Appendix D

Supporting Information

Explanation of Salt Loading Factor and Deep Percolation Reduction from the On-Farm Irrigation Improvements

The following describes the process used to determine the anticipated predicted reduction in deep percolation from the various possible irrigation system improvements for the proposed Mancos Valley salinity control project. The field data is based on measurements in the Grand Junction and Delta areas, and is compared with the predictive formula developed by John Hedlund, USDA/NRCS, West National Technical Center, Portland, Oregon.

MEASURED DEEP PERCOLATION REDUCTION
From the Grand Valley Irrigation Monitoring Data 1985, 1986, and 1987

Application Efficiency = (Consumptive Use / Infiltrated Amount) * 100
Deep Percolation = Infiltrated Amount – Consumptive Use

The following table presents typical deep percolation amounts monitored for the full season in the field with electronic flow recorders measuring the infiltrated irrigation amount minus the predicted evapo-transpiration consumptive use rates based on Grand Valley weather station data and adjusted for crop stage. Data was also collected in the Lower Gunnison area and provides similar results.

MEASURED DEEP PERCOLATION

App. Eff.	Deep Percolation	Difference (DP Reduction)
25%	31.0”	
		11.0”
35%	20.0”	
		7.5”
45%	12.5”	
		5.0”
55%	7.5”	
		3.5”
65%	4.0”	
		2.0”
75%	2.0”	
		1.0”
85%	1.0”	

APPROXIMATE APPLICATION EFFICIENCIES AND MEASURED DECIMAL PERCENT REDUCTION IN DEEP PERCOLATION FOR EACH IRRIGATION IMPROVEMENT COMBINATION

	After	**25%**	**35%**	**45%**	**55%**	**65%**	**75%**	**85%**
Before		**UF**	**IF**	**IF+**	**IFM**	**SR**	**CP**	**MS**
UF	**25%**	na	.355	.597	.758	.871	.936	.968
IF	**35%**	na	na	.242	.403	.516	.581	.613
IF+	**45%**	na	na	na	.161	.274	.339	.371
IFM	**55%**	na	na	na	na	.113	.177	.210
SR	**65%**	na	na	na	na	na	.064	.097
CP	**75%**	na	na	na	na	na	na	.032

SYSTEM DESCRIPTIONS

UF = Unimproved flood, wild flood, etc.

IF = Improved flood system, gated pipe, flex pipe, concrete ditch, etc., no improved management

IF+ = Improved flood system, pipeline-gated pipe, ported concrete ditch, siphon tube, some management application

IFM = Any type of improved flood system with irrigation water management applied

SR = Side roll sprinkler system, gated pipe with surge, etc. and irrigation water management

CP = Center pivot system

MS = Center pivot system with LEPA, micro spray, drip irrigation, etc.

PREDICTED DEEP PERCOLATION
Using the Irrigation Requirement from the Grand Valley Irrigation ET and Precipitation Data 1985, 1986, and 1987

The following table presents predicted deep percolation amounts and predicted deep percolation reductions using John Hedlund’s model, with the irrigation requirement based on field measurements and ET data during the same period as the measured data. The predictive formula uses the assumption that a 20 inch irrigation requirement being met by a system at 50 percent application efficiency means 40 inches of water need to be applied to meet the crop requirement. Of the 40 inches water applied in this scenario, 20 inches meets the crop consumptive needs and the other 20 inches are excess water. The excess water is typically about 50 percent runoff and 50 percent deep percolation. Thus the predicted deep percolation is represented by the following formula.

Predicted Deep Percolation =
((Irrigation Requirement / (Application Efficiency/100)) – Irrigation Requirement) x 0.5

Note: A 21.0 inch irrigation requirement is the average value for the crops grown minus rainfall for the 1985 to 1987 Grand Valley data in the previous tables. The same irrigation requirement is used to test the predictive formula at the same amount of irrigation water as the measured data.

PREDICTED DEEP PERCOLATION @ a 21 Inch Irrigation Requirement

App. Eff.	Deep Percolation	Difference (DP Reduction)
25%	31.5”	
		12.0”
35%	19.5”	
		6.7”
45%	12.8”	
		4.2”
55%	8.6”	
		2.9”
65%	5.7”	
		2.2”
75%	3.5”	
		1.6”
85%	1.9”	

APPROXIMATE APPLICATION EFFICIENCIES AND PREDICTED DECIMAL PERCENT REDUCTION IN DEEP PERCOLATION FOR EACH IRRIGATION IMPROVEMENT COMBINATION

	After	**25%**	**35%**	**45%**	**55%**	**65%**	**75%**	**85%**
Before		**UF**	**IF**	**IF+**	**IFM**	**SR**	**CP**	**MS**
UF	**25%**	na	.381	.594	.727	.819	.889	.940
IF	**35%**	na	na	.213	.346	.438	.508	.559
IF+	**45%**	na	na	na	.133	.225	.295	.346
IFM	**55%**	na	na	na	na	.092	.162	.213
SR	**65%**	na	na	na	na	na	.070	.121
CP	**75%**	na	na	na	na	na	na	.051

SIDE BY SIDE COMPARISON OF MEASURED AND PREDICTED DEEP PERCOLATION AND RUNOFF

Note: A 21.0 inch irrigation requirement is the average value for the crops grown minus rainfall for the 1985 to 1987 measured data in the upper table. The same irrigation requirement is used to test the predictive formula at the same amount of irrigation water as the measured data.

Efficiency	**Irrig Req.**	**Net Appl.**	**Pred Runoff**	**Pred Deep Perc**	**Meas Deep Perc**	**Diff**
25	21.0	84.0	31.5	31.5	31.0	0.5
35	21.0	60.0	19.5	19.5	20.0	-0.5
45	21.0	46.7	12.8	12.8	12.5	0.3
55	21.0	38.2	8.6	8.6	7.5	1.1
65	21.0	32.3	5.7	5.7	4.0	1.7
75	21.0	28.0	3.5	3.5	2.0	1.5
85	21.0	24.7	1.9	1.9	1.0	0.9

The predicted deep percolation values using John Hedlund’s formula compare favorably with the actual field measurements in Grand Valley.

DEEP PERCOLATION REDUCTION

Using the anticipated decimal percentage reduction in deep percolation from the preceding tables for example, an irrigation system improvement from an unimproved flood system to an improved flood system with irrigation water management applied should achieve a 72.7% reduction in deep percolation predicted, or a 75.8% reduction in deep percolation measured. An irrigation system improvement from an unimproved flood system to a side roll sprinkler should achieve an 81.9% reduction in deep percolation predicted, or an 87.1% reduction in deep percolation measured. Since the values for both the measured and predicted methods compare favorably, the predictive formula was used for the Mancos Project area.

The system changes described here are the ones planned for the Mancos Project. The anticipated reduction in deep percolation for the project area at the planned ratio of 25% of the project participants converting from unimproved flood to improved flood with irrigation water management, and 75% of the project participants converting from unimproved flood to sideroll sprinklers, results in a weighted average predicited reduction in deep percolation for the project of 79.6% (.25 x 72.7 + .75 x 81.9 = 79.6). This weighted average improvement is expected for each acre treated.

Data has been collected in several areas that demonstrate these levels of application efficiency will be achieved with properly managed irrigation systems. However, field trials have demonstrated that, although sprinkler systems consistently achieve better than the predicted 65 percent application efficiency, some of the improved flood irrigation systems do not meet full irrigation water management standards every year. An evaluation of field trial data on a wide variety of improved flood systems and crops indicates that on average improved flood systems will achieve an application efficiency of less than the optimum 55 percent. A better long term average is about 40 to 50 percent application efficiency, which averages a 20 percent reduction in efficiency. For this reason the percentage reduction in deep percolation for unimproved flood to improved flood with irrigation water management is adjusted from 72.7% to 58% (72.7 x .8) to compensate for the systems that do not meet standards every year.

