Water Catchments on the Fort Apache Indian Reservation

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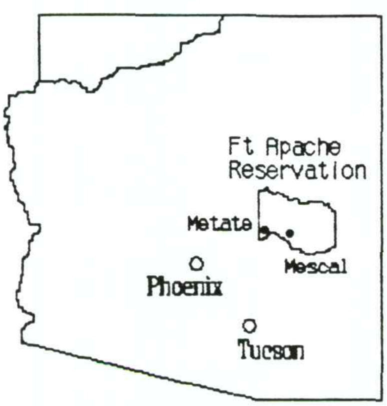
Water harvesting is an ancient technique of water supply which consists of collecting precipitation from a prepared surface and storing it for later use. While this concept has been used for many years to provide animal and domestic drinking supplies at various places in the United States and elsewhere in the world, it is not considered a universal low-cost water supply technique. Research efforts during the past 30 years have been directed toward the development of lower-cost, durable materials for use on water-harvesting systems. In the early 1960's several water harvesting catchments were installed on the Fort Apache Indian Reservation in central Arizona to provide drinking water for livestock and wildlife. These



installations were a cooperative effort between the USDI, Bureau of Indian Affairs (BIA) and the USDA-Agricultural Research Service (ARS), U.S. Water Conservation Laboratory, Phoenix, Ariz., to field evaluate various water harvesting methods and materials for providing drinking water in remote rangeland areas. Although installed as operational watering systems, they were experimental in nature and there were several failures in the initial installations. The philosophy of these early installations was to start with the lowest cost materials and techniques. If these systems failed, then more expensive approaches were tried. This continued until a successful system was developed. Over a period of about 10 years, these cooperative efforts resulted in the development of design procedures and materials which would provide the required water supplies. Over 25 years later, two of these water harvesting systems are still functional.

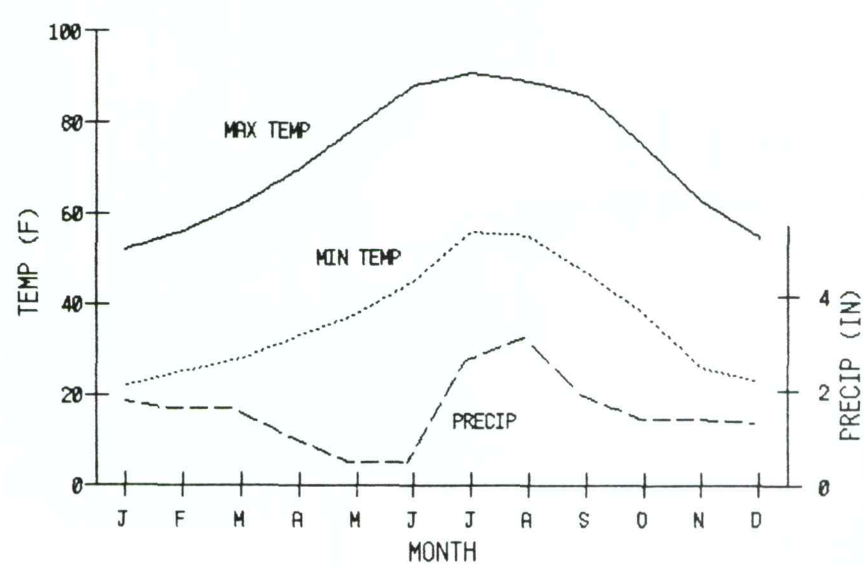
Metate

This water harvesting system is located in the southwestern portion of the Fort Apache Indian Reservation at an elevation of approximately 4,000 ft. in a semiarid shrub vegetative zone. The system was designed to supply drinking water for approximately 25 cattle grazing the surrounding rangeland in a spring use pattern. Various wildlife (deer and small game) were to use the water facilities year long.

The topography of the area is rough with small benches of relatively level ground. Vegetation consists of a mixture of warm-season grasses intermixed with juniper. The climate is considered mild with a mean annual precipitation of approximately 18 inches. The surface soil was derived from decomposed granite and classified as a clay loam with 36% clay, 26% silt and 38% sand. The soil cracks upon drying, forming sand sized aggregates from the fine soil particles (clay and silt).

