STATE OF COLORADO

DEPARTMENT OF LAW

1707

AGRICULTURAL ENGINEERING STUDY
SOUTHERN UTE & UTE MOUNTAIN
UTE INDIAN RESERVATIONS

LA PLATA WATERSHED

FINAL REPORT

DESIGN & COST ESTIMATE FOR
OFF-FARM IRRIGATION FACILITIES &
PIA DETERMINATION

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D.1 GENERAL

The purpose of this task report is to present the methodology for determining practicably irrigable acreage (PIA) for the La Plata Watershed. The test for PIA requires that the revenues exceed the cost. The land under consideration when cropped and irrigated must return sufficient net positive income to pay for the costs of providing irrigation water to the farm headgate. In order to determine PIA it is necessary to conceptually design an irrigation transmission system to deliver water to the farm headgate for each arable parcel. The annualized cost of the off-farm irrigation water transmission system is compared to the net positive income (payment capacity) of the parcel.

Arable lands were identified by Stoneman and Landers. Potential crops, irrigation water requirements, on-farm irrigation systems cost, and other related agronomic information were prepared by Boyle and presented in Task A and B reports. Economic methodology and net agricultural returns were prepared by Western Research Corporation.

This preliminary PIA analysis compares the preliminary net agricultural return with the cost of water delivery from the primary water source to the parcel headgate. For this preliminary analysis, the highest net agricultural return for each climatic zone is used. Off-farm irrigation transmission facilities were conceptually

designed for those parcels with preliminary payment capacities greater than the off-farm water pumping costs. The pumping cost was re-evaluated, added to the facilities cost, and compared to the preliminary payment capacity.

To complete the PIA analysis, the cropping pattern and payment capacities were reviewed by the economist taking into account the practicality of the cropping pattern for the particular parcel and any agronomic costs that might be particular to the parcel. Several iterations of this process between the economist and the engineer were sometimes necessary in order to develop the most economical parcel and facilities layout. Those parcels that still exhibited positive residual payment capacity after these further analyses were then determined to be practicably irrigable.

D.2 SELECTION OF PARCELS FOR OFF-FARM DESIGN

Parcels to be considered for PIA analysis were identified in the Task B Report along with on-farm irrigation costs. The Task B report identified irrigation costs for handmove sprinkler, sideroll sprinkler, gravity (furrow or basin), center pivot, and center pivot with sprinkler in the corners. Computer tabulation compared on-farm irrigation costs to the crop payment capacity for an alfalfa/barley crop rotation.

The first step in making this task analysis was determination of the presently irrigated lands on Southern Ute Indian lands. W. W. Wheeler & Associates, Inc., hydrology consultant, identified from

aerial photographs and other information available to them the lands presently irrigated and provided to Boyle a marked print of the base map. The amount of irrigated acreage was then planimetered from the base map and tabulated. It should be noted that presently irrigated land covers some land not classified and Class 6 (non-irrigable) soils as determined by Stoneman-Landers, soil consultants.

For the remaining irrigable parcels, an analysis was made to determine the residual water payment capacity when only the off-farm static pumping lift costs where added to the on-farm costs identified in Task B. Based on the elevation of the nearest water supply and the elevation of the highest point in each parcel, the static lift to serve the parcel was calculated using the computer program developed for the Task B report. The power cost to lift the annual water requirement to each field was then calculated assuming a 75 percent pumping plant efficiency which is a conservatively high assumption; and a field delivery pressure of 60 psi for all but gravity irrigated fields.

It should be noted that the parcel water payment capacity residual analysis (Appendix D) was slightly modified from the analysis presented in the Task B draft report. Land leveling costs for gravity irrigated fields were not included in the Task B on-farm costs. The Task B report, however, estimated land leveling quantities in the range of one foot average cuts at a cost of $0.50 to $1.00 per cubic yard. As a conservatively low estimate, an average 6-inch cut at $0.50 per cubic yard for a total cost of $403 per acre

was assumed for this Task D analysis. Amortizing this cost at 8-3/8 percent interest over 50 years gives a cost of $34.40, or in round numbers, $35 per acre. This cost was then included in the on-farm costs for gravity irrigation.

