IRRIGATION PROBLEMS IN NORTHERN COLORADO

By

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Mr. Chairman, Ladies & Gentlemen of the Forum:

In my story of irrigation problems in Northern Colorado, I will try to give you a general picture of this territory with special reference to the larger portion of the area which now forms Northern Colorado Water Conservancy District, the contracting and repayment agency for the Colorado-Big Thompson Project.

Some small ditches on the first bottom lands were taken out in various places in the South Platte Valley in the 1860s, but the first cooperative effort which set up a real milestone in irrigation development was the Union Colony at Greeley.

In 1870, when the Denver Pacific was building the first railroad into the Territory of Colorado from Cheyenne, these people from the far east, with no knowledge of western conditions, emigrated and settled upon a tract of prairie where the City of Greeley now stands.

They undertook to establish their homes and future under a kind of cooperative society. Many of the somewhat visionary ideas of this group later proved impracticable in operation and some of the original members of the Colony dropped out, but despite early failures and disappointments they fought it out and finally wrote an important chapter in the story of western reclamation.

The early history of this Colony is a record of failures and disappointments, but also of courage, persistence and adaptability to conditions.
Only a few of these men had farming experience and of course their knowledge of irrigation was mostly hearsay and very fragmentary. It is related that they made several attempts to get advice and suggestions from the Mormon Colony in Utah, but secured little that would help and that they had to learn what could be grown and how to grow it by costly experience. Engineering knowledge was almost absent. The main dependence for technical information seems to have been a book on irrigation in Italy which one of them had. It was generally considered at first that the streams were practically inextinguishable and would supply water for millions of acres in Eastern Colorado.

The Colony officers estimated that ditches from the Cache la Poudre and Thompson Rivers to irrigate the 60,000 acres of land owned by the Colony could be constructed for $20,000 and of course the first ditches built were entirely inadequate for even the small acreage then planted. Some of the ideas of what we would call "the duty of water" were of course wide of the mark.

Fortunately, the leaders of the Colony included a group of intelligent, resourceful men, some of them Union Army officers, who tackled each succeeding problem with hard-headed determination and worked out a pattern for cooperative irrigation development that has been followed closely in many places. When other ditches were later taken out upstream from the Colony and their crops were drying up, these same farm leaders, in their own way, laboriously worked out a theory of priority of right by use, recording these rights in the Courts and with the administration to be under the supervision of a state officer.

This plan was finally incorporated in an Act which was passed by the State Legislature in 1878 against the opposition of much of the
legal fraternity of those pioneer days. The opposition contended that establishment of rights to the use of water required no legislation and could be determined by litigation between conflicting claimants.

When the Colony officers first appeared before the District Court to secure decrees for their ditches under the new Act, the Court itself at first refused to consider such procedure on the ground that the law was unconstitutional. Later on in 1886, Dr. Elwood Mead, then the young Assistant State Engineer, made the first comprehensive survey of irrigation conditions in Northern Colorado and in his report commented forcefully on the fact that the first decrees issued by the Courts bore little relation to the actual capacity of the various canals which he had measured accurately for the first time. Anyway, while the men who guided the Colony affairs for the first few years had impracticable ideas in some respects, they did blaze a trail in the development of irrigation.

The most apparent vestige of some of their original ideas is the fact that the City of Greeley, now with a population of 16,000, is still "dry" from a refreshment standpoint.

Anyway, the success of this Colony, such as it was, was widely advertised by Horace Greeley in the New York Tribune and was largely responsible for the rapid settlement and development of Northern Colorado during the 1880s.

Other colonies patterned after the one at Greeley, as well as other groups and individuals, carried on a rapid development of the irrigation systems which now cover this District.
During the 1890s when the land under crop had already exhausted the stream supplies, there came an era of reservoir construction to conserve the winter and flood flows.

After about 1900, a period of optimism resulted in additional ditch and reservoir construction largely financed by the organization of irrigation districts which resulted in a number of projects being financed and built, with poor prospects of water supplies. Some of these districts first defaulted and then later were abandoned or re-organized in some way, although a number also are still going concerns with more or less satisfactory annual results.

