the
WATER HAULER'S BULLETIN

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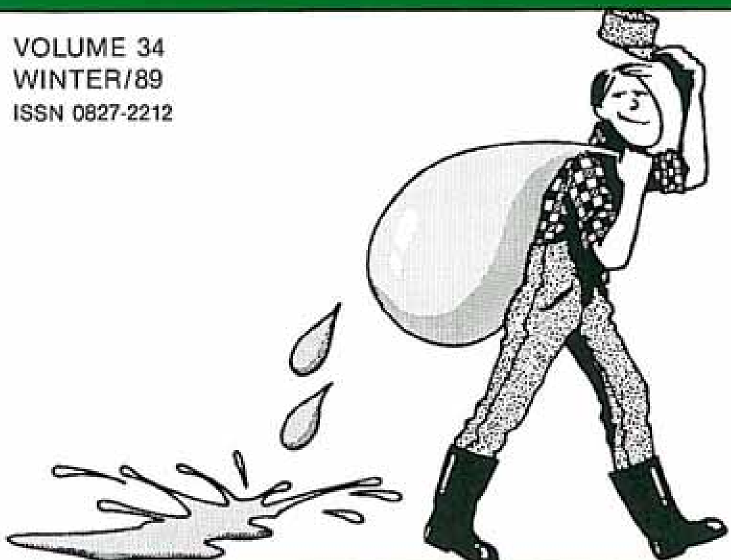

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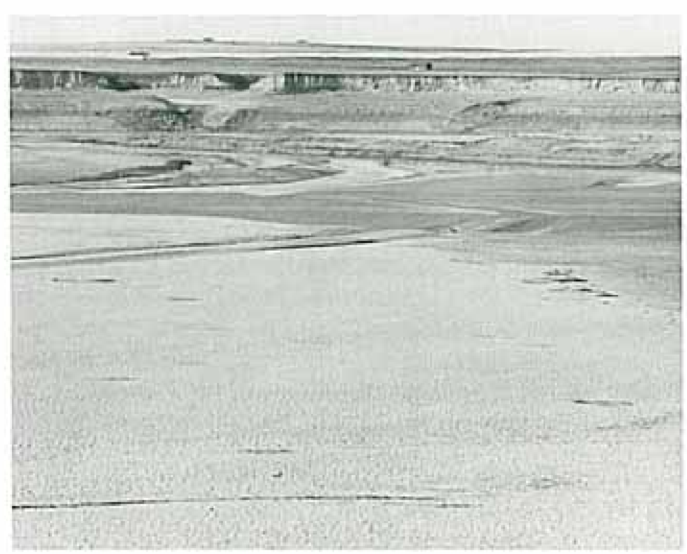
1988 A YEAR OF EXTREMES

Low Runoff and High Water Demands

The year 1988 was an "extreme" in southern Alberta with its lack of runoff and high irrigation demands. It was marked by the second lowest runoff since 1951 and for most irrigation districts, the highest ever water demand says Doug Clark, head, irrigation headworks branch, Alberta Environment.

Runoff was near or above normal in April and early May due to warm temperatures melting the snow pack at an accelerated rate. The runoff forecast as of May 1, 1988 for the Oldman river at Lethbridge was for 70% of normal. However, runoff forecasts are also based upon the assumption that normal rainfall will occur during the forecast period. For the months April through September, rainfall measured at Lethbridge was only 63% of normal, which had the doubly harmful effect of lowering the runoff volume from the predicted 70% to 45% and of greatly increasing the crops' moisture deficit. From mid-May to the end of September runoff in the basin was below the lower quartile with a more severe plunge occurring starting in mid-June. Total natural flow for the Oldman river at Lethbridge was just over one million acre-feet compared to a normal of 2.3 million acre-feet for the May - September period.



St. Mary Reservoir after the 1988 irrigation season.

