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PROGRESS REPORT

RESEARCH AND DEVELOPMENT PROJECT

ON

SEDIMENTING METHODS OF SEALING IRRIGATION CANALS

Prepared for

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by

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ENGINEERING RESEARCH

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INTRODUCTION

Research and development work on the sedimenting methods of sealing irrigation canals has been carried on at Colorado State University for the past 4-1/2 years. A major part of the research work has consisted of field trial activities in operating canals. The program has also included laboratory research work, most of which has been directly related to the field trial activities. Some of the lab work, however, has been of a more fundamental research nature not directly related to any one particular field site.

Most of the field studies, and perhaps all of the more successful ones, have been entirely financed and installed by irrigation districts or companies and individual farmers. A high-swell or drilling mud type of bentonite clay has been used in almost all of the project work to date. In some cases, water softening chemicals or other sediments, such as local clays and sawdust, have been used in combination with the bentonite. In one recent instance, a chemical sedimenting material, called SS-13, was used in place of a clay sedimenting agent.

During the past year and during the coming year the project activities at the University have been and will be concentrated on research and development activities related to the following field sites:

1. Lateral 19.3 -- The Central Nebraska Public Power and Irrigation District -- near Holdrege, Nebraska.

2. Coachella Canal -- Station 288 to 713 -- Imperial Irrigation District -- near Holtville, California.

3. Coors Farm -- middle mile in ditch along west edge of farm -- near Center, Colorado.

4. Connection Canal -- West Portal of Trans-mountain Diversion System -- Twin Lakes Reservoir and Canal Company -- near Aspen, Colorado.

5. Lateral 1 -- Pathfinder Irrigation District -- North Platte Project -- near Torrington, Wyoming.

Research project salary and laboratory costs for the above work are being paid by the Agricultural Research Service, the Bureau of Reclamation, and the CSU Experiment Station. The field costs for each of the development trials are being paid by the company or district involved in each of the trials -- except for the Lateral 1 installation which was financed and installed by the Bureau of Reclamation.

In the time allotted today, I'll briefly outline the programmed work that has been completed to date and that is planned for the coming year at each of the trial sites. In addition, I'd like to also briefly outline the sedimenting activities that are being sponsored by the State of Wyoming, through the Wyoming Agricultural Extension Service and the Wyoming Natural Resource Board.

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Since of necessity the discussions must be quite brief, please feel free to write to me at the University, if you'd like more details about any or all of the project work at the field sites or in the laboratory. We'll be very glad to send information to you as it becomes available in a published report form. I believe that information on the Wyoming work can be obtained by writing directly to the Wyoming Agricultural Extension Service in Laramie or to the Wyoming Natural Resource Board in Cheyenne.

FIELD SITE WORK (EXCLUDING LATERAL 1)

The research and development activities relating to the first four sites -- i.e., Lateral 19.3, Coachella, Coors, and Twin Lakes -- are set up on a three-year study period basis. The activities for the first year have been completed. In general, these are the activities that are being sponsored by a contract with the Agricultural Research Service of the U. S. Department of Agriculture. However, there is unavoidably some overlap between the Bureau of Reclamation and the Agricultural Research Service. Experimental site and work details are outlined in Table I.

TABLE I

SUMMARY OF EXPERIMENTAL SITE DETAILS AND WORK

ateral or Canal istrict or Company est Reach earest Town	Description of Pervious Soils	Operational Factors Capacity of site reach Normal Season Dry-outs during season	Reasons for Sealing Saving of Water	Saving of Land
ateral 19.3 of B-65 Main Lateral System ne Central Neb. Pub. Pow and I.D. eadgate to Mile 4.4 ertrand, Neb.	Loessial soil Wind-deposited silt material. Quite pervious where root and stem holes are prevalent	30 cfs to 10 cfs March or April to October No dry-outs once season has started	Yes	No not in immediate vicinity
oachella Canal Section as maintained by Imperial Irrigation District tation 288+00 to 713+00 oltville, Calif.	Predominantly sandy with some thin discontinuous clay lenses. Canal skirts western edge of extensive sand dune area.	Design cap--2200 cfs Max. Mo. Mean in 1956 1100 cfs Min. Mo. Mean in 1956 311 cfs Continuous operation No dry-outs	Yes	No not in immediate vicinity of trial reach (Reach 2)
iddle mile of 2 mi ong ditch along west ide of farm iolph Coors Experimental Farm enter, Colorado	Sandy to gravelly material with a thin, fairly continuous clay layer just below the bottom of ditch	Max. cap 8± cfs April or May to September Intermittent irrigations	Yes in water short years	No
onnection Canal of Trans-mountain Diversion System win Lakes Reservoir and Canal Co. 700 feet between Tunnel 1 and Lincoln Gulch Dam spen, Colorado	Materials range from intensely fractured granite bedrock to coarse rock talus. Typical alpine terrain near timber line	Design cap 350 cfs Snow melt period usually from around June 1 to middle of July	Yes	Yes Seepage was flooding access road

TABLE I (cont.)

