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The water works system of the city of Trinidad, Colorado

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THESIS

for the degree

of

CIVIL ENGINEER

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SUBJECT

THE WATER WORKS SYSTEM

of the

CITY OF TRINIDAD, COLORADO

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By

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Approved

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The Trinidad Water Works is a municipal owned public utility operated by the city under the jurisdiction and regulation of the Public Utilities Commission of the State of Colorado. The plant is operated by gravity and without filtration. Estimated value of plant $5,000,000.00.

For convenience the subject of this thesis will be divided into sections, namely: Collection, Storage, Purification and Distribution. No distinct lines will be drawn between the divisions however, each being treated without particular regard one to the other.

COLLECTION

An area of land on which the snow and rainfall drains to any one given point, natural lake, reservoir or other, is known as a watershed.

Trinidad's water supply originates in the Sangre De Cristo Range, a portion of the Rocky Mountains in southern Colorado, having an average elevation of perhaps 10,000 feet above sea level, where the North Fork of the Las Animas River takes its origin, a distance of approximately fifty miles northwest from the City.

The character and topography of the watershed naturally influences the quantity and to an extent the quality of water which eventually reaches the point of storage.

Trinidad's watershed consists of land of a steep mountainous character, an area of approximately forty square miles, the rain will rapidly run off the surface and into the stream so that only a small quantity is lost by sinking into the soil and a very small amount by evaporation. It is well covered by a growth of pine trees and shrubs which are of considerable value as tending to hold the snow and to decrease evaporation by lowering the temperature. They also pervent, to an extent, the washing away of the soil and filling up of water ways; their value in this way possibly more than offsets the value of the amount of water absorbed by them. The average yearly rainfall in this vicinity is seventeen inches. The average depth of the snowfall is a difficult figure to obtain due to the extreme roughness of the watershed and the severe wind storms which constantly carry the dry snow from one point to another. However, the records thusfar show that the Sangre De Cristo Range always carries snow when other points along the Rocky Mountain Range fail, the last available records show 178 inches.

It has been found necessary to employ patrolmen on the watershed areas. It is their duty to inspect all premises to prevent pollution of any nature. Our patrolmen have authority to eject or arrest persons found polluting the water or building camp fires which may cause damage to surrounding territory. Under no circumstances do we allow camping, hunting or fishing on the watershed areas. Under the laws of this State, violators are punishable by a cash fine or imprisonment.

The United States Forestry Department assists us in prosecuting violators and to educate the public that each person owes it to the community in general, and to one's self in particular, to see that the laws governing the sanitation of a water supply are observed in every respect. If a water is safe to start with, it is much easier to keep it so, as any additional cost which may be entailed resulting from the wilful pollution of a water supply is borne by the general public in the end.

STORAGE

Water flowing over the land surface of the earth and in streams, which is not disposed of by soil absorption,

evaporation or used by vegetation, will, in time, find its way to the sea, unless restrained by natural or artificial causes.

The City of Trinidad has acquired by actual purchase a perpetual water right of 7¾ cubic feet per second carried in the North Fork of the Las Animas River and the water is taken from said stream at a point approximately six miles below the afore mentioned watershed proper, by the means of a concrete headgate through a thirty-six inch double gate valve from whence the water is diverted through a thirty-six inch concrete pipe, a distance of 3200 feet to our North Lake reservoir which has a capacity of four hundred million gallons.

Generally speaking, all of the water carried by the North Fork of the Las Animas River can be termed "Surface Water" and contains a very small amount of mineral salts, there being only a small quantity on the land surface and is thusly quite different from underground water sources.

The impounding of surface water as a reserve supply is not the only important reason for storage. As previously stated, the water which is collected on the drainage area carries with it on its course to the point of

storage a considerable amount of the soil over which it passes, together with more or less vegetable matter, minerals and bacteria. Removal of the mineral content, when in solution and of a harmless nature is not of so much importance. The coarse material such as gravel and sand is deposited as soon as the water loses its velocity on entering the storage area, and as the movement of the water decreases by spreading out over the area, more of the soil in suspension is precipitated until there remains only the very fine particles of clay, vegetable matter and bacteria to be disposed of.

Under favorable conditions most of the clay particles will settle to the bottom of the lake in a short time, providing the water is not disturbed to any great extent by stream currents or action of high velocity winds.

I find the vegetable or plant life in water is one of the difficult problems to overcome in the handling of a water supply for domestic uses, though all of this plant life is harmless to the health of mankind, some of the species become troublesome if allowed to increase to a very great extent. The plant life which becomes most troublesome in domestic water supplies is of the algae variety (incorrectly called frog scum or water moss). It is generally a blue green color in this locality, and is found principally along the shallow banks of the lake.