It is a misconception that irrigators in southern Alberta are not dependent on rainfall. A normal snow pack in the mountains does not translate into a normal runoff volume unless the snow melt is supplemented by a normal amount of rainfall. Evidence of this occurred in 1988, where a 70% of normal snow pack produced only a 45% of normal runoff due to the lack of rain in the headwaters. Rain is even more useful for a successful irrigation season when it falls directly on the crops. In 1988, rainfall at Lethbridge from May through September was only 150 mm vs. a norm of 250 mm. The 100 mm shortfall, when applied over the 700,000 irrigated acres in the Oldman river basin, amounts to 230,000 acre-feet of water on the farmers' fields. This is more dramatic when one considers that, due to system losses, well over 300,000 acre-feet of water would have to be diverted from the rivers in order to put 230,000 acre-feet on the crop. This is more water than the total storage capacity of the St. Mary reservoir.

On the Waterton - St. Mary headworks system, operations in 1988 started early. Diversions commenced March 5 from the Belly river to the St. Mary reservoir. On April 5 the St. Mary River Irrigation District (SMRID) began diversions into their main canal from the North dam at Milk River Ridge reservoir for purposes of filling 40 Mile Coulee reservoir. By the third week of April the district was making irrigation deliveries. Irrigation demand continued at a high pace through to the end of July. For the four months, April to July, water demand was 285,000 acre-feet above the 1984-87 average for the same period.

Regular operating reviews took place throughout the season between the SMRID Main Canal Advisory Committee and irrigation headworks branch. In July the Advisory committee, recognizing that Alberta Environment's reservoirs would be depleted by mid-September if the consumption rate continued as forecast, agreed that measures must be implemented to ration the remaining supply. Alternatives were evaluated and in late-July all four affected districts [St. Mary River Irrigation District (SMRID), Raymond Irrigation District (RID), Taber Irrigation District (TID) and Magrath Irrigation District (MID)] decided to implement restrictions which would allow each district only 125 mm of water per acre at each district's headgate from August 1 to October 10. During this period the SMRID started to withdraw more heavily from their internal storage and less from Alberta Environment's reservoirs. At the end of the season all parties agreed the restrictions had succeeded. No irrigators had run short of water and more than anticipated carry-over storage remained in the system.

As of the end of November the Waterton - St. Mary headworks system had released 880,000 acre-feet, including 760,000 acre-feet for the irrigation districts' use and about 120,000 acre-feet for in-stream use. This resulted in a depletion of about 200,000 acre-feet from Alberta Environment's three storage reservoirs (St. Mary, Waterton and Milk River Ridge) over the course of the irrigation season.

The Lethbridge Northern headworks system diverted about 225,000 acre-feet from the Oldman river for the Lethbridge Northern Irrigation District (LNID). Another 25,000 acre-feet was taken from Keho reservoir for a total gross diversion to the district of 250,000 acre-feet. This was the most water used in a single season by the LNID and was accomplished as a result of the main supply canal being upgraded by Alberta Environment from 21 m^3/s to 42 m^3/s. Construction was completed in 1988, one year ahead of schedule, which was fortuitous as Keho reservoir would have been empty in August had the extra capacity not been available.

The Mountain View, Leavitt, Aetna headworks system was pushed to the limit in 1988. Only one minor short duration delivery problem occurred at the bottom end of the system, says Clark.

Private in-stream irrigators also required more than the usual water in 1988. Over the past 10 years their needs have been rising steadily. In 1988 over 30,000 acre-feet, above what is required for minimum flows, was released into the rivers downstream of the St. Mary dam, Waterton dam, Belly river - St. Mary diversion and Oldman river diversion. In addition, the department diverted 3,300 acre-feet into Willow creek for domestic and irrigation use from the Oldman river via the Lethbridge Northern headworks main canal.

Gross water diversion in the Oldman river basin on a district basis ranged from 1.8 acre-feet/acre in the St. Mary project to over 2.5 acre-feet/acre in the foothills districts.

