Roads: A History of Erosion and Dewatering of the Arid Southwest
A Holistic View

After a 35 year career with the US Forest Service and 20 years as a private consultant Bill Zeedyk, noted Wildlife Biologist and Surface Hydrologist, has observed that " Roads are the biggest impediment on our watersheds. They concentrate and divert water, dewatering one area and causing erosion in another. Plant vigor suffers, soils are washed away and sediment fouls our water courses."

The history of roads in the arid southwest started with the first Spanish carts with their crud wooden wheels that cut ruts across the arid landscape. The next set of wheels to follow had steel rims and were introduced via the Santa Fe Trail. The ruts cut by the pioneer's wagons can still be seen today and many of them are now 20 foot deep arroyos. The steel tired wagons traversed every corner of the west that they could be driven over or a primitive road was constructed. In many cases the arroyos and gullies we now see are a legacy of these old wagon roads and trails, especially in the valley bottoms where it was the easiest place to travel in a horse drawn wagon. The ruts in the valley bottom converted the original sheet flow to a concentrated flow. Once the water was trapped in the ruts the velocity was increased enough to down cut the ruts to the point that there are gullies today that are 20 to 30 feet deep.

The advent of the automobile only exacerbated the scenario mentioned above. Many of the original auto routes followed the same path as the wagon roads. When a road washed out or gullied out to the point it could not be traversed, the road/wheel ruts where just moved over and another route was continued. This scenario can be observed at many locations where there are parallel gullies and or parallel washed out roads.

Post World War II brought us a barrage of heavy earth moving equipment. The bulldozer was the tool of choice for building all road systems, but especially useful in building low standard county, ranch, logging and mining roads. Between 1945 and today there have been tens of thousands of miles of low standard roads carved into the watersheds in the southwest. Many of these road are now abandoned and have created miles of eroding gullies and scars across the western landscape.

The damage created by roads to our watersheds and their surface hydrology is unprecedented to any other anthropogenic activity in the arid southwest. Couple the effects of roads with the effect of overgrazing and livestock trailing, we now have a landscape that is totally changed from what it was 200 years ago.

We cannot reclaim what we have lost in soils and vegetation diversity, but we can make the appropriate adjustments in our current road systems to reestablish the original surface hydrological flow patterns that have been disrupted by roads. Using the appropriate road drainage systems we can then curtail erosion, further loss of soils, harvest road water to reinvigorate vegetation and stitched the natural surface hydrocele flow pattern back together.

What has been observed over time is that roads collect, concentrate and divert the original natural surface flow patterns within our watershed. This concentration and diversion of flows takes water out of one micro watershed and diverts it into another. The first micro watershed is de-watered and the plant vigor and species diversity is reduced. The second micro watershed is overloaded with the additional flows causing erosion, down cutting and accelerated sediment contribution into the mainstem system. Sediment has been identified as the number one water pollutant in our western river systems. It creates geomorphic channel evolution by increasing deposition on point bars, transverse bars and mid channel bars that accelerates stream bank erosion, which contributes more sediment into the system. This sets up an insidious chain reaction that overloads the entire system with sediment and creates mass erosion. This overload of sediment plugs up irrigation works and costs billions of dollars a year to filter out of the water supply so it can be used in municipal water systems.

In conducting numerous watershed condition assessments, primarily using the criteria set forth in Watershed Assessment of River Stability and Sediment Supply, II Edition (WARSSS) Rosgen 2009, it has been observed that roads in general come out on top of the list of situations within the watershed that are contributing to watershed instability and an increase in sediment supply.

When planning solutions to restore and stabilize watersheds, it has become obvious that the proper drainage of the road systems will make a significant contribution toward reversing the downward watershed trends and restoring the natural surface hydrological patterns.

Proper road drainage (restoration) systems are one of the most cost effective ways to restore watershed function and decrease erosion and sediment contribution into the overall system. The proper drainage of roads has many benefits for the dollars invested. These benefits included: 1.) Significant reduction in the need for road maintenance and retention of road surfacing materials. 2.) Reduction of erosion and sediment. 3.) Reconnection of channel flows that have been diverted by roads. 4.) Harvesting of road drainage water to re-hydrate the landform and increase plant vigor and species diversity. It has been estimated that each road drainage feature can rehydrate ¼ to ½ acre of

landform, stabilize and restore numerous micro watersheds that have been adversely affected by road systems.

The science and physics that drive the erosional process on roads is quite simple. We have only two factors to deal with. The first factor is the amount of water that is discharged on the road surface (lengths of road) and the amount of time the water is allowed to run down the road surface. The second factor is the slope to the road. The first factor, discharge we can do a lot about, by aggressively draining the road surface. The second factor, slope we are generally not able to do much about due to the topography and/or the cost of rerouting the road.

Slope is the driving factor in the erosion of road surface and erosion in general. If the discharge (volume of water on the road surface) remains the same but the slope is doubled (2% to 4%) the ability for the water to move surface materials is 4X and the size of particles the water can move is increased by 8X. Hence, the need for more and better drainage features as the road slope increases.

A skilled surface hydrologist practitioner can see the numerous situations created by roads. These same situations are often overlooked by the untrained eye. The art in designing and creating landscape scale road drainage systems is in the practitioner's ability to "read the landscape". The trained practitioner is able to fret out the smallest details that contributed to landform degradations created by roads. The trained practitioner will see much more opportunity to drain the road system than the untrained observer. The practitioner's design will result in numerous road drainage features; therefor, aggressively and properly draining the road as well as stitching the natural surface hydrological flow patterns back together.

In the practice of road drainage systems in the southwest it has been concluded that the design and installation of road drainage features needs to be aggressive to be effective. The term aggressive refers to the number and frequency of road drainage features installed per any given mile of road. In the training of practitioners in this field of work, it has often been said, " It is better to err on installing too many drainage features than not enough." This philosophy has born out to be true. Many practitioners after completing a road drainage project and after monitoring it for a year have come back with the conclusion. " I wish I would have read the landscape better and installed more drainage. I still have problems that need to be addressed."

For best results in the implementation of a road drainage system it is advisable to employ well-trained equipment operators and select proper equipment. The equipment operator needs to have a good ability to "read the landscape" and a fundamental understanding of why and how the work is to be conducted. The construction of road drainage features needs to be done in an aggressive manner. The word aggressive refers to the need to insure that a good amount of materials is used in each drainage feature. This will guarantee that the drainage feature will stand the test of time and need very little or no maintenance in the future. The drainage feature also needs to be constructed so that it drains properly, does not create a mud puddle or scour out.

In Conclusion: Since the negative effect of roads on watershed stability has been well documented, it is a forgone conclusion that the condition of many miles of low- standard roads in the southwest needs to be addressed. Since road drainage is very cost effective per mile treated and per problem solved, it should then be one of the first treatments conducted in the pursuit of restoring watersheds.

This information has been compiled by Steve Carson, Surface Hydrologist and Fluvial Geo-morphologist Practitioner
Steve has personally designed and constructed over 6,000 road drainage features, which equates to approximately 600 miles of roads treated over the last 12 years. These road treatments have been conducted on projects in Texas, New Mexico and Arizona. The projects have been conducted over a wide range of land management structures. They include projects for the US Forest Service, BLM, Game and Fish, State Land Departments, County Road Departments, and numerous private landowners and ranchers. The projects encompass all eco regions within the southwest and range in elevation from 1,500 feet to 10,0000 feet above sea level. Steve has reached a very simplistic conclusion about the affects of roads on watersheds, " Different location, same problem, and same solution; get the water off the road ASAP".

I hope you find this information helpfull.

Best Regards,

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