D.3 OFF-FARM IRRIGATION TRANSMISSION SYSTEM COST

D.3.1 General

The off-farm irrigation transmission facilities will generally consist of transmission pipelines, pumping stations, and diversion facilities. Roads for access to pump stations; rights-of-way; and the extension of electrical power services to pumping stations were not included in the cost analysis. Costs for those items included are based on experience with similar facilities. All costs are then amortized using a discount rate of 8-3/8 percent over a 50 year project life.

D.3.2 Pumping Stations

Pump station costs were estimated using an equation which considers flow and horsepower as variables. The equation is based on Boyle's experience with various size agricultural pump stations which include pump motor, pump structure, valves, surge control, and power panel. The equation is:

$$\text{Cost } (\$) = 2441(GPM)^{0.41} + 150(HP)^{1.05}$$

where GPM is the system flow rate in gallons per minute and HP is the gross horsepower.

D.3.3 Pipelines

The cost of pipelines is estimated based on experience in water transmission pipeline work. The least cost type of pipe material for the various diameters is reflected in the estimate. Pipeline costs have been compared with pipeline cost estimates from the United States Bureau of Reclamation (USBR) Dolores Project as well as the Animas-La Plata Definite Plan Report. Installed estimated pipeline costs are shown in Table D.1.

D.3.4 River Diversion Structures

River diversion structures were included for parcels over 30 acres. The diversion structure would be constructed across the river to form a pool of water with sufficient depth for the pump to draw from. A weir type diversion structure consists of a 4 foot high wall with a footing and riprap on each side for stability and protection from ice damage. The estimated cost of the structure is $210 per foot. The diversion structures were estimated to be 50 feet long for the La Plata River.

It may not be practical to build a massive diversion to serve a small parcel. A farmer farming a small parcel with low flow requirements would probably have a simple temporary diversion which could be nothing more than a berm graded across the river with a backhoe or dozer to form a shallow pool for his pump to take suction from if flows in the stream are low. If stream flows were too large to allow installation of a temporary diversion, a low flow could most likely be pumped without a diversion.

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TABLE D.1
PIPELINE COSTS

Pipe Diamet. (inch)	Installed Cost - $/ft 1/					
	100 psi	150 psi	200 psi	250 psi	300 psi	350 psi
4	10.50	11.00	11.50	12.00	12.50	13.00
6	12.00	12.50	13.00	14.00	14.50	15.00
8	15.50	16.00	17.00	17.50	18.50	20.00
10	20.00	21.00	22.50	23.50	25.00	26.50
12	24.00	26.50	28.50	31.00	33.00	35.00
14	28.50	32.00	35.00	38.00	41.00	44.00
15	31.00	34.50	38.50	42.50	45.50	49.00
16	34.00	37.50	42.00	46.00	50.00	54.00
18	41.00	45.00	50.00	54.00	59.50	65.00
20	48.50	53.00	58.00	63.50	69.00	75.00
21	50.50	55.50	60.50	66.00	71.50	77.00
24	62.00	69.00	75.50	82.00	88.50	95.50
27	75.50	82.00	88.50	96.50	104.00	112.00
30	89.50	96.50	103.00	111.00	120.00	128.50
33	104.50	111.00	116.50	126.50	137.50	148.50
36	115.50	122.00	130.50	142.00	155.00	166.00
48	150.00		164.00			
54	184.00		206.00			
60	222.00		230.00			
66	260.00		304.00			
72	296.00		332.00			
78	335.00		360.00			

1/ Unit construction cost including 10% allowance for appurtenances.

The berm may require regrading several times during the irrigation season. However, the overall cost of such diversions is minimal. The decision on the type and size of diversion will vary with each parcel and would require extensive review in the field. Therefore, in order to simplify the analysis it is assumed that no special diversion structure will be required for parcels of 30 acres or less.

In cases where several parcels can be served from one diversion and the combined acreage is over 30 acres, the cost of the diversion is divided between the parcels in proportion to parcel acreage. This approach is believed to be conservative (in favor of generating PIA) and realistic for this type of analysis.

D.3.5 Other Costs

Annual maintenance of major facilities including pipelines, pump stations, and river diversions is estimated at 0.5 percent of the initial construction cost.

The cost of electrical energy is assumed to be $0.068605/KWhr for the Southern Ute area and $0.065039/KWhr for the Mountain Ute area. These are commercial user rates being charged during the first half of 1985. A detailed discussion of the power costs was previously provided.

