Conway Gulch PAM Demonstration

David F. Ferguson, Water Quality Resource Conservationist with the Idaho Soil Conservation Commission
October 29, 1997

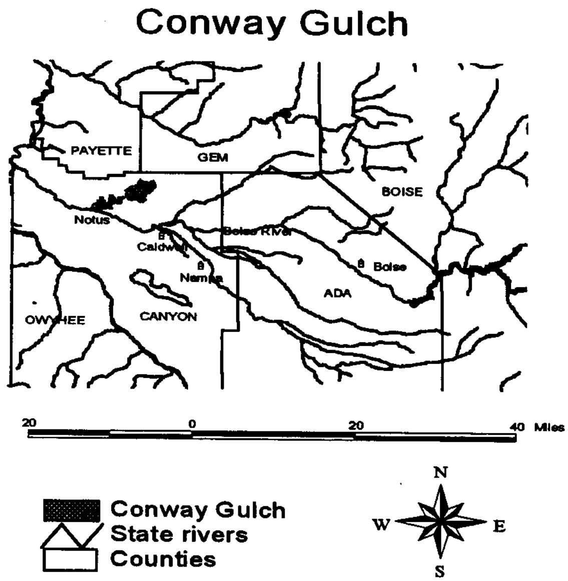
Polyacrylamide, also known as PAM, was applied in granular and liquid forms within an entire watershed for a two-week period. The Conway Gulch watershed is located in the northwest portion of Canyon County and consists of approximately 40 farms on over 4,000 acres of cropland. Waste water from the fields and the drain was analyzed for phosphorus, sediment, PAM, and other parameters. Field outflow rates were compared to drain outflow rates and approximately ½ of the water in the drain consisted of only field runoff. PAM was not found detrimental to the drain's water quality. PAM was detected only twice, each less than 0.8 ppm. Soil erosion on each field where PAM was applied was reduced, as well as sediment within the drain. Poor water management with high field runoff reduced PAM effectiveness. PAM was found to be an effective sediment control practice and did not seem to negatively impact the drain. Pam was well adopted by each of the farmers within the watershed and usually applied at rates less than what is recommended.

Introduction

In June of 1997, Polyacrylamide (PAM) was applied on all surface irrigated row crop fields within the Conway Gulch watershed. This watershed is located in the northwest part of Canyon county, Idaho and is a tributary of the Boise River. Surface irrigation is the dominant form of irrigation and generally occurs on silt loam soils that have high potential for erosion. Surface water is applied through corrugations created mechanically. Irrigation water is delivered to farm fields through complex canal systems that are charged with Payette and Boise River water. This water is then pulled through farm head gates, often measured with Cipoletti weirs, then diverted into concrete ditches, earthen ditches, and gated pipes. Water is applied to the crops through corrugates between crop rows. A range of 30 to 60% of the water applied runs off of most fields to ensure proper crop wetting at the end of the field. The fields are typically leveled with grade to ensure crop-watering uniformity. Wastewater running off the fields is usually loaded with sediment, nutrients, and sometimes farm chemicals.

Wastewater from surface irrigated fields can impact the drain with these various pollutants. Idaho water quality standards and EPA Gold Book recommendations for sediment and nutrients are often interpreted as exceeded in the drain and in the Boise River downstream of the mouth of this drain. There are a variety of farming practices and physical conditions that make it difficult for farmers to control erosion and reduce pollutant loading. Many farmers in the county have readily adopted PAM but not completely within any one watershed. There are concerns that excessive use of PAM on an entire watershed would impact aquatic species within a water body. This demonstration was implemented to identify impacts of a watershed application of PAM.

Project Area Description



The mouth of this watershed is located about 1/2 mile downstream of Notus, Idaho, at latitude 43°00' and longitude 116°47'40" and stems northeast, intersecting interstate I-84. There are approximately 7,616 total acres within the watershed, with 4,355 in row crops, 1,425 acres under sprinkler, and 375 in irrigated pasture. Canyon county is a leading seed producer in the world and has over 50 different crops grown through an 8 month growing season. In a semi-arid climate, precipitation comes rarely during that summer months and irrigation is required. Typical crops grown in the area are alfalfa hay, alfalfa seed, winter wheat, spring wheat, oats, barley, dry beans, edible beans, sugar beets, commercial onions, onion seed, field corn, corn for silage, seed corn, carrot seed, celery seed, and potatoes.

Most of the tillage that occurs is "conventional tillage" that eliminates most of the remaining crop residue. Wheat and alfalfa seed residue burning is also common to reduce the number of tillage operations to achieve complete residue removal. Polyacrylamide is a common tool used for erosion and sedimentation control, along with other practices such as filter strips and sediment ponds.

