
XIV	Soil Control	18 50	1720 1717	<1 1.72	<1 <1	<1 <1	- <1.5				

* Values are EC in mmhos/cm @ 25° C.

-- No reading.

APPENDIX TABLE 47. SURFACE RUNOFF AND WATER QUALITY DATA FOR TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS, FOLLOWING A 0.75 INCH (19.05 mm) 30-MINUTE STORM. ANVIL POINTS STUDY SITE. August 14, 1974

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VII	X	XI	XIV
Runoff/plot (liters)	--	--	--	--	26	45	--	--	--	--	2.9	9.8	7.6	1.7
Sediment/plot (grams)	--	--	--	--	581.4	428.2	--	--	--	--	63.4	327.7	404	32
pH	--	--	--	--	7.1	6.8	--	--	--	--	7.0	7.2	7.0	7.7
EC μ hos/cm @ 25°C	--	--	--	--	2099	817	--	--	--	--	1314	1097	1164	1106
Na (ppm)	--	--	--	--	120	14	--	--	--	--	34	30	138	70
Ca (ppm)	--	--	--	--	174	120	--	--	--	--	100	151	30	75
Mg (ppm)	--	--	--	--	115	32	--	--	--	--	21	36	28	16
K (ppm)	--	--	--	--	24	20	--	--	--	--	70	30	39	69
CO ₃ (ppm)	--	--	--	--	0	0	--	--	--	--	0	0	0	0
HCO ₃ (ppm)	--	--	--	--	120	106	--	--	--	--	500	147	210	451
NO ₃ (ppm)	--	--	--	--	2	4	--	--	--	--	5	3	3	4
SO ₄ (ppm)	--	--	--	--	1236	408	--	--	--	--	144	408	394	115
Cl (ppm)	--	--	--	--	20	14	--	--	--	--	35	34	37	40
SAR	--	--	--	--	1.7	0.3	--	--	--	--	0.8	0.6	0.5	0.8

-- No runoff.

APPENDIX TABLE 48. SURFACE RUNOFF AND WATER QUALITY DATA FOR USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. FOLLOWING A 0.75 inch (19.05 mm) 30-MINUTE STORM. ANVIL POINTS STUDY SITE. AUGUST 14, 1974

	NORTH ASPECT						SOUTH ASPECT					
	60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale	
	13	11	9	7	5	3	14	12	10	8	6	4
	13	11	9	7	5	3	14	12	10	8	6	4
Runoff/plot (liters)	--	--	--	--	--	1.2	--	1.2	--	--	1.2	1.2
Sediment/plot (grams)	--	--	--	--	--	30	--	21.2	--	--	155.7	107.3
pH	--	--	--	--	--	7.6	--	7.3	--	--	7.2	7.4
EC μ hos/cm @ 25°C	--	--	--	--	--	1875	--	1640	--	--	1189	1624
Na (ppm)	--	--	--	--	--	161	--	79	--	--	44	80
Ca (ppm)	--	--	--	--	--	122	--	108	--	--	98	148
Mg (ppm)	--	--	--	--	--	36	--	20	--	--	21	31
K (ppm)	--	--	--	--	--	70	--	98	--	--	57	70
CO ₃ (ppm)	--	--	--	--	--	0	--	0	--	--	0	0
HCO ₃ (ppm)	--	--	--	--	--	543	--	584	--	--	386	449
NO ₃ (ppm)	--	--	--	--	--	6	--	7	--	--	6	1
SO ₄	--	--	--	--	--	192	--	254	--	--	168	206
Cl (ppm)	--	--	--	--	--	198	--	71	--	--	66	150
SAR	--	--	--	--	--	3.3	--	0.8	--	--	1.0	1.6

-- No runoff

APPENDIX TABLE 49. SNOWMELT RUNOFF AND WATER QUALITY DATA FOR TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. MARCH 13, 1975

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VIII	X	XII	XIV
	120+	120+	93	120+	69	120+	3.5	105.0	120+	120+	210.8+	120+	120+	20.0
Runoff/plot* (liters)														
Sediment/plot (grams)	98.4	84.1	86.7	92.2	55.3	97.2	2.6	93.7	115.9	92.3	104.5	89.2	99.4	17.7
pH	7.0	7.4	7.3	7.5	7.6	7.1	7.5	7.3	7.3	7.3	7.2	7.1	7.2	7.7
EC μ mhos/cm @ 25°C	100	100	110	100	350	180	310	200	190	260	200	500	750	150
Na (ppm)	4.6	2.3	2.3	2.3	13.8	2.3	11.5	6.9	6.9	6.9	4.6	2.3	2.3	2.3
Ca (ppm)	8.0	8.0	10.0	8.0	32.0	22.0	24.0	20.0	18.0	30.0	22.0	82.0	144.0	14.0
Mg (ppm)	2.4	2.4	2.4	2.4	10.8	3.6	9.6	4.8	4.8	16.8	4.8	6.0	8.6	2.4
K (ppm)	3.9	3.9	3.9	3.9	3.9	2.0	15.6	7.8	7.8	7.8	7.8	3.9	3.9	3.9
CO ₃ (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO ₃ (ppm)	42.7	42.7	42.7	30.5	36.6	18.3	73.2	85.4	79.3	61.0	67.1	24.4	54.9	48.8
NO ₃ (ppm)	1.2	1.2	1.2	1.2	1.2	0.6	18.6	3.1	3.1	3.1	3.1	1.2	0.6	12.4
SO ₄ (ppm)	9.6	9.6	14.4	14.4	148.8	72.0	43.2	14.4	19.2	76.8	52.8	216.0	360.0	9.6
Cl (ppm)	7.1	3.6	7.1	7.1	7.1	3.6	21.3	7.1	7.1	10.7	3.6	3.6	3.6	7.1
SAR	.37	.18	.17	.18	.42	.12	.42	.36	.37	.25	.18	.07	.04	.15

* The primary collector, a plastic container, held 113 l; overflow into the culvert was measured but some water was lost as the culvert was not well sealed, the leaks were sealed in July 1975.

APPENDIX TABLE 50. SNOWMELT RUNOFF AND WATER QUALITY DATA FOR USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. MARCH 13, 1975

	NORTH ASPECT							SOUTH ASPECT						
	60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil	60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
Runoff/plot (liters)	22.0	37.0	8.5	8.0	46.0	120+*	49.0	95.0	193.8+*	120+*	120+*	154+*	120+*	25.0
Sediment/plot (grams)	16.0	28.9	6.1	6.0	28.2	69.6	23.0	66.5	117.2	82.7	106.2	124.1	82.2	17.4
pH	7.3	7.3	7.3	7.5	7.6	7.5	7.5	7.4	7.4	7.6	7.4	7.5	7.6	7.5
EC μ hos/cm @ 25°C	100	100	200	210	160	70	150	160	160	215	170	220	240	130
Na (ppm)	2.3	2.3	6.9	11.5	2.3	2.3	2.3	6.9	6.9	4.6	4.6	2.3	4.6	2.3
Ca (ppm)	12.0	10.0	14.0	14.0	16.0	6.0	8.0	14.0	20.0	26.0	16.0	20.0	16.0	14.0
Mg (ppm)	2.4	2.4	3.6	3.6	2.4	2.4	2.4	3.6	3.6	4.8	3.6	9.6	12.0	2.4
K (ppm)	3.9	7.8	15.6	11.7	3.9	3.9	7.8	7.8	7.8	7.8	7.8	7.8	11.7	3.9
CO ₃ (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO ₃ (ppm)	61.0	61.0	48.8	67.1	61.0	30.5	61.0	85.4	85.4	85.4	67.1	91.5	97.6	42.7
NO ₃ (ppm)	6.2	6.2	24.8	6.2	0.6	0.6	0.6	4.3	1.2	6.2	3.7	1.2	0.6	6.2
SO ₄ (ppm)	4.8	4.8	4.8	14.4	14.4	1.4	4.8	9.6	14.4	14.4	9.6	52.8	43.2	4.8
Cl (ppm)	3.6	3.6	17.8	21.3	3.6	3.6	3.6	7.1	14.2	7.1	7.1	3.6	3.6	7.1
SAR	.16	.17	.42	.70	.14	.20	.18	.42	.37	.22	.27	.14	.21	.15

* The primary collector, a plastic container, held 113 l; overflow into the culvert was measured but some water was lost as the culvert was not well sealed, the leaks were sealed in July 1975.

[illegible]

APPENDIX TABLE 52. SURFACE RUNOFF AND WATER QUALITY DATA FOR USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS, FOLLOWING A 0.42 INCH (10.6 mm) STORM DURING THREE 30-MINUTE INTERVALS. ANVIL POINTS STUDY SITE. JULY 16, 1975

	NORTH ASPECT							SOUTH ASPECT						
	60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil	60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
Runoff/plot. (liters)	3.2	2.0	--	1.8	2.0	--	--	--	2.0	--	1.5	--	--	--
Sediment/plot (grams)	4.7	5.9	--	7.3	6.7	--	--	--	10.2	--	5.7	--	--	--
pH	8.1	8.2	--	8.3	8.3	--	--	--	8.2	--	9.0	--	--	--
EC μ hos/cm @ 25°C	800	1200	--	2600	2300	--	--	--	2300	--	4100	--	--	--
Na (ppm)	16.10	34.5	--	126.5	103.5	--	--	--	85.10	--	202.4	--	--	--
Ca (ppm)	90.18	136.27	--	152.30	184.37	--	--	--	178.36	--	164.33	--	--	--
Mg (ppm)	14.59	21.89	--	41.34	48.64	--	--	--	32.83	--	81.47	--	--	--
K (ppm)	27.37	58.65	--	168.13	164.22	--	--	--	144.67	--	355.81	--	--	--
CO ₃ (ppm)	0	0	--	0	0	--	--	--	0	--	294.0	--	--	--
HCO ₃ (ppm)	439.27	646.71	--	1189.70	1134.79	--	--	--	1183.59	--	1220.2	--	--	--
NO ₃ (ppm)	1.86	1.24	--	3.10	2.48	--	--	--	3.10	--	4.34	--	--	--
SO ₄ (ppm)	14.41	24.02	--	14.41	76.85	--	--	--	100.86	--	76.85	--	--	--
Cl (ppm)	17.73	42.55	--	177.30	159.57	--	--	--	141.84	--	354.60	--	--	--
SAR	0.46	0.72	--	2.34	1.75	--	--	--	1.53	--	3.21	--	--	--

-- No runoff

APPENDIX TABLE 53. SNOWMELT RUNOFF AND WATER QUALITY SAMPLES FOR TOSCO SPENT SHALE, SOIL-COVERED
TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. MARCH 18, 1976

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VIII	X	XII	XIV
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VIII	X	XII	XIV
Runoff/plot (liters)	64.0	78.0	341.4	648.0	369.8	875.2	36.0	47.0	75.2	78.0	68.0	88.0	96.0	13.7
Sediment/plot (grams)	1.9	0.78	6.0	9.6	4.8	1.2	0.36	1.9	6.0	6.2	2.0	0.8	3.8	1.1
pH	6.9	6.8	6.9	6.9	6.7	6.6	7.0	7.0	7.1	7.0	6.8	6.7	6.8	6.8
EC μ mhos/cm @ 25°C	200	100	200	100	400	300	200	300	300	300	200	1600	1000	200
Na (ppm)	2.3	2.3	2.3	<2.3	6.9	<2.3	4.6	6.9	6.9	6.9	4.5	9.2	4.6	4.6
Ca (ppm)	18.0	14.0	18.0	14.0	48.1	40.0	18.0	26.1	34.1	34.1	24.0	310.6	166.3	24.0
Mg (ppm)	4.9	3.6	4.9	2.4	9.7	4.9	4.9	8.5	8.5	10.9	7.3	48.6	28.0	4.9
K (ppm)	15.6	11.7	11.7	7.8	7.8	3.9	15.6	31.3	31.3	27.4	19.6	27.4	27.4	11.7
CO ₃ (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO ₃ (ppm)	109.8	73.2	54.9	61.0	85.4	36.6	85.4	134.2	146.4	122.0	97.6	97.6	103.7	79.3
NO ₃ (ppm)	1.9	1.2	2.5	1.2	0.6	0.6	1.2	2.5	3.1	1.9	2.5	1.2	1.9	1.9
SO ₄ (ppm)	9.6	9.6	28.8	4.8	134.5	96.1	4.8	9.6	9.6	38.4	9.6	893.4	470.7	14.4
Cl (ppm)	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	7.1	10.6	3.5	<3.5	<3.5	<3.5	<3.5
SAR	0.13	0.14	0.12	0.15	0.24	0.09	0.25	0.30	0.27	0.26	0.21	0.13	0.09	0.22

-- No sample collected this date.

APPENDIX TABLE 54. SNOWMELT RUNOFF AND WATER QUALITY SAMPLES FOR USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. ANVIL POINTS STUDY SITE. MARCH 18, 1976

	NORTH ASPECT							SOUTH ASPECT						
	60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil	60 cm (24") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
Runoff/plot (liters)	21.6	9.7	10.0	10.5	8.0	6.0	22.0	<1.0	2.0	2.0	1.0	15.2	25.8	13.0
Sediment/plot (grams)	0.22	0.29	0.80	0.32	0.08	0.30	0.88	0.12	0.34	0.14	0.26	0.61	0.77	2.1
pH	6.8	7.1	7.3	7.2	7.1	7.1	7.3	7.1	6.9	7.2	7.4	7.3	7.0	7.0
EC μ hos/cm @ 25°C	200	400	400	300	400	500	400	1200	300	700	1100	500	300	500
Na (ppm)	4.6	9.2	6.9	6.9	6.9	6.9	6.9	13.8	6.9	13.8	25.3	9.2	6.9	4.6
Ca (ppm)	16.0	38.1	38.1	20.0	28.1	36.1	34.1	70.1	36.1	58.1	100.2	40.0	18.0	32.1
Mg (ppm)	3.6	8.5	8.5	6.9	9.7	21.9	7.3	31.6	7.3	18.2	28.0	19.5	15.8	7.3
K (ppm)	11.7	27.4	27.4	23.5	46.9	54.7	46.9	199.4	15.6	46.9	78.2	31.3	19.6	82.1
CO ₃ (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO ₃ (ppm)	61.0	122.0	176.9	115.9	128.1	152.5	158.6	274.4	115.9	262.3	482.0	195.2	122.0	158.6
NO ₃ (ppm)	1.9	37.2	1.9	1.2	1.9	3.1	1.9	4.3	1.2	3.7	5.6	1.9	1.2	1.9
SO ₄ (ppm)	19.2	28.8	24.0	28.8	38.4	91.3	28.8	96.1	28.8	24.0	9.6	9.6	<4.8	96.1
Cl (ppm)	<3.5	3.5	17.7	3.5	31.9	39.0	28.4	191.5	7.1	56.7	92.2	56.7	35.4	3.5
SAR	0.27	0.35	0.26	0.35	0.20	0.22	0.28	0.34	0.27	0.21	0.58	0.30	0.29	0.19

-- No sample collected this date.

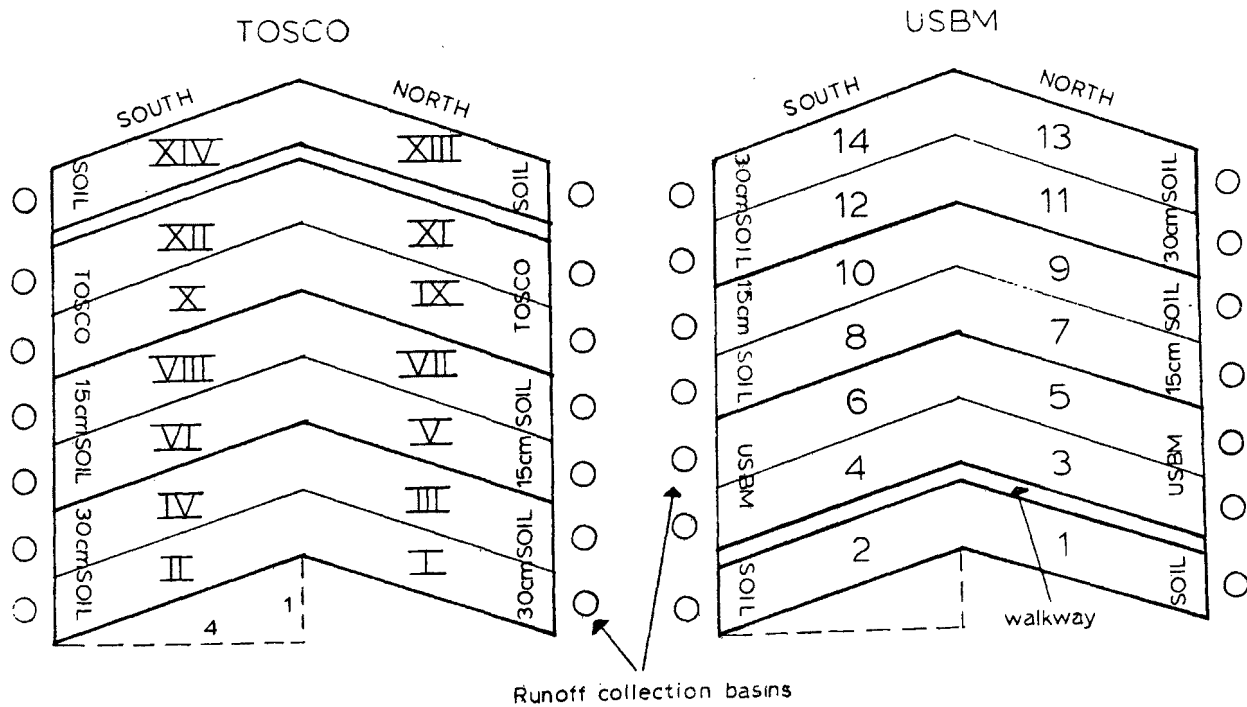
APPENDIX TABLES

HIGH-ELEVATION STUDY SITE

The following Appendix Tables (55-95) are a complete tabulation of all data for each treatment and replication between 1973 and 1976.