A recalculated weighted reduction in deep percolation for the Mancos Valley Project is, 25% of the project participants converting from unimproved flood to improved flood with adjusted irrigation water management at a 58% reduction, and 75% of the project participants converting from unimproved flood to sideroll sprinklers at an 82% reduction, results in a weighted average predicted reduction in deep percolation for the project of 76% (.25 x 58 + .75 x 82 = 76). This adjusted weighted average improvement is expected for each acre treated.

The project anticipates that 60 percent of the irrigated acres in the Mancos Valley will have an improved system with the project. At a 76% reduction in deep percolation times the 60 percent planned treatment acres results in a net 45.6 percent reduction in deep percolation and total salt load from on farm irrigation improvements in the Mancos Valley. The values in the Mancos Valley Salinity Control Project Plan and Environmental Assessment are based on this data.

SALT CONTRIBUTING ON FARM IRRIGATION RETURN FLOWS

It is estimated based on John Hedlund's previous work that salt carrying return flows are typically between 25 and 80 percent of the excess irrigation water. For this project we are estimating that 25 percent of the excess irrigation water returns to the river as a salt carrying flow. The rest of the water is picked up and reused as irrigation water on lower level fields or is used by phreatophytic vegetation, and does not actually carry salts back to the river. Since the excess water is approximately 50 percent surface runoff and 50 percent deep percolation, 25 percent of the total excess water equals 50 percent of the deep percolation as salt carrying return flows.

DITCH SEEPAGE

The ditch seepage calculations are based on a wetted width adjusted for volume of flow times a length to determine the square feet of wetted surface, times the number of days water is in the ditch, times a seepage rate in acre feet per day based on the predominant soil type. This is the standard method developed and described in John Hedlund's Salinity Primer and is consistent with the standard used for all of the other salinity project areas.

Pipeline seepage is assumed to be zero, concrete ditch seepage is assumed to be 15 percent of the earthen ditch seepage, and the polyacrylamide seepage rate is estimated to be at 50 percent of an untreated earthen ditch. The current range in seepage reduction observed with polyacrylamide has been about 35 to 75 percent in the limited number of field trials completed to date.

SALINITY WORKSHEET

The salinity ranking worksheets developed for each of the states is based on the same data, assumptions, and uses the same processes described here to calculate the anticipated reduction in deep percolation and subsequent reduction in salt loading. The main adjustments specific to a project area are the geologic and geographic differences in the salt loading factors, and adjustments for areas that are chronically water short. Due to early season runoff all of the areas have an equal opportunity for deep percolation at the beginning of the irrigation season, but not all of the salinity project areas have the water available for late season deep percolation. The Mancos Valley is typically water short late in the season.

SALT LOADING FACTOR

The original anticipated salt loading factor of 4.2 Tons /Acre Foot was based on McElmo Creek as the closest salinity project area. The initial assumption was the values should be similar. Later evaluations indicate that portions of the Mancos Valley have salt loading factors similar to the McElmo project area, but the average value for the area should be somewhat less. The following is based on data collected by Steve Yochum, NRCS Hydrologist at vaious location in the Mancos Valley during the 2001 field season, and data collected previously at the Mancos River gauging station and Chicken Creek at Route 184 .

It is assumed that the salinity increase in a location is based on the salinity concentrated of the outflow water minus the salinity concentration of the inflow water. The difference is the amount picked up in a location by the excess seepage and deep percolation.

Inflow salt load amounts:

West Mancos at Jackson Gulch

8/7/01	39 mg/l
5/8/01	103 mg/l
Ave.	71 mg/l

Mancos River Mid Valley

5/8/01	102 mg/l
Ave.	102 mg/l

Mancos River Gauging Station

7/16/80	141 mg/l
8/20/80	127 mg/l
5/13/81	162 mg/l
6/17/81	151 mg/l
7/15/81	217 mg/l
8/20/81	169 mg/l
8/7/01	115 mg/l
Ave.	155 mg/l

Mancos River at Route 160

5/8/01	190 mg/l
8/7/01	216 mg/l
Ave.	203 mg/l

Chicken Creek

5/14/80	110 mg/l
6/18/80	335 mg/l
7/16/80	169 mg/l
8/20/80	190 mg/l
5/13/81	207 mg/l
6/17/81	148 mg/l
7/15/81	196 mg/l
8/20/81	196 mg/l
5/8/01	120 mg/l
8/7/01	170 mg/l
Ave.	184 mg/l

Upper Chicken Creek

5/8/01	35 mg/l
8/7/01	66 mg/l
Ave.	51 mg/l

Average of All Sites
(71+102+184+155+51+203)/ 6 = 127.7 mg/l

Average inflow value equals 127 mg/l, round to **130 mg/l**

Outflow salt load amounts:

Note: 0.0013587 is the accepted conversion from mg/l to Tons/ Acre Foot for Colorado River salinity control projects.

Weber Drainage

11/14/01	3,065 mg/l		
8/7/01	2,480 mg/l	Ave. 2,772 mg/l – 130 mg/l inflow =	2,670 mg/l
			x 0.0013587
			3.6 Tons/Ac Ft

Mancos River Upper Valley

8/8/01	1,150 mg/l	Ave. 1,150 mg/l – 130 mg/l inflow =	1,020 mg/l
			x 0.0013587
			1.4 Tons/Ac Ft

Mancos Lower (above Mud Creek)

8/8/01	3,000 mg/l		
11/15/01	3,540 mg/l	Ave. 3,270 mg/l – 130 mg/l inflow =	3,140 mg/l
			x 0.0013587
		(Combine with Mud Creek)	4.3 Tons/Ac Ft

Mud Creek (at highway

11/14/01	3,370 mg/l	Ave. 3,370 mg/l – 130 mg/l inflow =	3,240 mg/l
			x 0.0013587
		(Combine with Mancos Lower)	4.4 Tons/Ac Ft

Chicken Creek

11/14/01	1,830 mg/l	Ave. 1,830 mg/l – 130 mg/l inflow =	1,700 mg/l
			x 0.0013587
			2.3 Tons/ Ac Ft

The estimated percent in irrigated area represented by the sampled sites are:

Site	Percent	Weighted Average
Weber Drainage	20%	.2 x 3.6 Tons/Ac Ft
Mancos	30%	.3 x 1.4 Tons/Ac Ft
Mancos Lower and Mud Creek	30%	.3 x 4.35 Tons/Ac Ft
Chicken Creek	20%	.2 x 2.3 Tons/ Ac Ft

Weighted Average Salt Loading Factor for the Mancos Project Area is **2.9 Tons/ Ac Ft**

Associated Supporting Document

“Mancos Valley Salinity; Hydrologic Study Report”, Steven E. Yochum, PE, Hydrologist, NRCS Northern Plains Engineering Team, 2004

The following are the Summary and Conclusions, a complete copy of the hydrologic study report is available under a separate cover.

MANCOS HYDROLOGY: SUMMARY AND CONCLUSIONS

The Mancos Valley is an agricultural valley located in the lower portions of a 203 square mile Mancos River watershed. As of 1994, there were 14,900 acres being used for agriculture, of which 11,700 acres were irrigated. Of this irrigated area, 9900 acres are irrigated by flood practices while 1800 acres are irrigated by sprinklers. Irrigation water is diverted at approximately 46 locations of the Mancos River and its tributaries with an average diverted volume of 42,100 ac-ft. The average system efficiency was found to be 32 percent.

Exposures of Mancos Shale are extensive in the watershed. The low gentle folds of this formation are interspersed by faults and uplift of a few hundreds of feet or less. These uplift features appear to have a direct relationship to salt yield from the watershed. It appears that the lower portion of the unit is extremely salty while upper portions contain moderate to low levels of salt. This variability in salt availability can also be observed in soil conductivity data collected throughout the valley.

Water quantity and quality data have been collected by various federal and state agencies and the Ute Mountain Reservation. In addition to this, several synoptics were conducted in 2001. These data were interpreted to quantify and partition (between sources) salt loading in the valley.

Typical dissolved solids content in the Mancos River consists of (from the typical highest to lowest contribution) sulfate, calcium, sodium, magnesium, chloride and potassium. The upper reaches (above most of the irrigated agriculture) tend to have more magnesium than sodium content and a much lower sulfate proportion.