There are approximately 40 farmers within the watershed with an average farm size of 120 acres. Field sizes typically range from 10 to 50 acres. Most of the farmers have participated in conservation programs and water quality programs such as the State Agricultural Water Quality Program and the USDA Water Quality Incentive Program.

Water Quality Conditions

Conway Gulch has been monitored for many years with data available from 1973 through 1996. Some of this data is shown in Table 1. The persistent pollutants are sediment, phosphorus, and fecal coliform. Water quality improvement practices have been implemented to address these pollutants in the lower Boise River area since the 1980s.

Table 1. Historical Water Quality Data

Date	Average Flow (cfs)	Average Temp. (celcius)	Average Dissolved P (mg/L)	Average Total P (mg/l)	Average Susp. Sed (mg/L)	Average Sed. Load (tons/day)	Sample Number	Sample Date Range
1973	39	15	0.19	0.40			9	Apr-Dec
1974	42	13	0.26	0.58			13	Jan-Dec
1975	56	13	0.20	0.42			12	Jan-Dec
1976	30	13	0.17	0.44			11	Jan-Nov
1979	48	12	0.18	0.28			3	Oct-Dec
1980	71	14	0.18	0.41			12	Jan-Dec
1981	64	13	0.16	0.26	117	20.2	20	Jan-Dec
1982	23		0.17	0.24	33	2.0	2	Feb-Mar
1988	26		0.18	0.20	19	1.3	3	Oct-Dec
1989	48		0.15	0.31	150	19.4	15	Jan-Sept
1994	26	12	0.18	0.25	75	5.3	5	May-Dec
1995	37	15	0.15	0.26	109	10.9	22	Jan-Dec
1996	42	13	0.14	0.27	130	14.7	19	Jan-Oct

The Lower Boise River Plan was developed by the Canyon Soil Conservation District in 1980 to study the agricultural effects on water quality within the lower Boise River. It was developed to understand the water quality problems and to plan strategies for reducing agricultural pollution and encourage landowners to use conservation practices. The Conway Gulch State Agricultural Water Quality Program (SAWQP) was initiated in 1983 to implement conservation and water quality practices.

Many practices commonly known as Best Management Practices were installed within the gulch area. Many sediment ponds, sprinkler systems, concrete ditches, buried pipelines, land leveling and gated pipe were installed from 1983 through 1997 to reduce sediment and nutrient loading to the drain.

Demonstration Strategy

Many agencies, local organizations, and businesses contributed to this demonstration. Agency support was provided by the Agriculture Research Service, University of Idaho, Idaho Department of Agriculture, Natural Resources Conservation Service, and the Soil Conservation Commission. Local support came from the Canyon Soil Conservation District, Black Canyon Irrigation District, Wilber Ellis, Allied Colloids, Integrated Biological Systems, Cyanamid, Producers Supply Co-op, UAP Northwest and the watershed farm owners and operators.

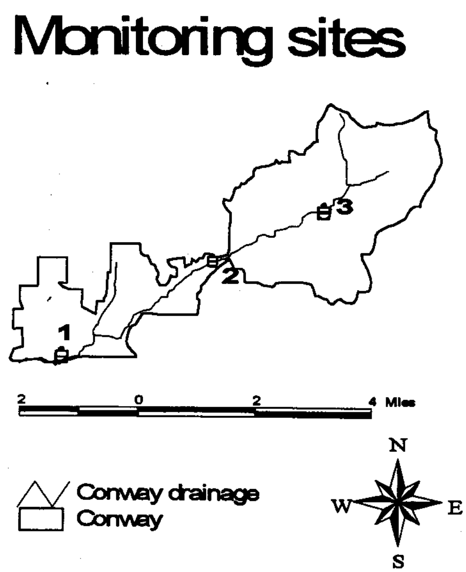
To initiate the PAM demonstration, landowners and operators were notified to participate in the demonstration. The District also supplied information about PAM application and other farm practices. The drain monitoring started on June 9 but very few farmers were irrigating at the time and the drain was unusually clear because of little irrigation. The demonstration was delayed a week to capture more typical irrigation and other farming activities.

Starting on June 16 through June 27, PAM was applied to many row crop fields before or during irrigation. The farmers either had previously acquired PAM through local suppliers or were provided PAM by the District before the demonstration started. One farmer did not have time to apply it, so SCC and NRCS staff applied granular PAM to the head end of his row cropped fields. This PAM was applied with a coffee cup, using about ½ cup per furrow, placed just below the siphon tubes or gated pipe gates in the corrugates.