**The District Area**

At the present time there are over 800,000 acres of land in the District which is irrigated if and when water is available. There are 615,000 acres of this which is taxed as irrigated land, the balance being marginal in the opinion of the county assessors. This area is served by 120 separate irrigation systems. Most of these organizations are mutual ditch companies with a few irrigation districts on the lower reaches of the South Platte River.

The Conservancy District has a present population of about 140,000 people, mostly American born, and the cities and towns are modern, up-to-date farming communities. The State Agricultural College, State University and the State College of Education are located in or near the District.

There are thirteen sugar factories in the area with a proportionate number of canneries, creameries, flour mills, etc. It might be said that the principal exports of the District are sugar and meat, although many kinds of vegetables and all other Temperate Zone crops are grown.
Practically every farm has a food lot and the winter feeding of lambs and cattle is one of the main industries.

Crop yields on limited acreages of vegetable specialties or early potatoes often run to $300.00 per acre, but the average acre value on a typical farm with a rotation program including alfalfa, sugar beets, potatoes, small grain, corn and dry beans will, with standard prices, be about $50.00 if water supply and all other growing conditions are favorable; but if the breaks are not so good and particularly if the water plays out, the income may drop to as low as $20.00 or less and the farmer will owe the bank more than when he made his gamble in the spring.

Water Supply

While this District has many of the problems that beset most other reclamation areas in the west, the principal continuing problem has been the short and extremely variable water supply.

As indicated before, the large amount of excellent land has perhaps resulted in extension of the irrigated area beyond what was justifiable for years of short or even average supply.

The annual original supply of water flowing into the District from the South Platte River and the various tributaries, varies from 1,400,000 acre-feet in occasional peak years to as low as 400,000 acre-feet in some minimum years. For the past fifteen years the average original supply was about 710,000 acre-feet or less than one acre-foot per acre for all the land.

The return flow situation however deserves a little explanation. When irrigation first began, the run-off from the mountain snow melt and seasonal rains flowed down the South Platte River during the
spring months and the stream beds would later practically dry up in the fall and winter. With the development of irrigation in the upper portions of the District and with soils that have a fairly good drainage, the return flow to the lower portions of the streams has developed to a point where in any selected period of years the annual diversions for both direct irrigation and for storage are practically double the amount of the original water supply. There is very little run-off in the plains area. So that while the irrigated areas near the mountains are still subject to extreme water shortages, the systems downstream the main Platte River are somewhat better supplied from the more stable return flows. In fact the systems on the main Platte River from Greeley east receive fully 90% of their supplies from return flow. It is the major part of the area lying near the mountains which is particularly subject to the short, variable water supplies and where crop losses are most extreme.

One other difficulty with our water supply is the fact that the amount is largely unpredictable. Of course we have snow fall reports but they are not dependable in estimating what our season's supply will be for the reason that the major run-off which occurs in May, June and July, depends more on the spring rains and other weather conditions in the mountains during these months than on the depth of snow on the mountain snow gauges. In fact our annual supplies show little relation to the snow fall bulletins.

Precipitation in the District averages about 12 inches, with years as low as 6 inches, with two-thirds of this supply falling in the crop growing season.
In the mountain watersheds, the precipitation will amount to
18 inches or more, but likewise most of this comes in summer storms
and the winter snow pack is often very light except on the high
peaks.

Consequently, the farmers must plan and plant the season's crops
with the water supply to grow and mature them still an unknown quan-
tity.

Irrigation Systems

It is impossible to speak definitely about M. & O. practices,
the duty of water, organization and other such practical matters.

Among the 120 irrigation systems, large and small, that cover
this area can be found a wide variety of policies and methods.

Hardly any two systems are much alike, as each one was con-
structed and developed by independent farmers with their own original
ideas and with a minimum of legal or technical assistance.

These systems may be divided into three general groups.
The first group would include the first ditches built along the
various streams covering the low lying lands most easily irrigated.

These systems are of course small ones and are partnerships or
mutual companies with rather primitive methods of operation.

As they hold the oldest decrees, they are often careless in
their use of water and the duty runs up to five and six acre-feet
per acre, but as these bottom lands are usually well drained, the
excess gets quickly back to the stream for use below.

