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WATER HAULER'S BULLETIN

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SURFACE WATER QUALITY MONITORED IN RETURN FLOW STREAMS

Concern has been expressed about the impact of agriculture on surface and groundwater quality throughout Canada and the world. A 1991 U.S. study reported that pollution from agricultural land was serious and widespread in the United States, and agricultural runoff accounted for more than half the pollution in rivers and lakes. In southern Alberta, the quality of water used for irrigation in the irrigation districts is generally considered excellent, with average salinity (EC) levels ranging from 0.28 to 0.36 dS/m, average sodicity (SAR) levels ranging from 0.3 to 0.6 and average total dissolved solids (TDS) ranging from 154 to 212 mg/L. Nevertheless, the Bow River Water Quality Task Force reported in 1991 that irrigation return flows were direct sources of pollutants into the Bow River and its tributaries.

Graeme Greenlee obtains water sample from a drain outlet.

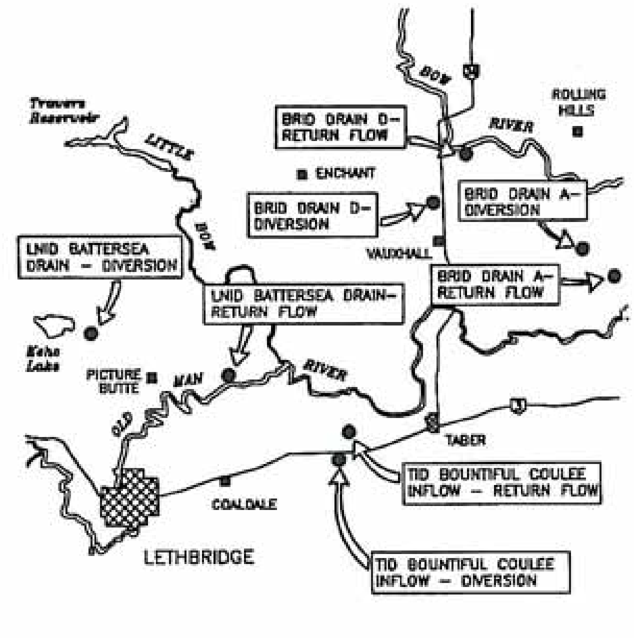


Figure 1. Surface water quality sampling locations

Alberta Agriculture, Food and Rural Development has been monitoring surface water quality in a number of Alberta irrigation districts since 1989. "We want to find out where Alberta stands regarding surface water quality in comparison to the rest of the world," says Graeme Greenlee, a scientist with the Land Evaluation and Reclamation Branch in Lethbridge.

Greenlee monitored surface water quality from May 6 through October 5, 1992, at eight sites consisting of one water diversion location and the related return flow stream in each of four drainage areas in three irrigation districts (Figure 1). Water samples were collected weekly and were analyzed for pH, electrical conductivity (EC), soluble cations, sodium adsorption ratio (SAR), soluble anions (including nitrate) and TDS. In addition, water samples collected on May 11 were analyzed for nine herbicides, water samples obtained on June 14 were analyzed for 20 herbicides, three insecticides and two fungicides, and water samples gathered on July 7 from the four return flow streams were tested for 10 herbicides. Monitoring results were compared to Canadian water quality guidelines and changes in irrigation water quality between diversion locations and the corresponding return flow streams were assessed. This study did not attempt to address the specific sources of any contaminant detected.

Greenlee found that levels of salinity, sodicity and TDS showed only slight degradation in water quality between the water diversion locations and return flow streams, with most values well within the Canadian water quality guidelines for human/livestock consumption and irrigation. However, the TDS in return flow streams in the Lethbridge Northern Irrigation District and Bow River Irrigation District were significantly higher than at the diversion sites on several occasions. In some instances, the TDS exceeded the Canadian water quality guideline for human consumption.

The increased TDS in the return flow streams is somewhat surprising, since most irrigation return flow in the districts is not the result of irrigation related surface runoff. Irrigation water is diverted from the river, either directly or through a reservoir, and flows through a canal system for irrigation purposes. The excess water, which results from normal hydraulic operation of most open canal systems, returns back to the river without being used for irrigation.