In 1963 a catchment area of 50 × 200 ft. on a 4% slope was cleared of vegetation by a bulldozer and hand raked smooth. A 50 × 50 ft, 6 ft deep pit with 1:2 sideslopes was excavated at the lower edge of the catchment area to store the runoff water. The area was enclosed by a 4-strand barbed wire fence. A pipe from the bottom of the pit provided water to a drinking trough outside the fenced area.

The first treatment on the catchment area and storage pit was a two-coat spray application of an asphaltic material. The asphalt did not penetrate into the soil and was deposited as a thin coating on the soil surface. The coating cracked upon drying, which allowed water into the soil, which also cracked upon drying and further increased the rate of treatment deterioration. Within four



Monthly temperature and precipitation

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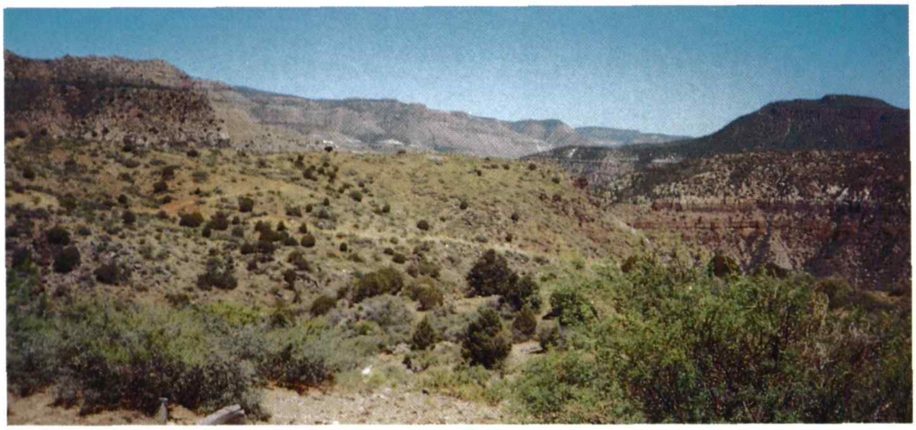

Rangeland area of the lower Salt River canyon, Fort Apache Indian Reservation.

months the treatment had disintegrated and only traces of the asphalt remained.

The following year the catchment area surface was disked, treated with a chlorate soil sterilent, and compacted with a small steel drum lawn roller. The area was sprayed with a solvent based asphalt solution which penetrated the soil to a depth of 1/4 to 1/2 inch. A month later a 1.5 mil thick black polyethylene film was bonded to the stabilized soil surface with an asphalt emulsion.

The storage pit was lined with a fabricated-in-place asphalt fiberglass matting. This lining consisted of placing an inert fabric, fiberglass matting on the soil surface. The fabric was saturated with a water based asphalt emulsion which penetrated through the material, bonding it to the underlying soil. The asphalt hardens into a semirigid membrane, cementing the fabric strands together and sealing the pore spaces.

Inspection of the site a year later revealed a number of holes in the polyethylene covering on the catchment surface. Even after the catchment area was rolled with the lawn roller during the installation process, a few scattered pebbles remained on the soil surface. Although the polyethylene sheeting was bonded to the soil over most of the area, at each pebble there was a small area of film not bonded in place. At these locations the plastic was partially free to move and abrasion on the underlying gravel wore holes in the plastic, destroying the integrity of the covering.

The plastic film covering was removed, leaving the underlying stabilized soil intact. The area was compacted with a vibrating roller which pushed the loose gravel into the existing asphalt catchment surface. A 2 mil thick black polyethylene sheeting was bonded with an asphalt emulsion to the compacted-stabilized soil. The storage pit fiberglass lining was given a top-coating of an asphalt emulsion. During the next couple of years the treatment was effective in collecting rainwater but the runoff water was discolored from oxidized asphalt which migrated through the polyethylene film.

In the 1968 the entire catchment area was re-covered with a fabricated-in-place asphalt fiberglass matting by the same technique used to line the storage reservoir. The asphalt-fabric membrane covering on the catchment area and water storage pit has been an effective covering for over 20 years. Minor fence maintenance, plant removal, and re-coats of asphalt emulsion on the fiberglass surfaces at a 3- to 5-year interval have been the only remedial measures necessary.