Operation is handled by a farmer ditch rider who prorates or
divides the supply. If the deliveries are measured at all, it may
be on some original conception of a "miner's inch".
Little maintenance is done and the annual cost may be as low as 40 cents per acre.

There are no records kept except by the Water Commissioner on the stream who reports to the State Engineer the headgate diversion. Until late years many of these ditches did not have adequate measuring flumes or recording devices.

Of course the lands under these ditches are well supplied with direct flow and never need reservoir water.

However, although there are about 75 of these small ditches, they only cover about 90,000 acres altogether or about 12% of the total acreage in the District.

The second and principal group of systems would include most of those which were first built in the 1870s and 1880s to cover large tracts of bench or prairie lands.

These are all mutual companies and also have wide variations in operating methods, water value of stock, measurement of water, etc.

About 35 of these organizations cover some 600,000 acres of land or 80% of the District.

Many of these systems or the lands under them have little or no reservoir supplies and suffer severely in short years.

Annual direct water deliveries under these systems vary with the season's supply, the relative dates of appropriation and the location on the streams.

Due to the return flows, a canal on the lower river may be diverting a full head when one with an older decree, but higher up, will be dry. As with everything else, delivery losses vary according to conditions, but in ditches of this general class they are from 20 to 35%.
In occasional good years some of these ditches will have a headgate diversion of direct flow as high as four acre-foot per acre and the average may be about two acre-foot; but the average diversion in most years will be well below two acre-foot and in short years, such as have occurred so often lately, the average diversion for this class of systems will be one acre-foot or less with many ditches dry much of the season.

Of the total diversions in a typical year, about 80% is for direct diversion to the land with the balance covering the storage of winter flow and occasional surplus flood discharges.

In the District there are about 60 reservoirs of consequential size, with a total capacity of 600,000 acre-foot. Several hold 40,000 acre-foot or more but most of them are from 5,000 to 10,000 acre-foot.

These reservoirs catch the winter flows and occasional flood run-off. The winter return flows in the main Platte are usually sufficient to fill the large reservoirs in the lower portion of the District, but the winter flows from the mountain streams are low and the reservoirs in the upper part of the District depend mainly on surplus spring run-off which is often negligible. Over a period of years, those upper reservoirs with a total capacity of 300,000 acre-foot are only 50% efficient.

Up to a few years ago, all storage decrees were subservient to direct use regardless of dates; but under a recent Court decision direct and storage appropriators are now listed and administered together according to dates of decrees.

Some of the reservoirs are owned by the organizations operating direct irrigation systems and the stored water is prorated in accordance with stock ownership.
Most of them however are owned by separate entities with the stock distributed to other agencies or largely to individuals.

This stored water is a live commodity during the crop growing season and is measured and delivered in units of acre-foot or more often 1,000,000 cubic feet by the various canal companies for a carrying charge.

This stored water sells usually between $3.00 to $6.00 per acre-foot, but sometimes goes as high as $12.00 for late season use on maturing crops.

In this main group of systems which we are considering, the average M. & O. cost will average a little over $1.00 per acre although there are wide variations.

The management of the systems under the farmer Boards of Directors is fairly efficient, very economical and rather distrustful of change or technical advice.

Employment of operating personnel is usually on a piece basis and there are only a few superintendents with technical training.

Few systems keep accurate records of water handled and the annual reports to stockholders are mostly concerned with financial affairs. Such things as crop reports are practically unknown.

A few of the larger systems have some modern equipment and are gradually improving their property with better turnouts, measuring devices and other structures. More of this kind of work should be done but with every year's crop a gamble on water supply and all the other uncertainties, the general policy is to keep assessments at rock bottom.
Supplemental Supplies

To help meet the pressing need for more late water, several transmountain diversions into the head of the Cache la Poudre River have been made in years past.

These projects furnish about 50,000 acre-feet annually and while the cost has been extremely high, they have perhaps justified it in the high productive value of the water.

Several of the systems which have gone all out in attempts to get more water by building storage reservoirs or diversions are still heavily in debt.

During the past decade when water supplies have been particularly short, irrigation wells have been constructed almost wherever ground water is available.