A relatively sparse selenium record has been gathered in the Mancos Watershed. Seventy-five samples on the main stem Mancos have found a maximum concentration of 12 ug/l, though the majority of the samples collected had undetectable concentrations. Mud Creek basin values were the highest, at up to 104 ug/l. The Colorado State Water Quality Control Commission has designated a chronic criteria of 5 ug/l while the EPA’s drinking water maximum contaminant level is 50 ug/l.

The synoptics of 2001 indicated total dissolved solid concentrations ranging from 32 to 3070 mg/l. The results from earlier (1979-81) NRCS synoptics indicate a similar range, though some higher values were noted in the Mud and Weber watersheds. Baseflow concentrations, load, and concentration gradients all indicate a zone of high salinity contribution (a “hot zone”) in a strip of land passing from the northwest to the southeast, with lesser to little contribution outside of this zone. For example, instantaneous total dissolved solid load during synoptic 3 increased from 2070 kg/day at the Mancos River at the Mancos gage, to 11,000 kg/day above the Mud Creek confluence, to 39,900 kg/day below the Weber Drainage confluence. Below this point the salt concentration increased from 1470 mg/l to only 1530 mg/l, despite passing through 40 miles of stream channel. The synoptic collected load data across the hot zone, illuminating areas of high salt contribution. Specifically, the Mud Creek reaches, the Mancos River reach between Mancos to a bit below the Mud Creek confluence, and the upper Weber Drainage appear to be large salt contribution areas. Agricultural land to the immediate northeast of this zone appears to be a moderate contributor of salt, while land above the town of Mancos appears to contribute only slightly to the river's salt load. There does not appear to be significant contribution of salt downstream of the agricultural portion of the watershed. These observations and interpretations agree with the geologic mapping and soil conductivity levels in the basin. Interestingly, the soil conductivity measurements also shows this hot zone continuing across the drainage divide into the vicinity of Dolores, which has been shown in previous salinity control studies to be a large contributor of salt.

The streamgage on the Mancos River at Rt. 666, with a drainage area of 526 square miles, has the most data available for analysis. The watershed between the Mancos Valley and this gage is relatively dry, with average precipitation raging from 9 to 21 inches, in comparison to the valley's watershed range of 15 to 41 inches. Mean daily flow at this gage is 48 cfs, with a peak average daily flow of 1890 cfs. On average, 44,400 ac-ft of water pass this gage per year. This volume is only slightly more than the average flow diverted in the Mancos Valley. Approximately 400 field measurements and water sample analyses were performed at this site. Using this data, total dissolved solid load was computed using a seven-parameter regression model for thirty years of record and an average load of **42,300 tons/year** was estimated. This value agrees remarkably well with the previous estimate of 43,000 tons/year (SCS 1984). A baseflow separation was also performed and an average load of **26,200 tons/year** was estimated. These load estimates may not account for all sources, specifically the first flush of salts from stream channels and any salts not yet dissolved in suspended sediment and bed load passing the gaging station. Additionally, it should be noted that this average baseflow load changed slightly from the previous estimate of 26,800 tons/year due to the use of a water year average instead of an irrigation year average. This change was necessary to provide confidence limits and standard errors of prediction for the estimates. Considering the uncertainty involved in such analyses, these two numbers should be considered identical.

The baseflow concentrations, load, and concentration gradients of the synoptics support a hypothesis that a major majority of baseflow salt load leaving the Mancos Valley is from irrigation return flow. These synoptics also indicate that little additional baseflow is yielded from the lower Mancos at Rt. 666 watershed. The exclusion of first flush salt flows and undissolved salts derived from sediments mobilized from crop and range lands from the load computations adds support to the selection of this relatively high salt yield. Hence, the baseflow dissolved salt loading estimate of 26,200 tons is a reasonable estimate for irrigation return flows

Therefore, this study recommends the use of an average annual load estimate from irrigation practices of **26,000 tons**. The value was rounded to two significant figures to reflect the appropriate degree of certainty. This recommendation is based upon best professional judgement, using available data. If greater certainty is desired, additional data and analysis will be required.

Cultural Resource Overview and Recommendations:
Mancos Valley Salinity Control Project, Montezuma County, Colorado

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Abstract
This report is a cultural resource overview for the Mancos Valley Salinity Control project that is contemplated for private lands within the Mancos Valley of Montezuma County, Colorado. The purpose of the overview is to identify known cultural resources that may be impacted by irrigation ditch improvements that may be implemented by the USDA’s Natural Resources Conservation Service (NRCS). Additionally, this report offers recommendations on managing resources identified and for further work. This information will be useful for NRCS planners and those who may implement the project.

The Mancos valley contains and is surrounded by significant cultural resources dating to prehistoric and historic eras. The most notable site in the area is Mesa Verde National Park, a World Heritage Site. The study area itself contains 120 known archeological sites that represent both prehistoric and historic usage of the area. Of these, four are on the National Register of Historic Places (NRHP). Another three are eligible to the NRHP. Additionally, three sites are on the Colorado State Register of Historic Places. Several sites are close to or may have been impacted by ditch systems. There is a high probability of impacting cultural resources during irrigation improvements.

It is recommended that a cultural resource inventory be done followed by monitoring while new ditches are installed. Ongoing concerns include the possibility that irrigation improvements may cut across or through significant sites, sites that may need stabilization, encountering unmarked burials, and determining if the ditches themselves are important cultural resources.

Introduction

This section is a cultural resource overview for the Mancos Valley Salinity Control project that is contemplated for non-federal lands in the Mancos Valley of Montezuma County, Colorado. The purpose of the overview is to identify known cultural resources that may be impacted by irrigation ditch improvements planned by the United States Department of Agriculture, Natural Resources Conservation Service (NRCS). Secondly, it predicts that additional resources will be found during project implementation. Additionally, this report offers recommendations on managing resources identified and for further work. This information will be useful for NRCS planners and those who may implement the project.

Two authorities pertain to cultural resource concerns. The first is the National Historic Preservation Act of 1966 (NHPA) that established a comprehensive program to preserve the cultural and historic resources of the Nation. Section 106 of the act requires federal agencies to consider the effects of their actions on these resources. The National Environmental Policy Act of 1969 (NEPA) is the second authority. Title 1 Section 101(b)(4) states that one purpose of the act is to preserve important historic, cultural, and natural aspects of our national heritage. The State Level Agreement (SLA) between NRCS and the Colorado Office of Archaeology and Historic Preservation (OAHP) integrates NRCS projects into the Section 106 process. Additionally, the role of OAHP is to review Section 106 projects. An addendum to the Programmatic Agreement specifically discusses determinations of no effect and exempt undertakings related to irrigation projects. The two authorities are independent but can be integrated and coordinated into one cultural resource compliance process. Other authorities that may apply include Colorado CRS 24-80-401 (Historical, Prehistorical, and Archaeological Resources Act) and Colorado CRS 24-80-1301 (Unmarked Human Graves Act). If the project includes lands owned by the state, county, city, town, district, or any subdivision of the state then consultation with OAHP is needed. Additionally, if unmarked human graves are encountered then the Unmarked Human Graves act may apply. NRCS is incorporating NEPA, 40 CFR Parts 1500-1508, into the process and is considering air, noise, and scenic qualities within the scope of work. Survey for cultural resources will be phased. The consideration of this report is to identify known resources within the Area of Proposed Effect (APE) and to predict the presence of additional resources based on an understanding of the regional resource base. Mitigation is outlined in the Memorandum of Understanding.

Area of Consideration and Possible Impacts

The Mancos Valley contains and is surrounded by significant cultural resources dating to prehistoric and historic eras. This area has a long history of archaeological research and this review is selective in the resources used; there has been no attempt at summarizing all the regional research.