D.3.6 Other Costs not Included

Other known costs which could be considered are costs for access roads to the pump stations, right-of-way costs where pipelines or pump stations may be on non-Indian land, and costs to provide electric power service to the pump station. These costs are either minor and/or difficult to estimate with available information. Therefore, for these preliminary analyses, they have not been considered at this time.

The cost of power line extensions to serve pumping facilities could be quite high, especially if three phase power is required. Three phase power will be required for pump stations over 25 horsepower.

D.4 PRELIMINARY PRACTICABLE IRRIGABLE ACREAGE

D.4.1 Existing Irrigated Lands

Lands currently irrigated are assumed to be PIA requiring no further evaluation. Table D.2 summarizes the currently irrigated acreage in the watershed. The acreage is also identified on maps included as Figure D.1, D.2, D.3, and D.4.

D.4.2 Water Supply

An examination of the hydrology data for the La Plata River shows that there is sufficient virgin flow during the summer irrigation periods to serve the potential arable lands directly from the river. Therefore, it was not necessary to perform any operational studies involving storage reservoirs.

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TABLE D.2
CURRENTLY IRRIGATED ACREAGE

Parcel No.	Currently Irrigated Gross Acres	Non-Irrigated Gross Acres
L 39	7	26
L 43	6	1
L 63	7	125
L 65	51	14
L 75	28	9
L 76	40	0
L 77	4	64
Unparcelled	8	
TOTAL	151	239

D.4.3 Cropping Pattern

For the preliminary analysis of PIA, a cropping pattern with the highest net agricultural returns was used. Table D.3 identifies this cropping pattern as well as the net agricultural return. Parcels in the La Plata watershed are located in climatic zones D, E, F, G, and H.

D.4.4 Preliminary PIA Analysis

A preliminary PIA analysis was performed comparing a parcel's payment capacity with a preliminary estimate of the cost to pump water from the river to the parcel. This preliminary water cost was based on the static pumping lift (the difference in elevation from the water surface in the river to the elevation of the parcel) for gravity irrigated fields or plus a field delivery pressure of 60 psi for sprinkler irrigation. Detailed tabulations of the analysis are shown in Appendix D.1. Table D.4 identifies only those parcels with an initial positive residual payment capacity requiring further consideration. A total of 82 parcels covering 2,573 acres showed an initial positive residual payment capacity.

An off-farm irrigation transmission system was designed for those parcels near the La Plata River showing an initial positive payment capacity. Those calculations are shown in Appendix D.2 and summarized in Table D.5. Parcels with a positive payment capacity after comparing the residual payment capacity to the cost of water are initially identified as practicably irrigable.

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TABLE D.3
PRELIMINARY CROPPING PATTERN

Climatic Zone	Elevation Range, ft.	Crop Mix 1/	Maximum Net Agricultural Return 2/ $/ac/yr
A	<5,000	Corn, Soybeans	375
B	5,000-5,400	Corn, Soybeans	330
C	5,400-5,800	Corn, Soybeans	285
D	5,800-6,200	Alfalfa, Malt Barley	270
E	6,200-6,600	Alfalfa, Malt Barley	240
F	6,600-7,000	Alfalfa, Malt Barley	210
G	7,000-7,400	Alfalfa, Malt Barley	185
H	7,400-7,800	Alfalfa, Malt Barley	160
I	7,800-8,200	Grass Hay, Pasture	85
J	>8,200	Grass Hay, Pasture	70

1/ Cropping mix and maximum net agricultural return provided by Western Research Corporation, April 11, 1986.

2/ Maximum net agricultural returns do not include on-farm irrigation costs.

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TABLE D.4
PARCELS WITH PRELIMINARY RESIDUAL PAYMENT CAPACITY
(Considering pumping only)

