

PROGRESS REPORT
TO
VALLEY-WIDE SEWER COMMITTEE
GRAND JUNCTION AND MESA COUNTY, COLORADO

ANALYSIS OF LAND APPLICATION ALTERNATIVES
FOR
WASTEWATER TREATMENT

June 1977



HENNINGSON, DURHAM & RICHARDSON

ENGINEERING · ARCHITECTURE · PLANNING

DENVER

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FOR
WASTEWATER TREATMENT

GRAND JUNCTION AND MESA COUNTY, COLORADO

BACKGROUND

As part of our agreement, dated September 23, 1976, with the City of Grand Junction and Mesa County, the following services are to be included in the final pre-design report:

"4. Perform additional technical cost-effective studies and social and environmental evaluations of land application of secondary effluent versus a mechanical treatment process as described in the facility plan. The land application evaluation will include such items of study as:

- Land Application Methods
- Land Suitability
- Salinity Consideration
- Site Evaluations
- Treatment Prior to Land Application
- Land Area Required For:
 - a. Treatment
 - b. Storage
 - c. Buffer Zone
 - d. Distribution
- Land Use Compatibility
- Public Acceptance."

In our progress reports to the Valley-Wide Sewer Committee on March 15, 1977 and on May 11, 1977, cost estimates for land application alternatives of wastewater treatment were presented and discussed in detail, along with cost estimates for mechanical treatment alternatives plus treatment and reuse alternatives. In comparison with the other forms of treatment, the land application alternatives were not as cost-effective as recommended Alternative VI, a mechanical treatment system.

At the May 11, 1977 meeting a motion was passed requesting HDR to give further consideration and study to other land application alternatives while moving ahead with recommended Alternative VI. We were also asked to review the land application proposal as presented by Mr. Ed Carpenter, Engineer, an interested member of the community.

Therefore, this progress report to the Valley-Wide Sewer Committee provides additional information concerning the analysis of land application alternatives as prepared by HDR of Denver and Culp/Wesner/Culp of El Dorado Hills, California.

GENERAL

Land application of treated municipal wastewater provides a source of irrigation water for the production of crops. Some constraints include protection of ground water and surface water quality and the public health. The Grand Valley has a salinity problem which requires careful management of all irrigation systems. The magnitude of this problem along with alternative control measures has been presented in a draft report by the Soil Conservation Service (SCS), U.S. Department of Agriculture.* In summary, the control measures consist of limiting leachate from irrigated lands and erosion from non-irrigated areas. To control salinity due to leachate, a high irrigation efficiency should be used. The present irrigators in the valley use 30% efficiencies. By using sprinkler systems rather than ridge and furrow systems, the efficiency can be increased to 70 - 80%. Sprinkler systems when properly designed and operated, can minimize runoff which is a source of salts and suspended solids.

*GRAND VALLEY SALINITY STUDY, DRAFT, Soil Conservation Service, U.S. Department of Agriculture, December 1976.

SOILS

The soil characteristics of an area are often the most important factors in the selection of a land application method and site. According to the Soil Conservation Service (SCS), soils of the Grand Valley contain high concentrations of salts and low concentrations of organic matter and plant nutrients. Soils that are suitable for agriculture in the Grand Valley have been most widely developed through the network of irrigation canals. These irrigated soils annually produce crops that include corn, alfalfa, orchard crops, small grains, sugar beets, and pasture grasses. However, the soils located to the north of the existing agricultural district are of particular interest as a potential site for the irrigation of crops.

A soil survey was recently completed for lands to the north of the existing agricultural district of the Grand Valley by the SCS Area Office in Grand Junction. Soils in this area were assigned soil capability classifications by the SCS to indicate the suitability of the soils for crop production. These soil classifications are shown in Table 1.