There are around 2,000 of these wells now with discharges of from 1 to 4 second-feet. While the costs are heavy, most of them have been justified by the crops saved.

One of the minor problems is the effect these pumps have on the under flow and the supply in the stream for the lower appropriator. Complaints have been loud but no litigation or proposed legislation has materialized yet. Many irrigation men are on both horns of the dilemma

A scientific study of the underground water supply would give more light but many local men are opposed to that. They say it would be just college theories.

Irrigation Districts

The third group of projects is the Irrigation Districts which have pulled through. Those remaining ones are all on the Platte River and have survived because they have large storage reservoirs which can be filled from the winter flow.
The construction cost of these ventures was extremely high and the resultant bonded debt in most cases has been compromised. The direct decrees of these systems are seldom active and the main dependence is on their stored water.

Storage and delivery losses in these systems are extremely high often running up to over 50%, but turnout deliveries will average around one and one-quarter acre-feet per acre.

Some of these systems, with which I am acquainted, use a "Charge and Credit" system of water delivery by which all supplies of both direct and reservoir water are pooled by the canal. Each water user is credited with his estimated deliverable amount as they become known, in proportion to acreage or stock ownership and is allowed to draw on demand against these credits. Accurate book accounts are kept for each user and of course all measurements are fairly accurate.

This tends to a more economical and productive use than is possible under the usual pro-rate delivery.

So far I have been trying to give you a general picture of the situation, which all indicates that the outstanding problem of Northern Colorado is the limited and fluctuating water supply.

Crop losses in the area, under the present crop regime, due to water shortage alone, are estimated to average around $7,000,000 annually. Moreover, the natural trend of irrigated farming is away from the cereal and forage crops to a greater production of vegetables, sugar beets and other row crops requiring larger amounts of late season water.

This trend is of course blocked unless another supply can be secured to supplement and stabilize the local flows.
Now I would like to tell you what Northern Colorado is trying to do about it.

**Plans & Reports**

The idea of diverting more water from the headwaters of the Colorado River has been floating around over since the country was settled, but in 1933 when the conditions were pretty serious and also when the Federal Government (if you can remember) was looking for jobs for men instead of men for jobs, a group of Greeley men, again, organized and raised a fund for a survey to determine once and for all whether a feasible project was possible.

This preliminary study and report, made by R. J. Tipton, outlined a possible irrigation and power project that would divert about 300,000 acre-feet from the Colorado River watershed at an estimated cost that was economically feasible.

This report was submitted to Washington officials and in January, 1935, Secretary of the Interior Ickes allotted $150,000 to the Bureau of Reclamation to cover the cost of a complete survey and report of the proposed project.

This report was completed and released in April, 1937. It is a comprehensive study, thoroughly analyzing all aspects of the project.

The report outlined a combined power and irrigation system, described a feasible plan for diversion of 320,000 acre-feet annually and found that the revenue from the sale of water at a price of $2.00 an acre-foot, together with the income from the power plants, constituted a feasible project under the Reclamation law and recommended construction.
The report includes plans and estimates for over thirty of the principal features, including six power plants, tunnels, storage reservoirs, etc. with a total estimated cost of $44,000,000.

Among the features is the Green Mountain Dam and Power Plant on the Blue River, a tributary of the Colorado, primarily for replacement purposes.

Other principal features include Granby Reservoir of 450,000 acre-foot capacity, for collection and storage of the headwaters of the Colorado River, the 13.1 mile "Alva B. Adams" diversion tunnel through the Continental Divide; conduits and power plants down the course of the Big Thompson River with storage and distribution works in the east slope foothills.

It is planned that the flow through the tunnel will be equalized throughout the year to around 500 second-foot and that with a fall of 2,800 feet to the storage reservoirs, the power plants to be installed, together with the one at Green Mountain, will have a total capacity of 184,000 k.w. with annual production of 650,000,000 k.w.h. of firm and 155,000,000 k.w.h. secondary energy at the market. After turning the turbines in all these power plants, the water is stored in the foothill reservoirs for discharge to the District lands during the irrigation season.

The District

In the early part of the program the various irrigation systems organized a Water Users Association as a mutual stock company to assist in the promotion of the project.