Further evaluation of the increased TDS values in these return flow streams show that they generally corresponded to surface runoff during and immediately following major rainfall events. It is therefore likely that the increased TDS values in the return flow channels would be short-lived.

Nitrate is highly water soluble and therefore very mobile. Potential agricultural sources of nitrate contamination include nitrogen fertilizers, runoff from feedlots and manure storage facilities, and overloading of land with manure. Nitrate concentrations were very low at all water diversion sites and associated return flow streams in this study, with values ranging from 0 to 1.9 mg/L. These levels are well within the Canadian water quality guidelines for human (10 mg/L) and livestock (100 mg/L) consumption.

Pesticides applied to agricultural land may enter surface waters through runoff from rainfall or irrigation, and to a lesser extent by wind erosion. Runoff losses vary considerably and depend on: pesticide application rates; formulation and method of application; timing of application relative to timing of irrigation; and chemical properties of pesticides.

A trace of only one herbicide (bromoxynil) was detected on May 11 at one of the eight monitoring locations, the Bountiful Coulee diversion in Taber Irrigation District. The nine herbicides tested for on May 11 were not found at any of the other sampling sites. Traces of only two herbicides (dicamba and 2,4-D) were observed at the Bountiful Coulee diversion on June 14, and one herbicide (2,4-D) was detected on the same date in the associated return flow stream. Low levels of bromoxynil, 2,4-D, dichlorprop and MCPA were also detected on June 14 in the Battersea Drain return flow stream in LNID, a low level of MCPA was found in the Drain A return flow stream in BRID, and a trace of 2,4-D was found in the Drain D return flow stream in BRID. The other 15 herbicides, three insecticides and two fungicides analyzed for on June 14 were not detected at any of the eight monitoring locations. Low levels of 2,4-D were found on July 7 in all four return flow streams monitored. A detectable amount of diclofop-methyl was also measured on July 7 in the Drain A return flow stream in BRID. The other eight herbicides tested for on July 7 were not observed in any of the four return flow streams sampled.

Bromoxynil, 2,4-D, dicamba and diclofop-methyl levels were well within the 1992 Canadian water quality guidelines for human/livestock consumption and irrigation. Dichlorprop and MCPA levels were also very low. Insecticides, fungicides and most of the herbicides tested for were not detected at any of the eight sampling locations.

In conclusion, Greenlee says, "the quality of water in four return flow streams in southern Alberta was generally found to be excellent for human/livestock consumption and irrigation."

Slight degradation in salinity, sodicity and TDS was observed in all four return flow streams in comparison to the water at diversion locations. Occasionally, TDS levels exceeded the Canadian water quality guideline for human consumption in two return flow streams. Elevated constituent levels were closely related to surface runoff during and immediately following major precipitation events. The impact of irrigation return flows on receiving rivers was nullified by the dilution effect, that ranged from a factor of 15 to greater than 500 times during the 1992 monitoring period.

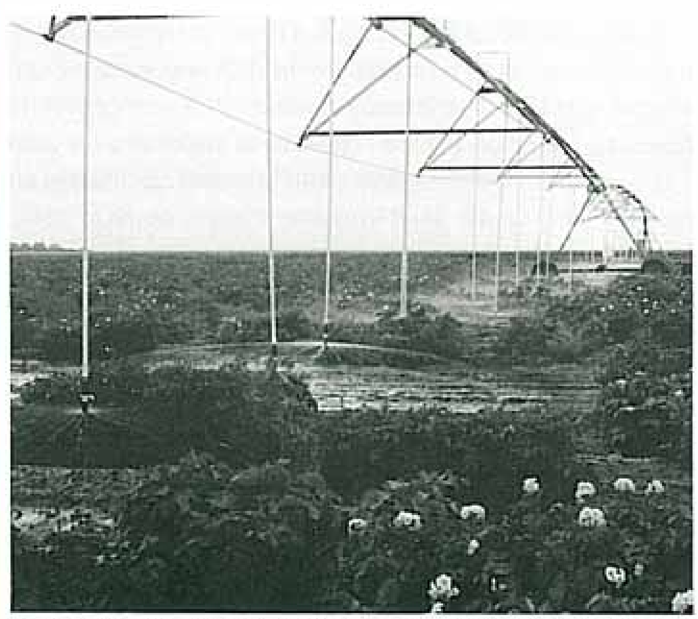
Nitrate and all of the pesticides investigated were either not present or were detected at low (safe) concentrations for human/livestock consumption and irrigation.