A guide to the plot layout and number system for the appendix tables is given below:

Plot Plan and Numbering System (Low elevation and High elevation study sites)



<u>Appendix Number</u>		<u>Page</u>
55	List of species and rate of seeding - 1974	128
56 - 59	Vegetation density and ground cover (quadrat method) - 1974	
	56 - TOSCO - north-aspect	129
	57 - TOSCO - south-aspect	130
	58 - USBM - north-aspect	131
	59 - USBM - south-aspect	132
60 - 63	Vegetation density and ground cover (quadrat method) - 1975	
	60 - TOSCO - north-aspect	133
	61 - TOSCO - south-aspect	134
	62 - USBM - north-aspect	135
	63 - USBM - south-aspect	136
64 - 67	Vegetation analysis (transect method) - 1976	
	64 - TOSCO - north-aspect	137
	65 - TOSCO - south-aspect	138
	66 - USBM - north-aspect	139
	67 - USBM - south-aspect	140
68 - 69	Moisture measurements (neutron probe) - 1974	
	68 - TOSCO - north and south-aspects	141
	69 - USBM - north and south-aspects	142
70 - 71	Moisture measurements (neutron probe) - 1975	
	70 - TOSCO - north and south-aspects	143
	71 - USBM - north and south-aspects	144
72 - 75	Moisture measurements (neutron probe) - 1976	
	72 - TOSCO - north-aspect	145
	73 - TOSCO - south-aspect	146
	74 - USBM - north-aspect	147
	75 - USBM - south-aspect	148
76 - 81	Salinity measurements (EC)	
	76 - TOSCO - north and south-aspects (1973-1974) . . .	149
	77 - USBM - north and south-aspects (1973-1974) . . .	150
	78 - TOSCO - north-aspect (1975)	151
	79 - TOSCO - south-aspect (1975)	152
	80 - USBM - north-aspect (1975)	153
	81 - USBM - south-aspect (1975)	154
82 - 83	Salinity sensor measurements - 1975-1976	
	82 - TOSCO - north and south-aspects	155
	83 - USBM - north and south-aspects	156

<u>Appendix Number</u>		<u>Page</u>
84 - 85	Salinity sensor measurements - 1976	
	84 - TOSCO - north and south-aspects	157
	85 - USBM - north and south-aspects	158
86 - 87	Surface runoff and water quality data - 1974	
	86 - TOSCO - north and south-aspects	159
	87 - USBM - north and south-aspects	160
88 - 95	Snowmelt runoff and water quality data	
	88 - TOSCO - north and south-aspects (March 13, 1975) .	161
	89 - USBM - north and south-aspects (March 13, 1975) .	162
	90 - TOSCO - north and south-aspects (March 10, 1976) .	163
	91 - USBM - north and south-aspects (March 10, 1976) .	164
	92 - TOSCO - north and south-aspects (March 17, 1976) .	165
	93 - USBM - north and south-aspects (March 17, 1976) .	166
	94 - TOSCO - north and south-aspects (March 31, 1976) .	167
	95 - USBM - north and south-aspects (March 31, 1976) .	168

APPENDIX TABLE 55. LIST OF SPECIES AND RATE OF SEEDING (kg/ha)
ON THE OIL SHALE RESEARCH PLOTS AT PICEANCE
BASIN STUDY SITE. JUNE 24, 1974

	Rate (kg/ha)
<u>Grasses</u>	
Bluebunch wheatgrass (<u>Agropyron spicatum</u>)	0.5
Beardless wheatgrass (<u>Agropyron inerme</u>)	0.5
Indian ricegrass (<u>Oryzopsis hymenoides</u>)	1.0
Western wheatgrass (<u>Agropyron smithii</u>)	0.5
<u>Forbs</u>	
Lupine spp. (<u>Lupinus spp.</u>)	1.0
Utah sweetvetch (<u>Hedysarum boreale utahensis</u>)	0.8
Arrowleaf balsamroot (<u>Balsamorhiza sagittata</u>)	0.5
James penstemon (<u>Penstemon jamesii</u>)	0.8
Rocky Mountain penstemon (<u>Penstemon montanus</u>)	0.8
<u>Shrubs</u>	
Antelope bitterbrush (<u>Purshia tridentata</u>)	2.0
Big sagebrush (<u>Artemisia tridentata</u>)	1.0
Fourwing saltbush (<u>Atriplex canescens</u>)	1.0
Rabbitbrush (<u>Chrysothamnus spp.</u>)	0.5
Serviceberry (<u>Amelanchier utahensis</u>)	1.0
Mountain mahogany (<u>Cercocarpus montanus</u>)	1.0
Winterfat (<u>Ceratoides</u>)	0.5

APPENDIX TABLE 56. VEGETATION DENSITY AND GROUND COVER (QUADRAT METHOD) ON NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. SEPTEMBER 1974

	30 cm (12") Soil Cover								15 cm (6") Soil Cover								TOSCO Spent Shale								Soil							
	I				III				V				VII				IX				XI				XIII							
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4				
<u>GRASSES</u>																																
Western wheatgrass	2*	-	2	3	-	3	-	1	1	3	3	1	1	2	1	-	4	3	1	2	1	-	2	4	-	1	1	2				
Bluebunch wheatgrass	3	2	3	5	1	4	1	2	2	4	3	2	1	4	7	-	6	7	1	3	2	1	4	-	1	2	1	1				
Indian ricegrass	1	-	-	-	1	-	-	-	1	-	3	1	2	2	-	1	2	1	-	2	-	1	-	-	-	-	-	-				
Basin wildrye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
<u>SHRUBS</u>																																
Winterfat	-	-	-	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Fourwing saltbush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-				
Rabbitbrush	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Bitterbrush	-	-	1	-	1	-	-	-	-	-	1	-	1	-	1	-	1	1	-	-	-	1	-	-	1	-	-	-				
Big sagebrush	4	8	11	18	1	2	-	1	4	9	2	2	-	10	12	-	7	7	5	8	4	2	6	3	2	8	3	5				
Mt. Mahogany	2	1	1	-	3	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	2	2	2	1	-	-	-				
<u>FORBS</u>																																
Utah sweetvetch	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1	-	-	-	-	1	-	-	-	-	-				
Penstemon (spp.)	5	3	5	2	-	3	-	-	2	5	-	1	2	3	2	-	2	-	-	1	1	1	2	-	3	4	-	2				
Lupine (spp.)	-	1	-	-	-	-	-	2	-	-	1	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1				
TOTALS	17	17	23	30	7	12	1	7	10	22	14	7	9	30	23	2	23	20	7	16	9	6	14	14	9	15	6	11				
% COVER/PLOT	45				40				35				30				30				35				35							

* Values are total number of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each plot.

APPENDIX TABLE 57. VEGETATION DENSITY AND GROUND COVER (QUADRAT METHOD) ON SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. SEPTEMBER 1974

	30 cm (12") Soil Cover				15 cm (6") Soil Cover				TOSCO Spent Shale				Soil			
	II		IV		VI		VIII		X		XII		XIV			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
<u>GRASSES</u>																
Western wheatgrass	2*	1	2	1	1	-	-	1	2	-	-	-	2	-	-	-
Bluebunch wheatgrass	1	2	2	2	3	1	-	2	1	2	2	3	2	1	2	3
Indian ricegrass	-	1	-	1	-	-	1	-	1	1	3	-	1	-	-	-
Basin wildrye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>FORBS</u>																
Winterfat	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Fourwing saltbush	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bitterbrush	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-
Big sagebrush	3	6	3	8	3	2	2	5	-	2	3	4	2	3	2	2
Mt. Mahogany	-	-	-	-	-	1	-	-	-	-	1	1	-	-	-	1
<u>FORBS</u>																
Utah sweetvetch	2	-	-	-	-	2	1	5	-	-	2	1	-	-	-	-
Penstemon (spp.)	-	1	4	5	-	2	2	3	1	-	1	2	-	-	-	1
Lupine (spp.)	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
TOTALS	9	11	11	18	7	6	4	13	5	2	5	15	6	2	12	17
% COVER/PLOT	30				35				30				25			

* Values are total number of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each plot.

APPENDIX TABLE 58. VEGETATION DENSITY AND GROUND COVER (QUADRAT METHOD) ON NORTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. SEPTEMBER 1974

	30 cm (12") Soil Cover								15 cm (6") Soil Cover								USBM Spent Shale								Soil			
	13				11				9				7				5				3				1			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
<u>GRASSES</u>																												
Western wheatgrass	1*	2	1	4	-	1	1	-	-	2	1	1	1	-	1	3	-	-	1	2	2	2	-	1	2	-	-	2
Bluebunch wheatgrass	3	2	2	4	-	2	2	-	1	3	1	1	2	2	2	3	1	2	2	3	3	3	1	2	2	2	-	3
Indian ricegrass	-	1	-	-	-	-	-	-	-	-	1	1	-	1	-	1	-	2	-	-	1	-	-	-	-	1	-	1
Basin wildrye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																												
Winterfat	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bitterbrush	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-
Big sagebrush	-	-	4	4	15	8	-	3	7	9	8	10	3	10	4	5	-	-	2	3	10	-	-	-	7	10	4	3
Mt. Mahogany	1	-	-	-	-	-	-	-	1	-	-	-	1	-	1	2	-	1	-	-	2	-	1	1	-	-	-	-
<u>FORBS</u>																												
Utah sweetvetch	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
Penstemon (spp.)	-	2	2	2	3	3	5	1	-	-	-	3	2	5	2	2	-	2	-	-	-	-	-	-	3	1	-	1
Lupine (spp.)	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
TOTALS	7	8	9	14	19	14	9	4	9	16	12	18	10	18	10	16	2	9	5	8	19	5	2	5	16	13	5	10
% COVER/PLOT	35				30				25				20				15				20				35			

* Values are total number of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each plot.

APPENDIX TABLE 59. VEGETATION DENSITY AND GROUND COVER (QUADRAT METHOD) ON SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE, SEPTEMBER 1974

	30 cm (12") Soil Cover								15 cm (6") Soil Cover								USBM Spent Shale								Soil			
	14				12				10				8				6				4				2			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
<u>GRASSES</u>																												
Western wheatgrass	3*	2	1	3	1	1	4	1	2	1	1	1	2	2	2	1	2	2	-	2	2	3	2	1	2	-	2	1
Bluebunch wheatgrass	2	1	2	2	1	2	2	2	2	3	1	2	2	3	2	1	2	2	2	2	3	2	1	2	2	-	3	3
Indian ricegrass	-	1	-	1	-	-	2	-	-	-	-	2	-	1	1	-	2	1	-	1	-	-	1	-	-	-	1	-
Basin wildrye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																												
Winterfat	-	-	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Fourwing saltbush	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	-	-	-	-	1	-	1	-	-	-	-
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Bitterbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Big sagebrush	6	-	-	4	3	-	2	7	4	3	3	3	-	1	-	2	2	1	3	5	2	-	-	3	7	4	4	6
Mt. Mahogany	-	-	1	1	-	-	1	-	-	-	-	-	-	-	1	1	-	-	1	-	-	-	-	-	-	1	-	-
<u>FORBS</u>																												
Utah sweetvetch	-	-	-	-	-	-	-	-	2	-	-	-	-	1	-	-	1	-	-	-	-	-	-	1	-	-	-	-
Penstemon (spp.)	2	-	-	-	2	2	3	-	1	-	-	-	5	3	-	4	-	-	-	2	-	-	2	2	2	3	2	-
Lupine (spp.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
TOTALS	13	15	6	11	7	5	14	10	11	7	5	9	9	11	7	9	11	6	7	13	7	6	6	10	13	9	13	11
% COVER/PLOT	40				45				20				25				20				45				25			

* Values are total number of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each plot.

APPENDIX TABLE 60. VEGETATION DENSITY AND GROUND COVER ON NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. SEPTEMBER 1975

Quadrat #	I 30 cm (12") Soil				III 30 cm (12") Soil				V 15 cm (6") Soil				VII 15 cm (6") Soil			
	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover
1	5*	1	3	45	4	4	4	60	3	2	8	45	5	0	8	65
2	4	0	3	70	7	3	2	90	6	3	8	65	6	0	3	40
3	4	2	8	90	5	2	6	60	3	0	7	35	4	1	3	35
4	6	0	5	30	5	4	3	55	2	0	4	25	5	1	4	40
5	5	2	3	55	4	7	2	95	2	4	3	35	5	3	4	65
6	5	0	4	40	4	4	3	80	3	0	9	40	5	1	2	50
7	4	0	0	35	4	0	3	40	4	0	4	50	3	0	3	35
8	4	2	4	55	6	4	3	50	4	2	5	40	2	1	1	25
9	8	1	3	45	5	3	7	55	3	2	9	55	3	2	3	50
Totals	45	8	33	\bar{x} 51	44	31	33	\bar{x} 65	30	13	57	\bar{x} 43	38	9	31	\bar{x} 45

Quadrat #	IX TOSCO Spent Shale				XI TOSCO Spent Shale				XIII Soil			
	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover
1	10*	0	5	60	8	2	4	80	3	3	2	40
2	4	3	7	65	7	1	2	75	4	0	3	50
3	7	1	3	70	7	4	2	75	4	0	5	45
4	6	2	3	45	7	0	0	50	5	2	4	50
5	6	2	2	75	8	2	0	70	5	3	4	60
6	5	1	3	65	5	2	1	70	3	0	2	30
7	7	1	5	80	3	4	0	30	4	3	7	60
8	4	4	3	60	8	4	1	70	4	2	3	55
9	7	1	2	45	7	1	0	55	5	1	2	55
Totals	56	15	33	\bar{x} 62	60	20	10	\bar{x} 63	37	15	32	\bar{x} 44

* Values are total numbers of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each quadrat.

APPENDIX TABLE 61. VEGETATION DENSITY AND GROUND COVER ON SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. SEPTEMBER 1975

Quadrat #	II 30 cm (12") Soil				IV 30 cm (12") Soil				VI 15 cm (6") Soil				VIII 15 cm (6") Soil			
	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover
1	5*	1	0	65	5	3	4	55	7	3	7	60	5	1	6	35
2	3	2	0	50	6	0	5	45	4	3	1	50	5	4	6	45
3	6	1	3	60	4	3	3	60	4	2	4	45	6	2	3	45
4	6	1	2	55	3	4	2	85	6	3	2	35	6	3	10	45
5	6	1	0	60	6	0	2	35	4	2	1	40	6	0	4	50
6	4	0	1	25	4	0	3	40	4	2	4	40	7	0	8	60
7	3	2	0	50	5	1	4	60	2	1	3	30	5	1	4	40
8	6	4	0	80	5	1	3	55	6	2	1	55	3	0	3	25
9	5	0	0	40	5	3	4	60	5	2	3	50	2	1	6	30
Totals	44	12	6	\bar{x} 54	43	15	30	\bar{x} 55	45	20	26	\bar{x} 45	45	12	50	\bar{x} 42

Quadrat #	X TOSCO Spent Shale				XII TOSCO Spent Shale				XIV Soil			
	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover
1	8*	0	0	55	7	3	5	60	4	1	2	40
2	10	3	0	60	8	4	2	55	6	2	3	55
3	6	4	2	50	6	2	2	45	5	2	7	60
4	9	2	4	45	7	2	0	40	6	2	4	45
5	11	2	1	70	7	1	3	50	3	0	0	15
6	7	3	0	50	5	0	1	30	3	2	1	40
7	6	3	5	55	7	0	0	50	7	1	3	40
8	12	2	1	90	5	1	0	60	3	3	0	45
9	10	1	0	50	6	0	2	50	3	1	2	55
Totals	79	20	13	\bar{x} 58	58	13	15	\bar{x} 49	40	14	22	\bar{x} 44

* Values are total numbers of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each quadrat.