Mescal

This water harvesting system is in a climatic and vegetative zone similar to that of the Metate water harvesting system. In 1965, a catchment

Metate water harvesting catchment.

Mescal water harvesting catchment.

area approximately 94 × 94 feet on a 10% slope was cleared with a bulldozer. After clearing, the area was hand raked to remove rocks and treated with a soil sterilant. The cleared area was covered with a 20-mil thick sheeting of chlorinated polyethylene. Twenty foot wide strips of the sheeting were unrolled on the soil surface and the edges bonded together with a petroleum solvent. The outside edges of the sheeting were anchored at the berms of the catchment area.

This installation technique was similar to the methods used in previous installations using butyl rubber sheetings. Many of the butyl covered catchments were destroyed by wind. The wind drag forces on the butyl sheeting frequently caused holes from abrasion on rocks or other underlying protrusions. The chemical composition of the chlorinated polyethylene sheeting used on the Mescal catchment provided a durable covering (very flexible and puncture resistant) which conformed to all surface irregularities. Since installation, maintenance has been limited to repairing a few small holes caused by plants, tears from wildlife walking on or chewing on the surface covering, and a few minor pinholes in weak areas of the sheeting. Repairs are easily made with small scrap patches of the original material bonded to the covering with a sprayable petroleum solvent. In 1975 the berms on the side of the catchment area were rebuilt and the edges reburied. It was also necessary to replace a piece of the covering in a small area on the lower end that was damaged by water and sand abrasion.

Water collected from the catchment area drains to one corner and into a 40,000 gal steel-rim tank set into a circular concrete base. The tank bottom is sealed with a 22 mil thick vinyl sheeting bonded to the tank rim. A pipe leads from the storage tank to a drinking trough outside the enclosing fence. The system supplies water to approximately 60 cattle winter grazing the surrounding rangelands. Various wildlife use the facility on a year-round basis.

In 1978 a floating cover was placed on the storage tank to reduce the quantity of water lost by evaporation. Expanded polystyrene sheets, 4 ft. × 4 ft., coated on both sides with a paraffin wax, were joined together with stainless steel wire and clamps made from 2 inch PVC (rigid plastic) pipe. The cover was an effective means of evaporation control for about 5 years. Birds liked to perch on the sheets to drink the water. Seeds from the bird droppings grew into small plants which tended to accelerate the deterioration rate of the polystyrene sheetings. Also, winds broke some of the sheets into smaller pieces which were washed over the side when the tank was full.

General Comments and Observations

During the time of installation and the initial use period, Mr. C-Eric Granfelt, former BIA range conservationist, made the following observations regarding factors contributing to the success of water harvesting systems.

1. All vegetation on and near the catchment area should be eliminated on at least an annual basis.
2. Asphaltic surfaces usually require a surface re-treatment every 5-7 years to maintain a satisfactory performance.
3. Berms around the catchment apron should be covered with the same material as the catchment surface and kept free of vegetation.

4. The catchment surface should be able to withstand the impact of animal hoofs.
5. The catchment surface should be as smooth as possible to prevent sediment deposits and standing water.
6. Pipes from the catchment area to the storage facility should be designed to prevent small animals from walking on or in the pipe and falling into the tank.
7. Care must be taken to insure there are no leaks around the piping system from the storage facility to the drinking trough.
8. The bottom edge of the tank walls must be completely sealed to the tank bottom.
9. A sump at the outflow portion of the catchment is desirable.
10. A valve and pipe cleanout should be installed between the storage facility and the drinking trough.
11. Storage tanks should be covered or have some method of controlling evaporation.
12. Float valves for the drinking troughs should be enclosed in protective containers outside of the drinker.
13. Drinking troughs should be set on gravel pads with a gentle slope falling away for a distance of 4+5 ft.

Unfortunately, the sheeting used on the Mescal catchment is no longer commercially available. This sheeting has proven to be a durable and easily maintained covering. The chemical and physical characteristics of the material allowed the sheeting to conform to all surface irregularities and withstand wind forces which had been a major problem with other flexible sheeting such as butyl rubber.

The Mescal site location and aspect may also minimize the impact of wind blowing over the catchment surface. Materials for the asphalt-fabric treatment on the Metate catchment are still available. This treatment is being used on other sites in various places in the United States. These two water supply harvesting systems have more than surpassed the original design expectations.

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