Supply/demand in the Bow river basin was very similar to the Oldman river basin early in the season. The situation appeared serious by mid to late May. However, end of May and early June rains in the Calgary-Vauxhall-Brooks area reversed the trend and put operations back onto a more normal pattern. Natural runoff for the Bow river at Calgary ended up 83% of normal for the May - September period, comparing closely to the department's May 1 forecast of 84%. By the end of the operation season both the Eastern Irrigation District (EID) and the Carseland - Bow river headworks system had more water in storage than there was at the start of the season.

Even with more abundant rainfall in the Bow river basin than in the Oldman river basin, the three irrigation districts had record high water diversions. On an acre-foot/acre basis the gross water diversion varied from just under 2.5 acre-feet/acre for the Bow River Irrigation District (BRID), to 3 for the EID and 3.5 in the Western Irrigation District (WID).

No supply problems should be experienced by any district if moisture conditions are better in 1989 than in 1988. Greatest concern is the SMRID, RID, TID and MID which are supplied by the Waterton - St. Mary headworks. Should conditions similar to 1988 recur, water restrictions and other water conservation measures will have to be considered for this system. Through careful water management, these districts could make it through another year like 1988. However, the laws of probability state that runoff and rainfall amounts will be greater in 1989, than they were in 1988. If this proves true, then these districts should be able to ensure deliveries to their water users.

Alberta Environment will be meeting with the irrigation districts early in the new year and throughout the irrigation season in order to update operating forecasts.

An interesting footnote to 1988 is that, even though it was so dry, 64% of the total flow from the South Saskatchewan basin passed into Saskatchewan. The highest percentage of flow came from the Red Deer river where all of the natural flow left Alberta plus return flows from the WID and EID.

For more information please contact Doug Clark, Head, Irrigation Headworks Branch, Alberta Environment, Provincial Building, Lethbridge, Alberta, T1J 4C7. Telephone (403) 381-5300.■

Editor's Note

In 1975, the Province of Alberta announced that Alberta Environment was committed to take over all major on-stream headworks and to assume all rehabilitation, operation and maintenance costs. To date the province has acquired the headworks to all of the irrigation districts with the exception of the Ross Creek, United and Eastern Irrigation Districts. The government owned headworks are operated and maintained by the irrigation headworks branch of the development & operations division. Their objective is to maintain a secure and continuous supply of water to irrigation districts and for all other uses.

SMALL HYDRO DEVELOPMENT

Potential Opportunities For Irrigation Districts

Have you ever stood above Raymond Chute or Springhill Drop and watched in awe at the speed and power of the water exiting from the flip bucket? The thought of harnessing that power has no doubt occurred to many an observer. The thought probably occurred to the original designers and builders, but that was long before many of the electrical transmission and distribution systems that today criss-cross the province were in existence.

A new opportunity to exploit the energy in falling water in the chutes and drops of the irrigation water delivery systems is presenting itself with the enactment in June 1988 of Bill 54: Small Power Research and Development Act. This act, the fruit of intense lobbying by small power producers all over the province, legislates a payment of 5.2 cents per kilowatt-hour (kW-h) for energy delivered to the utility grid system by a small power producer. The 5.2¢/kW-h is significantly in excess of what prior contracts with the utility paid for, say, wind-generated power.

Two power plant sizes are envisioned under the program

- up to 2,500 kW
- pilot projects greater than 2,500 kW

As an indication of the total revenue from such a facility, a 2,500 kW small hydro plant operating at this capacity 60% of the time will yield over $600,000.00 in revenue annually.

Raymond Chute

What are the factors that influence the feasibility of such a project on the numerous chutes and drops that are features on water delivery systems in southern Alberta?

- energy produced
- capital and cost
- interest rates
- contract terms with utility
- operating and maintenance costs

The energy produced is a function of the flow rate, head available, and efficiency of the turbine/generator unit. Of pivotal importance is the flow/duration curve at the project location. The more constant the flow conditions, the more efficient are the machines available.