The study area includes a large part of the Mancos USGS quadrangle map with adjacent areas on the Millwood, Rampart Hills, and Thompson Park maps. The lands under consideration are cropland. Table 1 lists the ditches that may be improved. In total, the existing irrigation system extends about 104 miles and contains 34 earthen ditch system that supply water to about 9,176 acres of crops. At this time the specific ditches and locations of the new pipe system have not been determined. Most if not all of the existing system is under consideration to be improved. In general, the goal is to place the new pipe system within the current ditch right-of-ways. Currently, the ditches are open surface systems controlled by gates. A Gravity Pressure System is the proposed pipeline for installation. This requires installing a pressure pipeline that would supply water to sprinkler systems that irrigate cropland. Additionally, new on-farm sprinkler systems may be installed on some farms. Improving water supply to farmland will result in less ditch seepage and deep percolation. These improvements will reduce salt loading into the Mancos River, and eventually, the Colorado River, which is the overall goal (Soil Conservation Service 1984).

Possible impacts to cultural resources during pipeline installation will come from subsurface soil disturbances (below plow zone or depth of prior disturbance). Excavation below subsoil may impact cultural resources by cutting into archeological deposits of artifacts and features. In addition, some or all of the ditches may qualify as historic engineering features themselves. Modifications to these ditches could be considered an adverse impact. Existing ditches may have also cut through other prehistoric or historic archeological sites. Pipeline installation may impact these previously impacted sites. The sprinkler systems are categorically exempt from Section 106 review per the programmatic agreements.

As mentioned, the Mancos Valley contains and is surrounded by significant cultural resources dating to prehistoric and historic eras. The most notable site in the area is Mesa Verde National Park, a World Heritage Site. The study area itself contains 120 known archeological sites that represent both prehistoric and historic usage of the area. Of these, four are on the National Register of Historic Places (NRHP). Another three are eligible to the NRHP. Additionally, three sites are on the Colorado State Register of Historic Places. Several sites are close to or may have been impacted by ditch systems. High probability exists for impacting cultural resources during irrigation improvements.

It is recommended that a cultural resource inventory be done followed by monitoring while new pipelines are installed. Ongoing concerns include the possibility that irrigation improvements may cut across or through significant sites, or sites may need stabilization. Others are the possibility of encountering unmarked burials; and determining if the historic ditches themselves are important cultural resources.

Table 1: Ditches in the Mancos Irrigation System

Name	Number	Irrigated Acres
Bauer Reservoir	504	769
Beaver	505	541
Boss	506	173
Carpenter and Mitchel	508	186
Crader	513	45
Crystal	514	660
Davenport	517	61
Doerfer	519	82
East Mancos Highline	522	196
Exon	524	60
Field	525	74
Frank	527	106
Giles	530	206
Glasgow and Brewer	531	350
Graybeal	532	62
Henry Bolen	534	539
Jim Bean	537	9
John Carter	538	174
Lee and Burke	542	242
Lee	543	123
Long Park	544	360
Mathews	546	161
No. 6	551	308
Ratliff and Root	554	1290
Robbins	559	32
Samson	562	100
Sheek	565	520
Smith	566	98
Smouse	567	35
Webber	576	872
Webber Reservoir Inlet	577	325
Willden and Brinkerhoff	581	87
Williams	582	149
Willis	583	172
Total acreage		9,176

The following sections review the environmental setting, the archeological chronology, and known cultural resources for the study area. The final section makes recommendations for the next steps.

The Environmental Setting

The proposed project is in the Mancos Valley of Montezuma County, Colorado. Properties in the study area are on the Mancos, Millwood, Rampart Hills, and Thompson Park USGS Quadrangle maps. All the ditch systems are on private land. Currently, Mesa Verde National Park, the Ute Mountain Ute Reservation, and the San Juan National Forest dominate the region. These lands are important for residences, recreation,

water, fish and wildlife, timber, grazing, minerals and other light industry. Mancos is the main town in the area and US Highway 160 and County Road 184 (Weber Road) are the main access roads. Major landmarks include Mesa Verde Plateau, Weber Mountain, Menefee Mountain, and Flint Rock Point. Important water systems include Mancos River, Mud Creek, Weber Creek, and Chicken Creek. Several reservoirs are north of Mancos. Elevations range from 6600 to 7200 feet above sea level. Numerous gravel pits are in the area and three cemeteries are along Weber road, south of Mancos. Also, north of town is an old railroad grade for the Rio Grande and Southern Rail Road, built in 1891.

Geologically, the shales of the Mancos formation, a marine formation, underlie most of the Mancos valley. The Mesa Verde Group of three formations overlies the Mancos to the east, west and on Weber Mountain. On the north is an outcrop of Dakota Formation that underlies the Mancos. Geographic landforms in the valley include terraces and floodplains, alluvial fans, and hillsides and escarpments (Soil Conservation Service 1984, Natural Resources Conservation Service n. d.).

The general soil units of the study area include the Lillings-Ramper-Fluvents, Wetherill-Pulpit-Gladel, Granath-Ilex-Ormiston, and Sideshow-Zigzag units. Soils on floodplains, stream terraces, and alluvial fans are the Lillings-Ramper-Fluvents unit. These soils have alluvium and mixed parent materials and they are very deep. Soils on hills and mesas include the Wetherill-Pulpit-Gladel and Granath-Ilex-Ormiston units. These soils developed as eolian and residuum deposits from sandstones or sandstones and shale. These soils are deep, except for Gladel that is shallow. The Sideshow-Zigzag unit is found on hills, ridges, alluvial fans, and knobs. The parent material is alluvium and residuum from shale. The Sideshow soil is deep and the Zigzag soil is shallow with shale at 6 to 20 inches (Natural Resources Conservation Service n. d.).

The valley is primarily farmland. Irrigated crops include alfalfa and small grains. Dryland farming crops are pinto beans and winter wheat. Vegetation on non-farmed lands is sagebrush, pinyon pine, Utah juniper, and Gamble oak scrubland. Major animals currently and in historic times include small mammals, coyotes, antelope, bighorn sheep, elk, mule deer, and wild turkeys. The climate is semi-arid, and average annual precipitation is 10 to 15 inches at Cortez. Late summer rains and snowfall provide most of the moisture.

Archeological Chronology

The following is a chronological summary of the Mancos area (Table 2). The prehistory section takes its lead from the context volume for the Southern Colorado River (Lipe et al 1999). The Modern Stage is used here, but it has not been fully integrated into the local archeological literature (Moore 2002). Additionally, the Southern Colorado River context volume divides the study area into smaller units because there has been enough research done in the Four Corners region to make more refined analyses and comparisons. A Delores Unit is defined that includes the middle portion of the Delores River and the upper part of the Mancos River. Therefore, the Mancos valley is part of the Delores Unit for the context volume’s purposes. Other units adjacent to the Delores one include the Monument-McElmo, Mesa Verde-Mancos, and La

Plata units. As this study area is at the southeastern end of the Delores unit the possibility that it blends into the Mesa Verde-Mancos unit is considered.

While other Colorado context areas have well defined Paleo-Indian and Archaic stages this study area does not. Instead, these terms are used for sub-periods. The authors of the Southern Colorado River context volume (Lipe et al 1999) believe that there is not enough information to define the early stages in southwestern Colorado. In addition, there appears to be little difference between the two early periods except in the form of artifact types. The later portion of the Paleo-Indian period appears Archaic mostly because this region is part of an intermountain Paleo-Indian life-way that is somewhat unique in Western North America (Frison 1992; Pitblado 1998). In other Colorado context areas the Paleo-Indian life-way was a subsistence strategy based on the hunting of large game (bison, mammoth) with some supplemental foods coming from plants and small animals, and, the Archaic life-way was a broad based subsistence pattern wherein a variety of foods were used.

In this study area, the later half of the Paleo-Indian period was a life-way pattern that was Archaic not the traditional Paleo-Indian. But, the artifact types are Paleo-Indian in style. Angostura and Great Basin stemmed points are found from this part of the period. A year round habitation cycle is suggested for the Southern Colorado Rocky Mountains, nomadic mobility was bounded (not far ranging), and there was a focus on local stone raw materials, mainly quartzite. The early portion of the Paleo-Indian period has Folsom points and may suggest a more typical Paleo-Indian pattern. The Archaic period reflects a broad spectrum hunting and gathering way of life. Plant processing is also more evident as grinding stones are more frequently found when compared to earlier times.