The excessive growth of algae can be prevented very easily, without injury to other beneficial plant life, by the use of copper sulphate dissolved in the lake water in the proportions of one pound of the chemical to one million gallons of the water.

Very little of the larger plant life becomes troublesome in this region. On the contrary, many are decidedly beneficial to the water, absorbing as they do many undesirable qualities in the water, releasing oxygen to be taken up by the water, and furnishing protection and food for the animal life necessary to the maintenance of a good water supply.

PURIFICATION

Water derived from carefully guarded sources such as Trinidad's, or from good springs, tunnels and deep wells, is generally of such quality as to permit of its use without employing artificial methods of purification.

The city of Trinidad maintains a regular water testing laboratory where our water is tested three times per week in accordance with the method prescribed by the

American Public Health Association of New York.

For illustration, our test of March 30th, 1925, shows 184 colonies on gelatine plate; none on agar plate; and none on agar-lactos-litmus plate. Gas test with 10 c.c. water, trace; turbity 15 with no B-Coli on any plate. The amount of water used in our plate tests is 0.5 c.c.

The agar plate gives the number of bacteria developed at 37° C. The gelatine plate gives the number developed at room temperature 20° C. to 24° C. These latter represent the Saprophytic varieties, while those on the agar plates represent the parasitic varieties including the colon bacillus. The agar-lactose-litmus plate gives the colon bacillus, when present, in red colonies and so saves some time, as all the red colonies must be examined at once microscopically. The count of colon bacillus colonies however is taken from the agar plate. The colon bacillus is rarely found in Trinidad's water.

As the temperature rises however, the number of colonies will increase, but never in the history of the Trinidad Water Works thusfar, have we had to resort to any mechanical or chemical processes to further purify our water other from the condition in which we receive it.

In other words, the City of Trinidad takes its water direct from the snowy range into their various, well guarded reservoirs, six in number, and from them direct to its respective consumers without any pollution. A most remarkable asset to any community and one that cannot be overestimated in actual value.

DISTRIBUTION

After surface waters are stored in the main reservoirs, then filtered and treated if necessary, it starts on the course to distribution.

As previously stated, Trinidad's water supply is first collected in our so called North Lake Reservoir which is located at a distance of approximately forty-three miles from the City and at an elevation of 8478 feet above sea level. This reservoir is a natural storage basin. The water is held in restraint by an earth dam of only 324 feet long including a twenty foot spillway and thirty-one feet high. The upstream side of the dam has a 3 to 1 slope, well riprapped and the downstream side has a 2 to 1 slope well sodded. A concrete valve tower is located in the upstream slope of the dam, through which by

means of suitable valves we take the water into a 15" steel pipe line to our main station of distribution, called Madrid, Colorado, located on the South side of the Purgatoire River, a distance of approximately twenty-nime miles from North Lake, having an elevation of 6264 feet above sea level. Here we have three artificial concrete lined earthen reservoirs, designated by numbers one, two, and three, having capacities of eight million, seven million and thirty-eight million gallons respectively.

Before the water enters the reservoirs it is measured through Cippoletti trapezoidal Weirs and we endeavor to deliver four million gallons per day to this station.

Before our water leaves Madrid it is carried through a central valve chamber where we divert our water to the north and south of the Purgatoire River. The south line is a 24" wood stave pipe and leads directly into South Trinidad, a distance of approximately twelve miles. The north line is a 20" wood stave pipe and carries the water from Madrid station across the Purgatoire River to our reservoir number four, located at Jansen, Colorado, a distance of approximately eightmiles from Madrid, having an elevation of 6218 feet above sea level and approximately four miles from the City of Trinidad.

This is an artificial concrete lined earthen reservoir having a capacity of seven million gallons and primarily serves our consumers in North Trinidad.

On the South side of the City we have an emergency reservoir, known as the Maple Street reservoir, having a capacity of one and one half million gallons to which formerly the water was pumped direct from our former south side main. Recently, however, our south side main was enlarged and since then the pumping plant has been abandoned and the reservoir is temporarily out of service.

I now have under construction our seventh reservoir, and same is to be known as Monument Lake. This reservoir will have a capacity of seven hundred million gallons. It will be located near the Sangre De Cristo Range about four miles southwest of our present North Lake Reservoir. When completed, the new water main from Monument Lake will be connected to our present main line from North Lake. The estimated cost of same is one half million dollars. The plans and specifications are as yet not completed.