Hydro plants typically are capital-intensive. Capital costs have to cover: intake structure and gates, penstock and powerhouse (including turbine and generator costs for interconnecting to utility grid). The most expensive item is generally the tubine/generator set.

Interest on borrowed money is generally the largest annual cost component in constructing and operating a small power facility. The rate at which a proponent can borrow funds often determines the viability of the project.

Terms of the power supply contract (duration, escalation clause, etc.) will also have an impact on project feasibility. A major disadvantage of Bill 54 from a small hydro viewpoint, is the lack of any price escalation requirements. The 5.2¢/kW-h price appears to be fixed for the duration of the contract.

Significant interest is being shown in the program, not only from irrigation districts but also from industrial and commercial sources. Wind and biomass are covered in the program, as well as hydro.

The economics on some of the irrigation structures look good, in spite of generation being limited to the irrigation season. Based on the program and the correct funding and contractual terms, the power generated could be a major source of revenue to the irrigation district.

For more information please contact Tom Field, Assistant Regional Manager, CH2M Hill Engineering Limited, 11 Floor, 815 - 8 Avenue S.W., Calgary, Alberta, T2P 3P2. Telephone (403) 237-9300. ■

FROM THE FARM PERSPECTIVE

Positive Pressure At The Pump – The Design Must Be Accurate

Ever since the first irrigation pipeline was put in the ground, the irrigation community has been told of the great benefits obtained from having positive pressure at the pump. The benefits are many and make good economic sense, but this positive pressure can become an operator's nightmare.

During the period from 1969 to November, 1988, over half a million lineal metres of closed pipeline systems have been installed in the thirteen irrigation districts. It is safe to say that, in general, the districts and their farmers are happy with the pipelines because several problems are reduced or eliminated. Laterals which once meandered through a quarter section causing severance problems have been replaced by buried pipelines. These pipelines also eliminate seepage areas and reduce maintenance costs.

The farmer also benefits from the possibility of connecting his pumps directly to the turnout. A direct connection to the district line reduces problems associated with dugouts, such as weeds and priming of the pump. There are also potential energy cost savings by the farmers due to the positive pressure available at the turnout.

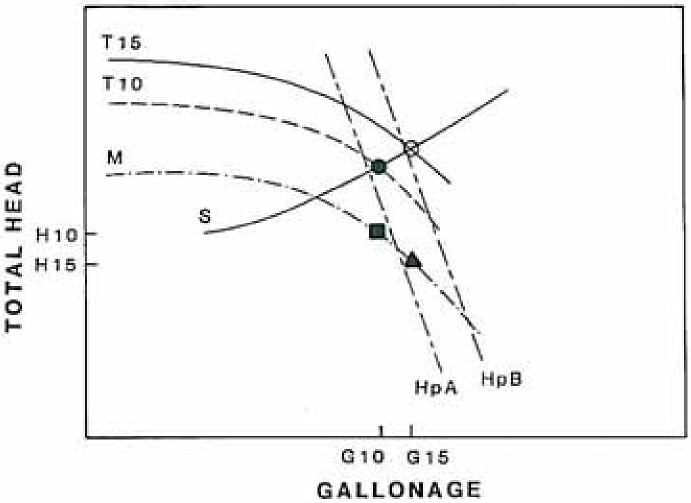
Once the farm system is connected to the district line, the two operate far more as one system than was ever conceived of during the days of open ditches. Instantaneous shutdowns of the farm system have the potential of increasing water hammer problems in the district line. This problem is aggravated in areas where there are a large number of electric units. In the case of a power failure, several units will shut down simultaneously increasing the risk of water hammer.

The positive pressure available to the farmer at the district turnout may not be the money saver and great help that the farmer expects. The minimal affect is to eliminate the need to prime the pump. However, if the estimate of the district's discharge pressure is inaccurate, problems may occur, especially with electric installations.