Sites dating to the Paleo-Indian and Archaic periods are rare in the Four Corners area but are found occasionally. Usually they are found as surface finds on steep terrain. Outside this study area but in the nearby Rampart Hills there are several Archaic open camps and isolated finds (5MT.9476, 5MT.9479-9483, 5MT.9485, 5MT.9487-9488, and 5MT.9638-9643). In the study area these sites are likely to be buried in the valley floor, as the soils are deep. Sites from these periods will usually be considered significant unless they have been heavily disturbed.

Table 2: Chronological Outline of the Mancos Valley area.

Stage	**Period**	**Date Range**
Modern	Post-Capitalism	A.D. 1921-present
Modern	Capitalism	A.D. 1860-1921
Modern	Proto-historic	A.D. 1540-1860
Late Prehistoric	Post Puebloan	A.D. 1300-1540
Late Prehistoric	Pueblo III	A.D. 1150-1300
Late Prehistoric	Pueblo II	A.D. 900-1150
Late Prehistoric	Pueblo I	A.D. 750-900
Late Prehistoric	Basketmaker III	A.D. 500-750
Late Prehistoric	Basketmaker II	1000 B.C.- A.D. 500
Undetermined	Archaic	5500 B.C.-1000 B.C.
Undetermined	Paleo-Indian	12,040 B.C.-5500 B.C.

The Late Prehistoric Stage has several periods and all but the last are part of the Basketmaker-Puebloan (“Anasazi”) cultural tradition. As there has been a great deal of research done in the Four Corners area on this stage, it is well defined and the sub-periods are well understood. The sequence has two main terms, Basketmaker and Pueblo, that emphasize the importance or not of ceramics, architecture, and domesticated foods. These two terms are also given numbers to help understand the periods. The sequence is Basketmaker II, Basketmaker III, Pueblo I, Pueblo II, and Pueblo III. These terms are abbreviated as BII, BIII, and PI, etc. An original BI period is now part of the Archaic period. Basketmaker sites may or may not have ceramics, and, there may be some evidence of domesticates. Puebloan sites generally have both plus room-blocks, the apartment like structures that are famous across the Southwest. The general trend during the stage was significant cultural change from less complex societies to more complex ones in the region. This change is seen in the increasing usage of domesticates that later became intensive agriculture based on corn and beans. Social changes included a trend toward the aggregation of smaller social units into larger ones ending with centralized political control and ceremonial centers. Architecture changed from small pit house structures to large above ground pueblos, apartment like towns and villages. These cultural changes waxed and waned across the region with some areas growing as others declined. At the end of the cultural tradition in the study area there was a general out-migration, ‘abandonment’ has been the popular term, to areas to the south. During the Post Pueblo period different cultures (Navaho and Ute) moved into the area and maintained a life-way similar to the Archaic pattern of hunting and gathering.

As the Late Prehistoric stage has had so much research done there are numerous topics that could be discussed. For this background review a brief look at population changes for the Delores and Mesa Verde-Mancos

units is useful as they may help in predicting the amount and quality of sites to be encountered.
Table 3 provides population estimates for various date ranges. Lipe et al. (1999: 189, 235, 264, and 325-326) provided population estimates for each of the units during the BIII and PI periods at years A. D. 560, 680, 800, 860, and 920. For the PII and PIII periods, estimates were made for the whole study area, all units combined, and over certain time blocks. The Delores and Mesa Verde-Mancos unit data has been extracted from the total population estimates based on the percentage of sites represented for each unit per period. For example, Lipe et al. reported that the Delores Unit contained 4.76 percent of all known PII sites in their study area. Also, they provided conservative and liberal population estimates for their whole study area. The conservative numbers are used here. So, the Colorado portion of the Four Corners area had, conservatively, a population of 1,680 people during the A. D. 880-920 time range. Therefore, approximately 80 people lived in the Delores unit during those years (4.76 percent of 1680 is 80). For the PIII period the Delores unit contained 4.2 percent of the known sites, so that number was used to calculate the estimate. For the Mesa Verde-Mancos unit the PII number was 46.06 percent and the PIII percentage was 28. These calculations are rough estimates and do not consider site size, number of room blocks, or size of rooms. Lipe et al. (1999: 264) also provided useful cautions on using these numbers. For comparative purposes, Montezuma County had populations of 3,058 in 1900, and, 16,510 in 1980. In 1980 the Delores and Mancos subdivisions of the county had 1,865 and 1,785 people respectively (Soil Conservation Service 1984). Thus, there are times in the prehistoric past when the populations of the Delores and Mesa Verde-Mancos units were greater than they have been in historic decades or even today.

From these estimates the population growth (decline) rate can also be estimated (Table 4). The growth rate was calculated by taking the change in population for each block of time and using the differential as a percentage of the base population and adjusted to annual rates of change. For example, in the Delores unit the growth rate for the A. D. 680 to 800 era is 0.832. The population went from 250 to 500 people over 120 years. The gross change is 250 people at a rate of 2.08 persons per year (250/120 = 2.08). The number 2.08 expressed as a percentage of the starting population of 250 is 0.832, the growth rate for that range of dates. Growth rates vary over time as Table 4 shows. The growth rate can be compared to the Rate of Natural Increase (RNI), another theoretical construct. A normal, healthy population will have a RNI of 1 percent. RNI is the excess of births over deaths and does not include other factors such as in- or out-migration, environmental change, or social variables. RNI can vary but rarely more than 1 percent. According to the Population Reference Bureau (www.prb.org) in 2002 the world average RNI was 1.3. Less developed nations were at 1.6; more developed nations were at 0.1; and North America was at 0.6.

Negative growth rates indicate a population in decline. The carrying capacity of the environment has been over stressed, people moved out, and/or they had more deaths than births. Growth rates at or near 0 indicate a population stressing the carrying capacity of its environment. Rates that are 2 or more points above or below 1 generally indicate migration in or out of a region. These statements are descriptive and reasons for decline, stagnation or rapid growth would need to be postulated through some theoretical model.

The growth rates in Table 4 provide some interesting patterns for the Delores and Mesa Verde-Mancos units over time. For the years A.D. 560 to 1000 each unit seems to have had its own pattern of growth, migration and decline. The Delores unit starts with a near zero population that then became an average rate up until 800-860 when there was a large in-migration. Next, there was a decline during 860-960, possibly from a modest out-migration. This was followed by an era of average growth, 960-1000. The Mesa Verde-Mancos unit started with a few more people and had an average growth rate from A. D. 560 to 860. Then there was a decline for 40 years until 920-960 when there was an extremely large in-migration. The in-migration slowed down to a modest growth rate during 960-1000. From 1000 to 1320 the two units were synchronized with an era of 80 years of carrying capacity stress (1000-1080), then a return to a normal growth pattern (1080-1160), followed by 120 years of stress (1160-1800), and then a decline (1280-1320). This last decline is associated with the well-known ‘abandonment’ of the greater Mesa Verde area in the late 13th century and was likely a slow out-migration. The years 860-920 were also possibly a time of abandonment of both units, particularly in the Delores unit.

These numbers suggest that the study area should have a significant number of PI sites compared to other time periods, as it seems to have had the largest population during the stage. Also, if the Mancos valley portion of the Delores unit blended into the Mesa Verde-Mancos unit then the south end of the valley could have a high concentration of PII sites, as well.

Table 3: Population estimates for the Delores and Mesa Verde-Mancos units at designated times.
(Source: Lipe et al. 1999: 189, 235, 264, and 325-326)

Period	**Year(s) A. D.**	**Delores Unit Est. Population**	**Mesa Verde-Mancos Unit Est. Population**
BIII	560	0 people	***>250 people***
BIII	680	>250	500
PI	800	500	1000
PI	860	3000	1500
PII	920	>250	>250
PII	920-960	160	1550
PII	960-1000	234	2270
PII	1000-1040	254	2458
PII	1040-1080	272	2630
PII	1080-1120	419	4057
PII-PIII	1120-1160	577	5587
PIII	1160-1200	583	3887
PIII	1200-1240	579	3860
PIII	1240-1280	579	3860
PIII-Post P	1280-1320	290	1937

Table 4: Growth Rates in the Delores and Mesa Verde-Mancos units at designated times.

