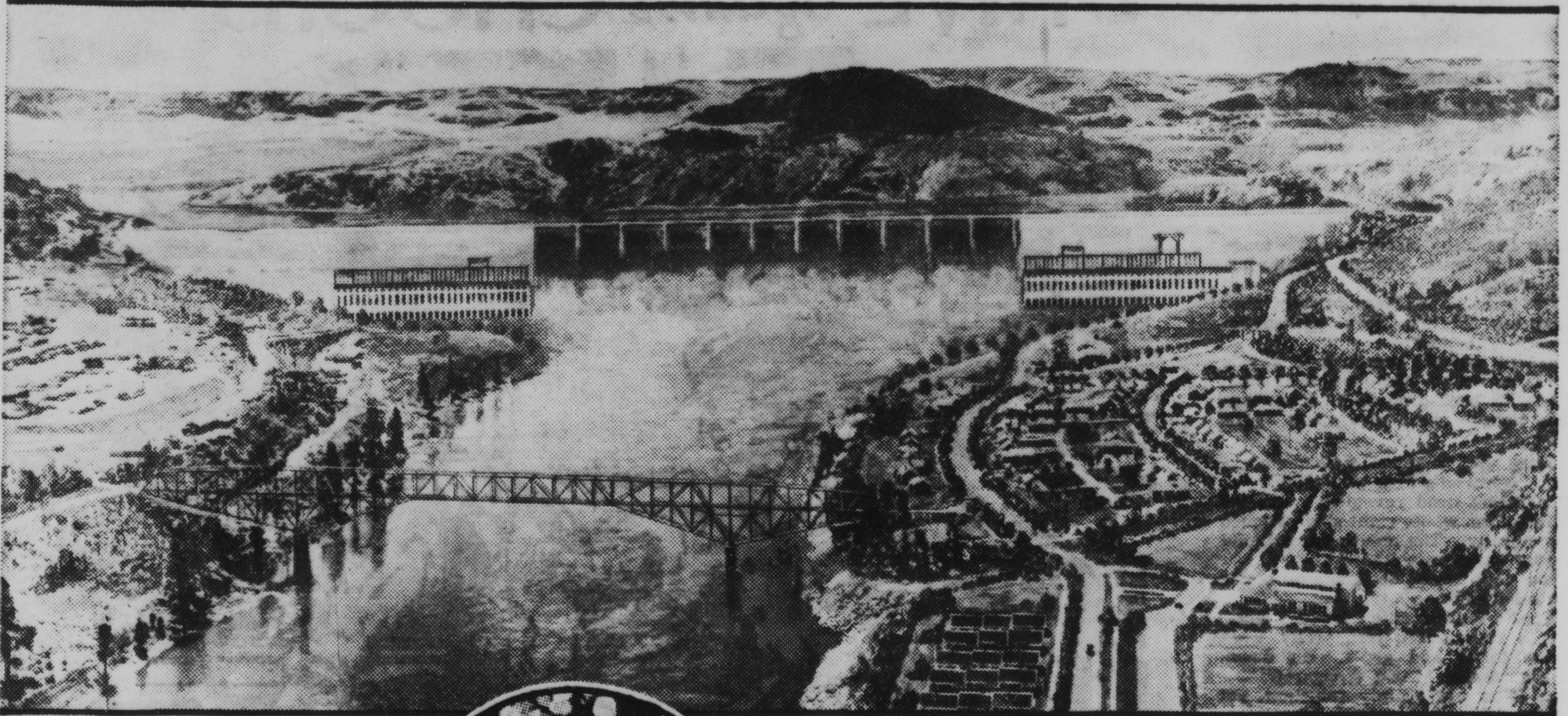
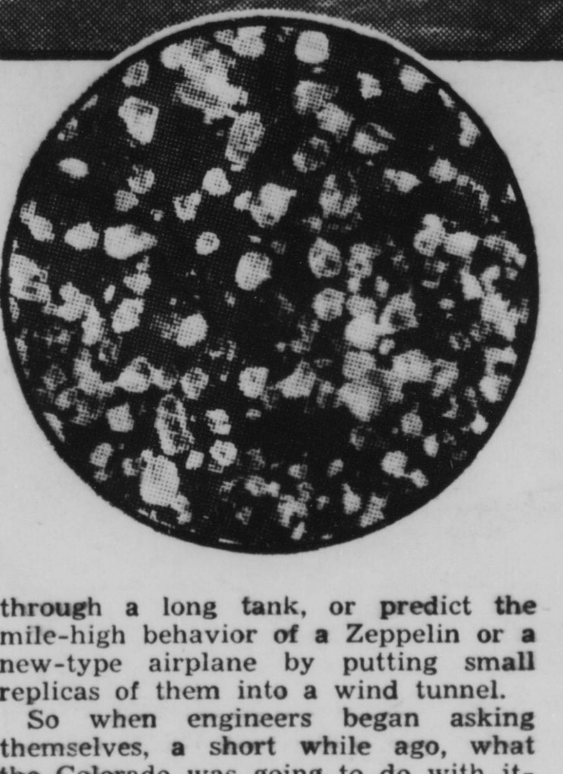
Trying to OUTGUESS the RIVERS





The Columbia river below Grand Coulee dam, as it will look after the dam is completed. What will the silt-freed waters do to this channel? . . . At left, sand from the Colorado river as seen under the microscope.

By Dr. Frank Thone

AMERICA'S great rivers are rapidly being won away from the ranks of the unemployed.

Boulder Dam has gone to work; its "juice" now pours over the wires clear to the Pacific shore, and before long the million thirsty throats of Los Angeles will be wet with Colorado river water. Norris Dam is generating light for thousands of homes in Tennessee Valley cities and countrysides. Day and night the walls of the Bonneville and Grand Coulee dams rise higher—and even in advance of their completion are generating more than a little political heat.