TABLE 1
SCS SOIL CAPABILITY CLASSIFICATIONS

<u>Name</u>	<u>SCS Symbol</u>	<u>Classification</u>
Billings	B _s	Class II _s
Youngston	Y _o	Class II _e
Avalon	A _v C	Class III _e and IV _e
Persayo	P _e D	Class IV _e and VI _e
Fruita Avalon Association	F _a C	Class IV _e
Uffens Loan	U _f C	Class IV _s
Chipeta	ChD	Class VII _s
Badlands	B _a	Class VII and VIII
Rock Outcrops	R _p	N/A

Referring to Table 1, Class II thru Class VIII soils are rated on a scale ranging from moderate limitations to varying degrees of severe limitations for crop production, respectively. Following the class number, the subscript s means the soils are shallow and/or stoney and the subscript e means the soils are erosive. Of the soils listed in Table 1, Billings, Youngston, Avalon, and Persayo are best suited for the irrigation of crops. About 90% of the soils in this area are Class III, IV and V soils which are characteristically shallow, require an extensive amount of erosion control measures, and are basically suited for low return crops such as alfalfa and pasture grasses.

PROPOSED ALTERNATIVES

Irrigation with treated wastewater can be very costly when long pumping distances are required. In the progress report submitted to Grand Junction/ Mesa County by HDR on May 11, 1977, costs were determined for land application within two miles of the proposed plant site (Alternatives IX and X). These alternatives are essentially the same except for the operation of one new plant as compared to a two-plant system, respectively. The irrigation system would utilize center pivot irrigation rigs for high rate irrigation (i. e., low efficiency). With this system, the water usage is 6 feet per year with a 33% efficiency rating. This efficiency is similar to that found in the existing irrigated areas. Therefore, the salts leached to the ground water would not change significantly. This low efficiency would not be acceptable in new areas which were not irrigated previously. As discussed previously, efficiencies above 70% should be maintained to minimize leachate.

The intent of this progress report is to provide the following descriptions of two additional land application alternatives that have been investigated. Alternative IX-A evaluates the proposal of Mr. Ed Carpenter, Engineer, for a system on lands owned by the Federal Government and regulated through the Bureau of Land Management (BLM). Alternative IX-B evaluates a

privately owned site to the north of Fruita.

Costs associated with Alternatives IX, IX-A, IX-B and X are shown on Tables 2 and 3. Construction costs plus operation and maintenance costs are shown on Table 2. Construction costs include an 8% escalation factor for a one year period from January 1977 thru January 1978 and 15% contingencies. Project costs as well as a cost-effectiveness analysis prepared in accordance with the Environmental Protection Agency guidelines, are shown in Table 3 for each alternative.

Alternative IX-A

The BLM area site, as proposed by Mr. Carpenter, is located to the north of the Government Highline Canal between the City of Grand Junction and Fruita. Most of the area consists of badlands soils which are not generally suitable for irrigation. Within the site there is approximately 4,750 acres of irrigable land. For salinity and erosion control a sprinkler system is required using a center pivot sprinkler system. In order to minimize land leveling, a solid set system could be used but would be more costly. To maintain the system at 70% efficiency, the liquid application rate should be 4.0 feet per year on a 3,750 acre land area.

Within the SCS salinity study quoted previously, there are net returns shown for farmers in the area raising alfalfa and pasture. These are \$73 per acre and \$3 per acre respectively (150 acre parcels). In order to induce a farmer to locate an operation in this area, the land development and system construction and operation and maintenance costs must be such that he can still obtain these returns.

Alternative IX-B

The Fruita area site consists of approximately 5,500 acres of privately owned land that includes portions which are not irrigable. Some of the BLM land is irrigable and could be exchanged for privately owned land following purchase by the operating agency. This site will require some site preparation such as land leveling, but minimal clearing since portions of the area were previously farmed. The Ruby Lee Reservoir, known locally as Garr Mesa Reservoir, could be used for storage with minimal improvements. These improvements consist of removing silt previously deposited and raising the dam embankment to an appropriate height. There will then be adequate storage capacity for the 12.5 mgd initial system by providing approximately 185 days of treated effluent storage.