Period	Year(s) A. D.	Delores Unit % change/year	Mesa Verde-Mancos Unit % change/year
BIII	560-680	Not meaning full	***0.832***
BIII-PI	680-800	0.832	0.833
PI	800-860	8.320	0.833
PI-PII	860-920	-1.526	-1.388
PII	920-960	-0.900	13.000
PII	960-1000	1.150	3.411
PII	1000-1040	0.213	0.207
PII	1040-1080	0.177	0.175
PII	1080-1120	1.35	1.356
PII-PIII	1120-1160	0.942	0.942
PIII	1160-1200	0.020	-0.894
PIII	1200-1240	-0.002	-0.017
PIII	1240-1280	0.000	0.000
PIII-Post P	1280-1320	-1.247	-1.245

The Modern Stage is divided into three periods: the Proto-historic, Capitalism, and Post-Capitalism. The Proto-historic period represents the years when European influences entered into the region but American Indian tribes still controlled much of the land. In general, this area was Navaho and Ute territory during the period. European influences include: Spanish traders and military expeditions from New Mexico in the seventeenth and eighteenth centuries, and, American fur trappers exploring most of the region in the early half of the nineteenth century (Carson 1998; Sanchez 1997; West 1998). It may seem inconsistent to separate the Post Pueblo and Proto-historic periods as both had Navaho and Ute peoples living in the area. The change is based on a hypothesized subsistence and settlement pattern change. The presence of Europeans in the region is a significant difference, specifically in that they introduced horses. As Navaho and Ute peoples adopted horses their cultural patterns changed. Pedestrian hunter-gatherers have significantly different subsistence and settlement patterns than do mounted hunter-gatherers (Binford 2001).

The Navaho are one of the groups that lived in the region during the Post Pueblo period. They also occupied the Four Corners area of Colorado at the beginning of the Proto-historic period when the Spanish first settled into the Rio Grande valley. This tribe is an Apachean speaking group related to Jicarilla, Mescalero, Lipan, and several others. The origin of this group is not well understood but they appear to have been in the Four Corners region for several centuries. Among Anthropologists a debate has been ongoing regarding how long the Navaho have been in the region, and, what route was taken for their initial entry into it. Apacheans are related to the Athabaskan language stock with a homeland in Alberta and British Columbia, Canada. The Apacheans migrated south and occupied large portions of the plains and southwest. Some argue that the migration route was down the plains and then west across the greater Southwest. Others believe that an intermountain route was taken. A third view would be a blend of the two; there are so many Apachean tribes that a single route is unlikely. Again, when these migrations occurred is debated and opinions range from 500 years ago to 1500 years ago (Towner 1996). The Navaho currently have a large reservation in northern Arizona, southern Utah, and northwestern New Mexico.

The Ute are another group that historically lived within the Mancos region. This wide ranging ethnic group was made up of several bands that historically lived in Colorado, northern New Mexico, and eastern Utah (Simmons 2000). Linguistically, the Ute are closely related to the Southern Paiute of southern Utah and Nevada. They are also part of a broader Shoshonean or Numic language group that includes the Shoshoni, Comanche, Northern Paiute, Western Paiute, Bannock, Lemhi, Goshute, and, distantly, the Hopi. Similar to the Apachean question, the prehistory of the Numic peoples is a matter of some controversy. The general consensus is that the Numic groups have an origin to the west of the historic Ute territory. Exactly where this original homeland was is debated; it possibly was in the central Great Basin or southern or far-western part of it. From this original home land Numic bands spread out to occupy most of the interior of the western United States. When this ‘Numic Spread’ occurred is also debated. Some place it as far back as 3500 years ago; others place it to about 1000 years ago. The essays in Madsen and Rhode 1994 summarize these debates very well. The Ute Mountain Ute reservation is adjacent to the Mancos Valley.

The Capitalism period is characterized by the capital goods industries that drove the Colorado economy in the later half of the nineteenth century, mining, ranching, logging, and agriculture (West 1998). The history of the Mancos area iterates these main themes. The Post Capitalist period reflects the economy’s shift away from capital goods towards information control and knowledge based labor. Knowledge-based workers are generally in service sectors that provide specialized services such as accounting, legal consultation, and scientific studies. For the Mancos area this is reflected by the focus on recreation and land management. Today, the Mancos area is a rural community whose few residents enjoy the amenities of Durango and Mesa Verde.

Proto-historic sites will be rare and hard to distinguish from the Post Puebloan period. Sites dating to the last two periods will be numerous and will reflect mining, ranching, recreation, and support functions such as utilities and transportation.

In summary, sites dating to all periods are likely to be present in the Mancos Valley. The changing population and subsistence patterns suggest that rates of material culture accumulation waxed and waned over time. The peak accumulation periods were the PI, PII, PII, Capitalism, and Post Capitalism ones, as these are the more sedentary periods. Periods when nomadic patterns were the norm (Paleoindian, Archaic, Post-Pueblo, and Proto-historic) are represented by sparser accumulations.

Irrigation in the Mancos Valley

The Mancos Valley has a long and interesting history (Freeman 1958). Spaniard Don Juan Maria de Rivera marched through the valley in 1765, having come from New Mexico. His party named most of the streams and landmarks of the area. The Rio Mancos was named at that time after an accident left a man crippled. It means the Crippled One. Later, in 1776, Father Escalante came through the valley and may have camped there.

Prospectors who had come to work the mines within the La Plata Mountains claimed the first homesteads in 1874. They returned to the valley in 1875 and worked their claims, growing grains, potatoes, and gardens. They brought in the first cattle herds and the valley was cattle country for many years. In 1881 the town of Mancos was laid out and lots were developed. In 1885 there were numerous businesses, including a shoemaker, a blacksmith, a bank, a grocery store, a general merchandise store, a hotel, two saloons, and a post office. The railroad was built through town in 1891. Throughout the early history of the area sawmills, gristmills and dairys filled out the local businesses.

Farming soon became a major industry as irrigation was implemented. The first ditch seems to have been the Brewer-Glasgo, built in 1878. Frank Hallford organized the Crystal Creek Ditch Company in 1881. South of town the Webber community of Mormons built several ditches and reservoirs in the early 1880s. This included the Webber Ditch, Webber Ditch No. 2, and reservoirs south and northeast of Mancos. In 1904 the Summit Irrigation and Reservoir Company developed ditches and reservoirs north of town combining the Joe Moore Reservoir, Pruett Reservoir, Turkey Creek ditch, and Lost Canyon water rights. In 1902 the Weber Reservoir, on the Middle Mancos, was enlarged. The Bauer Reservoir #2 was built in 1902-3. Water from the Bauer Lake was fed to farms in 1907. In 1908 the Summit Reservoir was raised higher due to excessive rains. Also, in 1910, the Upper Bauer and Webber reservoirs were enlarged. And in 1911 the Crystal Creek Water Company was organized to bring water from Crystal creek to new farms on Grand View Mesa. Dry farming “above the ditches” started in earnest in 1906.

For the town of Mancos water issues were very important. Fires in 1901 forced a discussion about a pressure water system for Mancos. In April 1902, there was an additional move to get a pressure water system. On March 3, 1903, the town voted to build the pressure water system, but nothing was done. In February 1904 the town board again voted to build a water works system for Mancos. Finally, it was completed August 1904. At that time old muddy ditches that serviced homes were abandoned. A Water Conservancy District to help valley farmers was discussed in August 1935. In 1938 the Mancos Water Conservancy District was informally set up and Jackson Gulch was chosen as the site for another reservoir. The plan was approved with WPA funding in 1940. At that time the Mancos Valley Conservancy District was formed. Construction at Jackson Dam was started in 1944 and finished in 1949.