For more information, please contact Graeme Greenlee, Land Evaluation Section, Land Evaluation and Reclamation Branch, Alberta Agriculture, Food and Rural Development, Agriculture Centre, Lethbridge, Alberta, T1J 4C7. Telephone (403) 381-5893. ■

LOW PRESSURE SPRINKLER SYSTEMS MAKE A COMEBACK

In the late 1970s and early 80s, when energy costs started to rise, many irrigation farmers with center pivot systems converted them to low pressure spray heads, says Gordon Cook, P. Eng., irrigation specialist with the irrigation branch in Taber. This was done to reduce the operating pressure of their irrigation systems and keep their pumping energy costs down. Unfortunately, when these irrigation systems were operated at 100 to 200 kPa, the radius of throw from the spray heads was very short. This resulted in tremendously high application rates under the center pivots and a great deal of runoff. The cost and energy savings from the low pressure operation were outweighed by crop loss due to ponding and the associated difficulties with farming around wet areas. As energy costs stabilized, producers began to choose higher pressure sprinkler packages with wider water throw and lower potential for runoff.

Once again, says Cook, times have changed. Electrical energy rates have risen by approximately 30% in the last two years. Forecasts are for natural gas prices to rise as well. Luckily, the irrigation farmer has much better technology to choose from regarding center pivot sprinklers and farming practices. The irrigation branch is trying to provide producers with some hands-on experience in low pressure center pivot sprinkler technology. In cooperation with Agriculture Canada at the Vauxhall substation, a demonstration site has been set up to show and evaluate



Demonstration project at Vauxhall using low pressure sprinkler heads on drops at pressures of 105 kPa to 140 kPa.

the latest in low pressure sprinkler packages. Tremendous savings in energy consumption have been realized by using Nelson Spinner and Senninger LDN sprinkler heads on drops at pressures of 105 kPa to 140 kPa.

The demonstration is partly funded by Farming for the Future, Nelson Irrigation Corporation, Senninger Irrigation Corporation, Reinke Manufacturing and RPH Irrigation of Lethbridge. However, the demo is much more than new sprinklers. Farming practices that can be used to reduce runoff by increasing soil intake rates and creating small reservoirs to trap excess water until it has time to fiitrate in are also demonstrated. Soil intake rates are evaluated under several different crops and tillage treatments. Planting row crops in concentric circles can reduce runoff. It even allows the passage of sprinklers through a corn crop's canopy to eliminate wind drift and almost all evaporative losses.

Producers reap the benefit of low pressure sprinkler systems by reducing their energy costs.

Most of the cost saving is a result of pressure reduction. A smaller portion of the saving is a result of higher application efficiency due to reduced wind drift and evaporation. Higher application efficiency equates in fewer operating hours for irrigation pumps. The use of sprinklers on drop tubes, as in the demonstration, can increase application efficiency for a center pivot irrigation system by 10 to 15%, says Cook. "In certain crops, such as corn seeded in a circle, the application efficiency may be increased by as much as 25%. This can be done with little or no runoff, depending on the soil type and topography. Unfortunately, many of Alberta's sprinkler irrigated acres are on relatively steep slopes and heavy soils which present tremendous runoff problems for low pressure sprinkler packages. However, the demonstration is designed to demonstrate runoff control practices that can be implemented under any sprinkler system. Although runoff from sprinkler systems may not end up in irrigation drains, it is still a wasted part of on-farm water demand," states Cook.