APPENDIX TABLE 62. VEGETATION DENSITY AND GROUND COVER ON NORTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. SEPTEMBER 1975

Quadrat #	13 30 cm (12") Soil				11 30 cm (12") Soil				9 15 cm (6") Soil				7 15 cm (6") Soil			
	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover
1	6*	0	2	45	4	1	4	55	3	0	2	35	3	0	2	75
2	6	0	5	55	4	1	3	60	6	1	2	85	5	0	3	60
3	3	2	1	25	6	0	3	60	4	0	2	45	5	0	5	40
4	4	0	3	35	4	0	2	35	5	0	4	50	5	0	3	50
5	4	1	3	60	1	0	2	20	4	1	3	55	6	0	3	45
6	4	2	3	45	3	1	4	40	4	0	3	45	5	2	6	55
7	3	1	1	35	4	0	3	35	4	3	3	45	5	2	4	60
8	3	4	5	55	3	0	3	30	6	2	4	70	5	0	3	50
9	6	2	4	50	5	1	2	45	5	1	3	60	5	1	3	50
Totals	39	12	27	\bar{x} 45	34	4	26	\bar{x} 42	41	8	26	\bar{x} 54	44	5	32	\bar{x} 53

Quadrat #	5 USBM Spent Shale				3 USBM Spent Shale				1 Soil			
	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover
1	6*	0	0	50	6	1	0	35	6	2	5	60
2	6	1	0	45	6	0	0	85	6	0	6	85
3	5	1	3	35	7	0	2	80	3	0	7	30
4	7	0	2	55	4	3	0	50	5	0	3	70
5	6	1	1	55	9	2	2	65	4	0	5	40
6	4	1	1	60	3	2	0	45	4	0	3	50
7	6	1	1	45	6	1	0	45	5	2	3	50
8	7	1	1	55	5	4	0	55	7	0	7	40
9	9	3	1	55	6	0	1	40	5	0	2	25
Totals	56	9	10	\bar{x} 44	45	13	5	\bar{x} 56	45	4	41	\bar{x} 50

* Values are total numbers of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each quadrat.

APPENDIX TABLE 63. VEGETATION DENSITY AND GROUND COVER ON SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE
SEPTEMBER 1975

Quadrat #	14 30 cm (12") Soil				12 30 cm (12") Soil				10 15 cm (6") Soil				8 15 cm (6") Soil			
	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover
1	2*	0	3	55	4	2	5	65	5	2	3	50	7	2	3	70
2	4	2	3	60	6	1	5	75	4	1	2	70	4	1	5	45
3	4	0	5	75	5	0	6	50	4	3	4	50	6	2	5	60
4	3	1	4	35	5	1	3	55	5	1	5	50	8	1	5	65
5	3	1	1	80	4	2	4	60	7	1	5	60	3	0	2	40
6	2	1	0	20	3	1	1	70	7	2	3	55	3	2	6	65
7	4	0	2	30	7	0	4	55	6	1	3	60	3	1	3	30
8	4	0	0	40	4	1	2	45	3	1	3	40	4	2	5	40
9	5	0	1	45	3	0	0	30	4	0	4	45	7	0	7	80
Totals	31	5	19	\bar{x} 49	41	8	30	\bar{x} 56	45	12	32	\bar{x} 53	45	11	41	\bar{x} 55

Quadrat #	6 USBM Spent Shale				4 USBM Spent Shale				2 Soil			
	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover	Grass	Shrub	Forb	% Cover
1	6*	3	0	60	7	3	0	60	8	0	4	85
2	7	0	0	50	8	2	0	40	4	1	5	70
3	10	0	4	55	11	3	0	80	5	4	6	80
4	6	3	1	45	8	3	2	50	4	2	2	60
5	8	2	2	65	6	2	0	60	6	0	3	50
6	5	1	4	55	8	2	0	45	2	1	1	45
7	4	2	0	40	6	2	1	55	1	0	4	25
8	6	1	0	50	7	2	0	55	2	0	4	30
9	4	3	0	55	7	2	4	60	3	1	2	55
Totals	56	15	11	\bar{x} 53	68	21	7	\bar{x} 56	35	9	31	\bar{x} 56

* Values are total numbers of individual plants per (20.3 x 40.6 cm) quadrat. Percent vegetative cover was estimated for each quadrat.

APPENDIX TABLE 64. VEGETATION ANALYSIS (TRANSECT METHOD) ON NORTH-ASPECT TOSCO SPENT SHALE,
SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY
SITE. AUGUST 1976

	30 cm (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale						Soil		
	I			III			V			VIII			IX			XI			XIII		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
<u>GRASSES</u>																					
Western wheatgrass	43*	39	138	52	123	108	112	96	74	109	198	117	176	254	251	142	230	229	55	111	122
Bluebunch wheatgrass	5	-	-	-	-	4	19	-	19	-	-	8	-	-	-	-	-	-	-	-	-
Crested wheatgrass	-	19	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	13	63	36	36	31	34	16	44	26	21	17	9	-	6	9	8	17	11	46	37	14
Timothy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	-	-	-	-	17	25	10	5	28	6	14	17	9	5	8	-	-	5	-	-	14
Bluegrass	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																					
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	21	8	-	84	38	10	7	23	49	96	34	14	110	43	50	123	44	51	138	110	30
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bitterbrush	-	-	-	-	-	-	14	2	-	5	2	13	-	3	-	-	-	-	-	-	-
Big sagebrush	-	-	6	-	-	6	6	-	-	-	4	-	-	-	5	-	-	-	-	-	-
<u>FORBS</u>																					
Globe mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon (spp.)	9	70	72	23	45	95	94	70	65	42	57	79	-	-	-	-	-	6	10	7	51
Utah sweetvetch	-	11	-	-	15	3	34	33	14	13	7	11	6	4	21	-	-	-	6	-	-
<u>WEEDY ANNUALS</u>																					
Cheatgrass	2	21	39	-	11	-	-	25	11	-	-	6	-	-	-	-	21	12	11	21	34
Mustard (spp)	-	-	5	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	18	-	15
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild lettuce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wheat	23	-	-	9	28	8	25	40	34	5	-	-	11	50	-	-	11	16	-	6	-
No Vegetative Cover	177	27	54	146	46	42	13	2	30	93	17	64	32	11	6	87	27	20	66	67	66

* Values are total centimeters of above ground vegetative cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower, 1/3 of each plot.

APPENDIX TABLE 65. VEGETATION ANALYSIS (TRANSECT METHOD) ON SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. AUGUST 1976

	30 cm (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale						Soil		
	II			IV			VI			VIII			X			XII			XIV		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
<u>GRASSES</u>																					
Western wheatgrass	48*	70	53	85	128	131	117	88	79	136	115	137	215	94	218	121	232	180	15	27	60
Bluebunch wheatgrass	-	-	-	-	-	-	-	-	-	27	8	-	-	-	-	-	-	-	4	-	22
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	63	49	57	49	27	68	19	49	10	21	16	11	28	15	19	80	11	13	48	80	96
Timothy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	-	-	-	5	-	18	-	13	19	5	7	3	5	-	5	-	-	-	-	-	-
Bluegrass	-	-	-	-	-	-	-	-	-	6	2	11	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																					
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	141	39	67	59	60	28	54	33	50	7	26	49	24	59	48	69	37	73	158	68	20
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bitterbrush	-	-	-	7	7	5	-	4	-	-	-	-	-	-	-	-	-	-	-	4	-
Big sagebrush	5	28	13	-	-	6	-	9	-	-	4	-	-	6	10	-	-	-	-	-	-
<u>FORBS</u>																					
Globe mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon (spp.)	13	33	38	6	38	58	31	45	52	57	54	47	-	-	-	-	-	-	14	-	34
Utah sweetvetch	-	8	-	-	6	4	22	48	6	17	4	-	-	18	-	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																					
Cheatgrass	32	12	38	6	-	-	-	-	-	-	-	9	-	15	-	-	-	4	-	12	32
Mustard (spp)	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russian thistle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild lettuce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wheat	-	-	-	12	5	-	11	-	47	9	-	-	4	16	-	-	-	-	11	-	7
No. Vegetative Cover	51	81	92	121	79	37	94	51	87	61	114	83	74	127	50	54	70	80	100	159	81

* Values are total centimeters of above ground vegetative cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower, 1/3 of each plot.

APPENDIX TABLE 66. VEGETATION ANALYSIS (TRANSECT METHOD) ON NORTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. AUGUST 1976

	30 cm (12") Soil Cover						15 cm (6") Soil Cover						USBM Spent Shale						Soil		
	13			11			9			7			5			3			1		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
<u>GRASSES</u>																					
Western wheatgrass	84 *	56	67	77	46	64	178	78	161	102	97	165	123	159	212	180	239	249	135	109	70
Bluebunch wheatgrass	-	12	-	-	-	-	-	19	27	18	16	16	-	-	-	-	-	-	13	-	10
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	7	37	4	22	33	23	4	8	17	-	-	-	7	-	-	12	-	-	38	7	-
Timothy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	-	-	19	-	-	35	-	13	2	14	-	29	-	5	5	-	6	-	-	22	12
Bluegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																					
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	91	47	6	57	14	27	44	8	-	23	15	-	154	79	26	54	54	17	-	-	-
Rabbitbrush	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bitterbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big sagebrush	-	-	8	-	-	9	-	19	9	-	-	-	-	-	-	-	-	9	11	23	13
<u>FORBS</u>																					
Globe mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon (spp.)	-	13	27	7	-	91	13	41	72	25	50	35	-	-	-	-	-	-	37	41	109
Utah sweetvetch	-	5	5	-	24	-	9	-	-	7	7	-	-	-	11	-	-	8	-	7	-
Yellow sweetclover	-	-	-	-	-	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>WEEDY ANNUALS</u>																					
Cheatgrass	-	-	15	-	-	-	-	-	-	7	9	4	-	11	2	-	-	15	26	18	-
Lambsquarter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59	-	-
Mustard (spp)	-	-	14	-	-	14	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-
Snap-dragon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-
Russian thistle	44	9	70	17	33	71	-	21	-	13	-	41	-	-	-	-	-	-	14	22	14
Wild lettuce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wheat	8	4	45	-	-	-	-	7	13	31	62	9	6	5	-	4	-	-	-	-	-
No Vegetative Cover	159	167	72	170	168	60	87	136	69	110	94	49	60	85	94	100	51	56	71	40	22

* Values are total centimeters of above ground vegetative cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower, 1/3 of each plot.

APPENDIX TABLE 67. VEGETATION ANALYSIS (TRANSECT METHOD) ON SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE.
AUGUST 1976

	30 cm (12") Soil Cover						15 cm (6") Soil Cover						USBM Spent Shale						Soil		
	14			12			10			8			6			4			2		
	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3	line 1	line 2	line 3
<u>GRASSES</u>																					
Western wheatgrass	51	42	66	67	66	104	114	61	65	84	52	166	96	115	123	84	167	130	27	19	114
Bluebunch wheatgrass	-	-	-	-	-	-	27	-	39	14	13	29	-	7	16	-	12	14	4	-	-
Crested wheatgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian ricegrass	26	30	11	38	34	16	-	-	28	33	17	4	24	5	-	5	14	4	27	8	13
Timothy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin wildrye	-	-	-	-	-	-	18	-	-	-	-	10	-	-	-	-	-	-	-	-	-
Bluegrass	3	-	4	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-
<u>SHRUBS</u>																					
Winterfat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fourwing saltbush	25	80	81	102	112	65	47	41	59	69	66	26	110	130	75	145	73	107	131	-	22
Rabbitbrush	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	6	28	-
Bitterbrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big sagebrush	-	-	-	-	10	5	-	14	-	-	-	-	-	-	-	-	-	9	-	-	15
<u>FORBS</u>																					
Globe mallow	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon (spp.)	8	15	26	13	-	30	19	27	10	13	22	4	-	-	-	-	26	-	35	60	36
Utah sweetvetch	3	-	-	-	-	-	5	13	-	-	-	-	-	21	-	-	-	6	-	-	-
<u>WEEDY ANNUALS</u>																					
Cheatgrass	-	-	17	4	14	-	5	11	66	11	-	45	-	7	25	5	-	19	86	27	105
Mustard (spp)	-	-	-	2	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Russian thistle	91	14	-	37	57	-	-	38	-	-	-	-	16	-	-	-	6	-	24	54	6
Wild lettuce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wheat	13	26	44	5	42	-	22	39	30	20	19	18	-	6	72	-	-	28	-	24	-
No Vegetative Cover	130	143	90	82	57	90	84	106	51	106	139	49	54	56	39	111	56	33	14	120	39

* Values are total centimeters of above ground vegetative cover by species. Transect lines averaged 335 cm in length. Line 1 in upper, line 2 in middle, and line 3 in lower, 1/3 of each plot.

APPENDIX TABLE 68. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. 1974

NORTH ASPECT																		
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale					
	I			III			V			VII			IX			XI		
	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10
15	12.5*	--	5.5	19.7	--	7.2	29.7	--	3.7	23.0	--	2.2	19.0	18.2	4.7	13.2	8.2	10.7
30	21.5	--	16.0	23.0	--	17.7	32.2	--	31.5	34.5	--	24.7	19.7	19.0	17.0	23.0	19.0	22.0
45	21.5	--	17.0	19.0	--	17.7	31.2	--	29.0	30.5	--	26.5	19.0	17.2	21.2	18.2	19.7	21.2
60	19.7	--	19.2	16.5	--	17.7	28.0	--	28.2	27.2	--	24.7	14.0	15.7	22.0	15.7	18.2	23.0
75	19.7	--	18.7	15.0	--	17.7	26.5	--	27.2	24.0	--	24.7	14.0	15.7	23.7	16.5	16.5	22.0
90	14.0	--	17.0	13.2	--	17.7	25.5	--	28.2	21.5	--	26.5	13.2	15.0	24.7	16.5	18.2	24.7
105	12.5	--	17.0	11.5	--	17.0	23.0	--	30.0	19.0	--	26.5	13.2	13.2	23.0	16.5	18.2	26.5
120	13.2	--	16.0	11.5	--	16.0	22.2	--	30.0	17.2	--	28.2	13.2	12.5	23.7	15.7	15.7	25.5
135	13.2	--	16.0	11.5	--	16.0	19.7	--	30.0	16.5	--	28.2	12.5	11.7	23.7	17.2	17.2	26.5
150	13.2	--	16.0	11.5	--	16.0	19.7	--	33.2	15.7	--	30.0	13.2	13.2	24.7	19.7	18.2	27.2
165	14.0	--	17.7	11.5	--	16.0	19.7	--	33.2	15.0	--	31.5	13.2	15.0	24.7	20.5	19.7	28.2
180	--	--	--	--	--	--	--	--	--	15.7	--	31.5	--	--	--	--	--	--

SOUTH ASPECT																		
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale					
	II			IV			VI			VIII			X			XII		
	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10
15	18.2	--	7.2	24.7	--	8.2	28.0	--	2.2	27.2	--	2.2	24.7	17.2	10.7	21.5	16.5	13.2
30	26.5	--	17.0	33.0	--	17.7	35.5	--	28.2	34.7	--	29.0	23.0	23.0	10.7	24.0	22.2	21.2
45	28.0	--	22.0	30.5	--	21.2	32.2	--	30.0	29.7	--	26.5	16.5	19.0	21.2	18.2	21.5	21.2
60	23.0	--	23.0	27.2	--	21.2	31.2	--	28.2	26.5	--	24.7	15.0	18.0	23.0	16.5	16.5	21.2
75	19.7	--	21.2	21.5	--	22.2	28.0	--	28.2	24.7	--	26.5	14.0	17.2	23.0	15.0	17.2	23.0
90	16.5	--	21.2	20.5	--	21.2	24.7	--	26.5	21.5	--	26.5	13.2	13.2	24.0	16.5	17.2	24.0
105	12.5	--	21.2	18.2	--	23.0	21.5	--	28.2	23.0	--	28.2	12.5	13.2	24.0	14.0	14.0	24.0
120	9.0	--	20.5	15.0	--	22.2	19.7	--	28.2	21.5	--	30.0	13.2	13.2	24.0	13.2	14.0	23.0
135	8.2	--	19.2	12.5	--	22.2	17.2	--	28.2	18.2	--	30.0	15.0	13.2	24.7	12.5	12.5	23.0
150	8.2	--	19.2	12.5	--	23.0	17.2	--	28.2	19.0	--	30.0	15.0	14.0	24.7	12.5	12.5	23.0
165	8.2	--	19.2	13.2	--	23.7	19.7	--	31.5	19.7	--	30.0	15.0	15.0	26.5	15.0	15.7	24.7
180	--	--	--	--	--	--	21.5	--	31.5	--	--	--	--	--	--	15.0	16.5	24.7

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No readings.