Later on, in 1936, when the Bureau report made it evident that the project could be constructed under the Reclamation law, it was
realized that some special form of entity was necessary to contract with the United States, guarantee repayment of construction costs and at the same time be able to properly distribute the benefits and the charges over such a self-developed and complicated area.

Among the many considerations involved was the fact that the need for supplemental water varied widely under different systems and even on different farms which indicated that the water distribution plan must be elastic and perhaps by voluntary action by the users.

Also, it was believed that some way should be found to place a part of the cost of the project on all the real and personal property in the area as a reflection of the indirect benefits to business, industry and general prosperity from the increased and stabilized water supply.

After many months of effort, the plans and ideas were incorporated in a bill for the Conservancy District Act which was enacted into law by the State Legislature and later upheld as to constitutionality by the Supreme Court.

This Act provides for the organization of "Conservancy Districts" by District Courts upon proper petition and showing of stated numbers of property owners.

The Board of eleven Directors is appointed originally and as terms expire by the Court to avoid the expense and the political hazards of elections.

The Board has all the usual powers necessary for such organizations. In addition, the Board has the power to levy taxes on all the real and personal property in the District up to a rate of one-half mill during the construction period and to one mill thereafter.
case of default or deficiency, an additional one-half mill may be levied.

I should say here that there has been no opposition to the mill tax. The railroads and other corporations supported the plan.

Also, the Board has the power of allotment of water to municipalities, districts and individuals and to levy water taxes and assessments.

The collection of all taxes and assessments is made by the various county taxing officials.

Of course, the Board also has the power to contract with the United States for the construction of irrigation works, but only after a resolution providing for the execution of such a contract has been approved by an election of property owners which, in this case, was almost unanimous.

The Contract

After the District had been organized and the first Directors appointed, the Board entered into a series of negotiations with Bureau of Reclamation officials to agree on the form of a repayment contract.

This agreement was finally approved and was executed by District officers and the Secretary of the Interior in the summer of 1938.

Briefly, the contract provides for the construction of the Colorado-Big Thompson Project as described in detail on a 50-50 basis.

The District is to repay in forty years, under Reclamation procedure, one-half a cost of not over $50,000,000 and the balance of the cost to be covered by income from the power plants.
The power features remain in full control of the United States and the irrigation benefits accrue to the District.

The District, as an entity, is the responsible repayment agency and with the obligations of the contract established and the Conservancy District Act as the foundation, the District officers began the job of working out the details of the tax collection and water distribution plan.

On the basis of the full $25,000,000 repayment,—which it will undoubtedly be,—the annual charge will be $625,000, although the contract provides a sliding scale of payments beginning at $450,000 in the early years.

To meet the annual charges from water sale income alone, the cost would have to be $2.00 per acre-foot during the forty year period.

However, it is estimated that the mill tax will produce an average of fully $150,000 a year, equal to about one-fourth of the annual payment.

It was therefore decided to contract the sale of the water at a firm price of $1.50 per acre-foot which will produce $465,000 on the 310,000 acre-foot units of supply and together with the general tax income, fully cover the annual payments.

It would be impossible to properly distribute the water in such an area unless the cost was definitely fixed.

Rather than attempt to induce any of the irrigation systems to contract for blocks of water for their stockholders which would have imposed water on many farms where it was not needed and also entailed opposition from many groups still doubtful of the feasibility of the
project, a plan was worked out to encourage the allotment of the water on a basis of petitions from individual landowners.

With the present wide variance of water supplies on even different farms under the same system, such a plan was necessary to secure the most beneficial use of the new supply of water.

In order to properly control these individual allotments, the District has compiled a case history,—as it might be called,—of the present water supply of every farm in the area, based on the average water value of the stock, shares, acreage, reservoir rights or pumping plants attached to the farm.

Allotment of water on the petition is thus usually limited to an amount that will total 2.5 acre-foot per acre, headgate diversion, including the present supply. This is all to prevent speculation and to spread the benefits as widely as possible.

After published notice and final approval and order by the Board of Directors, the petition and order,—now a contract,—is recorded in the proper county and establishes a tax lien on the described land to secure the payment of the taxes to be assessed covering the number of acre-foot allotted at $1.50 per acre-foot, the payments to begin after water is available.