For irrigation water supply authorities, the benefits in store are reduced water consumption and reductions in drainage loads. One of the eventual spinoff advantages for irrigation districts may be the expansion of their respective irrigated land base as a result of being able to extend a capped water supply over an enhanced acreage.

In addition, the prospects for reductions in surface water runoff and resulting decreases in roadside drainage can be encouraging for rural municipal authorities.

The overall goals of the low pressure sprinkler demonstration are twofold: reduce farmers' costs while not jeopardizing production and to increase on-farm water application efficiency. Both goals need to be met to insure the viable existence of irrigated agriculture in our province. Producers are meeting both goals through the wise use of new equipment and farming practices, concludes Cook.

For more information or to arrange a tour, contact Gordon Cook, P. Eng., Irrigation Specialist, Irrigation Branch, Alberta Agriculture, Food and Rural Development, P. O. Box 640, Taber, Alberta T0K 2G0. Telephone (403) 223-7908. ■

Row crops such as potatoes pictured above are planted in concentric circles to reduce runoff.

DATE TO REMEMBER

A.I.P.A. ANNUAL CONFERENCE

NOVEMBER 22 & 23, 1993

Lethbridge Lodge Hotel

PRELIMINARY ENGINEERING FEASIBILITY STUDIES UNDERWAY FOR SUMMERVIEW AND KEHO IRRIGATION PROJECTS

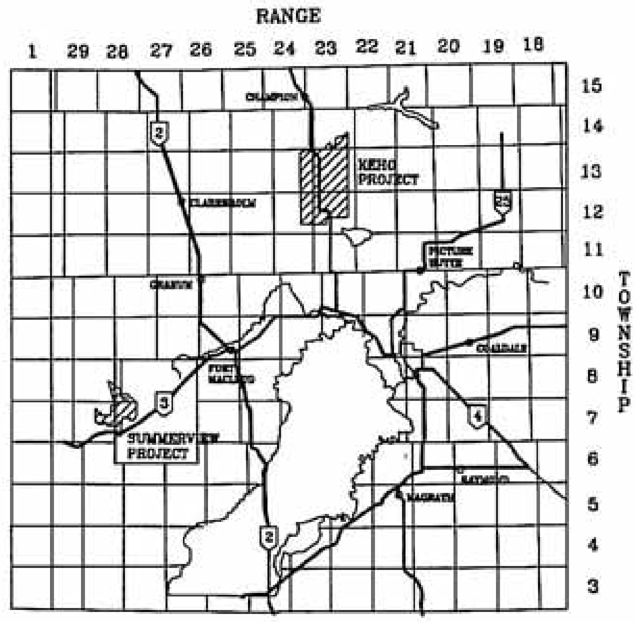
Potential irrigators in the Pincher Creek and Barons areas are anxiously awaiting the results of preliminary engineering studies being carried out to determine the feasibility of irrigation for their areas.

The Summerview project, located immediately east of the Oldman Dam near Pincher Creek, would irrigate approximately 7700 acres. Water would be taken directly out of the reservoir or from the Oldman River immediately downstream of the reservoir site. According to Murray Lewis, chairman of the Summerview Water Users Association, "Developing the project would help realize the agronomic potential of the Summerview area creating opportunities for the continued growth and expansion of the local food and forage based industries."

The Keho project is located to the west and north of the Village of Barons. This project would irrigate approximately 10,000 acres of land and would receive water from the Alberta Environmental Protection supply canal to Keho Reservoir. Farmers here are interested in diversification of their farming practices and adding to the economic base of the Village of Barons.

The preliminary engineering studies are being carried out by Prairie Farm Rehabilitation Administration with assistance and cooperation of Alberta Agriculture, Food and Rural Development and Alberta Environmental Protection departments. Alberta Agriculture, Food and Rural Development has provided preliminary land classification analysis for the projects and Alberta Environmental Protection has provided funding for topographic mapping of the areas. Each project study is being managed by committees made up of the landowners, and by participating agencies. Stakeholder groups have also been invited to participate in the input and direction of the studies.