APPENDIX TABLE 69. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. 1974

NORTH ASPECT																					
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						USBM Spent Shale						Soil		
	13			11			9			7			5			3			1		
	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10
15	19.7 [*]	--	5.5	33.0	--	7.2	33.0	--	18.7	31.2	--	16.0	29.0	27.2	16.0	28.0	26.5	17.0	29.7	--	7.2
30	29.7	--	16.0	33.0	--	19.2	32.2	--	28.2	31.2	--	26.5	29.7	29.0	27.2	31.2	28.0	28.2	33.0	--	23.0
45	29.7	--	21.2	29.7	--	26.5	32.2	--	27.2	33.0	--	28.2	27.2	29.0	28.2	27.2	29.7	28.2	30.5	--	24.0
60	28.0	--	24.7	24.7	--	25.5	29.7	--	26.5	29.7	--	30.7	26.5	26.5	27.2	26.5	26.5	29.0	30.5	--	28.2
75	27.2	--	26.5	24.7	--	25.5	28.0	--	29.0	29.7	--	30.0	24.7	25.5	29.0	26.5	26.5	28.2	24.7	--	29.0
90	24.0	--	24.7	24.7	--	27.2	28.0	--	29.0	29.7	--	30.0	24.7	24.7	27.2	25.5	24.7	29.0	15.7	--	30.0
105	22.2	--	24.7	23.0	--	27.2	26.5	--	28.2	26.5	--	30.0	24.7	24.7	29.0	24.7	23.0	28.2	13.2	--	30.7
120	21.5	--	24.0	21.5	--	28.2	24.7	--	28.2	28.0	--	31.5	24.7	24.7	29.0	24.7	24.0	29.7	13.2	--	30.7
135	21.5	--	24.7	20.7	--	26.5	25.5	--	31.5	28.0	--	33.5	26.5	24.0	30.0	26.5	25.5	29.7	15.0	--	30.7
150	21.5	--	26.5	21.5	--	26.5	25.5	--	31.5	26.5	--	33.5	26.5	24.7	31.5	26.5	26.5	31.2	15.7	--	30.0
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15.7	--	33.2
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

SOUTH ASPECT																					
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						USBM Spent Shale						Soil		
	14			12			10			8			6			4			2		
	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10	5/24	6/5	9/10
15	26.5	--	5.5	24.7	--	10.7	29.7	--	6.5	34.0	--	10.7	24.0	23.0	14.2	24.7	24.7	15.0	31.2	--	12.5
30	24.7	--	16.0	23.0	--	16.0	33.2	--	18.7	34.0	--	28.2	32.2	28.2	26.5	28.0	25.5	25.5	33.0	--	17.0
45	27.2	--	21.2	26.5	--	21.2	33.2	--	27.2	29.0	--	28.2	29.0	27.2	27.2	26.5	27.2	27.2	33.0	--	22.0
60	28.2	--	24.7	24.0	--	24.0	32.2	--	29.0	28.2	--	28.2	25.5	27.2	29.0	26.5	27.2	30.0	29.7	--	23.0
75	27.2	--	26.5	24.0	--	25.5	30.7	--	29.0	25.5	--	26.5	26.5	26.5	29.0	24.7	26.5	30.0	29.7	--	28.2
90	26.5	--	26.5	22.2	--	25.5	30.7	--	30.0	25.5	--	24.7	24.7	24.7	30.7	25.5	26.5	30.0	18.2	--	31.5
105	27.2	--	28.2	22.2	--	25.5	30.7	--	31.0	25.5	--	26.5	24.7	23.0	28.2	25.5	27.2	30.7	13.2	--	31.5
120	27.2	--	28.2	22.2	--	25.5	29.7	--	32.5	25.0	--	26.5	24.7	24.0	28.2	26.5	25.5	30.7	13.2	--	31.5
135	26.5	--	27.2	22.2	--	24.7	30.7	--	32.5	25.0	--	30.0	24.7	24.7	31.5	26.5	27.2	32.5	13.2	--	30.0
150	24.7	--	26.5	22.2	--	24.7	30.7	--	33.2	25.0	--	31.5	--	--	--	26.5	27.2	33.2	15.0	--	32.5
165	24.0	--	28.2	22.2	--	24.7	30.7	--	35.2	--	--	--	--	--	--	--	--	--	15.0	--	35.2
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No readings.

APPENDIX TABLE 70. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. 1975

NORTH ASPECT																		
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale					
	I			III			V			VII			IX			XI		
	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12
15	27.8*	27.3	16.5	30.3	28.8	17.0	18.0	24.8	22.5	14.3	18.3	23.5	34.3	17.3	13.3	26.3	21.5	20.5
30	24.0	35.8	24.0	25.5	32.3	23.5	28.5	34.5	26.8	37.5	34.5	27.8	25.5	34.5	22.3	33.0	33.0	23.8
45	18.8	33.3	24.5	18.8	31.3	24.5	27.8	35.5	26.3	32.8	35.5	26.3	21.5	34.5	23.0	25.5	33.0	23.5
60	20.3	33.3	25.5	17.3	29.8	25.0	25.5	34.5	25.8	24.8	34.5	25.7	21.5	35.5	24.5	19.8	32.3	22.8
75	17.3	32.3	24.0	16.5	29.8	24.0	24.8	35.5	27.3	24.0	34.5	27.3	22.5	35.5	25.0	21.5	33.0	24.8
90	15.0	29.8	24.5	15.0	28.0	23.5	24.8	36.3	28.5	24.0	33.8	28.5	21.0	35.5	26.0	23.0	34.5	26.0
105	13.5	24.8	23.0	13.5	25.5	23.5	24.0	36.3	28.3	23.3	34.5	28.5	20.0	35.5	26.3	22.3	34.5	26.8
120	14.3	24.0	22.0	13.5	25.5	24.0	25.5	35.5	29.3	24.0	36.3	28.5	19.3	35.5	25.5	21.5	34.5	26.8
135	16.5	24.0	21.0	14.3	24.8	22.0	24.0	35.5	29.3	24.0	35.5	29.3	19.3	36.3	27.3	24.0	36.3	28.0
150	16.5	24.8	22.0	15.0	25.5	22.0	24.8	38.0	29.3	24.8	35.5	29.3	20.0	37.0	27.5	24.0	37.0	29.3
165	17.3	25.5	21.0	14.5	25.0	21.0	24.8	38.0	28.8	25.5	35.5	28.3	21.5	37.0	27.5	25.5	36.3	29.8
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SOUTH ASPECT																		
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale					
	II			IV			VI			VIII			IX			XI		
	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12
15	20.8*	28.8	15.5	20.0	36.3	16.0	11.3	21.5	18.8	8.0	14.8	18.0	17.8	17.0	16.8	24.0	26.3	17.8
30	27.3	37.0	26.0	26.3	36.3	24.5	33.5	35.5	24.5	35.3	38.0	24.0	24.8	33.3	24.8	29.5	35.8	25.8
45	24.0	34.5	27.6	24.0	34.5	25.5	32.0	37.0	24.5	30.3	37.0	25.0	23.3	35.3	26.3	25.5	36.5	26.3
60	22.3	33.0	25.5	21.5	33.8	26.5	27.3	35.5	23.0	27.3	34.5	24.0	23.3	34.3	23.5	23.3	34.0	23.8
75	24.8	31.3	24.0	20.0	33.0	23.3	27.3	36.3	27.3	25.5	35.5	26.0	22.5	36.0	25.6	20.3	34.8	25.8
90	19.3	30.5	23.2	21.0	32.3	22.0	25.5	34.5	28.3	24.8	34.5	29.0	21.5	36.8	27.3	21.5	36.5	27.3
105	19.3	28.8	22.1	20.0	29.8	23.2	24.8	36.3	28.5	25.5	36.3	28.5	21.0	37.8	28.3	21.0	36.5	28.3
120	17.5	28.0	20.5	18.5	28.8	20.5	24.0	34.5	29.3	26.3	36.0	29.0	21.0	38.5	29.7	22.0	37.5	29.8
135	18.3	28.0	21.3	17.8	28.0	21.5	24.8	34.5	29.3	25.5	35.5	29.0	21.0	38.5	30.8	21.5	37.5	31.8
150	18.3	28.0	21.3	18.5	28.0	22.5	24.0	36.3	28.8	25.5	36.0	29.0	21.0	39.5	31.0	21.0	38.3	31.0
165	--	--	--	22.5	31.3	23.0	28.8	36.3	28.0	25.5	36.0	29.0	21.5	39.5	33.0	21.0	38.3	31.8
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 71. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. 1975

NORTH ASPECT																		
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						USBM Spent Shale					
	13			11			9			7			5			3		
	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12
15	30.5*	30.5	23.8	30.5	27.5	25.0	31.5	29.8	23.0	34.8	28.0	28.0	34.8	27.5	23.0	32.3	28.5	25.5
30	28.5	35.3	21.3	32.3	35.3	22.5	33.5	34.0	29.3	34.8	32.3	31.0	34.8	32.3	29.3	34.8	40.0	29.3
45	26.3	34.8	19.5	28.0	34.8	20.0	30.5	33.0	29.8	31.5	33.0	29.8	28.0	33.0	28.0	31.0	40.0	29.8
60	26.3	34.8	22.5	23.0	29.8	22.5	24.3	32.3	29.8	28.0	33.0	26.3	25.0	32.3	29.3	25.0	40.0	29.8
75	25.5	31.0	25.0	23.0	29.8	25.5	24.3	31.0	28.5	26.3	34.0	28.0	24.3	32.3	29.8	25.5	40.0	29.8
90	23.8	29.8	28.0	23.0	29.8	26.8	23.0	31.0	30.5	26.3	33.0	28.0	24.3	33.0	28.0	25.5	40.0	31.5
105	22.5	28.0	31.5	23.0	30.5	29.3	23.0	31.0	31.0	25.5	34.0	28.0	25.0	33.0	26.8	23.0	40.0	30.5
120	22.5	26.3	29.3	22.5	28.0	28.5	23.0	32.3	32.3	26.3	35.3	28.5	25.5	33.0	30.5	28.0	40.0	29.8
135	23.0	26.3	28.0	22.5	29.8	28.5	25.5	34.8	32.3	28.5	35.3	31.0	25.0	33.0	31.0	28.0	40.0	32.3
150	23.8	26.3	28.0	22.5	29.8	29.8	27.5	35.3	33.0	26.3	35.3	31.5	25.0	33.0	31.0	27.5	40.0	34.0
165	--	--	--	--	--	--	27.5	35.3	34.0	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

SOUTH ASPECT																		
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						USBM Spent Shale					
	14			12			10			8			6			4		
	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12	3/19	5/17	10/12
15	19.0*	26.3	31.3	19.5	25.5	23.8	23.0	25.5	28.5	25.5	28.0	27.5	22.5	31.0	23.8	26.3	34.0	16.5
30	19.5	32.3	20.8	18.3	40.0	28.5	26.8	40.0	31.5	30.5	40.0	31.0	33.0	40.0	29.3	34.0	40.0	29.3
45	20.0	32.3	25.0	19.5	40.0	29.3	28.0	40.0	31.0	29.3	40.0	33.0	29.8	40.0	29.8	34.0	40.0	28.5
60	22.5	31.0	28.5	19.5	40.0	25.0	26.8	40.0	28.0	25.5	40.0	32.3	28.5	40.0	29.3	32.3	40.0	28.5
75	23.0	29.8	27.5	22.0	40.0	28.0	25.0	40.0	28.0	23.0	40.0	30.5	35.3	40.0	28.5	28.5	40.0	29.8
90	25.0	36.5	25.5	22.5	40.0	27.5	25.0	40.0	27.5	22.5	40.0	31.5	26.3	40.0	29.3	28.5	40.0	29.3
105	24.3	25.5	24.3	22.0	40.0	28.0	26.8	40.0	27.5	23.0	40.0	33.0	25.5	40.0	31.0	28.5	40.0	28.5
120	25.5	25.5	26.8	22.0	40.0	26.3	26.3	40.0	30.5	24.3	40.0	33.5	26.3	40.0	31.0	28.5	40.0	31.5
135	25.0	26.3	28.5	19.5	40.0	28.0	26.3	40.0	33.0	24.3	40.0	34.8	28.5	40.0	29.3	29.8	40.0	33.0
150	23.0	26.3	28.5	21.3	40.0	28.0	28.0	40.0	34.0	24.3	40.0	35.3	28.5	40.0	29.8	31.0	40.0	33.5
165	22.5	25.0	28.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 72. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. 1976

Depth (cm)	I								III								V							
	30 cm (12") Soil Cover								30 cm (12") Soil Cover								15 cm (6") Soil Cover							
	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14			
15	--	27.8*	18.8	13.8	7.8	7.8	4.3	--	30.1	18.0	15.0	7.8	7.0	6.8	--	17.3	6.50	9.5	3.5	2.5	<.2			
30	--	29.8	26.5	17.5	13.8	10.3	11.5	--	31.0	26.5	21.3	13.8	12.0	15.8	--	15.8	29.0	26.5	13.8	10.0	9.0			
45	--	31.5	26.5	19.3	17.0	14.5	12.3	--	34.0	26.5	23.5	17.5	15.3	17.3	--	37.0	31.5	27.3	20.5	14.8	11.5			
60	--	29.8	27.3	21.8	20.5	17.0	17.3	--	32.8	24.8	22.3	18.8	17.0	19.8	--	34.0	30.3	27.3	22.3	18.5	17.3			
75	--	29.0	24.3	22.3	21.3	16.3	18.3	--	29.0	24.8	22.3	20.5	20.5	19.8	--	32.8	29.0	26.5	24.3	20.3	20.5			
90	--	26.5	23.5	21.3	21.3	16.3	18.3	--	28.5	23.5	22.3	22.3	20.5	19.8	--	31.5	31.5	27.8	26.0	21.3	20.5			
105	--	24.3	21.8	21.8	21.3	17.0	17.3	--	27.3	24.3	23.5	22.3	20.5	19.0	--	31.5	29.8	29.0	27.3	23.3	23.0			
120	--	22.3	21.3	21.8	21.3	18.0	17.3	--	26.5	22.3	24.3	22.3	22.0	19.0	--	32.8	31.5	29.0	28.5	25.0	22.3			
135	--	21.8	24.8	24.3	26.5	22.0	23.0	--	24.8	23.5	22.3	22.3	22.0	22.3	--	32.8	31.5	29.8	27.3	25.0	26.3			
150	--	24.3	26.5	27.8	28.5	23.8	26.3	--	24.8	24.3	24.8	26.0	23.8	22.3	--	32.8	29.8	29.8	29.0	27.8	28.0			
165	--	26.0	29.0	29.0	32.0	23.8	27.3	--	24.8	24.3	24.8	26.0	25.5	22.3	--	31.5	32.8	31.5	31.0	27.8	28.0			
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--			

Depth (cm)	VII								IX								XI								XII							
	15 cm (6") Soil Cover								TOSCO Spent Shale								TOSCO Spent Shale								Soil							
	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14				
15	--	14.5*	4.8	13.3	3.5	5.0	0.2	--	22.3	13.8	9.5	3.5	.2	.2	--	15.0	9.5	4.0	2.3	.2	.2	--	27.3	21.3	15.0	10.8	7.5	4.5				
30	--	14.5	26.5	26.5	12.0	10.8	9.5	--	22.3	26.0	17.0	7.3	2.8	2.8	--	13.0	26.0	13.8	5.3	2.8	2.5	--	27.3	27.8	21.8	17.5	18.0	13.8				
45	--	40.0	30.3	26.0	13.0	8.8	8.8	--	32.8	26.0	19.3	10.8	6.5	5.3	--	32.8	27.3	18.8	12.0	7.5	4.3	--	35.3	29.0	23.5	18.8	18.0	15.5				
60	--	37.5	27.3	24.8	15.8	8.8	7.0	--	29.0	26.0	22.3	15.8	8.5	4.5	--	31.5	24.3	18.8	15.8	9.3	6.8	--	35.8	29.8	24.3	18.8	17.0	15.5				
75	--	29.8	26.5	26.5	18.8	12.8	8.8	--	29.0	26.0	24.3	17.5	10.3	7.0	--	28.5	26.5	21.3	17.5	15.0	11.5	--	35.8	29.8	26.5	17.5	18.0	14.5				
90	--	29.0	27.3	27.3	22.3	15.8	12.0	--	29.0	27.8	24.3	20.5	15.0	9.5	--	29.0	26.5	26.0	22.3	21.8	15.8	--	35.3	29.8	24.8	18.8	18.0	15.5				
105	--	29.8	27.3	26.5	22.3	15.8	14.5	--	29.8	26.5	26.0	22.3	17.0	12.0	--	29.0	27.8	24.8	26.0	23.8	18.3	--	31.5	29.8	26.5	18.8	18.0	14.5				
120	--	29.0	27.3	28.5	24.3	22.5	18.0	--	29.0	27.3	26.5	24.3	21.8	16.3	--	29.8	29.0	26.5	27.3	25.5	19.8	--	26.5	27.8	26.5	18.8	18.0	14.5				
135	--	29.8	27.8	29.8	26.5	21.5	18.8	--	29.8	27.8	27.3	24.3	21.8	18.8	--	31.0	30.3	29.0	31.0	28.5	23.0	--	--	--	--	--	--	--				
150	--	31.0	29.8	31.0	27.3	24.5	20.5	--	31.0	27.3	27.3	26.0	21.8	18.8	--	33.3	30.3	29.0	32.9	29.3	24.0	--	--	--	--	--	--	--				
165	--	31.5	29.8	31.0	29.0	27.5	22.3	--	31.0	27.8	27.3	27.3	25.5	20.5	--	34.0	32.8	29.8	31.0	30.3	26.3	--	--	--	--	--	--	--				
180	--	--	--	--	--	--	--	--	31.5	27.8	27.3	27.3	25.5	20.5	--	33.3	32.8	29.8	31.0	30.3	26.3	--	--	--	--	--	--	--				