For example, take the case where the actual turnout pressure is less than the estimated design pressure. The recommended impeller trim of the farm pump will then be too small. The resulting system flow and operating pressure will be less than designed and the distribution poor. The farmer will apply less water than he is anticipating. Therefore, the system will need to be operated for more hours thus reducing the time available to complete the other farming operations.

A more critical problem arises when the actual turnout pressure is higher than the design pressure. In this case, the pump impeller will be too large for the actual operating conditions. There will be too much water applied, the energy costs will be higher than need be and electric motors may be overloaded.

TYPICAL PUMP CURVES WITH VARIABLE DISTRICT PRESSURE



● SYSTEM OPERATION WITH 70 kpa POSITIVE HEAD
○ SYSTEM OPERATION WITH 105 kpa POSITIVE HEAD
■ PUMP OPERATION WITH 35 kpa POSITIVE HEAD
▲ PUMP OPERATION WITH 70 kpa POSSITIVE HEAD
M - MANUFACTURER'S PUMP CURVE
T15 - TOTAL OF MANUFACTURER'S CURVE AND 70kPa (10 psi) TURNOUT PRESSURE
T10 - TOTAL OF MANUFACTURER'S CURVE AND 105kPa (15 psi) TURNOUT PRESSURE
S - SYSTEM CURVE
HpA&HpB - HYPOTHETICAL HORSEPOWER CURVES

The operating conditions are determined by the intersection of the appropriate pump curve and system curve. In the case where the design turnout pressure is 70 kPa (10 psi), the T10 curve represents the effective discharge characteristics of the turnout discharge and the manufacturer's pump curves in series. The intersection of T10 and S curves is identified by the black dot. Since the turnout and the pump are effectively acting in series, the gallonage of G10 is the same through both. The actual operating condition of the pump is identified by a square on the M curve.

If the turnout pressure was underestimated by 35 kPa (5 psi), the T15 curve would actually be the representative curve. The operating condition is identified by a circle. In this case, the system flow has increased to G15. The actual operating condition of the pump is identified by a triangle on the M curve.

With the increase in gallonage from G10 to G15, the system's energy consumption also increases. In this hypothetical case, the motor may be prone to overload. The design operating condition can be served by a motor with A horsepower. However, the actual operating conditions draw more than the A horsepower and would require a motor with B horsepower. The underestimated pressure is likely to have a cumulative effect upon the gallonage over the entire pipeline.

When designing a district pipeline, it is important to be realistic with the expected losses. It is generally better to overestimate rather than underestimate the turnout pressure. The expected operating practices must be taken into account. If it is unlikely that there will ever be 100% demand on a large system, then the head loss calculations should be made accordingly.

The farmer and on-farm system designer must realize that they are part of a dynamic system with no absolutes unless a pressure reducing valve is to be used at the turnout.

It appears that both the districts and the farmers are pleased with gravity pipeline systems and will continue its use where possible and practical. However, both users of the system must work together to achieve the common goal.

For more information contact Dave Monaghan, P. Eng., Irrigation Specialist, Irrigation Branch, Alberta Agriculutre, Agriculture Centre, Lethbridge, Alberta, T1J 4C7. Telephone (403) 381-5136. ■

IRRIGATION IN ALBERTA — FACTS AND IMPACTS

Did you know that only 4% of the agricultural land in Alberta is irrigated? From this 4% some 30 different crops are grown and a very intensive livestock industry drawing on feed grain and feeders from all regions of Alberta, contribute to some 13 to 15% of our total annual gross agricultural production. None of the irrigated crops or commodities are in a surplus position in terms of global markets. ■

REFLECTIONS ON THE PRESENTATIONS AT THE SECOND NORTH AMERICAN CONFERENCE ON PREPARING FOR CLIMATE CHANGE

Affect on Southern Alberta?

On the basis of presentations made at the second North American Conference on Preparing for Climate Change, climatologists and scientists are convinced more than ever regarding global warming. Presentations indicated implications of the change were not for agriculture only. There were effects on health, coastal changes, wildlife, population shifts, tourism, and climate changes on the: arctic, antarctic, coast lines and forests.