SUMMARY OF EXPERIMENTAL SITE DETAILS AND WORK

Work To Date	Results	Future Work
Selection of Lat 19.3 as typical site Starting of evaluation of soil and water condition in site Water loss measurements	Field trial work tentatively scheduled for coming spring, but may be delayed to obtain better water loss data prior to sedimenting.	Continuation of evaluation work -- including water loss measurements.
Selection of Reach 2, Coachella Canal as site Completion of sampling of canal bed and potential sediments Completion of lab testing of canal bed and sediment samples Standpipe tests in canal Installation of SS-13 trial	The cost of the SS-13 trial was about $.01/sq.ft. Results to date are on encouraging side, but too soon to separate natural variations from sediment sealing effects.	1. Continuation of evaluation work -- including water loss measurements. 2. Detailed studies of bed load sand problem in Reach 2 and effects on sedimenting results.
Selection of ditch in Coors Experiment Farm Installation of Parshall flume measuring devices Sampling of ditch soils Preliminary field trial mix testing	Field trial was set for coming summer, but may be stymied if water table stays within a few feet of ground surface.	1. Continuation of evaluation work. 2. Installation work contingent upon water table dropping to at least 8 feet below ground surface.
Selection of Connection Canal as typical site Water loss measurements Installation of sediment sealing in test reach Evaluation of results	Costs not calculated as yet. Used combination of 1. Wyoming hi-swell bentonite 2. Colo. low-swell bentonite 3. Water saturated sawdust Excellent sealing results --has dried up extensive set of springs below canal	1. Continuation of evaluation work. 2. Installations in other unlined reaches of the West Portal System will probably be made this coming summer.

LATERAL 1 TRIAL

Lateral 1 serves an area of the North Platte Project, both in Wyoming and Nebraska, near Torrington, Wyoming and Henry, Nebraska. The Lateral is supplied from the Interstate Canal of the Pathfinder Irrigation District.

The test reach is approximately 6 miles long, extending from the Lateral headgate to Station 319+12. The maximum capacity of this Lateral is about 80 cfs.

The Lateral reach traverses an area of sand dunes. Thus, the Lateral bed and bank soils are predominantly a fine to medium grained sand with just a slight amount of clay and silt fines.

An installation was made by the Bureau of Reclamation in this Lateral reach during the spring of 1956. A high-swell bentonite and a chemical water softening additive, Tetrasodium Pyrophosphate, were used in the trial. The sealing results were initially very good, but after a canal dry-out immediately following the sedimenting, the sealing effect was destroyed.

Current research work in the laboratory at the University is being directed toward a study of possible methods of obtaining a more penetrating sealing effect than was obtained in the initial trial.

The bentonite sedimenting method has been included in the 1958 ASC Handbook for Wyoming. The cost sharing basis will be 50 per cent of all costs, except for Fremont County where it is my understanding that all canal lining or sealing practices are to be supported at a 75 per cent level.

Mr. Mike McNamee of the Wyoming Agricultural Extension Service is setting up demonstrational installations of the bentonite sedimenting method in those areas requesting such demonstrations. To date, installations are tentatively scheduled for the following areas: (1) Lander-Riverton area, (2) Thermopolis area, (3) Worland area, (4) Greybull area, (5) Lovell area, (6) Cody area, (7) Afton area, and (8) Sheridan area. Other areas are also under consideration.

The Wyoming Natural Resource Board is assisting in the demonstrational work.

One unique feature of the ASC specification is that the use of a water softening agent is not required. Discing of the canal bottom during the ponding phase of the bentonite ponding is required. This should adequately take care of any bentonite flocculation problems caused by hard water.

CONCLUSIONS

Since a major part of the present research program, as supported by the USDA, Agricultural Research Service, is set up on a three year basis with only the first year completed, no definite conclusions can be made. However, the sedimenting work in Wyoming has developed to the point where guiding conclusions and recommendations are being prepared. A tentative set of demonstrational site factors for the Wyoming work are appended to this report. It should be recognized that this list is still subject to change, but I believe that it does provide a good idea of some of the adaptation factors that must be fully considered in order to obtain good results from sediment sealing operations.

SUMMARY OF DEMONSTRATION SITE FACTORS

The following set of general requirements and assumptions for demonstrational sites in Wyoming is now being considered. This is only a tentative list and in any case these requirements and assumptions should not be considered as inflexible rules, but more as guiding conclusions.

1. Who pays for demonstration? -- It is assumed that an active local interest and leadership in the work at each site is essential. To be reasonably assured of the necessary support, the demonstrational work should be limited to only those sites where the local people will pay all of the sedimenting costs of materials, equipment and labor.

