

# SCIENCE

## against

# SILT

**Engineers turn the spotlight on sedimentation to help combat this menace to the Nation's water resources.**

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*Photo by William S. Russell, Region III*

**Sediment deposits in Lake Mead, world's largest man-made lake, just above Boulder Dam.**

Engineers and scientists call it sediment.

Irrigation farmers know it is simply mud and sand carried into their ditches and over their lands. Whatever its name, it is insidious, persistent, and powerful.

Silt—soil carried from land into streams—long has been recognized as a problem. And as a problem it is growing, because present-day complex developments in reclamation are vitally affected.

Sedimentation is not necessarily bad. The fertile acres in the Imperial Valley of California were created by silt boiling over from the Colorado River during its rampages. But it can wreck man's activities and works. Silt begins with erosion, which oftentimes strips farm lands of their best top-soil, or cuts ugly, damaging gullies. This soil, carried into a stream by rain run-off, can take up valuable space in reservoirs intended for storage of irrigation water. It can clog irrigation canals. It can cover good crop-producing lands with layers of useless soil.

Man cannot eliminate the forces of nature which create sedimentation. He cannot stop siltation. Even if he could, it probably would be unwise to do so. But he can learn more about it, and its effects on irrigation works and operations. And with this deeper and wider knowledge, he can devise ways and means of lessening its bad

effects, and using its good points so that they are turned to man's advantage.

That, in essence, is what the Bureau of Reclamation hopes to do. Reclamation engineers, in cooperation with engineers of other agencies concerned with this problem, are pooling their resources and technical skills. Investigations are aimed at reducing the effects of sedimentation, and thus preserving and protecting the investment of the farmer and the Federal Government in the irrigation works of the West.

The problem is a long-range one. Man sees only a small part of the erosion and siltation that occurs. Usually that is during times of flood or severe storm. But there is plenty of evidence, and the effects can be measured scientifically.

However, there is an immediate purpose in sedimentation investigations. That purpose is twofold. One is to help design and construct irrigation works that will meet the sedimentation problem better in the future. The other is to help relieve the farmer and other water users of present and potential troubles. For the long-time view, the quicker we can get a sure means of controlling sedimentation, the better off we will be.

Most people, especially those living in the East, have seen the deep damage to farm lands caused by erosion. The Department

of Agriculture estimates 100,000,000 acres of farms have been abandoned or impoverished to submarginal status by erosion.

When this soil is washed into the rivers, troubles start. Eastern residents can see dredging going on in all navigable streams. Constant vigil is needed to clear the channels in streams which are overloaded with sediment. Most all have seen levees, and note that they are constantly being raised. Such effort is made necessary in some of these instances because sediment is raising the river bed, and higher and higher levees are needed to hold back the water. In time, a stream bed may be as high as the surrounding farm lands, and when that happens, drainage of the farms becomes impossible, or at best, difficult and costly. Then too, ground-water levels may rise so high as to waterlog the farm land, making it unproductive.

More directly affecting irrigation are the problems of sediment in reservoirs and canals. Irrigation pumping intakes may be buried and city intakes may become useless or subject to expensive maintenance. Even if a stream is stabilized so that there is a balance between the water's scouring effect and the building up of the stream bed, construction of an irrigation dam may generate new problems by destroying that balance. Sediment will be trapped in the res-



*Photo by D. D. Suggs, former Region III engineering aide*

**Gulleys like this one near Tucumcari, N. Mex., are typical sources of silt in the Southwest.**

ervoir. The clear water below the dam then will be able to pick up materials from the stream bed and carry them on down to deposit sediment elsewhere.

Silt in reservoirs, quite obviously, can be a serious problem in the course of time. The sediment-laden water can damage moving parts in power and irrigation pumping machinery, and choke canals. The supply of irrigation water can be so reduced that the lands cannot be supplied with water. As the years go by, the reservoir's storage capacity can become so small that either new sources of water must be obtained or some of the irrigated lands must be abandoned. And the process can continue indefinitely until either of two things can happen: all the feasible dam sites in the stream will be used up and only a series of sediment-covered structures will remain; or the highly developed communities and farm areas will be abandoned.

Of course, this is a long-range view of what could happen. It need not happen, and the Bureau of Reclamation investigations are designed to help prevent such a possibility. The abandonment of a reservoir because it is filled with sediment may not seriously affect the present generation. However, unless the present trend is changed, unless we as a nation take this problem seriously, future generations may well have cause to lament our unsuccessful efforts to control sedimentation. Continued use of the best reservoir sites without adequate control of sediment will, in effect, deplete our Nation's resources just as reckless cutting of timbered lands without regard to their restoration depleted our Nation's forests. Future generations might

be presented with the incongruous picture of a dam, structurally safe for many more years of use, rendered useless because its water-storage capacity is gone.