Projects are based primarily on global circulation models taking into account a doubling of the atmospheric carbon dioxide (CO_2) and other greenhouse gases. Output is primarily temperature changes. The global warming would have greater effect at the high latitudes such as here in the Lethbridge region.

The effects of the CO_2 would not be on temperature alone, it would have a direct effect on plant growth through the process of photosynthesis. This could offset the effect of temperature but at present it is difficult to measure in the field.

Implications for agriculture are as follows:

- significant regional shifts in agriculture production are likely.
- demand for water for irrigation is estimated to rise. Effect of warmer temperatures would be offset by the use of more water, if available.
- extent to which direct effects of CO_2 would be beneficial is uncertain. This is difficult to measure in the field and has not been done accurately as yet.
- there would be northward extension of crop and livestock pests and diseases.
- farm management practices will have to change to make adjustments to the effect of climate change. These would include:
  - earlier planting.
  - substituting better adapted crop varieties and species.
  - increased demand for water.
  - redesign irrigation structures to lower evaporation.

In terms of community and regional levels there will be effects that would require planning and changes. This would include shifts in population depending on climate changes. If favorable (as predicted for The Great Lakes region due to the presence of usable water) people would move into the area. This would lead to pressures of increased tourism as well. Planning for these changes should consider:

- heating and cooling costs of homes, office and industrial buildings.
- changes in road construction and maintenance.
- water supplies of communities.
- consideration for drought resistant grasses, crops, and garden plants suited to a lengthening growing season.
- effluent discharges may have to be based on a function of river flow rates. If climate changes increase the frequency and intensity of low flow periods, treatment capacity may need to be increased.

Overall requirements include:

- more regional study on impact of climate changes.
- legislative responses to impact of climate changes.
- redesign of municipal water and irrigation structures to decrease evaporation.
- planning for more severe weather patterns, such as violent storms and severe drought.
- plant more trees throughout the area to offset losses in tropical forests.

Global warming may lead to other implications. Climate change resulting in population shifts could cause the abandonment of small towns. The effects on health such as increased chances of skin cancer need to be dealt with. Crops should not be grown in irrigated areas that can be grown in more northerly areas.

North America, (Canada and the United States independently) regardless of predicted climate change is seen as able to produce all the food required for its population. No famine! Another positive effect may be higher farm profitability, along with the resulting downstream economic buoyancy.

For more information please contact Einard Haniuk, Water Resources Institute, University of Lethbridge, 4401 University Drive, Lethbridge, Alberta, T1K 3M4. Telephone (403) 329-2014. ■

LEACHING RECLAMATION OF SALINE SOILS

Reclamation Study Underway

The reclamation of salt-affected soils, following drainage or canal rehabilitation, requires adequate internal drainage combined with the leaching (flushing) of salts from the root zone. The land evaluation and reclamation branch of Alberta Agriculture is conducting studies to determine the rate of reclamation with application of leaching water. As part of these studies, six soil cores representing different soil types were leached in the laboratory by continuous ponding with irrigation water. The changing quality of the effluent passing through the cores was sampled to represent changing salinity of the soil.

Leaching results comparing relative salinity reduction, the ratio of the effluent salt concentration (C) to the initial concentration (C_0) with the leaching ratio, the ratio of the depth of leaching water passing through the soil (D_L) to the length of the soil column (D_S) are shown in Figure 1. These moderate to severely saline soils (electrical conductivity, EC of 13 to 60 dS/m) had similar leaching characteristics despite being different soil types. Generally, the leaching curves could be described by the equation $(C/C_0) * (D_L/D_S) = 0.25$. This equation can be used to approximate the amount of leaching water that must pass through a given soil depth to achieve a desirable salinity level. For example, if the salt content of a soil in the upper 500 mm (D_S) is 20 dS/m (C_0) and the desired salinity level is 4 dS/m (C), then the depth of water (D_L) that must pass through the soil is:

$D_L = 0.25 * D_S * (C/C_0) = 0.25 * 500 * (20/4) = 625$ mm

From an irrigation water supply perspective, highly saline soils would not require substantially more water than moderately saline soils. However, marked differences occurred when the time of leaching was considered. Under continuous ponding, the time required to pass one depth of water through 500 mm of soil ($D_L/D_S = 1$) ranged from 2 to 460 days. These time differences reflect the different infiltration and/or percolation rates of the soils.