A BRIEF SUMMARY OF THE TRINIDAD WATER WORKS

The Trinidad Water Works operates in a territory about fifty miles in length and averaging from one to five miles in width. It serves consumers in the towns of Vigil, Weston, Segundo, Valdez, Primero, Madrid, Sopris, Piedmont, St. Thomas, Jansen and the City of Trinidad and some unincorporated territory adjacent to these places.

The population of the entire district served is approximately 30,000.

The City owns approximately 3000 acres of watershed land for the protection of its water supplies which joins directly to the United States Forest Reserve.

It has at the present time one storage reservoir of four hundred million gallon capacity.

It has four distributing reservoirs of approximately sixty million gallon capacity.

It supplies approximately five million gallons daily.

It has approximately a total of eighty-nine miles of pipe line.

It has 538 metered consumers and 3568 flat rate comsumers.

It maintains an average pressure in the City of Trinidad of ninety-eight pounds per square inch.

The average elevation of the City of Trinidad is 5964 feet above sea level.

Our present cost of operation is $88.00 per million gallons delivered at Trinidad. This figure can be materially reduced after our present bonded indebtedness is lifted.

The photographs next attached show our watershed area, part of the Sangre De Cristo Range, North Lake reservoir, reservoirs numbers One, Two, Three, Four, our emergency or Maple Street reservoir together with our proposed location of Monument Lake reservoir.

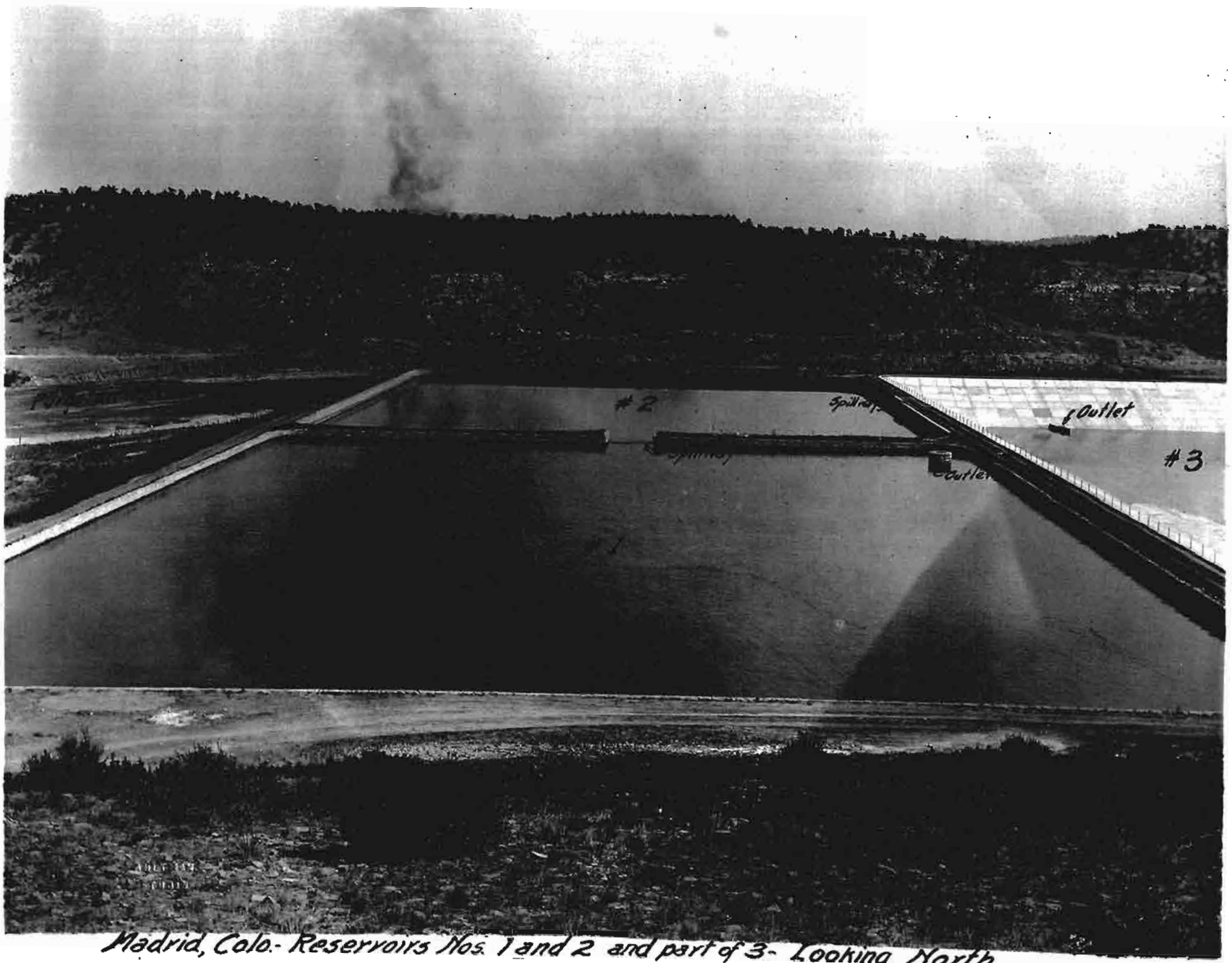
Sangre De Cristo Range - Origin of Trinidad's Water Supply

Main Intake on North Fork of Las Animas River * 36" D.I.