The investigations now starting are by no means the first attention by the Bureau of Reclamation to this subject. Sedimentation has long been recognized as a problem, and active steps have been taken in dam

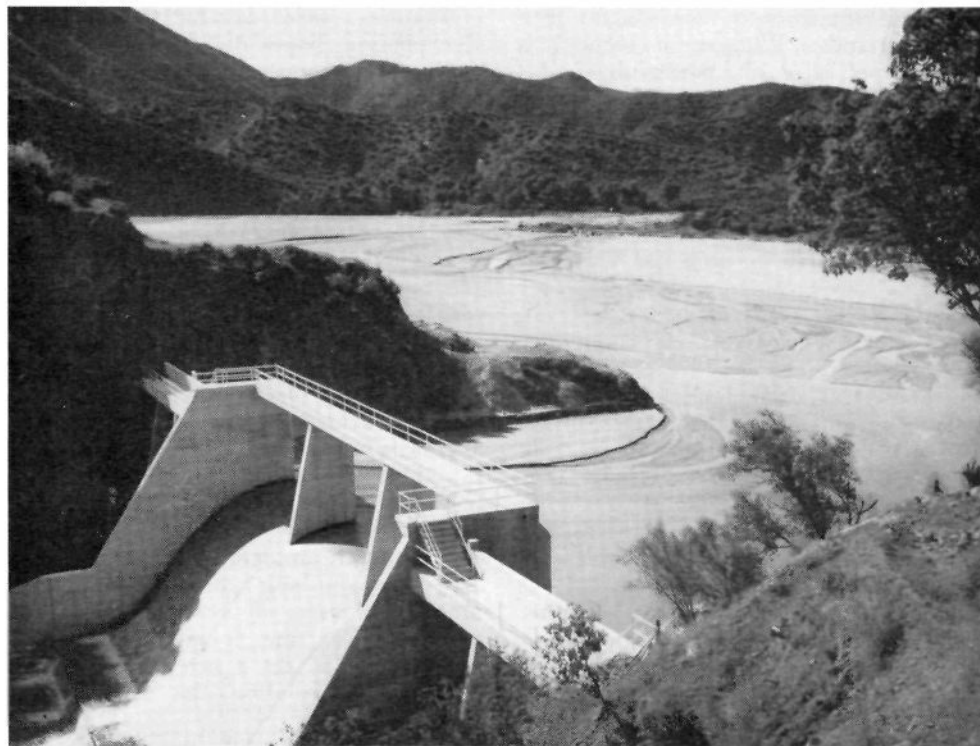
construction, for example, to mitigate the evil. But the investigations are coordinating, for the first time, all scientific and technical resources, in a concerted attack on the problem.

Bureau engineers have kept a watchful eye on the loss of water storage in various reservoirs. In some cases, they found the loss was growing at an alarming rate. Elephant Butte Reservoir, for example, in New Mexico, has lost 16 percent of its capacity in 25 years; Guernsey Reservoir on the North Platte River has lost 21 percent in 12 years; and Cucharas Reservoir in Colorado has lost 35 percent in 26 years.

One way to visualize the size of this loss is to picture the sediment deposited in Elephant Butte Reservoir each year being loaded into freight cars to be hauled away. It would take 400,000 cars, enough to make a train 4,000 miles long. Stated in another way, it means that each year enough water storage capacity is lost to irrigate between 5,000 and 7,000 acres of new land. Our job, as we can see it, must include ways of minimizing such incidents.

In the meantime, what has been done? Agencies such as the Soil Conservation Service, Forest Service, and Bureau of Land Management have worked on erosion control through maintenance of forests and other vegetal cover, by land management, the use of good farming methods, and installation of small erosion-control structures. Individual farmers, through their own initiative, have contributed much toward the prevention of erosion. Results have been good, in some cases, although the campaign is too new for results to be conclusive.

The Bureau of Reclamation, recognizing



*Photo by United States Forest Service*

**Mono Debris Dam, Calif., built for catching sediment. Note the almost-filled reservoir.**

that erosion is inevitable in certain respects, has in the past planned for it with the best means available. Portions of reservoir capacity have been reserved for "dead storage" for the accumulation of sediment. Only that storage capacity in excess of dead storage has been planned for use for irrigation, power, flood control, or other active purposes. The dead storage has usually been sufficiently large to store all the incoming sediment during the time that the cost of the project was being repaid by water and power users. But as mentioned earlier, where the sediment load is large, the dead storage will eventually be used up and the benefits from irrigation will be invaded in the years to come. Dead storage, Reclamation engineers believe, is satisfactory for relatively short-term economic evaluation of a particular project, but it is unsatisfactory in long-range utilization of the Nation's resources.