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 73. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. 1976

Depth (cm)	II 30 cm (12") Soil Cover								IV 30 cm (12") Soil Cover								VI 15 cm (6") Soil Cover							
	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14			
15	>40.0*	15.3	18.8	12.5	<.2	9.8	6.3	30.3	21.8	18.8	14.5	10.8	8.5	5.3	20.0	4.8	3.5	10.8	3.5	1.3	<.2			
30	>40.0	32.8	26.5	17.0	8.3	15.3	12.0	33.3	31.5	29.0	16.3	13.8	13.0	12.0	>40.0	32.8	29.0	20.0	10.3	9.5	6.0			
45	>40.0	31.0	27.3	17.5	15.0	11.8	11.3	31.0	31.5	29.0	19.3	15.8	13.0	12.0	>40.0	35.3	31.5	24.5	15.0	13.0	8.3			
60	>40.0	31.5	26.5	20.0	13.3	18.3	11.3	29.0	29.8	29.0	20.0	17.5	14.8	13.8	38.8	35.3	30.3	20.0	18.0	18.3	11.5			
75	39.5	28.8	26.5	20.0	17.0	19.0	13.5	26.5	29.8	27.3	20.5	20.5	18.3	16.3	38.3	33.3	29.8	24.3	23.0	22.0	17.3			
90	39.5	28.5	23.5	20.0	18.0	20.0	15.0	24.8	28.5	26.5	20.5	22.3	20.3	17.0	35.8	31.5	29.0	21.8	23.0	20.3	18.3			
105	39.5	26.5	24.8	20.5	20.0	19.0	16.0	24.3	26.5	26.0	20.5	22.3	20.3	18.8	35.8	32.8	27.3	24.3	24.8	23.8	19.0			
120	37.0	26.5	24.8	20.5	21.8	21.8	17.5	24.3	26.5	26.0	20.5	22.3	22.0	18.8	35.8	31.0	27.3	24.3	23.0	24.5	19.8			
135	37.0	26.5	24.8	21.3	23.0	22.8	17.5	24.3	26.5	26.0	20.5	22.3	21.0	19.5	35.8	31.0	29.0	26.0	24.8	25.5	20.5			
150	37.0	26.5	24.8	21.8	23.0	24.5	17.5	29.0	26.5	27.3	21.3	24.3	22.8	21.3	35.8	31.5	29.0	24.5	26.5	25.5	21.5			
165	37.0	26.5	24.8	21.8	24.8	24.5	17.5	29.0	31.0	31.0	24.8	29.0	25.5	24.8	35.8	35.3	32.0	27.8	29.8	29.0	25.5			
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--			

Depth (cm)	VIII 15 cm (6") Soil Cover								X TOSCO Spent Shale								XII TOSCO Spent Shale								XIV Soil							
	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14				
15	21.3*	7.3	8.3	11.5	5.3	1.3	.7	18.8	10.8	9.0	7.8	1.8	<.2	<.2	26.5	22.3	17.0	11.5	7.8	<.2	<.2	30.3	26.0	18.8	15.8	9.0	9.5	6.0				
30	35.3	37.0	30.3	20.0	12.0	9.0	7.3	30.3	29.0	24.8	12.0	6.5	4.0	1.8	31.0	31.0	23.5	15.8	10.3	5.8	3.5	32.0	35.3	29.0	20.0	18.8	16.5	17.0				
45	33.3	35.3	30.3	20.0	15.8	12.5	9.5	29.0	28.5	24.3	17.0	8.3	5.8	4.3	28.5	29.8	23.5	20.5	15.0	10.3	8.8	30.3	33.3	27.3	20.5	18.8	16.5	17.0				
60	32.0	31.5	27.8	18.8	18.8	15.0	15.0	28.5	29.0	27.3	19.3	10.3	6.8	4.3	24.8	27.3	23.5	20.5	16.3	12.0	10.8	22.3	29.8	26.5	21.8	18.8	18.3	16.3				
75	30.3	32.8	30.3	20.5	20.5	16.8	16.0	28.5	29.8	27.3	21.8	13.3	7.8	5.0	26.5	27.3	22.3	21.8	21.3	14.8	13.8	21.3	24.8	24.8	23.0	16.8	18.3	20.5				
90	30.3	31.5	27.8	21.3	24.3	19.5	19.3	28.5	29.8	27.3	23.0	17.0	11.3	6.8	26.5	29.0	24.3	24.5	21.3	18.3	17.0	20.0	20.5	19.3	21.8	17.5	18.3	15.5				
105	30.3	31.5	29.8	21.3	26.0	21.3	20.0	28.5	31.0	29.0	24.3	13.0	14.8	9.0	27.3	28.5	24.8	24.3	24.8	19.3	18.0	21.3	21.8	16.8	21.8	18.8	10.3	16.3				
120	30.3	34.0	29.0	23.5	26.0	22.0	20.8	27.3	29.8	28.5	24.5	20.0	15.8	11.5	30.3	29.0	24.8	26.0	24.3	20.3	18.8	23.0	23.0	27.3	24.3	18.8	18.3	14.5				
135	30.3	33.3	29.0	23.5	26.0	23.8	21.5	29.0	29.8	29.0	24.5	21.8	16.5	14.8	29.0	29.8	26.5	27.3	26.5	22.0	20.5	31.0	29.8	26.5	28.5	18.8	18.3	17.0				
150	32.0	33.3	30.3	23.5	27.3	25.5	22.3	30.3	31.0	28.5	26.5	23.0	18.3	18.3	29.0	29.8	26.5	29.0	28.5	23.8	20.5	--	--	--	--	--	--	--				
165	32.0	35.3	30.3	26.0	27.3	24.8	22.3	30.3	31.5	29.8	26.5	24.8	20.3	18.3	31.0	31.0	27.8	29.0	30.3	25.5	23.0	--	--	--	--	--	--	--				
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--				

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 74. MOISTURE MEASUREMENTS (NEUTRON PROBE) FROM NORTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. 1976

Depth (cm)	13 30 cm (12") Soil Cover								11 30 cm (12") Soil Cover								9 15 cm (6") Soil Cover								7 15 cm (6") Soil Cover							
	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14				
15	--	22.0*	19.8	15.0	10.3	10.0	6.0	--	18.5	16.3	17.5	8.8	10.8	5.3	--	22.0	21.5	21.3	15.8	12.3	9.5	--	21.5	23.0	19.3	12.0	11.8	7.0				
30	--	21.0	28.0	20.5	15.0	16.0	15.5	--	22.0	26.3	24.3	18.8	15.8	15.5	--	22.0	28.8	24.3	20.5	14.8	17.0	--	21.0	28.8	22.3	15.0	16.3	15.5				
45	--	19.0	29.8	26.0	18.0	17.8	17.0	--	21.5	27.0	28.5	24.3	18.0	18.8	--	20.5	27.0	26.5	22.3	18.0	18.8	--	21.0	30.5	27.3	20.0	21.0	18.8				
60	--	19.5	30.5	27.3	23.0	21.3	20.5	--	19.0	24.8	24.8	24.3	19.8	20.5	--	19.5	26.3	26.0	24.3	18.0	18.8	--	21.0	30.5	27.8	24.8	26.5	24.0				
75	--	18.5	26.3	26.5	24.8	23.0	22.3	--	19.5	26.3	27.3	24.3	19.8	18.8	--	19.0	25.5	26.0	24.8	19.8	20.5	--	20.0	30.5	27.3	26.5	28.3	25.5				
90	--	17.5	24.8	24.3	24.8	23.8	22.3	--	19.5	26.3	28.5	27.3	20.5	18.8	--	18.5	26.3	26.0	26.5	20.5	22.3	--	20.5	30.5	29.0	26.5	31.0	29.0				
105	--	16.5	23.0	24.3	24.8	22.0	20.5	--	19.0	26.3	28.5	27.3	24.0	20.5	--	18.5	25.5	27.3	27.3	21.5	22.3	--	20.5	30.5	29.8	29.8	31.0	29.0				
120	--	16.5	23.0	24.3	24.8	23.8	20.5	--	18.5	24.0	27.3	27.3	22.3	22.3	--	19.0	25.5	27.3	29.0	24.0	24.0	--	21.0	30.5	30.3	29.8	33.0	29.0				
135	--	17.0	22.3	26.5	26.5	24.8	20.5	--	18.0	25.5	28.5	27.3	24.0	22.3	--	20.5	26.3	29.0	31.0	24.8	29.0	--	22.0	31.3	30.3	31.5	33.8	30.8				
150	--	17.0	25.5	26.5	28.5	26.5	23.0	--	19.0	26.3	28.5	29.0	25.5	22.3	--	21.5	28.8	31.5	32.8	27.3	29.8	--	22.0	33.8	32.0	31.5	35.8	32.3				
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--			
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--			

Depth (cm)	5 USBM Spent Shale								3 USBM Spent Shale								1 Soil							
	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14			
15	--	23.5*	26.5	17.5	12.0	10.0	7.8	--	15.0	17.5	14.5	12.0	8.5	5.0	--	24.0	20.8	14.5	10.8	9.0	2.8			
30	--	21.5	33.5	21.8	15.0	16.0	17.0	--	23.0	28.0	24.8	15.8	15.0	14.0	--	23.0	27.8	16.3	16.3	14.3	12.8			
45	--	20.5	36.3	26.5	24.8	19.5	20.5	--	20.5	28.0	26.5	22.3	19.8	19.0	--	20.5	27.8	27.8	18.0	16.8	16.3			
69	--	20.0	34.3	27.3	26.5	23.0	20.5	--	20.0	27.0	27.3	24.3	20.8	19.8	--	21.0	27.8	27.3	20.5	17.8	15.5			
75	--	18.5	34.3	26.0	26.5	24.8	22.3	--	20.0	28.0	27.3	26.0	21.8	19.8	--	20.0	28.8	26.5	21.3	17.8	17.0			
90	--	18.5	34.3	27.3	28.5	24.8	25.5	--	20.0	27.0	26.5	27.3	23.8	22.3	--	18.0	25.5	26.0	22.3	16.8	15.5			
105	--	19.5	34.3	27.8	29.8	27.3	26.3	--	18.0	25.5	27.8	29.0	25.5	19.8	--	18.5	24.8	26.0	30.3	16.8	15.5			
120	--	20.5	35.3	29.0	29.8	29.8	29.0	--	20.0	23.8	29.8	29.0	29.3	28.0	--	19.0	24.8	26.0	26.5	16.0	14.5			
135	--	20.0	34.3	29.0	29.8	29.0	29.0	--	21.0	30.3	30.3	31.0	33.3	28.0	--	19.5	25.5	26.0	28.5	16.8	15.5			
150	--	20.0	34.0	27.8	29.8	29.0	28.0	--	20.5	30.3	30.3	32.8	33.3	30.5	--	19.0	24.0	27.8	28.5	16.8	15.5			
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20.5	26.3	27.8	30.3	19.5	15.5			
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--			

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 75. MOISTURE MEASUREMENTS (NUETRON PROBE) FROM SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. 1976

Depth (cm)	14								12								10								8										
	30 cm (12") Soil Cover								30 cm (12") Soil Cover								15 cm (6") Soil Cover								15 cm (6") Soil Cover										
	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14
15	30.3	18.8	17.3	12.0	6.5	7.5	5.3	31.0	24.3	17.8	13.3	12.0	12.5	8.8	35.8	10.8	11.5	12.0	6.5	9.0	2.0	34.0	15.8	14.5	12.5	8.3	8.0	5.3							
30	28.5	29.0	26.3	17.0	14.5	13.0	13.8	29.0	29.0	24.8	15.0	15.0	15.0	12.0	40.0	29.8	27.3	18.0	15.0	16.0	12.0	40.0	32.8	27.8	20.0	18.0	17.8	15.5							
45	23.0	22.5	26.3	20.5	17.0	15.8	18.8	27.3	29.0	24.8	19.3	17.0	15.0	15.5	40.0	32.8	28.8	23.0	20.0	17.8	18.0	37.0	32.8	27.0	26.5	20.0	19.5	20.5							
60	24.8	27.3	23.0	24.8	18.0	16.5	18.8	24.8	27.3	24.8	22.3	18.0	16.0	16.3	38.3	29.8	28.0	24.3	20.0	18.5	17.0	35.8	29.8	24.8	26.0	23.0	20.3	18.8							
75	26.0	24.8	26.0	24.8	20.0	17.5	16.3	26.0	28.5	26.3	24.8	20.0	18.5	17.0	37.0	29.8	28.0	24.8	23.0	18.5	17.0	35.8	29.0	24.8	26.5	24.8	21.3	20.5							
90	27.3	24.3	25.5	26.0	24.3	20.3	22.3	28.5	27.3	27.0	26.5	23.0	19.5	17.0	37.0	31.0	28.8	27.3	26.5	21.3	20.5	32.8	28.5	24.8	24.8	26.5	23.0	20.5							
105	27.3	24.3	26.3	26.5	26.5	20.3	20.5	30.3	31.5	27.0	28.5	24.8	22.0	20.5	38.3	32.8	31.3	29.8	28.5	24.8	23.0	35.8	29.8	26.3	24.8	28.5	24.8	24.0							
120	28.5	27.3	26.3	27.3	28.5	24.5	22.3	28.5	27.3	25.5	27.3	26.5	22.0	20.5	37.0	32.8	32.0	32.0	29.8	27.3	27.3	34.0	29.0	26.3	27.3	29.8	27.3	24.0							
135	27.3	26.5	26.3	27.3	28.5	25.5	25.5	28.5	26.5	24.8	26.5	28.5	24.8	20.5	38.3	31.5	31.3	31.0	31.5	29.0	27.3	35.8	31.0	27.8	29.8	29.8	29.8	27.3							
150	26.5	26.5	24.8	26.0	28.5	25.5	24.8	30.3	28.5	27.0	29.0	28.5	26.5	25.5	38.8	32.8	33.0	32.0	33.3	29.8	30.8	35.8	31.0	29.5	31.0	29.8	30.8	29.0							
165	27.3	24.3	24.8	26.0	28.5	27.3	29.0	--	--	--	--	--	--	--	38.8	32.8	33.8	32.0	34.5	31.5	30.8	--	--	--	--	--	--	--							
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--							

Depth (cm)	6								4								2							
	USPM Spent Shale								USBM Spent Shale								Soil							
	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14	3/10	3/31	5/8	6/9	7/8	8/12	9/14			
15	32.8*	15.8	17.0	10.8	10.8	11.5	5.3	38.3	20.0	17.8	10.8	10.3	12.3	6.0	38.3	22.3	19.5	13.8	12.0	10.8	8.0			
30	40.0	31.0	24.0	19.3	17.5	14.3	13.8	40.0	29.8	22.5	18.0	15.0	14.5	13.8	38.8	31.5	28.0	18.8	17.5	15.0	12.5			
45	38.3	31.0	24.8	21.3	18.8	16.0	16.3	38.8	31.0	24.8	22.3	18.0	18.5	15.5	40.0	33.3	29.0	20.5	18.8	16.0	17.3			
60	32.3	29.8	26.3	17.5	20.5	16.8	16.3	38.8	32.8	27.0	24.8	20.0	20.5	17.0	38.8	32.8	29.8	21.8	20.5	16.0	17.3			
75	38.3	31.0	27.8	27.3	22.3	17.8	16.3	35.8	31.0	26.3	26.5	23.0	21.5	17.0	40.0	35.3	32.3	18.8	18.8	16.8	18.3			
90	34.0	29.8	26.3	26.0	24.3	19.5	16.3	37.0	31.5	27.0	28.5	24.8	23.5	19.5	35.8	32.8	32.3	24.8	18.8	16.8	17.3			
105	34.0	28.5	25.5	26.5	26.0	21.3	17.0	34.0	29.8	27.8	27.3	26.5	23.5	19.5	34.0	31.0	31.5	24.8	18.8	16.0	17.3			
120	37.0	31.0	27.0	29.0	27.3	23.0	20.5	38.3	28.5	27.0	27.3	28.5	25.5	19.5	32.0	28.5	29.0	24.8	17.5	14.3	16.3			
135	38.3	31.0	29.5	29.0	29.0	26.5	24.8	38.3	31.0	27.0	31.0	31.5	30.5	24.0	31.0	25.8	27.3	24.8	17.5	14.3	15.5			
150	--	--	--	--	--	--	--	38.3	31.0	26.3	31.5	33.3	31.5	25.5	32.8	26.5	29.8	28.5	20.5	15.0	15.5			
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	35.8	26.5	30.5	29.8	20.5	16.8	17.3			
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--			

* Values are in percent moisture by volume as determined from a standard soil moisture curve.