It is possible under the Act to allot water to corporate organizations, but so far little of this has been done except several allotments to municipalities for domestic use provided for in the Act.

At the present time about 67% of the 310,000 acre-foot has been placed. The allotment of the remaining 100,000 acre-foot is being deferred until the project is nearer completion, when, it is believed, it will be easier to place it where it will do the most good and with the best repayment security, although that would be good almost anywhere.
It might be added that the annual use of the water can be moved by order of the landowner and that the actual ownership, together with the lien, can be re-allotted by hearing and order of the Board of Directors.

The annual distribution of the water will be under the supervision of the District acting through the State officials on the streams and the management of the various canals conveying the water to the users.

This may sound a little difficult to an outsider and it might be stated here that the present so-called "Exchange System" in use on all of our streams whereby water credits and dobits are moved up and down stream and all over the map, is already a mystery to the layman. The new supply will fit into this system and by reason of the large amount will form the backbone of an adequate late water supply to fill shortages throughout the District.

Here it might be mentioned that as the present original supplies are doubled by return flows and re-use, it is expected that the new water, which, it may be noted is to be about 40% of our present average original supply, will increase the return flows proportionately.

Under the contract, this water is claimed by the United States for the use of the District which may recapture and use it or allocate it to ditches on the basis of their decreed priorities.

For all practical purposes, it will probably become a part of the streams.
Construction

The first appropriation to the project for construction was for the fiscal year of 1938. Including the $6,249,000 item for the current year, the project has now had a total of $17,299,000 in six years.

Actual work on the first large feature was begun on Green Mountain Dam and Power Plant in November, 1938.

The dam itself is just now about completed and the equipment is being installed in the power plant so that by spring the 24,000 k.w. generators will be delivering that much energy to the war effort.

The first contractor moved to the East Portal of the 13.1 mile main tunnel in June, 1940. In the following September, another contractor started at the West Portal.

With a total of about twenty-five full months' work to date at both ends, the excavation is now 73% complete. The average monthly rate so far this year has been about 1,200 feet at each end.

The contractors are supplied with all necessary materials to complete the job and the tunnel should be "holed through" under the crest of the Continental Divide about next May.

The placing of the concrete lining will require about ten months additional.

Concrete materials are being screened and stock-piled now for that purpose.

In addition to these two features, the Bureau has constructed roads, camps and warehouses, as well as a number of power substations and connecting lines.

Efforts have been made for over two years to get Granby Reservoir Dam under way, but various difficulties have postponed any extensive work there.
However, the diversion tunnel around the dam site has been excavated and lined and other contractors are now performing work preliminary to construction of the main dam.

It is apparent now that the Continental Divide Tunnel, once considered the bottle-neck of the project, will be completed long before the other necessary features can be ready.

The people of Northern Colorado feel that a serious mistake has been made by the Administration in not pushing the project faster. They have been ready and anxious to do their part.

Instead of being perhaps one-fourth completed in the five years since the date of the first appropriation, it could have been far enough along so that it would now be nearly ready, at least, to make a big contribution to the war effort through the increased production of needed foods and the flows of electric energy in a comparatively safe location.

But that is all in the past and the country is now in a war where every pound of material and hour of labor must be put where it is hoped, it will help finish the dirty job in the shortest possible time.

How this situation is to affect the completion of the project is the question now.

Washington officials who should know say that the work must go ahead as fast as possible, but with a minimum use of critical materials for the present. On this basis, the increased appropriation for this year was recommended and appropriated.
But, while Green Mountain Dam has a high priority rating to assure the production of the badly needed power from this feature by next spring, the balance of the project is in a sort of "twilight zone" at the present.

It is believed that a still larger appropriation will be made for the next fiscal year so that all work possible under a low priority rating can be completed pending the time when the required steel and copper can be spared for the power plants, control gates, etc. This time may come soon if it is decided that the World War will probably last longer than the time required to complete the project.

Reports and construction schedules have been furnished Washington officials demonstrating that under an expedited program, the project can be essentially completed in about two years.

Anyway, when the Colorado-Big Thompson Project is finished, the main problem of Northern Colorado will be solved.