In certain areas where it has been recognized that sediment carried in canals would cause undue maintenance expenditures, elaborate works have been devised to remove most of the sediment before it enters the canal. An example is the desilting works for the All-American Canal in California.

Many plans have been investigated for removal of sediment from reservoirs to recover lost water-storage capacity. Except in isolated cases with peculiar local conditions, however, the cost of removal has been found to be far in excess of the benefits derived. Therefore it will be possible in only a very few cases to remove economically the sediment from reservoirs.

Until the present, planning oftentimes has been handicapped by lack of sufficient data. For example, preliminary plans for the Middle Rio Grande area have included proposals to construct dams on tributary streams to catch and store the sediment, thereby reducing the amount carried in the main stream.

Engineers felt that sediment-free water discharged from the reservoirs would tend to pick up some of the river bed material downstream and thus tend to deepen the river channel. As a result, the river could carry larger floods within its banks. Drainage would be improved in the valley and the ground water level would be lowered to the point where danger of waterlogging farm lands would be eliminated.

But several important questions remain to be answered. Engineers are unable to predict the depth of the scour of the river bed by the clear water, or the distance downstream that it will occur, or the effect that reduction in the natural variations of stream flow may have in reducing, ultimately, the channel capacities. They also want to know if the scoured material will merely be removed from one place only to be deposited at some other point in the channel. That would merely transfer the problem from one place to another. Also to be answered are questions as to whether the scouring might not be so deep as to endanger

*Photo by Emil Eger, former Region III Engineering Aide*

SCIENCE AT WORK. All-American Canal's busy silt-removing system.

bridge foundations or other river structures.

So a full solution to the Middle Rio Grande sedimentation problem must rely upon full and exhaustive investigations. And that is true of many other rivers. The Bureau of Reclamation program is designed to study fundamental problems, and conditions existing in major silt-prone areas, such as the Middle Rio Grande, in the West.

The investigations will follow several lines. Periodic surveys will be made of all reservoirs to determine the amount of sedimentation. From these, the Reclamation engineers will learn the rate of sedimentation which can be expected in reservoirs to be built in similar areas, and will have specific data on the actual water storage space left in existing reservoirs.

A crew, equipped with a supersonic echo-depth sounder developed by the Coast and Geodetic Survey for studies of ocean floors, will make these studies. A boat will travel across the reservoirs, receiving sound waves sent from the apparatus in the boat and bounced back by the reservoir bed. The time it takes for the sound to travel from the boat and back automatically records the depth of the water. Not only will this instrument measure the depth of the water—in most cases it will also measure the thickness of the sediment deposit, recording it continuously as the boat moves on its course. The "sounder" replaces the old, tedious, and oftentimes uncertain method of measuring depth by lowering a weight to the bottom and measuring the line on which the weight was suspended.

Laboratory investigations are to be started on a large scale. These are expected to supply some of the missing links in our knowledge of the fundamental laws of sedimentation. Specific problems will

be tackled. For example, models of channels will be constructed. Observations will be made on various rails of sediment load and variations in water flow, the effects of different river developments on the scour, silt deposition, in the stream channel downstream. These data will serve as a check on construction plans designed to meet the sedimentation problem.

These laboratory studies may eventually involve the use of models of an entire river system, reduced in scale to the size that can be accommodated at the Denver, Colo., Federal center. Such river models may have to be built outdoors because of their space, and will cover several acres. The "model study" method has been used successfully in designing dams, locks, and channels, but so far it has been used only sparingly for solution of sedimentation problems.

Some of the most experienced sedimentation specialists have been employed to pool their technical skills. Theirs is the arduous task of obtaining basic data, of sifting, coordinating, and interpreting these data, and of deriving practical solutions to many problems. It is not expected that all solutions will be forthcoming quickly or easily. Progress necessarily will be slow at times, for it is a new and challenging need. But efforts will be concerted. Duplication will be avoided, and coordination will be promoted, through a special subcommittee of the Federal Inter-Agency River Basin Committee. On this group are engineers from all interested Government agencies. Programs and activities of all can thereby be coordinated into a well-knit plan of action.

Water users, power consumers, and all beneficiaries of water resource development in the country, and especially in the West, will profit by this work.