-- No reading made.

APPENDIX TABLE 76. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES OF TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. 1973 and 1974

NORTH ASPECT																					
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale								Soil
	I			III			V			VII			IX				XI				XIII
	10/73	5/74	9/74	10/73	5/74	9/74	10/73	5/74	9/74	10/73	5/74	9/74	10/73	5/74	6/74	9/74	10/73	5/73	6/74	9/74	9/74
5	--	--	0.95*	--	--	1.7	--	--	2.7	--	--	2.6	6.8	6.9	2.0	13.0	5.1	7.6	2.1	16.0	1.2
15	--	--	0.65	--	--	1.1	--	--	1.7	--	--	1.1	8.8	4.9	2.1	5.3	9.3	--	2.1	4.9	0.6
30	--	--	2.50	--	--	3.5	--	--	2.9	--	--	3.2	11.2	5.6	3.6	4.5	9.2	6.1	3.2	4.4	0.8
45	--	--	--	--	--	--	--	--	--	--	--	--	--	9.2	--	4.9	--	--	--	4.5	0.6
60	--	--	7.0	--	--	7.6	--	--	2.9	--	--	3.0	11.4	9.1	8.2	6.2	11.2	10.1	9.1	4.8	--
75	--	--	--	--	--	--	--	--	--	--	--	--	--	9.4	--	8.3	--	--	--	5.1	--
90	--	--	7.6	--	--	9.3	--	--	3.6	--	--	3.1	11.3	9.2	20.0	13.5	11.0	8.3	20.0	8.4	--
105	--	--	--	--	--	--	--	--	--	--	--	--	--	9.4	--	13.0	--	--	--	15.0	--
120	--	--	12.0	--	--	9.3	--	--	4.6	--	--	3.5	11.3	9.4	20.0	15.5	11.0	9.3	20.0	17.1	--
135	--	--	--	--	--	--	--	--	--	--	--	--	--	9.4	--	16.0	--	--	--	17.5	--
150	--	--	--	--	--	--	--	--	--	--	--	--	13.2	8.8	20.0	17.0	11.0	7.8	20.0	16.5	--
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17.0	--	--	--	16.5	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

SOUTH ASPECT																					
Depth (cm)	30 cm (12") Soil Cover						15 cm (6") Soil Cover						TOSCO Spent Shale								Soil
	II			IV			VI			VIII			X				XII				XIV
	10/73	5/74	9/74	10/73	5/74	9/74	10/73	5/74	9/74	10/73	5/74	9/74	10/73	5/74	6/74	9/74	10/73	5/74	6/74	9/74	9/74
5	--	--	3.5*	--	--	2.4	--	--	3.4	--	--	5.7	14.9	11.0	2.0	18.0	10.8	7.6	2.0	15.0	1.0
15	--	--	1.1	--	--	0.95	--	--	3.7	--	--	2.4	18.7	--	2.0	5.8	11.1	--	2.1	10.5	1.0
30	--	--	3.2	--	--	3.8	--	--	3.6	--	--	3.9	--	4.5	4.8	4.3	11.4	6.1	5.2	5.2	0.8
45	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.5	--	--	--	5.2	0.6
60	--	--	5.5	--	--	3.2	--	--	5.6	--	--	3.5	11.2	7.1	12.5	10.1	11.1	10.1	14.0	5.1	--
75	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12.8	--	--	--	5.5	--
90	--	--	8.3	--	--	5.6	--	--	4.1	--	--	3.9	11.0	7.8	20.0	15.5	10.9	8.3	20.0	6.2	--
105	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15.5	--	--	--	9.2	--
120	--	--	9.7	--	--	16.0	--	--	5.6	--	--	5.6	11.3	8.3	20.0	16.0	11.1	9.3	20.0	15.5	--
135	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17.0	--	--	--	16.0	--
150	--	--	--	--	--	--	--	--	--	--	--	--	10.5	8.2	20.0	17.0	10.5	7.8	20.0	17.0	--
165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17.0	--	--	--	17.0	--
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	18.0	--	--	--	17.0	--

* EC Values are in mmhos/cm @ 25° C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 77. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES OF USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. 1974

NORTH ASPECT														
Depth (cm)	30 cm (12") Soil Cover				15 cm (6") Soil Cover				USBM Spent Shale					
	13		11		9		7		5			3		
	5/74	9/74	5/74	9/74	5/74	9/74	5/74	9/74	5/74	6/74	9/74	5/74	6/74	9/74
	5/74	9/74	5/74	9/74	5/74	9/74	5/74	9/74	5/74	6/74	9/74	5/74	6/74	9/74
5	--	0.4*	--	0.5	--	1.3	--	1.1	8.8	1.0	9.2	6.0	1.6	11.0
15	--	0.4	--	0.2	--	0.4	--	0.7	5.0	3.1	4.9	5.2	3.0	5.6
30	--	0.4	--	1.4	--	0.4	--	0.1	6.2	--	4.4	4.3	--	7.2
45	--	--	--	--	--	--	--	--	6.0	4.2	5.8	7.5	5.0	5.6
60	--	4.6	--	0.4	--	0.9	--	0.1	6.0	9.6	5.8	7.3	9.6	5.4
75	--	--	--	--	--	--	--	--	--	--	5.9	--	--	6.1
90	--	5.3	--	4.1	--	1.9	--	2.0	6.0	10.0	6.4	7.3	14.2	7.4
105	--	--	--	--	--	--	--	--	--	--	7.3	--	--	--
120	--	4.0	--	4.4	--	1.8	--	2.5	6.5	10.0	6.1	7.1	12.5	7.6
135	--	--	--	--	--	--	--	--	--	--	6.1	--	--	8.1
150	--	--	--	--	--	--	--	--	--	10.0	6.2	5.3	13.0	8.1
165	--	--	--	--	--	--	--	--	--	--	6.1	--	--	7.8
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--

SOUTH ASPECT														
Depth (cm)	30 cm (12") Soil Cover				15 cm (6") Soil Cover				USBM Spent Shale					
	14		12		10		8		6			4		
	5/73	9/74	5/74	9/74	5/74	9/74	5/74	9/74	5/74	6/74	9/74	5/74	6/74	9/74
	5/73	9/74	5/74	9/74	5/74	9/74	5/74	9/74	5/74	6/74	9/74	5/74	6/74	9/74
5	--	0.6*	--	0.6	--	2.7	--	2.3	4.8	1.7	18.0	6.6	1.5	16.0
15	--	0.4	--	0.4	--	1.4	--	1.2	5.4	2.7	4.7	5.0	3.0	2.2
30	--	0.4	--	0.5	--	0.2	--	0.5	5.9	5.0	7.2	5.9	6.1	5.6
45	--	0.8	--	1.3	--	1.8	--	0.8	5.9	--	7.1	6.6	--	6.2
60	--	3.9	--	3.6	--	2.0	--	1.2	5.7	10.0	8.0	6.6	11.5	6.0
75	--	--	--	3.5	--	--	--	--	--	--	7.9	--	--	6.9
90	--	4.1	--	3.7	--	2.0	--	1.1	5.7	12.0	7.5	5.5	15.0	5.9
105	--	--	--	3.1	--	--	--	--	--	--	7.3	--	--	7.4
120	--	4.5	--	4.0	--	2.0	--	2.0	5.1	12.0	6.7	6.9	15.0	6.0
135	--	--	--	--	--	--	--	--	--	--	7.7	--	--	6.3
150	--	--	--	--	--	--	--	--	--	12.0	9.8	--	12.0	6.2
165	--	--	--	--	--	--	--	--	--	--	8.3	--	--	7.1
180	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 78. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES ON NORTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. SPRING AND FALL 1975

Depth (cm)	30 cm (12") Soil Cover				15 cm (6") Soil Cover				TOSCO Spent Shale						Soil
	I		III		V		VII		IX			XI			XIII
	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	6/75	11/75	4/75	6/75	11/75	11/75
5	2.5 *	1.7	0.6	0.8	1.1	1.3	1.5	2.0	4.9	3.8	5.0	4.5	3.8	4.9	1.2
15	0.6	1.2	1.5	0.7	1.1	3.0	1.7	1.6	4.9	4.2	5.3	4.8	5.3	5.8	1.1
30	3.8	6.2	1.5	--	2.9	4.3	3.5	--	4.6	3.8	4.2	6.6	4.3	5.2	0.9
45	6.7	6.4	6.7	8.8	3.1	5.1	3.9	3.7	4.5	3.7	4.3	7.2	4.1	5.5	--
60	8.8	9.6	8.6	8.6	3.2	5.6	3.9	--	5.4	3.7	4.5	6.5	4.0	4.3	--
75	12.3	10.6	9.8	5.4	3.5	5.7	3.8	3.8	7.3	4.0	4.3	7.5	4.2	4.1	--
90	12.5	11.6	15.0	7.2	3.5	6.6	4.5	3.7	8.9	4.3	4.4	8.5	4.5	5.0	--
105	14.2	12.0	14.0	9.4	4.1	6.8	4.5	--	11.5	3.8	4.4	10.5	4.5	4.6	--
120	13.0	9.3	13.2	--	5.4	--	5.1	3.9	13.0	--	4.7	13.0	4.8	4.6	--
135	12.0	9.7	12.8	--	8.3	--	6.2	--	15.3	--	5.1	--	--	4.2	--
150	11.7	10.4	14.5	--	8.7	--	10.0	4.5	12.5	--	4.8	15.3	--	5.1	--
165	12.2	9.4	13.5	--	10.5	--	14.5	--	--	--	5.2	--	--	5.3	--
180	12.3	6.4	14.5	--	15.5	--	17.5	4.5	--	--	5.2	15.0	--	5.6	--
195	11.8	--	10.5	--	17.5	--	18.0	5.0	--	--	--	--	--	6.4	--
210	5.9	--	6.1	--	12.5	--	--	--	--	--	--	--	--	--	--

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 79. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES ON SOUTH-ASPECT TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS.
PICEANCE BASIN STUDY SITE. SPRING AND FALL 1975

Depth (cm)	30 cm (12") Soil Cover				15 cm (6") Soil Cover				TOSCO Spent Shale						Soil
	II		IV		VI		VIII		X			XII			XIV
	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	6/75	11/75	4/75	6/75	11/75	11/75
5	0.9*	0.5	0.6	1.1	0.8	1.7	0.5	0.9	5.4	2.7	3.9	4.8	3.3	6.0	1.5
15	0.7	0.6	0.9	0.9	2.8	3.6	1.4	2.3	4.5	3.6	2.8	4.4	4.1	5.9	1.4
30	1.9	1.5	2.9	7.4	3.6	4.9	3.2	4.2	4.3	3.7	4.2	4.6	3.9	4.4	0.9
45	4.7	6.5	3.9	6.4	3.1	--	3.5	--	4.8	3.7	5.3	5.3	4.1	4.5	--
60	6.0	7.6	5.3	8.2	3.5	4.1	3.6	5.4	7.0	3.7	4.3	8.5	4.1	4.6	--
75	13.0	--	8.4	--	3.6	--	4.2	3.7	6.8	4.1	4.7	7.5	4.3	4.0	--
90	13.0	8.8	14.3	9.0	4.2	4.1	4.3	5.7	5.8	--	4.5	7.3	4.2	4.6	--
105	15.0	--	14.3	--	4.7	--	5.3	--	6.3	--	4.0	9.1	--	4.7	--
120	15.0	9.9	16.2	9.0	6.4	4.4	6.9	3.9	7.9	--	4.4	11.5	--	5.1	--
135	15.0	--	15.9	--	8.5	--	13.0	--	9.0	--	4.7	13.0	--	4.9	--
150	12.5	10.3	15.8	11.1	12.2	4.9	17.0	4.1	11.0	--	5.0	15.0	--	5.0	--
165	13.2	--	15.0	--	15.5	--	18.5	--	10.0	--	4.4	15.0	--	5.3	--
180	10.7	9.9	13.5	11.4	16.5	4.9	18.0	4.1	--	--	4.8	--	--	5.2	--
195	11.6	--	7.1	--	15.5	--	17.2	5.3	--	--	4.8	--	--	5.9	--
210	5.2	7.2	4.7	5.8	--	5.5	13.5	4.7	--	--	--	--	--	--	--

* EC values are in mmhos/cm @ 25⁰ C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 80. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES ON NORTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS.
PICEANCE BASIN STUDY SITE. SPRING AND FALL 1975

Depth (cm)	30 cm (12") Soil Cover				15 cm (6") Soil Cover				USBM Spent Shale						Soil
	13		11		9		7		5			3			1
	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	6/75	11/75	4/75	6/75	11/75	11/75
S	0.6 *	0.8	1.2	1.0	2.4	1.2	2.1	1.0	2.1	2.2	1.7	2.6	2.3	1.9	1.5
15	0.5	0.8	0.6	1.1	1.2	1.3	1.5	2.9	3.6	2.7	2.2	3.8	2.0	1.7	1.3
30	0.6	0.7	0.6	5.5	2.9	2.1	3.7	3.6	3.8	4.0	4.6	5.4	2.6	2.5	0.8
45	3.2	4.8	4.3	6.2	3.6	1.8	4.3	4.3	5.1	5.7	4.5	6.2	3.0	4.9	--
60	6.6	7.4	5.6	8.2	3.5	3.5	4.8	4.6	5.8	5.5	4.6	5.8	4.2	4.9	--
75	6.6	9.2	6.4	7.7	3.8	4.5	4.9	5.1	6.1	5.9	4.4	6.2	4.4	4.9	--
90	6.5	6.8	6.9	9.0	4.5	5.4	5.6	4.8	6.6	6.7	4.2	5.6	5.3	5.0	--
105	5.5	7.0	6.9	8.8	4.7	6.2	6.8	5.2	--	5.1	5.0	6.0	5.1	5.0	--
120	7.2	6.2	6.8	8.1	6.0	4.6	--	6.6	--	5.3	5.5	5.3	5.0	4.4	--
135	6.6	7.0	6.5	8.0	6.1	4.5	--	4.9	--	6.0	6.0	4.5	5.2	5.8	--
150	6.3	--	5.6	--	6.1	4.5	6.0	4.7	--	6.2	5.0	--	5.5	5.2	--
165	6.1	--	5.5	--	6.2	4.3	7.2	3.5	--	6.0	4.8	--	6.0	4.5	--
180	6.0	--	5.3	--	6.1	4.3	--	--	--	--	5.0	--	--	4.5	--
195	5.8	--	4.2	--	4.5	3.4	--	--	--	--	5.2	--	--	--	--
210	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 81. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:L SAMPLE FROM CORES ON SOUTH-ASPECT USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS.
PICEANCE BASIN STUDY SITE. SPRING AND FALL 1975

Depth (cm)	30 cm (12") Soil Cover				15 cm (6") Soil Cover				USBM Spent Shale						Soil
	14		12		10		8		6			4			2
	4/75	11/75	4/75	11/75	4/75	11/75	4/75	11/75	4/75	6/75	11/75	4/75	6/75	11/75	11/75
5	1.0*	0.4	1.1	1.0	1.1	1.2	0.8	1.3	2.8	1.8	2.8	2.6	1.7	1.5	1.5
15	1.4	0.5	0.6	0.9	0.4	1.1	0.9	0.5	3.0	2.9	2.0	3.8	2.5	2.2	1.7
30	1.4	0.7	0.5	1.2	1.4	2.2	1.7	1.9	3.1	5.1	--	5.4	4.9	4.4	0.7
45	6.8	2.5	0.7	1.4	3.2	2.7	2.8	3.5	6.3	5.7	--	6.2	5.7	4.3	--
60	6.1	6.6	5.6	3.5	3.1	6.3	5.0	3.5	--	5.6	--	5.8	5.4	4.6	--
75	7.3	6.8	6.3	7.0	4.5	5.5	4.8	4.0	5.4	--	5.2	5.6	5.4	5.0	--
90	7.0	6.8	6.0	4.0	4.6	5.2	--	3.6	5.9	--	--	6.0	5.0	5.0	--
105	6.8	5.9	5.7	7.0	5.8	6.4	5.0	4.3	5.5	--	--	5.1	5.3	5.1	--
120	8.1	5.8	6.2	7.9	5.4	6.0	5.5	6.2	5.9	--	--	4.5	5.8	5.4	--
135	6.8	5.1	5.3	8.6	5.9	5.7	5.4	6.8	6.2	--	4.3	--	6.0	5.1	--
150	7.6	5.1	6.3	9.2	5.6	4.7	5.6	--	5.7	--	--	--	6.2	3.8	--
165	7.3	6.7	5.1	8.1	5.2	5.4	4.8	5.9	5.3	--	--	--	6.5	--	--
180	6.6	5.6	5.5	--	6.5	5.1	5.5	5.3	4.7	--	4.5	--	6.5	--	--
195	6.2	5.8	5.1	--	5.6	5.4	2.7	--	--	--	3.1	--	--	--	--
210	6.5	5.3	5.3	--	--	--	--	--	--	--	--	--	--	--	--