Prior Archeological and Historical Research within the Mancos Salinity Control Area

Previous archeological studies within the Mancos valley have generally been targeted at understanding the interesting Anasazi (or ancestral Puebloans) that intensively used the region and at satisfying Cultural Resource Management requirements. Numerous cultural resource inventories have been done for various timber sales, land exchanges, pipelines, and other land developments. A file search at OAHP came up with many sites and reports. Important large projects include those listed in Table 5.

Few local historical studies have been done. Freeman (1958) wrote a history of Montezuma County and Head (1986) did a history of banking in the county. Additionally, students from Fort Lewis Collage have done some oral history in the area. Two studies on local water developments and salinity issues have been done (Butler 1994; Stene 1994); both are available in the Denver Public library for local use only.

Historic preservation efforts in the vicinity include Mesa Verde National Park that it is a World Heritage Site. There are several buildings in and around the historic town of Mancos that are on the NRHP or on the Colorado State Register of Historic Places (Bauer Bank building, Bauer House, Mancos Opera House, Wrightsman House & Hotel, and the Mancos High School). One site on the state register (Bement site, 5MT.4388) is also owned by the Archaeological Conservancy, a non-profit organization devoted to preserving sites. The Rio Grande Southern Rail Road crosses the study area; some segments of it have been deemed eligible to the NRHP. North of the study area is the Lost Creek Archeological District in the San Juan National Forest. And, two other historic sites have been designated as eligible to the NRHP (5MT.10969 and 5MT.13799).

Table 5. Selected Cultural Resource Reports from within the Mancos Salinity Control project area.

Report #	Title
MC.FS.R8	1985 & 1986 Survey PI 41 to Highway 160 (Rifle-San Juan Transmission Line).
MC.FS.R135	Administering the National Forests in Colorado: An Assessment of the Architectural and Cultural Significance of Historic Administrative Properties.
MC.FS.R169	A Cultural Resources Inventory of Tri-State Generation's Lost Canyon-Durango 115V Transmission Line Reconductor Project, Montezuma and La Plata Counties, Colorado.
MC.FS.R234	An Archaeological Survey of Eleven Seismograph Lines for Geoquest Exploration, Inc., Montezuma and La Plata Counties, Colorado.
MC.LM.R32	Mapco's Rocky Mountain Liquid Hydrocarbon Pipeline.
MC.LM.R78	Synthesis of Historic and Prehistoric Data from the Cultural Resource Inventory of the Trans-Colorado Natural Gas Pipeline.
MC.LM.R139	Cultural Resource Inventory of Access Roads, Centerline Realignments, and Pipeyards Associated with the Planned Trans-Colorado Gas Transmission Project, Western Colorado and Northwestern New Mexico.
MC.LM.R142	Addendum Report #3, Summer 1998 Cultural Resource Inventories of Access Roads, Centerline and Route Changes Associated with the Trans-Colorado Gas Transmission Project, Western Colorado and Northwestern New Mexico.
MC.LM.R174	Shell CO2 Mainline.
MC.LM.R253	Ecological Variability and Archaeological Site Location in Southwestern Colorado: The Class II Cultural Resource Inventory of the Bureau of Land Management's Sacred Mountain Planning Unit.
MC.SHF.R64	Rio Grande Southern Railroad.
MT.CH.R7	Cultural Resource Inventory Along State Highway 160 East and West of Mancos, Montezuma County, Colorado.
MT.CH.R11	An Intensive Cultural Resource Survey Along U. S. Highway 160 Between Mancos and the La Plata County Line, Montezuma County, Colorado.
MT.E.R6	Class III Cultural Resource Survey of Northwest Pipeline Corporation's Mancos Pipeline Replacement Project, Montezuma County, Colorado.
MT.FS.M2	E Mancos Timber Sale.
MT.FS.R24	Mancos Hill Horse Pasture Fence.
MT.FS.R56	A Cultural Resource Inventory of the Millwood Timber Sale.
MT.FS.R57	Anderson Land Exchange.
MT.FS.R61	A Cultural Resource Inventory of the Joe Moore Timber Sale Project.
MT.FS.R74	A Heritage Resource Inventory of the Mancos Hill Horse Pasture Prescribed Burn, Montezuma County, Colorado.
MT.FS.R75	A Heritage Resource Inventory of the U.S. Forest Service, Mancos Ranger Station Exchange Project. Montezuma County, Colorado.
MT.FS.R84	A Heritage Resources Inventory of the Ramparts Burn Project, San Juan National Forest, Montezuma County, Colorado.
MT.FS.R78	National Register Eligibility Test of Site 5MT7244, San Juan National Forest, Montezuma County, Colorado.
MT.FS.R88	Cultural Resource Inventory of the US West Telecommunications Line, San Juan National Forest, Montezuma County, Colorado.
MT.LM.R16	Cultural Resource Survey of the Proposed Mancos-Montezuma County Sanitary Land Fill, Southwestern Colorado.
MT.LM.R148	Archaeological Survey of Mountain Gravel and Construction Company's Proposed Keith Gravel Pit and Access Roads, Montezuma County, Colorado.
MT.LM.R244	A Survey of Vandalism to Archaeological Resources in Southwestern Colorado.
MT.LM.R312	An Archaeological Survey of 6650 Feet of Western Geophysical's Seismic Line in East Canyon, Montezuma County, Colorado.
MT.NP.R26	A Class III Cultural Resource Inventory of the BLM-Managed Lands: The Chicken Creek Segment of the Mesa Verde National Park's Phase III Waterline Replacement Project, Montezuma County, Colorado..
MT.NP.R30	Class III Cultural Resource Inventory and Testing Program of BLM-Managed and Private Lands: The Chicken Creek Segment of Mesa Verde National Park's Phase III Waterline Replacement Project, Montezuma County, Colorado.
MT.NP.R32	Mesa Verde Waterline Replacement Project Phase III: Preliminary Report of Testing in Chicken Creek: 5MT10969, 5MT11731, 5MT11732, and 5MT11733.
MT.NP.R52	Mesa Verde Waterline Replacement Project Phase III Archaeological and Historical Studies.

List of Known Sites in the Study Area

Table 6 lists the sites that are in the Mancos study area. These sites are located in the same Township and Range Sections as an existing ditch. At this time the exact location of the new pipe system layout is not known but it will be laid within existing ditches or run close to them. Some ditches have been documented using GPS technology. Table 6 also indicates if a known site is adjacent to or has been impacted by a ditch based on a comparison of mapped ditch locations to archeological site maps at OAHP. A more refined assessment and comparison of site and ditch locations will have to be done at a later phase and in the field. The sites on the list are identified by site number, location, and type (P = prehistoric, H = historic). A comment is made about each site and the National Register of Historic Places (NRHP) classification is given, if known. Isolated finds are shown as IF in the comment box and they are, by definition, not eligible to the NRHP. The sites are listed in numerical order based on the site numbers. The number is a code, 5MT###. Colorado has the code number 5 and Montezuma County is MT; Mesa Verde National Park is MV. The number after is a running total that started at zero.

There are 120 sites in the study area. Of these, 83 are prehistoric, 34 are historic, one has both variables, and two are indeterminate as to general age. Of the 84 prehistoric sites 24 have enough data to assign a period. Noting that some sites have more than one period present, the following periods are represented: 1 Archaic site, 0 BI sites, 9 BIII sites, 12 PI sites, 10 PII sites, 2 PIII sites, and 1 Post-Puebloan or Proto-historic site. All of the historic European American sites date to the Capitalism and Post-Capitalism periods.

Two ditches that are part of the Mancos irrigation system have already been recorded. The Weber Reservoir Inlet Ditch (5MT.11643) and the Long Park Ditch (5MT.11644) were recorded by Alpine Archaeological Consultants in 1991. Neither one has been evaluated in relation to the NRHP. Two other ditches have also been recorded from the Mancos area. The Jackson Gulch Inlet Canal (5MT.11645) was reported by Alpine in 1991. It was revisited by La Plata Archaeological Consultants in 1994 and classified as not eligible to the NRHP (MT.FS.R57). This ditch seems to be on the north end of Jackson reservoir. The Turkey Creek Ditch (5MT.13802) was reported by Alpine in 2000 (MT.FS.R88) and classified as not eligible to the NRHP. The Colorado Engineering Context volume (King 1984) provides information and guidance on evaluating irrigation ditches.