Parcel No.	Gross Acres	Prelim. Residual Payment Capacity ($/ac/yr) Hndmve.1/	Sdroll.2/	Grav.3/	Cntrpvt.4/	Cpvt/Hmv.5/
L16	42	12	-6	-45		
L17	30	4	-25	-46		
L19	18	4	-39	-39		
L21	10	8	-70	-33		
L22	34	10	-18	-42		
L23	37	36	9	-16		
L24	17	32	-15	-8		
L25	56	56	38	0	-75	-65
L26	8	12	-101	-21		
L27	67	71	52	13	-47	-38
L28	49	90	71	37	-52	-42
L29	54	71	52	16	-63	-54
L30	37	93	68	47		
L31	18	106	63	72		
L32	22	114	81	79		
L33	8	86	-26	61		
L34	9	75	-20	48		
L36	20	53	16	9		
L37	18	53	7	9		
L38	63	59	37	-1	-66	-55
L39	26	75	42	30		
L40	22	75	40	33		
L41	53	87	66	30	-51	-41
L42	9	49	-48	14		
L43	1	22	-145	-10		
L44	96	74	56	13	-10	-2
L45	32	85	55	36		
L46	15	86	29	49		
L47	8	62	-51	32		
L48	10	66	-11	29		
L49	15	73	16	35		
L50	17	70	22	32		
L51	25	100	68	61		
L52	37	98	72	50		
L53	30	103	73	60		
L54	25	117	86	81		
L55	34	92	64	45		
L56	15	26	-32	-18		
L58	9	20	-77	-16		
L59	27	69	36	22		
L60	15	40	-16	-1		

Table D.4, continued

Parcel No.	Gross Acres	Prelim. Residual Payment Capacity ($/ac/yr) Hndmve.1/	Sdroll.2/	Grav.3/	Cntrpvt.4/	Cpvt/Hmv.5/
L61	9	40	-57	4		
L62	110	74	57	13	7	13
L63	125	112	93	58	70	67
L64	15	119	62	85		
L65	14	108	47	73		
L66	16	151	98	119		
L68	52	4	-14	-55	-128	-119
L69	33	3	-25	-49		
L70	56	6	-12	-53	-121	-112
L74	39	28	2	-26		
L75	9	61	-34	33		
L77	64	88	71	34	-33	-24
L78	9	73	-22	45		
L79	6	67	-80	43		
L80	10	94	17	61		
L81	9	40	-55	10		
L82	39	47	22	-4		
L83	7	23	-107	-5		
L84	8	6	-106	-24		
L85	32	80	52	35		
L86	27	104	73	65		
L87	40	63	45	11		
L88	11	34	-38	-3		
L89	11	52	-20	15		
L90	7	25	-105	-2		
L91	13	110	47	79		
L92	16	136	86	107		
L93	5	27	-138	1		
L94	10	106	30	76		
L127	38	51	26	1		
L128	23	48	16	8		
L129	184	63	45	6	43	32
L131	37	84	58	36		
L132	38	113	88	68		
L133	14	101	42	69		
L134	132	138	122	89	107	89
L135	21	127	95	96		
L136	39	122	98	78		
L137	50	135	120	89	-6	2
L138	53	156	141	111	17	26
L139	16	89	37	54		

Table D.4, Continued

1/ Hndmve - Handmove sprinkler, on-farm irrigation system.

2/ Sdroll - Sideroll sprinkler, on-farm irrigation system.

3/ Grav - Gravity on-farm irrigation systems.

4/ Cntrpvt - Center pivot sprinkler, on-farm irrigation system.

5/ Cpvt/hmv - Center pivot sprinkler, on-farm irrigation system with hand move in the corners.

TABLE D.5
SUMMARY OF OFF-FARM IRRIGATION WATER COST

Parcel No.	Gross Acres	Net Acres 1/	Pay.Cap. $/ac/yr 2/	Water Cost $/ac/yr	Residual Pay.Cap. $/ac/yr
L16	42	41.5	144	700	-556
L17	30	30	139	911	-772
L19	18	18	131	856	-725
L21	10	10	110	1,628	-1,518
L22	34	34	141	1,217	-1,076
L23	37	37	142	1,035	-893
L24	17	17	128	446	-318
L25	56	55.4	144	314	-170
L26	8	8	93	910	-817
L27	67	66.3	144	204	-60
L28	49	48.5	144	251	-107
L29	54	53.4	144	205	-61
L30	37	37	168	333	-165
L31	18	18	157	279	-122
L32	22	22	163	217	-54
L33	8	8	119	247	-128
L34	9	9	126	305	-179
L36	20	20	93	187	-94
L37	18	18	87	304	-217
L38	63	62.3	100	181	-81
L39	26	26	117	216	-99
L40	22	22	115	178	-63
L41	53	52.4	122	132	-10
L42	9	9	79	247	-168
L43	1	1	51	911	-860
L44	96	95	121	134	-13
L45	32	32	119	172	-53
L46	15	15	123	243	-120
L47	8	8	93	283	-190
L48	10	10	110	349	-239
L49	15	15	123	388	-265
L50	17	17	128	226	-98
L51	25	25	138	162	-24
L52	37	37	142	166	-24
L53	30	30	139	149	-10
L54	25	25	164	165	-1
L55	34	34	141	205	-64
L56	15	15	80	844	-764
L58	9	9	79	988	-909
L59	27	27	117	1,178	-1,061
L60	15	15	102	1,539	-1,437