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 82. SALINITY SENSOR MEASUREMENTS FOR TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS.
PICEANCE BASIN STUDY SITE. 1975-1976

Plot No.		Depth (cm)	Serial No.	NORTH ASPECT					
				1975			1976		
				4/23	6/11	8/28	6/9	8/12	9/14
I	30 cm (12") Soil Cover	18	3511	1.99*	2.04	<1.5	<1.5*	<1.5	--
		50	3337	20.5	15.00	9.2	13.0	>40.0	--
III	30 cm (12") Soil Cover	18	3334	1.93	1.0	<1.5	<1.5	<1.5	--
		50	3353	39.0	>40.0	>40.0	9.1	>40.0	--
V	15 cm (6") Soil Cover	18	3336	4.8	<1.50	3.3	4.1	9.2	--
		50	3576	5.53	3.80	3.35	4.0	4.1	--
VII	15 cm (6") Soil Cover	18	3361	5.07	1.90	1.7	4.10	2.15	--
		50	3327	5.88	2.90	3.1	3.7	5.9	--
IX	TOSCO Spent Shale	18	3348	10.80	2.65	3.7	10.0	31.0	26.0
		50	3359	18.0	2.25	3.4	6.1	20.0	18.0
		90	3574	29.0	3.40	3.5	4.8	5.6	9.0
		120	3585	30.0	4.50	4.0	4.6	5.15	6.5
		150	3598	29.0	14.0	5.1	4.8	5.35	7.3
XI	TOSCO Spent Shale	18	3363	9.0	<1.5	<1.5	4.1	2.3	2.7
		50	3342	16.0	3.1	3.9	4.9	11.4	16.0
		90	3267	32.5	4.10	4.0	5.3	6.4	16.0
		120	3583	28.0	6.8	5.3	5.3	6.7	8.0
		150	3599	24.0	19.0	6.6	0	0	10.5
XIII	Soil Control	No salinity sensor							
Plot No.		Depth (cm)	Serial No.	SOUTH ASPECT					
				1975			1976		
				4/23	6/11	8/28	6/9	8/12	9/14
II	30 cm (12") Soil Cover	18	3351	1.0*	2.20	2.2	<1.5	<1.5	--
		50	3362	9.8	9.50	6.7	10.0	15.0	--
IV	30 cm (12") Soil Cover	18	3330	3.10	3.3	3.3	3.7	<1.5	--
		50	3567	6.62	7.0	2.2	6.3	9.5	--
VI	15 cm (6") Soil Cover	18	3571	4.60	<1.5	4.8	8.0	34.0	--
		50	3561	7.30	3.50	3.2	3.8	3.85	--
VIII	15 cm (6") Soil Cover	18	3570	3.64	<1.5	2.5	5.5	11.8	-
		50	3578	4.3	2.2	1.8	2.3	<1.5	--
X	TOSCO Spent Shale	18	3344	11.25	3.0	3.5	5.1	9.7	6.5
		50	3568	14.25	3.50	3.2	3.4	2.4	4.5
		90	3503	30.0	3.9	3.6	4.4	2.25	6.0
		120	3580	35.0	--	5.0	5.7	7.5	9.0
		150	3597	27.0	6.50	4.8	4.2	2.9	6.5
XII	TOSCO Spent Shale	18	3573	12.0	2.06	<1.5	2.6	1.85	3.0
		50	3519	24.0	3.5	4.8	6.0	7.5	9.0
		90	3566	25.0	6.1	4.6	4.6	5.2	7.0
		120	3588	29.0	>40.0	4.5	<1.5	11.5	11.0
		150	3595	34.0	16.0	6.6	--	0	16.0
XIV	Soil Control	No salinity sensor							

* Values are EC in mmhos/cm @ 25°C.

-- No reading.

APPENDIX TABLE 83. SALINITY SENSOR MEASUREMENTS FOR USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. 1975-1976

Plot No.		Depth (cm)	Serial No.	NORTH ASPECT					
				1975			1976		
				4/23	6/11	8/28	6/9	8/12	9/14
13	30 cm (12") Soil Cover	18	3346	10.5*	35.0	11.0	11.8*	14.5	--
		50		--	--	--	--	--	--
11	30 cm (12") Soil Cover	18	3341	1.0	1.5	1.5	1.5	1.5	--
		50	3355	8.9	12.0	7.9	11.8	36.0	--
9	15 cm (6") Soil Cover	18	3517	3.25	1.5	1.5	6.8	1.5	--
		50	2991	2.50	2.4	1.5	1.5	1.5	--
7	15 cm (6") Soil Cover	18	3345	4.95	--	1.7	4.1	3.3	--
		50	3326	2.30	--	2.8	3.8	3.7	--
5	USBM Spent Shale	18	3562	3.25	1.5	1.5	2.4	1.5	1.5
		50	3564	5.05	1.7	1.5	1.5	2.05	2.0
		90	3575	8.80	2.7	2.4	2.4	3.0	3.5
		120	3593	7.90	7.8	4.5	4.5	4.55	5.0
		150	3581	7.90	4.2	3.2	3.2	5.1	5.2
3	USBM Spent Shale	18	3569	4.35	2.0	2.3	2.8	1.5	1.5
		50	3338	11.25	2.8	2.5	2.6	3.7	4.0
		90	3563	9.25	2.6	1.5	1.5	1.5	1.5
		120	3592	10.30	6.6	4.3	3.9	4.0	4.1
		150	3589	10.25	3.6	1.5	3.2	6.0	6.5
1	Soil Control	No salinity sensor							
Plot No.		Depth (cm)	Serial No.	SOUTH ASPECT					
				1975			1976		
				4/23	6/11	8/28	6/9	8/12	9/14
14	30 cm (12") Soil Cover	18	3329	1.9*	1.5	1.5	1.5*	1.5	--
		50	3354	7.05	13.0	8.2	9.2	4.95	--
12	30 cm (12") Soil Cover	18	3273	1.0	1.5	1.5	1.5	1.5	--
		50	3269	10.85	9.8	3.8	6.5	2.9	--
10	15 cm (6") Soil Cover	18	3325	2.98	1.5	1.5	2.3	1.5	--
		50	3340	4.23	2.3	2.3	2.1	1.9	--
8	15 cm (6") Soil Cover	18	3506	1.74	1.5	1.5	1.5	1.5	--
		50	3358	1.0	1.5	2.4	3.9	2.35	--
6	USBM Spent Shale	18	3579	4.10	1.5	1.5	1.5	1.5	1.5
		50	3560	7.33	1.7	1.7	1.5	1.5	1.5
		90	3572	9.0	2.65	2.3	2.1	1.5	2.0
		120	3582	8.65	2.9	2.7	2.6	0	1.5
		150	3596	11.5	6.0	1.5	3.5	0	1.5
4	USBM Spent Shale	18	3505	2.75	1.5	1.5	1.5	1.5	1.5
		50	3514	6.0	1.6	1.6	1.5	1.5	2.0
		90	3577	3.35	4.0	2.3	1.5	1.5	2.1
		120	3590	10.40	7.0	4.6	4.6	10.4	9.6
		150	3584	12.50	2.3	2.0	2.8	1.62	3.7
2	Soil Control	No salinity sensor							

* Values are EC in mmhos/cm @ 25°C.

-- No reading.

APPENDIX TABLE 84. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES OF TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. AUGUST 1976

Depth (cm)	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VIII	X	XII	XIV
S	3.0 *	0.9	0.6	1.1	3.0	4.2	1.8	1.0	0.6	2.4	0.6	2.8	2.1	1.6
15	3.5	0.7	0.6	--	5.8	5.4	2.4	0.8	1.2	3.2	1.9	4.0	3.7	3.7
30	3.8	2.4	3.2	3.8	4.6	4.4	2.2	--	2.6	4.0	2.9	3.9	5.7	1.3
45	11.3	10.4	3.5	3.1	4.2	4.5	--	6.6	7.0	4.0	2.9	3.8	--	1.2
60	11.1	10.4	3.5	3.3	4.1	5.4	2.4	7.2	--	3.8	3.0	3.6	4.0	1.0
75	11.1	10.1	3.7	3.3	4.2	5.4	--	9.3	9.4	4.1	3.0	3.6	3.6	0.9
90	9.4	10.2	4.5	3.2	3.6	4.9	--	8.4	10.3	4.3	3.3	3.6	3.0	1.1
105	11.4	10.2	4.1	3.5	4.5	5.3	--	10.1	--	4.2	3.4	4.1	4.0	0.8
120	11.5	7.4	4.0	3.3	4.0	5.6	2.2	10.1	10.4	4.4	3.4	3.8	3.9	0.5
135	11.5	10.1	4.3	3.4	4.4	5.7	1.5	8.9	--	4.8	3.8	4.6	4.8	0.6
150	9.7	10.3	4.4	3.8	5.0	5.8	1.6	9.2	10.4	4.3	3.8	4.3	5.7	0.8
165	9.9	10.3	4.4	3.6	6.0	6.5	1.9	9.6	--	5.0	3.9	5.6	5.9	1.0
180	9.7	--	9.1	3.7	7.0	5.7	1.0	10.1	10.2	5.0	4.5	4.9	6.0	1.4
195	--	--	4.1	3.7	8.2	7.0	1.4	9.7	--	4.9	4.1	5.7	7.0	1.0
210	--	10.0	7.6	3.5	10.0	7.3	1.4	6.9	6.2	5.0	4.1	6.0	7.2	0.8

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 85. SALINITY MEASUREMENTS (EC) DETERMINED ON A 1:1 SAMPLE FROM CORES OF USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE. AUGUST 1976

Depth (cm)	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
5	5.0 *	1.2	1.3	1.1	0.9	1.1	0.9	0.8	2.2	1.1	1.2	1.5	1.2	1.1
15	5.0	0.8	1.0	0.9	2.5	2.9	0.5	2.2	1.8	0.8	0.9	1.7	3.6	0.7
30	1.5	1.0	2.1	1.9	3.0	3.1	--	1.1	6.1	1.8	1.6	3.8	3.1	0.7
45	1.3	5.4	3.3	1.9	3.8	3.9	--	4.9	3.1	1.8	3.2	4.0	3.7	0.8
60	7.6	5.6	3.5	3.3	4.3	3.8	0.5	7.4	3.0	3.2	3.8	3.8	3.4	0.8
75	8.1	8.0	3.9	3.1	4.0	3.0	--	6.7	8.3	3.5	3.3	3.6	3.5	0.7
90	9.3	5.9	3.9	3.5	4.3	4.0	0.5	8.2	9.2	3.2	3.7	3.7	3.7	0.5
105	6.4	9.1	3.8	3.5	4.6	4.1	0.6	5.4	7.2	2.7	4.0	4.0	3.9	0.6
120	5.4	9.1	4.0	3.5	4.3	4.2	0.5	8.3	6.0	3.4	3.7	3.6	4.2	0.6
135	6.8	--	4.0	3.8	5.2	--	0.5	5.9	6.3	3.3	2.9	--	3.7	1.1
150	--	7.4	3.8	3.5	5.1	3.9	0.6	6.5	7.0	3.9	3.5	3.4	3.6	0.5
165	5.8	--	4.3	3.6	4.7	--	0.7	6.5	5.2	3.6	--	--	--	0.7
180	--	7.0	4.2	--	4.3	--	0.7	--	6.0	3.7	--	--	--	--
195	6.8	--	4.1	--	5.4	--	0.7	--	7.3	3.8	--	--	--	0.7
210	--	7.5	4.1	--	--	--	0.7	--	6.8	--	--	--	--	0.9

* EC Values are in mmhos/cm @ 25°C measured on a 1:1 spent shale to water by weight sample.

-- No sample collected.

APPENDIX TABLE 86. SURFACE RUNOFF AND WATER QUALITY DATA FOR TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS, FOLLOWING A 0.50 INCH (12.7 mm) STORM PICEANCE BASIN STUDY SITE. AUGUST 14, 1974

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XII	XIII	II	IV	VI	VIII	X	XII	XIV
Runoff/plot (liters)	--	--	1.5	--	10.5	--	--	--	--	--	--	24	32	1.5
Sediment/plot (grams)	--	--	30	--	68	--	--	--	--	--	--	587.5	234	22
pH	--	--	7.4	--	7.1	--	--	--	--	--	--	7.5	7.5	7.6
EC μ mhos/cm @ 25°C	---	--	845	--	2863	--	--	--	--	--	--	2260	2147	730
Na (ppm)	--	--	52.4	--	131.10	--	--	--	--	--	--	66.70	66.7	22
Ca (ppm)	--	--	68.75	--	350.0	--	--	--	--	--	--	302.50	301.3	67
Mg (ppm)	--	--	17.13	--	174.0	--	--	--	--	--	--	106.50	100	17
K (ppm)	--	--	9.17	--	12.1	--	--	--	--	--	--	9.75	11	3
CO ₃ (ppm)	--	--	0	--	0	--	--	--	--	--	--	0	0	0
HCO ₃ (ppm)	--	--	195	--	88	--	--	--	--	--	--	107	95	238
NO ₃ (ppm)	--	--	0.8	--	0.3	--	--	--	--	--	--	0.5	0.3	1
SO ₄ (ppm)	--	--	175	--	1584	--	--	--	--	--	--	1248	1224	77
Cl (ppm)	--	--	40	--	15	--	--	--	--	--	--	10	10	12
SAR	--	--	1.5	--	1.4	--	--	--	--	--	--	0.8	0.9	0.6

-- No sample collected this date.

APPENDIX TABLE 87. SURFACE RUNOFF AND WATER QUALITY DATA FOR USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS, FOLLOWING A 0.50 INCH (12.7 mm) STORM PICEANCE BASIN STUDY SITE. AUGUST 14, 1974

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
Runoff/plot (liters)	--	--	--	1.7	--	1.1	--	--	--	--	2.1	4.2	1.5	--
Sediment/plot (grams)	--	--	--	6.02	--	1.7	--	--	--	--	13.7	27.7	16.80	--
pH	--	--	--	7.9	--	8.0	--	--	--	--	7.6	7.2	7.8	--
EC μ mhos/cm @ 25°C	--	--	--	1213	--	1210	--	--	--	--	924	1874	1945	--
Na (ppm)	--	--	--	73.60	--	56.4	--	--	--	--	59	131.1	142.60	--
Ca (ppm)	--	--	--	57.50	--	89	--	--	--	--	72.50	167.5	161.3	--
Mg (ppm)	--	--	--	25.1	--	32.00	--	--	--	--	17.4	86.5	61.0	--
K (ppm)	--	--	--	27.50	--	7.4	--	--	--	--	5.8	23.6	21.3	--
CO ₃ (ppm)	--	--	--	0	--	0	--	--	--	--	0	0	0	--
HCO ₃ (ppm)	--	--	--	364	--	251	--	--	--	--	207	157	239	--
NO ₃ (ppm)	--	--	--	0.3	--	0.8	--	--	--	--	0.3	5.3	3.4	--
SO ₄ (ppm)	--	--	--	233	--	276	--	--	--	--	238	828	660	--
Cl (ppm)	--	--	--	40	--	35	--	--	--	--	25	15	40	--
SAR	--	--	--	2.0	--	1.3	--	--	--	--	1.6	2.1	2.4	--

-- No sample collected this date.

APPENDIX TABLE 88. SNOWMELT RUNOFF AND WATER QUALITY DATA FOR TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE.
MARCH 13, 1975

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VIII	X	XII	XIV
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VIII	X	XII	XIV
Runoff/plot* (liters)	200+	200+	200+	200+	200+	200+	200+	250+	250+	250+	250+	250+	250+	250+
Sediment/plot (grams)	82.8	95.6	143.9	135.2	209.3	141.7	69.8	146.1	146.1	135.2	135.2	115.5	137.3	87.2
pH	7.3	7.6	7.6	7.4	7.4	7.3	7.3	7.5	7.9	7.9	7.7	7.7	7.8	7.8
EC μ phos/cm @ 25°C	130	140	160	320	750	700	160	80	110	160	160	410	340	80
Na (ppm)	4.6	4.6	4.6	9.2	12.5	11.5	4.6	2.3	2.3	6.9	6.9	2.3	2.3	2.3
Ca (ppm)	16.0	16.0	20.0	30.1	95.3	96.2	14.0	8.0	14.0	18.0	18.0	72.0	54.1	10.0
Mg (ppm)	3.7	3.7	3.7	12.2	23.2	23.1	3.7	1.2	1.2	3.7	3.7	4.9	3.7	1.2
K (ppm)	3.9	3.9	3.9	7.8	20.1	19.6	7.8	2.0	2.0	3.9	3.9	3.9	3.9	3.9
CO ₃ (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO ₃ (ppm)	79.3	67.1	85.4	91.5	90.5	91.5	73.2	36.6	30.5	61.0	85.4	48.8	73.2	36.6
NO ₃ (ppm)	1.2	1.9	0.6	1.9	2.0	1.9	3.7	0.6	0.6	0.6	1.2	0.6	0.6	0.6
SO ₄ (ppm)	4.8	9.6	4.8	72.1	310.6	302.6	9.6	1.4	9.6	9.6	9.6	192.1	124.9	1.4
Cl (ppm)	3.6	3.6	3.6	10.6	6.7	7.1	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
SAR	.27	.27	.25	.36	.27	.27	.29	.20	.16	.38	.38	.07	.08	.18

* Total runoff was not accurately measured because of leaks in the collection basins. Leaks were sealed in July 1975. The total sediment was collected from each plot and reported in total gram per plot (plots are 3.5 x 6.7 m).