These soils were leached in the laboratory where runoff, evaporation, crop consumptive use and groundwater contributions were not considered. All of these factors will affect reclamation in the field. The depth of leaching water (D_L) is water passing through the soil and is water applied in excess of evaporation and crop use. Normally, irrigation applied to replenish the available water does not pass through the profile.

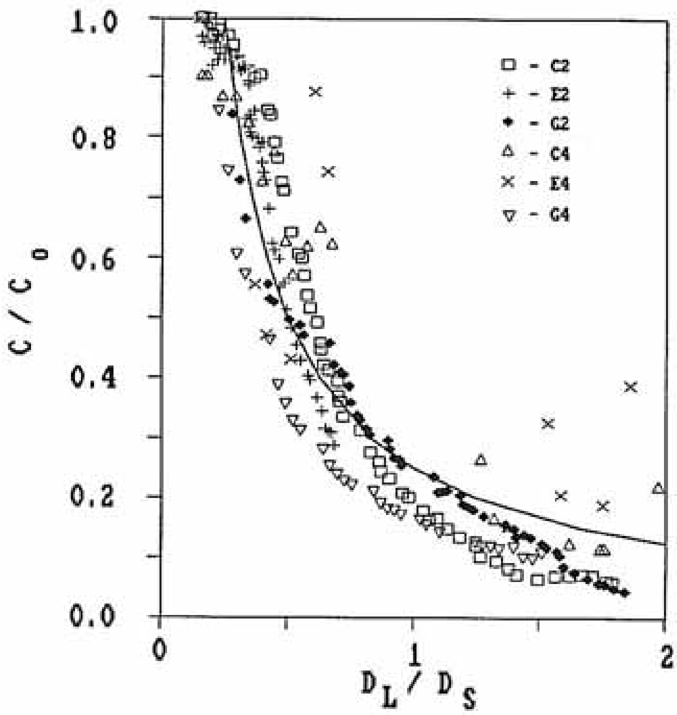


Figure 1. Relative Salinity Reduction

Leaching of soil salts will usually require additional applications in excess of normal irrigation. In some of the soil cores, the infiltration/percolation rates were very slow, and even with continuous ponding, required a long time to reclaim. In the field, similar soils would require special irrigation management such as might be provided by frequent applications in excess of evaporation and crop use.

These principles are currently being evaluated in a complimentary field study. For further information please contact Dennis Mikalson, Land Evaluation and Reclamation Branch, Alberta Agriculture, Agriculture Centre, Lethbridge, Alberta, T1J 4C7. Telephone (403) 381-5886. (Acknowledgement: this study was conducted by Brook Harker who is presently employed with PFRA.)■

DITCHRIDER TRAINING PROGRAM

Level I - February 6-10/89
Level II - February 20-24/89

Brought to you through the cooperation of Lethbridge Community College (LCC), the Irrigation Districts of Southern Alberta and Alberta Agriculture.

For further information please contact John Calpas at the LCC. Telephone (403) 320-3311.■

SOIL MOISTURE RESERVES AND OUTLOOK FOR THE SPRING

Most Areas Well Below Normal

Precipitation between harvest (20th of August and mid November) has been generally 40 - 50% of that normally expected. A few sites, such as Calgary, may have received as much as 70% of normal. At the same time, above average air temperatures and a longer period than normal before killing frost promoted high rate of water use by forages.