TABLE D.5 (continued)

Parcel No.	Gross Acres	Net Acres 1/	Pay.Cap. $/ac/yr 2/	Water Cost $/ac/yr	Residual Pay.Cap. $/ac/yr
L61	9	9	79	952	-873
L62	110	108.9	121	608	-487
L63	125	123.7	141	447	-306
L64	15	15	123	978	-855
L65	14	14	120	934	-814
L66	16	16	125	880	-755
L68	52	51.4	144	1,021	-877
L69	33	33	140	1,144	-1,004
L70	56	55.4	144	1,332	-1,188
L74	39	39	143	371	-228
L75	9	9	126	411	-285
L77	64	63.3	170	212	-42
L78	9	9	126	294	-168
L79	6	6	105	341	-236
L80	10	10	136	240	-104
L81	9	9	126	386	-260
L82	39	39	169	477	-308
L83	7	7	112	1,256	-1,144
L84	8	8	119	1,484	-1,365
L85	32	32	166	283	-117
L86	27	27	165	186	-21
L87	40	40	171	465	-294
L88	11	11	139	609	-470
L89	11	11	139	514	-375
L90	7	7	112	1,796	-1,684
L91	13	13	171	292	-121
L92	16	16	179	226	-47
L93	5	5	97	478	-381
L94	10	10	163	504	-341
L127	38	38	169	793	-624
L128	23	23	163	707	-544
L129	184	180.3	169	224	-55
L131	37	37	168	205	-37
L132	38	38	195	518	-323
L133	14	14	173	639	-466
L134	132	130.6	195	394	-199
L135	21	21	189	317	-128
L136	39	39	196	310	-114
L137	50	49.5	197	335	-138
L138	53	52.4	197	331	-134
L139	16	16	152	762	-610

Table D.5, Continued

1/ Net acres for parcel, irrigation system, combination resulting in the highest payment capacity. See Appendix D.1.

2/ Highest preliminary payment capacity from Appendix D.1.

3/ Parcel with positive residual payment capacity.

A number of parcels in the La Plata watershed had an initial positive residual payment capacity even though the distance to the river was considerable. Instead of designing individual lines of supply to each of these parcels, a single line was sized to serve all parcels. The per acre cost of this single transmission line was compared to the residual preliminary payment capacity of each parcel. The analysis for both parcels near and away from the river showed that no parcels had a remaining positive payment capacity.

D.4.5 Preliminary Practicably Irrigable Acreage Determination

Table D.6 and Figures D.1 through D.4 identify the preliminary practicably irrigable acreage for the La Plata watershed. The preliminary PIA consists only of that acreage currently irrigated. A total of 151 acres was identified as PIA in the La Plata Watershed. The estimated annual water diversions would be 382 acre-feet from the La Plata River.

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TABLE D.6
SUMMARY OF PRELIMINARY PIA LANDS

Parcel No.	Gross Acres	Net Acres 1/	Pay.Cap. $/ac/yr	Water Cost $/ac/yr	Residual Pay.Cap. $/ac/yr	Diversion Required 2/ ac-ft/yr.
Currently Irrigated Lands						
L39	7	7				14.5
L43	6	6				12.4
L63	7	7				16.8
L65	51	50.4				122.2
L75	28	28				75.5
L76	40	40				107.8
L77	4	4				10.8
Unparcelled	8	8				21.6
TOTAL	151	150.4				381.6

1/ Currently irrigated land net acres estimated based on criteria in Boyle's Task A report.

2/ Currently irrigated land diversion requirements are based on highest water requirements for the climatic zone (gravity irrigation) and cropping pattern with the highest net agricultural return.