APPENDIX TABLE 89. SNOWMELT RUNOFF AND WATER QUALITY DATA FOR USBM SPENT SHALE, SOIL-COVERED USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE.
MARCH 13, 1975

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12")		15 cm (6")		USBM			30 cm (12")		15 cm (6")		USBM		
	Soil Cover		Soil Cover		Spent Shale		Soil	Soil Cover		Soil Cover		Spent Shale		Soil
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
Runoff/plot* (liters)	200+	200+	200+	200+	200+	200+	200+	250+	250+	250+	250+	250+	250+	250+
Sediment/plot (grams)	82.8	69.8	93.7	74.1	78.5	93.7	76.3	91.6	74.1	85.0	82.8	87.2	71.9	91.6
pH	7.3	7.3	7.4	7.3	7.3	7.3	7.5	7.5	7.3	7.8	7.8	7.4	7.3	7.5
EC μ hos/cm @ 25°C	800	690	1240	800	1200	1180	80	80	80	100	120	190	170	80
Na (ppm)	6.9	9.2	13.8	18.4	41.4	16.1	2.4	2.3	2.3	4.6	6.9	4.6	4.6	2.3
Ca (ppm)	22.0	40.1	48.1	40.1	62.1	38.1	8.0	10.0	8.0	8.0	10.0	18.0	14.0	8.0
Mg (ppm)	9.7	10.9	18.2	23.1	51.1	24.3	2.3	2.4	2.4	6.1	3.7	7.3	6.1	2.4
K (ppm)	7.8	7.8	7.8	11.7	39.1	27.4	3.9	3.9	3.9	3.9	3.9	7.8	7.8	3.9
CO ₃ (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO ₃ (ppm)	79.3	85.4	67.1	109.8	170.8	122.0	43.7	42.7	48.8	73.2	61.0	42.7	48.8	42.7
NO ₃ (ppm)	322.4	254.2	508.4	272.8	155.0	372.0	1.2	0.6	0.6	0.6	0.6	1.2	1.2	1.2
SO ₄ (ppm)	9.6	9.6	38.4	48.0	384.2	124.9	4.8	0.5	4.8	4.8	9.6	76.9	52.8	4.8
Cl (ppm)	3.5	14.2	3.5	7.1	14.2	7.1	10.6	3.6	3.6	3.6	3.6	3.6	3.6	10.6
SAR	.31	.33	.43	.57	1.15	.50	.19	.17	.18	.30	.47	.23	.26	.18

* Total runoff was not accurately measured because of leaks in the collection basins. Leaks were sealed in July 1975. The total sediment was collected from each plot and reported in total gram per plot (plots are 3.5 x 6.7 m).

APPENDIX TABLE 90. SNOWMELT RUNOFF AND WATER QUALITY SAMPLES FOR TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE.
MARCH 10, 1976

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VIII	X	XII	XIV
Runoff/plot (liters)	--	--	--	--	--	--	--	432.7	485.4	377.5	654.4	507.8	354.8	205.2
Sediment/plot (grams)	--	--	--	--	--	--	--	18.0	16.8	12.0	24.0	30.0	13.2	10.8
pH	--	--	--	--	--	--	--	7.1	7.1	7.2	7.3	6.9	6.9	7.0
EC μ mhos/cm @ 25°C	--	--	--	--	--	--	--	300	400	400	300	1500	1500	200
Na (ppm)	--	--	--	--	--	--	--	11.5	9.2	20.7	16.1	20.7	32.2	9.2
Ca (ppm)	--	--	--	--	--	--	--	34.1	42.1	38.1	36.1	246.5	236.5	24.0
Mg (ppm)	--	--	--	--	--	--	--	13.4	14.6	17.0	14.6	60.8	64.4	7.3
K (ppm)	--	--	--	--	--	--	--	11.7	11.7	3.9	3.9	11.7	15.6	7.8
CO ₃ (ppm)	--	--	--	--	--	--	--	0	0	0	0	0	0	0
HCO ₃ (ppm)	--	--	--	--	--	--	--	183.0	183.0	170.8	152.5	97.6	97.6	109.8
NO ₃ (ppm)	--	--	--	--	--	--	--	1.2	1.9	0.6	1.2	1.2	0.6	0.6
SO ₄ (ppm)	--	--	--	--	--	--	--	19.2	19.2	52.8	48.0	773.3	816.5	14.4
Cl (ppm)	--	--	--	--	--	--	--	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5
SAR	--	--	--	--	--	--	--	0.42	0.31	0.70	0.57	0.31	0.48	0.43

-- No sample collected this date.

APPENDIX TABLE 91. SNOWMELT RUNOFF AND WATER QUALITY SAMPLES FOR USBM SPENT SHALE, SOIL-COVERED
 USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE.
MARCH 10, 1976

	NORTH ASPECT						SOUTH ASPECT							
	30 cm (12")		15 cm (6")		USBM		Soil	30 cm (12")		15 cm (6")		USBM		Soil
	Soil Cover		Soil Cover		Spent Shale			Soil Cover		Soil Cover		Spent Shale		
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
Runoff/plot (liters)	--	--	--	--	--	--	--	171.8	38.9	216.5	287.7	383.9	107.5	318.7
Sediment/plot (grams)	--	--	--	--	--	--	--	14.4	3.9	15.6	7.2	14.4	1.1	7.2
pH	--	--	--	--	--	--	--	7.1	7.1	7.3	7.2	7.1	7.0	7.1
EC μ mhos/cm @ 25°C	--	--	--	--	--	--	--	300	500	600	400	300	300	300
Na (ppm)	--	--	--	--	--	--	--	20.7	23.0	29.9	25.3	23.0	13.8	11.5
Ca (ppm)	--	--	--	--	--	--	--	24.0	24.0	36.1	24.0	24.0	26.1	30.1
Mg (ppm)	--	--	--	--	--	--	--	15.8	26.8	38.9	18.2	12.2	10.9	7.3
K (ppm)	--	--	--	--	--	--	--	3.9	15.6	15.6	7.8	3.9	7.8	3.9
CO ₃ (ppm)	--	--	--	--	--	--	--	0	0	0	0	0	00	0
HCO ₃ (ppm)	--	--	--	--	--	--	--	152.5	183.0	183.0	170.8	152.5	134.2	128.1
NO ₃ (ppm)	--	--	--	--	--	--	--	1.2	0.6	1.9	1.9	1.2	1.2	0.6
SO ₄ (ppm)	--	--	--	--	--	--	--	28.8	96.1	163.3	28.8	28.6	24.0	14.4
Cl (ppm)	--	--	--	--	--	--	--	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5
SAR	--	--	--	--	--	--	--	0.49	0.57	0.95	0.95	0.82	0.77	0.80

-- No sample collected this date.

APPENDIX TABLE 92. SNOWMELT RUNOFF AND WATER QUALITY SAMPLES FOR TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE.
MARCH 17, 1976

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VIII	X	XII	XIV
Runoff/plot (liters)	285.8	40.5	223.3	200.6	234.7	388.0	21.9	21.9	39.0	92.7	72.6	18.1	7.2	0.7
Sediment/plot (grams)	2.4	0.81	1.2	1.2	1.2	1.2	0.23	4.6	3.5	5.6	7.3	0.72	0.07	0.02
pH	6.8	7.1	7.0	7.1	6.7	6.8	7.4	7.3	7.3	7.3	7.4	7.0	6.9	7.1
EC μ mhos/cm @ 25°C	200	300	200	300	700	600	300	200	200	200	200	900	900	200
Na (ppm)	4.6	13.8	6.9	9.2	9.2	6.9	6.9	4.6	6.9	9.2	9.2	9.2	6.9	4.6
Ca (ppm)	12.0	26.1	16.0	24.0	100.2	86.2	30.1	26.1	24.0	20.0	24.0	140.3	162.3	22.0
Mg (ppm)	7.3	10.9	9.7	12.2	21.9	18.2	9.7	4.9	4.9	7.3	7.3	25.5	20.7	6.9
K (ppm)	19.6	7.8	3.9	3.9	7.6	7.8	11.7	<3.9	3.9	7.8	3.9	3.9	3.9	3.9
CO ₃ (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO ₃ (ppm)	79.3	109.8	79.3	103.7	54.9	54.9	164.7	97.6	97.6	97.6	103.7	73.2	54.9	103.7
NO ₃ (ppm)	1.9	1.9	1.2	1.2	1.2	1.2	1.9	1.2	1.2	<0.6	<0.6	<0.6	1.2	1.2
SO ₄ (ppm)	14.4	33.6	19.2	33.6	283.4	240.0	9.6	4.8	14.4	19.2	14.4	398.6	456.3	4.8
Cl (ppm)	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5
SAR	0.26	0.57	0.33	0.38	0.22	0.18	0.28	0.22	0.33	0.44	0.42	0.19	0.14	0.22

APPENDIX TABLE 93. SNOWMELT RUNOFF AND WATER QUALITY SAMPLES FROM USBM SPENT SHALE, SOIL-COVERED
USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE.
MARCH 17, 1976

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
Runoff/plot (liters)	--	290.3	528.8	533.4	427.8	533.4	415.3	7.5	8.0	--	3.5	<1.0	--	--
Sediment/plot (grams)	--	2.4	4.8	12.0	3.6	48.0	24.0	0.15	0.16	--	0.04	0.07	--	--
pH	--	7.1	7.0	7.2	7.2	7.5	7.3	7.1	7.0	--	7.0	7.1	--	--
EC μ mhos/cm @ 25°C	--	300	200	300	500	500	200	200	200	--	200	700	--	--
Na (ppm)	--	11.5	6.9	13.8	16.1	13.8	4.6	11.5	11.5	--	11.5	34.5	--	--
Ca (ppm)	--	24.0	18.0	26.1	24.0	36.1	26.1	24.0	18.0	--	14.0	42.1	--	--
Mg (ppm)	--	12.2	10.9	14.6	34.0	24.3	7.3	6.1	6.1	--	8.5	41.3	--	--
K (ppm)	--	11.7	7.8	7.8	15.6	15.6	3.9	3.9	3.9	--	3.9	19.6	--	--
CO ₃ (ppm)	--	0	0	0	0	0	0	0	0	--	0	0	--	--
HCO ₃ (ppm)	--	134.2	103.7	146.4	146.4	164.7	109.8	97.6	91.5	--	85.4	195.2	--	--
NO ₃ (ppm)	--	1.2	1.9	1.9	1.9	1.2	1.2	1.2	1.2	--	1.2	5.0	--	--
SO ₄ (ppm)	--	19.2	14.4	28.8	110.5	96.0	4.8	24.0	14.4	--	14.4	201.7	--	--
Cl (ppm)	--	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	--	<3.5	<3.5	--	--
SAR	--	0.48	0.32	0.53	0.49	0.44	0.21	0.38	0.60	--	0.60	0.90	--	--

-- No sample collected this date.

APPENDIX TABLE 94. SNOWMELT RUNOFF AND WATER QUALITY SAMPLES FOR TOSCO SPENT SHALE, SOIL-COVERED TOSCO SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE.
MARCH 31, 1976

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		TOSCO Spent Shale		Soil
	I	III	V	VII	IX	XI	XIII	II	IV	VI	VIII	X	XII	XIV
Runoff/plot (liters)	393.7	95.8	376.6	365.3	336.9	637.8	83.3	2.3	1.7	17.4	1.7	1.1	1.0	1.0
Sediment/plot (grams)														
pH	7.0	6.7	6.7	6.8	6.8	6.7	6.9	7.3	7.2	7.4	6.1	7.0	6.9	6.7
EC μ mhos/cm @ 25°C	100	70	90	100	400	400	100	200	200	200	200	900	800	200
Na (ppm)	2.3	<2.3	2.3	2.3	2.3	2.3	2.3	2.3	4.6	6.9	4.6	20.7	6.9	6.9
Ca (ppm)	18.0	8.0	8.0	16.0	76.2	54.1	10.0	30.1	32.1	32.1	22.0	124.2	148.3	22.0
Mg (ppm)	4.9	2.4	3.6	4.9	8.5	8.5	4.9	4.9	4.9	8.5	4.9	41.3	15.8	6.1
K (ppm)	3.9	3.9	3.9	3.9	3.9	7.8	3.9	3.9	3.9	3.9	<3.9	3.9	3.9	3.9
CO ₃ (ppm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO ₃ (ppm)	85.4	30.5	48.8	61.0	48.8	36.6	48.8	103.7	115.9	122.0	73.2	85.4	115.9	97.6
NO ₃ (ppm)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	<0.6	0.6	1.2	1.9
SO ₄ (ppm)	4.8	4.8	4.8	9.6	172.9	139.3	9.6	4.8	14.4	19.2	9.6	437.1	321.8	14.4
Cl (ppm)	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5
SAR	0.13	0.18	0.17	0.13	0.07	0.08	0.15	0.23	0.20	0.28	0.23	0.41	0.14	0.34

APPENDIX TABLE 95. SNOWMELT RUNOFF AND WATER QUALITY SAMPLES FOR USBM SPENT SHALE, SOIL-COVERED
USBM SPENT SHALE, AND SOIL CONTROL PLOTS. PICEANCE BASIN STUDY SITE.
MARCH 31, 1976

	NORTH ASPECT							SOUTH ASPECT						
	30 cm (12") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil	30 cm (12") Soil Cover		15 cm (6") Soil Cover		USBM Spent Shale		Soil
	13	11	9	7	5	3	1	14	12	10	8	6	4	2
Runoff/plot (liters)	121.1	348.3	529.9	530.0	433.4	530.0	410.7	7.5	--	3.4	<1.0	<1.0	<1.0	<1.0
Sediment/plot (grams)														
pH	7.1	6.9	7.0	6.8	7.0	7.5	7.1	7.0	--	6.9	6.9	6.1	7.1	7.2
EC μ phos/cm @ 25°C	200	100	200	100	200	200	200	200	--	200	200	200	300	300
Na (ppm)	2.3	2.3	6.9	2.3	2.3	2.3	4.6	11.5	--	6.9	6.9	6.9	6.9	9.2
Ca (ppm)	20.0	10.0	14.0	14.0	14.0	24.0	20.0	22.0	--	18.0	16.0	18.0	24.0	24.0
Mg (ppm)	4.9	7.3	7.3	6.1	9.7	8.5	6.1	7.3	--	7.3	8.5	10.9	10.9	9.7
K (ppm)	7.8	7.8	7.8	3.9	7.8	7.8	3.9	3.9	--	3.9	3.9	3.9	7.8	7.8
CO ₃ (ppm)	0	0	0	0	0	0	0	0	--	0	0	0	0	0
HCO ₃ (ppm)	85.4	73.2	85.4	67.1	67.1	97.6	85.4	97.6	--	85.4	85.4	6.71	103.7	143.2
NO ₃ (ppm)	1.2	1.2	0.6	1.2	<0.6	<0.6	0.6	0.6	--	0.6	0.6	1.9	<0.6	0.6
SO ₄ (ppm)	<4.8	<4.8	4.8	4.8	28.8	9.6	4.8	19.2	--	9.6	9.6	38.4	43.2	9.6
Cl (ppm)	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	--	<3.5	<3.5	<3.5	<3.5	<3.5
SAR	0.12	0.14	0.38	0.13	0.12	0.10	0.23	0.54	--	0.35	0.35	0.32	0.29	0.4

-- No sample collected this date.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/7-78-021		2.		3. RECIPIENT'S ACCESSION NO.	
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16. ABSTRACT Disposal of massive amounts of spent shale will be required if an oil shale industry using surface retorting is developed. Field studies were initiated in 1973 on two types of spent oil shale--coarse-textured (USBM), and fine-textured (TOSCO). The objectives of these studies were to investigate surface stability of and salt movement in spent shales and spent shales covered with soil after vegetation has been established by intensive treatment and then left under natural precipitation conditions. The plots were established at low-elevation (1,700 m) and high-elevation (2,220 m) study sites in north-western Colorado. A good cover of native species was established on all plots by leaching, N and P fertilization, seeding, mulching, and irrigation. High levels of Mo were found in plants grown in the spent shales compared to plants grown in soil. Re-salinization occurred following leaching of the TOSCO spent shale. The greatest runoff was from the TOSCO spent shale. Runoff was moderately to highly saline.					
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