The Summerview project has some interesting engineering challenges, states Allan Herbig, chairman of the Technical Subcommittee of the Summerview project. Pumping directly from the reservoir is not as easy as it may seem. The reservoir has a large potential drawdown which makes the costs of a regular intake structure very expensive. Other options including a floating barge has been considered. High winds in the area, and the long fetch length



of the reservoir make large wave heights probable, thereby creating some additional design problems.

Pumping from the river on the other hand has its own set of problems from intake siltation to embankment stability. Pumping from the river will add approximately 75 metres of additional elevation or lift. This additional lift will add approximately $25 per acre per year of pumping costs to the project.

Allan, who is also Alberta Agriculture, Food and Rural Development's representative on the Keho study team, states that the major challenge for the Keho project is to develop a scheme that will allow irrigation to the maximum number of water users without exceeding the acreage limitation of 10,000 acres and keeping the development costs within acceptable limits.

Results of the preliminary engineering estimates are expected later this summer for the Summerview project and by year end for the Keho project. This is really just the beginning. In addition to the costs of construction, other items to be reviewed include: operating costs, on-farm revenues and costs, other benefits to the area and communities, and an environmental overview of the projects. These must be carried out before a water license can be secured.

For more information, please contact Allan Herbig, P.Eng., Section Head, Irrigation Branch, Alberta Agriculture, Food and Rural Development, Agriculture Centre, Lethbridge, Alberta T1J 4C7. Telephone (403) 381-5152.■

FLOW MONITORING PROGRAM UPDATE:

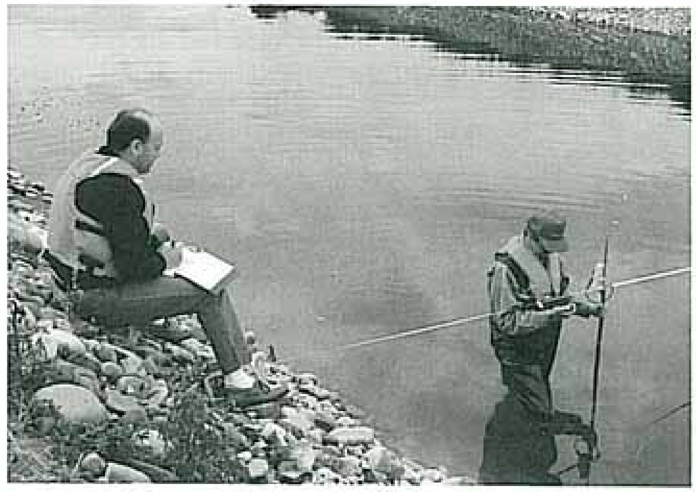
It's been four years since the irrigation branch embarked on a program to assist the irrigation districts of southern Alberta by providing flow and spill data to improve their conveyance efficiency. To say there has been a lot of water under the bridge is an understatement, says the program leader Jack Ganesh, P. Eng. Our intention for the program was to: help the water supervisor to better understand the water volume he is diverting, the amount the farmer actually uses and what is going back as return flow. The program has certainly grown and expanded since its inception in the Lethbridge Northern, Taber and United Irrigation Districts adds Ganesh.

In all the blocks we have studied, states Ganesh, the improvement was quite apparent, but in some cases it was difficult to evaluate. Sometimes heavy rain in the middle of the growing season makes operation difficult. This is usually a welcome relief for the farmer but a headache for the water supervisor who suddenly has to divert water. This makes it difficult to decide what is return flow from irrigation and what is run-off. In any case, the program is working to help him understand the problems better and make measured improvement.

There has been several additions to the program since it was first started, says Ganesh. "For instance, the district requested and we responded by providing rating curves/tables for key points and structures to help the water supervisors check the rate of flow at these points."