2. Pilot model method -- Each site, in addition to its important demonstrational function, is also a pilot model development. When working in a new area for the sedimenting work and with inexperienced people, it will be wise to choose an initial work site that is on the pilot model side of the overall canal seepage problem -- a site that is both typical and small scale.

3. Accessibility -- Sites should be selected that are accessible to both (a) equipment needed for the sedimenting work, and (b) visitors observing the demonstrational work.

4. Visible problem and result -- Accurate canal delivery loss data is desirable, but in many cases is not immediately or practicably obtainable. Thus, in general the demonstrational site should be selected where:

   (a) Seepage losses from the canal are producing a visible problem, such as seep damage in nearby lands, and

   (b) A reduction of canal seepage can be expected to produce a visible effect, such as a definite reduction in the size of the seep damaged area.

5. Special problems -- Since the bentonite sedimenting method is a canal sealing method only, this limitation should be carefully recognized. Problems, such as listed below, should be avoided or corrected before going ahead with the sedimenting work at the demonstrational sites:

   (a) Active erosion -- If the canal banks or bottom materials are actively eroding, normal control measures, such as riprapping or control structures, should be installed before starting any sediment sealing work.

   (b) Bed load sand -- Sand bar deposits that move along the canal bottom under normal water flow conditions are a special erosional problem. Since this problem and its effect on sedimenting is just now starting to receive research attention, sites with sand bar problems should be avoided in the demonstrational work now under consideration.

(c) Weeds -- Heavy growths of canal bank weeds, including cottonwoods, willows and cattails, or submerged water weeds can seriously interfere with the sedimenting procedures and especially with the evaluation of results. It will be wise to select canal sites for demonstrational purposes where the weeds are not a serious problem.

6. Site preparation -- For obvious reasons, if canal cleaning work is needed in the demonstrational site, it should be accomplished before and not after the sediment sealing work. In many cases, it will be of advantage to accomplish the work, such as backsloping of the canal banks or removal of sand and silt deposits from the canal bottom or insides of curves, immediately preceding the sedimenting.

7. Bentonite sediment -- While other sedimenting materials, either in combination with bentonite or as a substitute, may be required in special cases, a drilling mud grade of bentonite is the recommended sediment for the normal range of sealing problems. Bentonites, some of them of high quality, are found in many areas; however, to avoid the problems of mining and control of quality, it will be wise to use only the commercial bentonites of a drilling mud grade in initial demonstrational work.

8. Mixing method -- After considering the various mixing methods and equipment that can be used to obtain a satisfactory mixing of bentonite in water, the single jet mixer seems best for the Wyoming work. Mr. McNamee has a mixer that will be available for the demonstrational trials. A 4 to 6-inch centrifugal pump of the type used in portable sprinkler irrigation systems is needed at each trial. A standby air compressor will also be needed for emergency supplemental mixing and possibly for the air slide device in the bentonite hopper of the jet mixer.

9. Sedimenting procedure -- Since short reaches on relatively small canals are being selected for the demonstrational trials, the ponding method of sedimenting will be used in the Wyoming work. Location of check structures and possible locations for temporary dams for ponding should be considered in the selection of sites. The milky sedimenting mixture should be held in each ponded reach of canal for at least two days.

10. Discing of canal perimeter -- To be certain that the sedimenting bentonite does penetrate into the pervious materials, the canal bed and banks in each trial reach should be disced or scarified. This can be accomplished by dragging a spike-tooth harrow or similar farm implement along the canal bottom and sides of each trial reach. This should be done at the same time the milky sedimenting water is ponded in the trial reach.

11. Water softening chemical -- The use of a water softening chemical, such as one of the polyphosphates, is not planned in the Wyoming work. Therefore, due to the natural hardness of the canal waters, it is likely that the bentonite sedimenting mixtures will be unstable. The consequent flocculation and bentonite settlement problems could become serious on larger jobs, but on the demonstrational trials it is felt that the discing will adequately control the problems -- especially the problem of the flocculating bentonite having a definite tendency to form a surface layer type of seal on all but the most pervious materials.

12. Scheduling of trials -- In general the demonstrational trials are being scheduled for the week preceding the first canal water deliveries this coming spring. In some respects a later sedimenting time would be more favorable, but in most systems it would be difficult to interrupt the water deliveries long enough to obtain an adequate treatment. Frost and snow in the canal site reaches at the scheduled installation times can adversely affect the penetrated sealing results and, therefore, could present special problems.

13. Evaluation of results -- As previously mentioned, the demonstrational sites are being selected where the results of the sedimenting can be expected to produce a visible effect in the nearby seep damaged area. However, in addition to the visible effects that are, of course, very important from a demonstrational viewpoint, the development features or the pilot model aspects of the work in relation to similar problems in the surrounding areas are also most important. For this reason every effort should be made to tie-down and record the major factors of variables involved at each site. The latter work is especially important if the life of the sealing effect is to be conscientiously evaluated and, if necessary, improved.