The preferred irrigation system for this site is a sprinkler system with an efficiency of 70%. Using a 70% efficiency and assuming the irrigated lands are used for pasture and alfalfa, the annual water requirements are 3.5 feet per year and 4.0 feet per year respectively. For simplicity assume 50% of land planted with each crop for an overall water requirement of 3.75 feet per year. With a 12.5 mgd treatment system, the land required for the application site is 3,750 acres.

Requirements for implementation of this alternative site include land acquisition (private and BLM), an extension of the interceptor sewer from Grand Junction to Fruita, a force main from Fruita to the site, and completion of an environmental impact assessment. State approval of dam improvements for safety would also be required.

TABLE 2
 LAND APPLICATION COSTS
 ALTERNATIVES IX, IX-A, IX-B AND X
 Grand Junction/Mesa County

	<u>Alternative IX</u>	<u>Alternative IX-A</u>	<u>Alternative IX-B</u>	<u>Alternative X</u>	
	GJ/Mesa Co Owned New Plant Agricultural Area Site 12.5 MGD w/o Liner @ 6'/Year	GJ/Mesa Co Owned New Plant BLM Area Site 12.5 MGD w/o Liner @ 4'/Year	GJ/Mesa Co Owned New Plant Fruita Area Site 12.5 MGD w/o Liner @ 4'/Year	GJ/Mesa Co Owned Existing Plant Agricultural Area Site 5.7 MGD w/o Liner @ 6'/Year	GJ/Mesa Co Owned New Plant Agricultural Area Site 6.8 MGD w/o Liner @ 6'/Year
Capitol Construction Costs:					
<u>Facility</u>					
Administration Facilities	\$ 252,000	\$ 252,000	\$ 252,000	\$ --	\$ 252,000
Pumping Station(s)	1,260,000	1,006,000	1,006,000	690,000	810,000
Booster Station(s)	--	700,000	1,400,000	--	--
Pipelines to Site	560,000	3,990,000	4,760,000	1,344,000	450,000
Additional 54" Interceptor Sewer	--	--	3,465,000	--	--
Field Preparation	14,000	1,125,000	750,000	--	14,000
Storage Reservoir	5,000,000	6,387,000	1,500,000	--	5,000,000
Distribution Pumping	1,260,000	1,260,000	1,260,000	--	1,260,000
Center Pivot Equipment	1,680,000	3,082,000	3,082,000	--	1,680,000
Underdrains	840,000	1,381,000	1,381,000	--	840,000
Roads and Fencing	560,000	1,200,000	855,000	--	560,000
Monitoring Wells	8,000	40,000	40,000	--	8,000
Aerated Lagoons	1,760,000	1,825,000	1,825,000	--	1,144,000
Plant Modifications (by others)	--	--	--	840,000	--
Estimated Sub-Total	\$13,194,000	\$22,248,000	\$21,576,000	\$ 2,874,000	\$12,018,000
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Annual Operation & Maintenance Costs:					
<u>Facility</u>					
Existing Plant	\$ --	\$ --	\$ --	\$ 250,260	\$ --
New Plant	483,280	882,900	998,400	--	434,500
Estimated Sub-Total	\$ 483,280	\$ 882,900	\$ 998,400	\$ 250,260	\$ 434,500
Estimated Total	\$ 483,280	\$ 882,900	\$ 998,400	\$ 684,760	

TABLE 3
 LAND APPLICATION COST SUMMARY
 ALTERNATIVES IX, IX-A, IX-B AND X
 Grand Junction/Mesa County