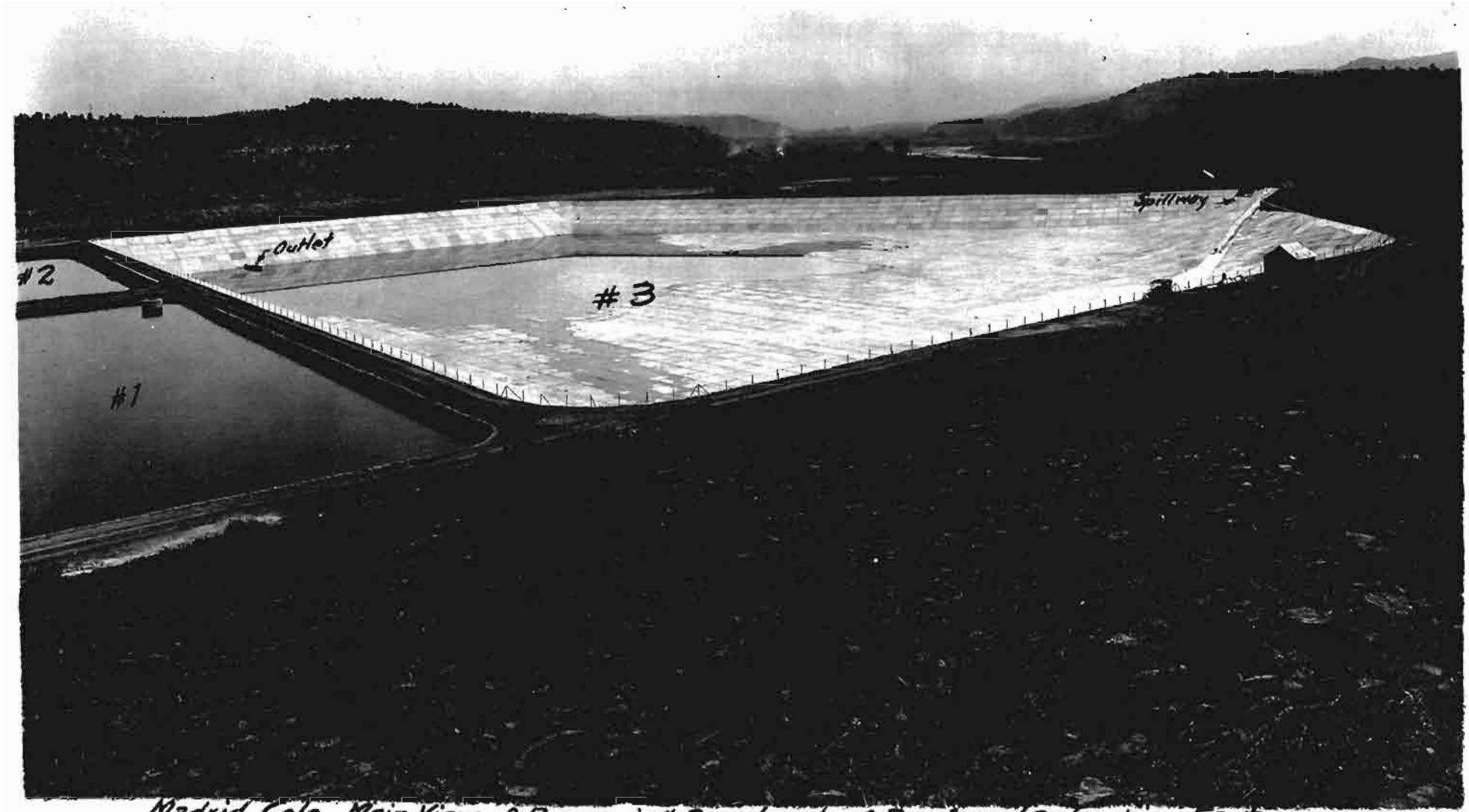
*Inlet to North Lake - Looking Southwest