In summary, the Paleo-Indian and Archaic periods are poorly represented in the Mancos study area. If these types of sites are encountered they will be buried in the deep soils and will likely be considered significant resources because they are rare. Sites from the BIII period are higher than expected, so the Mancos valley may have been used more than the Delores valley during that period; this would be an interesting topic to archaeologists as it may change their understanding of the period. Therefore, sites from this period would be significant due to the possibility that they could help refine current knowledge. Sites from the PI and PII period are predictably well represented. The high number of PII sites does suggest that the Mancos valley blends into the Mesa Verde-Mancos unit. PIII sites seem to be underrepresented in the study area. This may be a settlement pattern issue as many sites from this era are in the Lost Canyon District. Post Puebloan and Proto-historic sites are rare in the area; any found would be significant resources. Historic American sites are common and several are significant due to their architectural or social associations.

These observations are not intended to convey the idea that every site is significant. A conservative approach is to view every site as potentially eligible to the NRHP and evaluate it downward from there, as needed. After the evaluation process many sites will not qualify as eligible to the NRHP. As the list below shows many sites are isolated finds or lack the integrity to be considered NRHP eligible. Those sites that are more substantial and have some resemblance of integrity need to be assessed against the ideas and research questions expressed in the appropriate context volumes (Lipe et al. 1999; Buckles and Buckles 1984; King 1984)

Table 6: List of Sites in the Mancos Study Area.

Note: Table 6 contains confidential site location information and is not available for public review.

Consultation

Data was received from OAHP on March 24 and May 7, 2003. Agreements with Ute Mountain Ute and Southern Ute require notice of Ute cultural items.

Recommendation and Ongoing Concerns

It is recommended that an on-site cultural resource inventory be done. This inventory should be limited to those areas where new excavating will be done and any place that subsoil is to be disturbed. The ditches themselves can be recorded as sites, as they likely meet the age requirement of being historic structures. This study will also evaluate for NRHP purposes any and all sites encountered, including sites that have been previously recorded. The inventory will also need support from the ditch companies, particularly in notifying landowners and maintaining public relations while the fieldwork is in progress. Following the inventory a monitoring phase should be implemented by having an archeologist observe the excavation of the new ditches. If additional cultural materials are discovered then there are options to consider. First, the materials will need to be evaluated against the NHRP criteria where they may be dismissed as not eligible or determined to be potentially eligible. The potentially eligible sites can be handled in various ways. One would be to realign a specific new ditch to avoid these new cultural materials. Alternatively, an archeological data recovery effort can be done to mitigate the adverse effect of placing the new ditch through the cultural materials.

Several ongoing concerns include the possibility that irrigation improvements may cut across or through significant sites, sites that may need stabilization, encountering unmarked burials, and determining if the ditches themselves are important cultural resources.

One concern is that the ditches may have cut through earlier prehistoric or historic sites. While these are impacts that happened in the past, future changes to the ditches may exacerbate these impacts and lead to additional deterioration of significant sites. Some effort at stabilizing these sites may be needed. For example, if ditches have cut through room-blocks, kivas, or other pit features then there may be a need to stabilize them from erosion. Another option would be to mitigate the problem through archeological excavation.

As with any ground disturbing endeavor, the possibility of encountering burials is present. Such features pose numerous problems when found that generally lead to construction delays. For example, in Virginia a church expansion was stopped twice (each for two weeks) when burials were encountered and needed excavation. This impromptu project dominated the time of a staff archeologist for the next year (Moore, Owsley, and Sandness 1995). If burials are found they can be avoided. If the path of the pipeline cannot be rerouted around burials then the local sheriff and coroner, and the State Archeologist will need to be contacted and involved.

Finally, the ditches themselves may be cultural resources if they are 50 years old or more. It appears that many ditches will meet this requirement. As such they need to be recorded and evaluated for NRHP purposes. A context volume on historic engineering structures has been provided by the Colorado Historical Society (King 1984) to assist in this regard. Once the new pipeline is installed the old ditches may be abandoned. This is likely to end in their deterioration and leveling through natural processes. The public may be concerned about this and one way to offset the loss is to produce a brochure on the history of irrigation in the Mancos valley. The brochure can be made available to the public through local museums and libraries.

Alternatives

Currently the intent is to install the new pipeline adjacent to the existing ditches. A possible alternative is to run the pipeline down the ditches themselves, thereby reducing the volume of subsoil that may be disturbed. The ditches would be impacted but they may not need to be left intact.

References Cited

Binford, Lewis R.
2001 *Constructing Frames of Reference: An Analytical Method for Archaeological Theory Building Using Hunter-Gatherer and Environmental Data Sets*. University of California Press, Berkeley, CA.

Buckles, William G., and Nancy B. Buckles
1984 *Colorado Historic Archaeology Context.* Colorado Historical Society, Denver, CO.

Butler, Peter
1994 A Comparison of Policies for Controlling Irrigation-Induced Salinity in Southwestern Colorado. Ph.d Dissertation, University of Michigan.

Carson, Phil
Across the Northern Frontier: Spanish Explorations in Colorado. Johnson Books, Boulder, CO.

Freeman, Ira S.
1958 *A History of Montezuma County, Colorado: Land of Promise and Fulfillment*. Johnson Books, Boulder, CO.

Frison, George C.
1992 The Foothills-Mountains and the Open Plains: the Dichotomy in Paleoindian Subsistence Strategies Between Two Ecosystems. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford and J. S. Day, pp. 323-342. University of Colorado Press, Niwot, CO.

Head, June
1986 *One Hundred Years of Banking in Montezuma County*. First National Bank, Cortez, CO.

King, Joseph E.
1984 *Colorado Engineering Context*. Colorado Historical Society, Denver, CO.

Lipe, William D., Mark D. Varien, and Richard H. Wilshsen
1999 *Colorado Prehistory: A Context for the Southern Colorado River Basin*. Colorado Council of Professional Archaeologists, Denver, CO.

Madsen, David B., and David Rhode (eds.)
1994 *Across the West: Human Population Movement and the Expansion of the Numa*. University of Utah Press, Salt Lake City, UT.

Moore, Lawrence E.
Prehistoric Sites and Settlement Patterns in the Ken-Caryl Valley, Jefferson County, Colorado. *Southwestern Lore* 68(1): 1-22.

Moore, Lawrence E., Douglas W. Owsley and Karin L. Sandness.
1995 Military and Civilian Burials from Centreville, Virginia. *Quarterly Bulletin of the Archeological Society of Virginia* 50(4): 27-45.

National Cooperative Soil Survey
N.D. *Soil Survey of Cortez Area, Colorado. Parts of Dolores and Montezuma Counties.* Draft manuscript, USDA, Natural Resources Conservation Service, Lakewood, CO.

Pitblado, Bonnie L.
1998 Peak to Peak in Paleoindian Time: Occupation of Southwest Colorado. *Plains Anthropologist* 43(166):333-348.

Sanchez, Joseph P.
1997 *Explorers, Traders, and Slavers: Forging the Old Spanish Trail, 1678-1850.* The University of Utah Press, Salt Lake City, UT.

Simmons, Virginia McConnell.
2000 *The Ute Indians of Utah, Colorado and New Mexico*. University Press of Colorado, Boulder, CO.

Sims, Marsha
Mancos Watershed Project: Cultural Resources Inventory. Draft report, Natural Resources Conservation Service, Lakewood, CO.

Soil Conservation Service
1984 *Irrigation Improvements: Mancos Valley Salinity Control Study, Colorado River Salinity Control Program*. USDA, Soil Conservation Service, Denver, CO.

Stene, Eric A.
1994 *The Mancos Project*. Bureau of Reclamation History Program, Denver, CO.

Towner, R. H. (editor)
1996 *The Archaeology of Navaho Origins*. University of Utah Press, Salt Lake City, UT.

West, Elliot
The Contested Plains: Indians, Gold Seekers, and the Rush to Colorado. University Press of Kansas, Lawrence, KS.