	<u>Alternative IX</u> GJ/Mesa Co Owned One Plant Agricultural Area Site 12.5 MGD w/o Liner @ 6'/Year	<u>Alternative IX-A</u> GJ/Mesa Co Owned One Plant BLM Area Site 12.5 MGD w/o Liner @ 4'/Year	<u>Alternative IX-B</u> GJ/Mesa Co Owned One Plant Fruita Area Site 12.5 MGD w/o Liner @ 4'/Year	<u>Alternative X</u> GJ/Mesa Co Owned Two Plants Agricultural Area Site 12.5 MGD w/o Liner @ 6'/Year
Total Construction Cost*	\$13,194,000	\$22,248,000	\$21,576,000	\$14,892,000
Engineering @ 10%	<u>1,319,400</u>	<u>2,224,800</u>	<u>2,157,600</u>	<u>1,489,200</u>
Project Sub-total	\$14,513,400	\$24,472,800	\$23,733,600	\$16,381,200
Land Cost (Approximate)	<u>16,665,000</u>	<u>237,500</u>	<u>11,875,000</u>	<u>16,665,000</u>
Total Project Cost	\$31,178,400	\$24,710,300	\$35,608,600	\$33,046,200
Cost Effectiveness Analysis: @ 6-3/8% for 20 Years				
Present Worth of Capital Costs	\$30,865,400	\$27,099,700	\$40,087,300	\$32,917,400
Present Worth of O & M Costs	<u>6,786,700</u>	<u>12,398,500</u>	<u>14,020,500</u>	<u>9,616,000</u>
Total Present Worth	\$37,652,100	\$39,498,200	\$54,107,800	\$42,533,400
Average Annual Equivalent Cost	\$ 3,383,300	\$ 3,549,200	\$ 4,862,000	\$ 3,821,900
Unit Cost/1000 Gallons w/o Net Crop Income	\$0.74	\$0.78	\$1.07	\$0.84
w/NCI @ \$14/acre	\$0.73	\$0.77	\$1.05	\$0.83
w/NCI @ \$100/acre	\$0.69	\$0.70	\$0.98	\$0.79
Federal Grant - 75% of Eligible Costs	\$19,633,800	\$18,495,225	\$24,831,450	\$21,034,650
Local Share - 25% of Eligible Costs Plus Land Costs	\$11,544,600	\$ 6,215,075	\$10,777,150	\$12,011,550

*Capital construction costs include an 8% escalation factor for the period from January 1977 thru January 1978 plus 15% contingencies.

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IMPLEMENTATION

The implementation of a land application system in Grand Junction/Mesa County demands certain requirements to be met. These requirements are discussed as they relate to the four alternatives presented in this progress report.

Land acquisition for a land application system is, perhaps, the most important hurdle to be achieved. The land must be acquired before EPA will approve the project for Federal funding. Alternatives IX, IX-B and X propose sites in areas where the land is privately owned. However, Alternative IX-A proposes a site on lands which are the property of the Federal Government. These lands are administered by the U.S. Department of the Interior through the Bureau of Land Management (BLM). Based on a recent interview with Mr. Tom Owen of the Grand Junction District Office of BLM, the acquisition of Federal land is possible through two existing laws; the Recreation and Public Purposes Act of 1954, as amended, and the Federal Land Policy and Management Act of 1976. The constraints connected with acquisition of Federal land through these laws are listed in Table 4. Although existing laws provide procedures for the acquisition of Federal land by other political subdivisions and eligible groups, approval based on intended land use is much to the discretion of the BLM. Thus, a proposal for a land application site to satisfy Alternative IX-A must be directed to the BLM for approval. Mr. Owen indicated that implementation of such a plan could take from 3 to 5 years or longer.

The construction of reservoir type dams under Alternatives IX-A and IX-B would require the submission of plans and specifications for approval under Chapter 148-5-5, Colorado Revised Statutes of 1963, to the Office of the State Engineer of Colorado. These procedures are required for the construction

of any reservoir with an embankment exceeding 10 feet in vertical height, or a capacity more than 1,000 acre-feet, or a surface area exceeding 20 acres. Costs and expenses incurred by the State Engineer during his inspection of the project must be borne by the owner(s).