*North Lake Dam - Looking South

Madrid, Colo. - Storage Reservoirs Nos. 1, 2 and 3 - Looking East

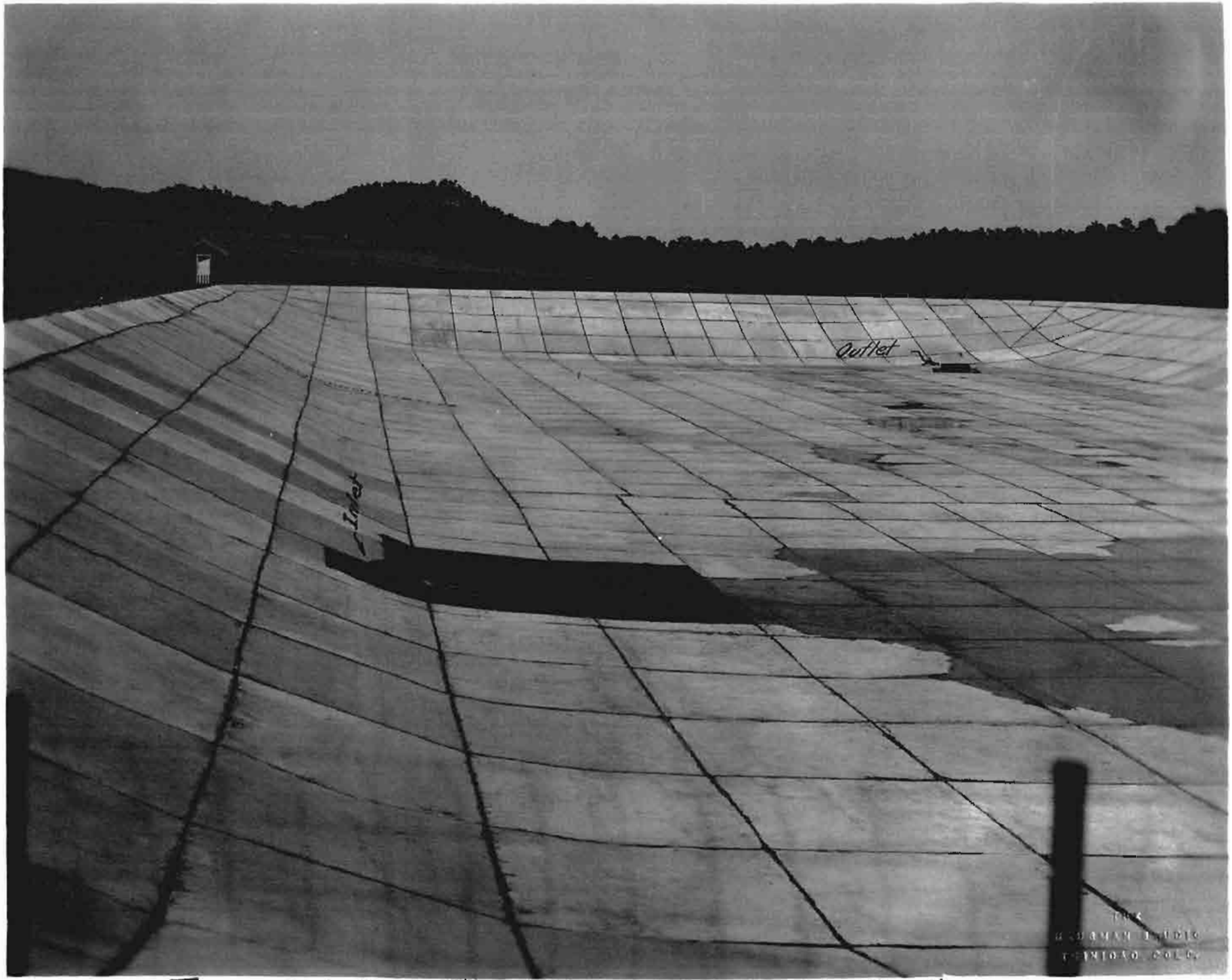


Madrid, Colo.- Reservoirs Nos. 1 and 2 and part of 3- Looking North



Madrid, Colo. - Main View of Reservoir # 3 and parts of Res. 1 and 2 - Looking East

Nearing Colo.-Main View of Reservoir #3 Looking West



Jansen, Cola-Main View of Reservoir #4 - Looking North

Jansen, Colo. - General View of Reservoir #4 Looking South

Trinidad, Colo.-Emergency or Maple St. Reservoir with Pumping Sta.-Looking East

Proposed Monument Lake Reservoir-Looking North.

* Proposed Dam Site of Monument Lake - Looking South