"Another addition to the program," states Ganesh, "includes a final year-end report on our findings, in conjunction with other related information. This report is quite comprehensive in its coverage of total inflow, total outflow, water consumption of the block, water balance per average acre, its comparison of crop water requirement to optimum yields and evaluation of canal capacity to meet peak demand. The analyses are done by us but some of the data are obtained from the water supervisor and the district's office. Data such as crop mix, acres irrigated and method of irrigation are obtained from the water supervisor. Assessed and terminable acres within the block are obtained from the irrigation district office."

The flow monitoring of irrigation blocks has also undergone some improvement in the way we involve the water supervisor. The first year that we work on a block we do not give the water supervisor any rating curves, but ask him to operate it as he has in the past. The following year we provide him with rating curves and tables on each site in his block. This means that he can visit each site and know the rate of flow and make adjustments at the appropriate points to change that flow. This allows us the opportunity



Jack Stewart (left) and Roger Johnson measure flows in an SMRID lateral.

to record the improvement he makes when he knows how much water he is diverting, how much is flowing at intermediate points and at the various tailouts or return flow channels. In many cases the reduction of return flow is quite apparent given the variability of climatic conditions from one year to the next.

"There is still another side benefit to the program", says Ganesh, "that we did not think of at the time the program was conceived." Data from this program was used to test/calibrate the District Irrigation Model developed a few years ago by Alberta Environmental Protection. The Model is now a great deal more sophisticated and requires several more climatic and soil inputs that we have not included in our study. A recent hydrometric study financed by the Alberta Water Resources Commission (AWRC) considers the flow monitoring program an important step in the right direction towards reducing return flow and for calibration of the Irrigation District Model. The AWRC also considers the calibrated staff gauges an important tool for improving water management within the district. It is encouraging to note that the hydrometric study also recommends that more intensive hydrometric monitoring of blocks be done to provide data to calibrate the Irrigation District Model. "With the model successfully calibrated, we hope to have a better tool to estimate return flow," says Ganesh.

"In conclusion," says Ganesh, "the overwhelming goal of the program is to save water by reducing return flow. Through our measuring, there is enough evidence to show that this is being achieved. Without some acceptable means of measuring or estimating flows, no one will be convinced that there has been a change."

For more information please contact Jack Ganesh, P. Eng., Evaluation and Monitoring Engineer, Irrigation Branch, Alberta Agriculture, Food and Rural Development, Agriculture Centre, Lethbridge, Alberta T1J 4C7. Telephone (403) 381-5869. ■

SILT TRAP PROVES EFFECTIVE

No more hand shovelling

Allan Mills, a water supervisor for the Chin/Horsefly reach of the St. Mary River Irrigation District (SMRID) Main Canal knows all about silt deposits in turnout structures. It used to take days of hand shovelling every spring to clean the huge build-up of silt that had been deposited in the inlet from the previous operating season. "If it wasn't cleaned out" says Mills, "I couldn't deliver water through the turnout structure when there were low flows in the Main Canal. But that's all changed" adds Mills.

Two operating seasons ago, he noticed that a 600 mm diameter turnout had a stop-log left in its upstream bulkhead guides and didn't have any silt build-up in front of its gate. All the silt was piled-up in front of the board with a lot still out in the channel. The idea twigged his brain. Next spring, Mills began to experiment with first one, then two and finally settled for three stop-logs in the bulk-head guides.

It worked, the results were quite evident after the water was turned out of the system for the season. Little silt remained in front of the gate.

One word of caution says Mills "Don't build them up higher than they need to be or you might be in the same predicament I found myself in. With low flows in the canal I couldn't get enough water out through the turnout. Stoplogs are darn hard to remove with water in the canal. It took a chain saw to cut them in half before I finally succeeded," concludes Mills.

For more information, please contact Allan Mills, Water Supervisor, St. Mary River Irrigation District, P.O. Box 278, Lethbridge, Alberta T1J 3Y7. Telephone (403) 328-4401.

Arrow points to huge buildup of silt in front of stop-logs in SMRID main canal turnout.