Most of us, when we behold these wonders that our hands have wrought, focus our attention on the dams themselves, and on the giant power plants at their feet. We give a thought, perhaps, to the tremendous artificial lakes they have backed up into what were empty canyons only a little while ago, and we bestow a passing look on the masses of churned water pouring back into the channels below.

Few of us, however, give that discharged water more than a second glance. Its work is finished, it has yielded its energy for conversion into electricity; it is now only a liquid exhaust, an aquatic ash, differing from other power-plant waste only in that it obligingly goes to the dump itself, instead of having to be hauled there.

Engineers, though, do not take quite so careless and inconsequential a view of that spent water. These fussy folk, trained to think quantitatively where the rest of us only guess qualitatively, still have questions to ask about that water even after they have squeezed all the electric juice out of it that they can get on a paying basis, and after they have taken toll of it for city use and irrigation.

SO long as water moves, it is developing energy—doing work on something. It is the engineer's business to know about energy and work—how much, where applied, what doing. So he looks downstream from the dam, and asks his questions.

But he doesn't always get his answers on the spot. Frequently he has to take the river indoors with him, into his testing laboratory, and repeat the questions there.

Of course it isn't possible to take such mighty streams as the Colorado or the Columbia into even the biggest engineering laboratory. But for at least some of the answers a small copy of the river will do almost as well as the original, just as marine engineers can figure out the best lines for an ocean liner or a battleship by towing a model through a long tank, or predict the mile-high behavior of a Zeppelin or a new-type airplane by putting small replicas of them into a wind tunnel.

So when engineers began asking themselves, a short while ago, what the Colorado was going to do with itself and its channel after it has "gone through the works" at Boulder Dam, they did not try to answer it at Boulder. They went back to Washington, D. C., and in the laboratories of the National Bureau of Standards they built a wooden river. It didn't look at all like the Colorado at Boulder Canyon, to be sure, but it did incorporate the particular factors that were giving concern to the engineers.

What they most wanted to know, in the particular downstream problem at Boulder Dam, was what the Colorado waters would do to the bottom of the river. Would the "scour" be faster or slower, now that the water gushes forth without the heavy load of silt it bore in the days before the dam was built?

For the water that comes out at the foot of the dam at Boulder—or of any dam, for that matter—is not the same as water in pre-dam days. A rapidly flowing river always carried along with it a considerable amount of mineral particles—sand and silt. The faster it flows the larger are the individual particles that it can carry, and also the larger is the total load.

When a dam is thrown across such a river, creating an artificial lake, the river behaves just as it does when it flows into the still water of a natural lake, or of the sea. It loses its velocity, and thus becomes unable to carry its load of mineral particles. The larger ones drop out first and the finer particles later.

A delta is formed; the reservoir begins to silt up. The water becomes very much clearer than it was in the old original stream; only the invisibly fine particles, that are in what is technically known as the colloid state, remain in suspension as the water leaves the dam.

SILTING up is something that happens to all dams. When a dam-created reservoir has become completely silted up, the dam of course is useless.

The lifetime of a dam is measured, among other things, by the number of years it will take for the silting-up process to complete itself. Engineers figure lifetime for dams, as they do for roads, skyscrapers, bridges, battleships and all the other works of man. They set these figures off against the cost and usefulness of the dams, when they are deciding whether given projects are economically justified.

With this silt out of it, what will the re-cleared water do when it rushes out of the enormous tailraces of the power plants?

The Bureau of Standards engineers built their wooden river to find that out.

Technically, the apparatus is called a flume. But modern "flume" differs by only a letter from the ancient Latin "flumen," which means a river, so that to call the contrivance a wooden river is not just a bit of fancy.

The Bureau of Standards flume is 40 feet long, 20 inches wide. On eight feet of its bottom, bottom sand from the Colorado river was placed, and water was flowed over that at various speeds and with varying amounts of stuff already in it. The muddy water that originally coursed through the canyon was imitated in the laboratory by churning up fine particles of clay in the supply tank from which it was pumped to the flume, until 3½ per cent of the weight of the water was made up of clay.

The work of the miniature river on its bed with clear water flowing was compared with its work when muddy water was used. Muddy water was found quite appreciably less efficient in causing scour on the sand bed. To cause the same amount of scour as clear water, it had to flow 10 per cent faster than clear water under similar conditions.

Sands somewhat coarser than those of the Colorado river bed were tried in the flume also, and it was found that with these the necessary increase in the velocity of muddy water was considerably greater, running as high as 25 per cent.

The difficult problem now facing the engineers is to correlate the results obtained with the little wooden river in the laboratory with conditions in the actual Colorado river, which is about 350 feet wide and 120 feet deep below the dam and travels about 10 times as fast as the laboratory river, yet has the same sand bed.

The exact answer to this question is not possible under the present state of hydraulic knowledge, but the results of this investigation indicate that a greater scouring away of the sand bed may be expected in the Colorado when clear water flows over it than was the case with the original muddy river. It is expected also that this scouring will progress gradually downstream.

While the results of this specific experiment will not apply directly to conditions below the other big dams now under construction or already in use, the general principle that clear water is a better "picker-upper" than muddy water will doubtless occupy the attention of engineers who stand at damsites and look downstream elsewhere.

Where a river flows over a rocky bottom, the increased scouring effect of clear water will be a matter of less concern; but there are very few large rivers of this nature. Most of them, like the Colorado, have beds of sand; others are muddy-bottomed. These can expect downstream deepening if they are dammed.

Studying stream action through the glass sides of an artificial river at the University of Minnesota.