In the interest of public health, local health authorities may require the aerated lagoons and storage reservoirs be lined for all the alternatives considered. Lining these facilities may be a necessity to prevent leaching of the effluent into the ground water and to control salinity problems. The cost to provide liners is estimated to be an additional \$7,000,000 investment in construction costs for each alternative.

Social costs are also anticipated for the implementation of Alternatives IX-A and IX-B. New utilities, roads, ditches, schools and other municipal facilities would become additional municipal costs which are not a part of the project.

Water rights could be an implementation problem for land application. The effects on water rights as it relates to the various irrigation companies serving the Grand Valley and the Colorado River must be thoroughly investigated.

TABLE 4

FEDERAL BLM LAND ACQUISITION CONSTRAINTS

<u>Subject</u>	<u>The Recreation and Public Purposes Act, 1954 as amended.</u>	<u>Federal Land Policy and Management Act of 1976</u>
Regulations	Latest revision August of 1971	June of 1978
Procedure for Acquisition	Submit application to BLM for approval, subject to revision	Submit land use plan to BLM for approval, subject to revision
Method of Acquisition	Purchase or lease	Purchase or exchange
Acreage Limitation	640 acres per year for sale of lands, no limitation for lease of lands	Tracts exceeding 2,500 acres require congressional approval
Purchase Price	\$2.50 per acre under the special pricing schedule or the fair market value less 50 percent	Not less than the fair market value as determined by the Secretary of the Interior
Lease Price and Term	\$0.25 per acre per year for maximum of 25 years.	N/A
Exchange	N/A	State procedure only
Implementation	Immediate	3 to 5 years

CONCLUSIONS REGARDING
LAND APPLICATION OF WASTEWATER FOR
GRAND JUNCTION AND MESA COUNTY

1. The land application alternative is interesting in that non-productive land can become productive and could be a plus to the local agricultural economy.
2. The land application method at the BLM site is technically possible.
3. For the land application sites studied in the Grand Junction area, total costs for land application methods are higher than for the recommended mechanical system. This is shown in the following summary:

	<u>Land Application (Agricultural Site) Alternative IX</u>	<u>Land Application (BLM Site) Alternative IX-A</u>	<u>Mechanical Treatment Alternative VI</u>
Capitol Cost	\$31,178,400	\$24,710,300	\$14,005,600
O & M	\$483,280/yr.	\$882,900/yr.	\$754,430/yr.
Unit Cost Per 1000 Gallons	\$0.69	\$0.70	\$0.47
Average Annual Equivalent Cost	\$3,383,300	\$3,549,200	\$2,166,600

4. The land application alternative could not be implemented until land is available and a management system established. (EPA has strict requirements in this regard.) This time requirement is indefinite at this time, estimated at 3 to 5 years for land availability. To this time must be added approximately 2 years for design and construction of

facilities. This delay would seriously affect Grand Junction's overall treatment schedule.

5. The Region 8 office of EPA advised on June 16 that to pursue the land application alternative, additional environmental assessment studies and a public hearing to establish local acceptability would be necessary. This would further delay the treatment program.

6. Implementation of the land application alternative could be accomplished by any of three ways:

- a. Municipal owned and operated.
- b. Municipal owned and contract operated.
- c. Privately owned and operated (City would provide effluent to irrigated areas at adequate pressures).

Any of the above methods would require significant time for organization.

7. Cost escalation will be greater for a land application system due to a delay in the program. Therefore, cost estimates shown would have to be escalated to date of implementation.

8. Based on our study of land application alternatives, we do not recommend this approach for the following major reasons:

- a. It is too costly. (Not cost-effective)
- b. Implementation will require lengthy delays.
- c. Will require the establishment of a well-planned land management system.
- d. There must be an established customer (user) for the effluent, prior to an EPA funding commitment.

9. We recommend, as we did at the May 11, 1977 meeting to proceed with Alternative VI, a new mechanical plant of 12.5 mgd capacity at the 22 Road site.