ANOTHER TIME SAVER

Larry Burr, a water supervisor with the St. Mary River Irrigation District, is becoming well known for his inventive capabilities that make his work more enjoyable. In the past, Burr required the help of an additional person and a survey instrument to set the height of staff gauges on water measuring weirs in his area. Burr used to attach the staff gauges to a post that had been driven in the bed immediately upstream. Frost action over winter would quite often cause the post to heave. This left the gauge at an incorrect elevation.

"Calibration has become easy with my adjustable staff gauge brackets" says Burr. "Slots in the brackets that attach the staff gauge to the structure allow for the vertical adjustment. I allow just enough water in the canal so it will trickle over the crest of the weir and then adjust the gauge to zero and tighten the two bolts. That's it, and it takes only minutes" concludes Burr.

For more information, please contact Larry Burr, Water Supervisor, St. Mary River Irrigation District, P. O. Box 278, Lethbridge, Alberta T1J 3Y7. Telephone (403) 328-4401. ■

Larry Burr points to slot in bracket that allows vertical adjustment.

NEW REPAIR METHOD FOR CONCRETE LINING

Cracked and broken-up concrete slip-form canal lining is a real headache for Taber Irrigation District (TID) manager Kent Bullock, P. Eng. "When you have 55 kilometres of unreinforced concrete lining with 75% estimated to be badly cracked and breaking-up, you have a major problem," says Bullock. "The board of directors doesn't have the money to replace the ten to twenty-year-old deteriorated lining. It was supposed to have a design life of fifty years" adds Bullock.

Bullock and his staff have tried to extend its life by various repair methods, none of which have been very successful or could be deemed a long-range solution. "Some sections are now so badly heaved and broken, no repair is possible," states Bullock.

Out of desperation, Bullock has settled on removing the worst side sections that have broken-up and slid down into the bottom of the ditch. Instead of replacing the section with hand formed concrete, TID staff replace the concrete with a combination of polyethylene liner, filter fabric and rock armour.

After removing the broken concrete section, the 1:1½ side slope is flattened out to 1:2 (1 vertical: 2 horizontal). The edge of the concrete remaining in the bed is cleaned to ensure a good bond between the replacement liner and the concrete. Inland #1455 woven membrane polyethylene is placed on the slope and caulked to the clean concrete. "The upstream edge is tucked underneath the existing concrete and backfilled to prevent water from getting under the polyethylene liner," says district assistant operation and maintenance superintendent Barry Jensen. "Next we place directly over the liner a filter fabric. The fabric provides some protection to the liner and is a good holding surface for the armour. Both fabric and polyethylene liner are keyed into a 200 mm deep trench that runs parallel along the top of the bank," states Jensen.

"The final step," says Jensen, "is to carefully machine place a good gradation of rock armour to a depth of 200 mm on the filter fabric. The filter cloth provides a rough enough surface to hold the armour material," states Jensen.

For short replacement sections, Bullock is not worried about losing canal capacity because of an increased roughness co-efficient. "Manning's n" for gravel armour is 0.037 to 0.025 (depending on canal size) to concrete's "n" of 0.016. "It shouldn't cause a problem in the short replacement sections," concludes Bullock.

Barry Jensen inspects rock armour. Note: Tranquil flow.

For more information please contact Kent Bullock, P. Eng., Manager, Taber Irrigation District, P.O. Box 129, Taber, Alberta T0K 2G0. Telephone (403) 223-2148. ■

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Designed to provide the operation and management personnel of Irrigation Districts with items of interst in their line of work. Comments are welcome.
Please contact Duncan Lloyd, editor, at Area Code (403) 381-5539, Lethbridge.

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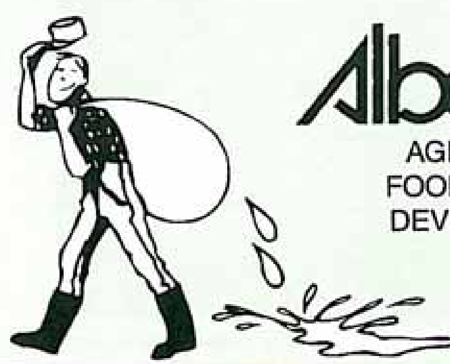

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