Dryland stubble in the irrigated region as of November showed little accumulation of post harvest precipitation. Fallow lands show only marginal improvements on this level (12 mm).

Irrigated lands will of course have a much greater range of soil moisture than dryland has this year. Post harvest precipitation accumulation will not have influenced either irrigated or dryland fields. Consequently many fields will be drier than normal. This situation may cause potential problems in 1989.

With irrigation water limited to 90 mm per acre in the St. Mary River irrigation system after August 1st, little or no water was available for fall irrigation to replace seriously depleted soil moisture reserves. In other irrigation districts where water was not limited and farmers were fall irrigating, subsoil moisture conditions are quite good (greater than 50% available moisture).

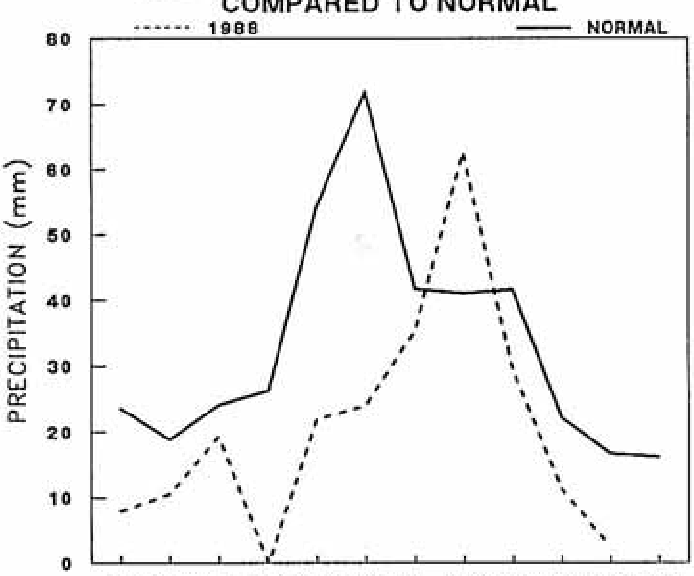
If the winter of 88-89 remains dry, surface soil moisture levels may be inadequate for germination, leading to the necessity to again irrigate the crop up or face non-uniform germination as in the spring of 1988. Based on past records, this situation is unlikely to occur two years in a row, but nevertheless the risk remains.

Combining the conditions of hot dry weather and the shortage of irrigation water supplies in some districts in the fall of 1988 will leave subsoil moisture levels badly depleted. This is particularly true of forage crops not receiving fall irrigation. Even normal winter and spring precipitation will not remedy this problem. This suggests that the 1989 irrigation season could begin early and have greater than normal water demands as farmers attempt to rebuild these depleted subsoil moisture reserves.

Already there may be a penalty because research has shown that frequently, crops seeded into good soil moisture reserves will out yield those seeded into poor moisture reserves, even when the same level of post seeding irrigation is maintained on both fields.

For more information please contact Dick Heywood, Water Management Specialist, Conservation & Development Branch, Alberta Agriculture at (403) 381-5861 or Bob Riewe, Irrigation Management Specialist, Irrigation Branch, Alberta Agriculture at (403) 381-5868. ■

1988 PRECIPITATION AT LETHBRIDGE COMPARED TO NORMAL



THE WATER HAULER'S BULLETIN

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

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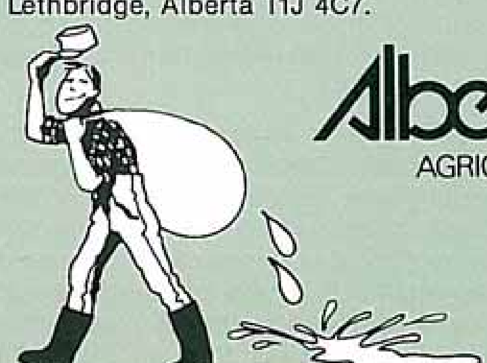

Alberta AGRICULTURE