The granular types of PAM used were Soilfix, Soil PAM, Soil Bond, and Superfloc. The only concentrated liquid PAM used was Pristine. Of the 26 farmers that applied PAM during the demonstration, 16 of them have used it in previous years. The surface irrigated row crops on which PAM was applied consisted of mostly beans, corn, and onions. The irrigated pasture, sprinkler-irrigated cropland, and fields with high residue crops such as wheat and alfalfa were not targeted for PAM application. However, some farmers applied PAM to their hay and grain crops in addition to their row crops.

Monitoring Methods

During the two weeks that PAM was applied by various means on surface irrigated fields, the Idaho Department of Agriculture monitored the gulch at three locations in the drain. Water monitoring occurred at each location at least 4 times a day. The individual samples were then shipped that same day for analysis. The monitoring station locations were the same the locations used by the Division of Environmental Quality in past monitoring so that a comparison could be made to past monitoring data. Chemical and physical parameters monitored were flow, suspended sediment, phosphorus, nitrogen, dissolved oxygen, temperature, conductivity, dissolved solids, and pH. This drain monitoring occurred on June 10, 17, 19, 24, and 26.



The ARS took samples on the June 12, 17, and 19 from the drain at each monitoring location and centrifuged the samples at the Black Canyon Irrigation District facilities. They were then analyzed for PAM at the Kimberly ARS center later. The SCC and the NRCS staff checked field runoff for flow, sediment, nutrients and PAM. Flow rates were taken at all field culverts entering the gulch along its entire length. Most of the field culvert locations were known because of the work done in the area through previous farm conservation work. Landowners also supplied additional information about any culverts hidden by vegetation and drain banks.

Samples of field runoff were taken directly from field culverts in plastic pint containers, which have sealed caps to ensure no contamination and stored in coolers during the sampling events. Within a few hours, many of the samples were checked for dissolved phosphorus using a HAC meter. A 5-gallon bucket and a stopwatch were used to determine flow rates at each field and drain culvert outflow. Most field culverts were easily reached and most runoff water filled the bucket in no less than a few seconds. Some drains and lateral spills entering the gulch were estimated because of the large volume of water. These larger drain and lateral flow rates did not seem to change much during the demonstration period.

Results

Very little PAM was detected from any of the fields and virtually no PAM detected in the gulch as shown in Table 2. One sample from the upper monitoring location contained about 0.6 ppm of PAM but was tracked back to a couple of bean fields being irrigated close by. PAM was generally applied at lower than the 10-ppm as recommended by the ARS. Many times the PAM was applied late in the irrigation set and was not very effective. When applied late, PAM only worked for a few hours after application before erosion began to occur.

Monitoring showed water quality in Conway Gulch to be better during the demonstration project than in the last 3 years of that same month. Gulch dredging in 1996, as well as higher than normal spring flows in 1997 may have also contributed to cleaner water during the demonstration period. It was noted that one or two eroding fields could impact the turbidity of the gulch and tremendously impair clarity. Sediment and phosphorus concentrations during the demonstration were near or below typical levels found in the month of June.

Very few fields were found to be severely eroding during the two-week period. In the lower watershed area near Notus, only two cornfields near Notus eroded at a substantial rate. These fields were treated with PAM later in the irrigation set but did not hold the sediment for very long because of the lateness of the application, the steepness of the fields, and the high irrigation runoff.

Table 2. Monitoring Results in Conway Gulch at Notus

Date	Flow (cfs)	Temp. (celcius)	Total P (mg/l)	Dissolved P (mg/l)	Suspended Sediment	Sediment (tons/day)
10-Jun	50.5	15.8	0.26	0.10	140	19.1
17-Jun	50.2	17.4	0.33	0.11	150	20.3
19-Jun	58.4	16.1	0.27	0.10	140	22.1
24-Jun	58.0	14.7	0.25	0.10	120	18.8
26-Jun	50.3	16.3	0.35	0.10	200	27.2

Date	PAM (ppm)	Field Inflow (total cfs)	Field Load (tons/day)	Field Dis. P (ave.mg/l)	Fields Irrigated	Fields with PAM used
10-Jun	0.0	no sample	no sample	no sample	no sample	no sample
17-Jun	0.0	26.3	25.0	0.41	60	19+
19-Jun	0.0	31.4	12.4	0.40	60	18+
24-Jun	no sample	29.6	69.0	0.13	53	21+
26-Jun	no sample	25.6	14.8	0.24	44	23+

Where any erosion was taking place, the irrigator or manager was interviewed to determine when PAM had been applied. It was consistently found that when a field was eroding, it was due to too little PAM applied or application occurred later after the irrigation water was set. Irrigators often have many fields to irrigate in one day and many other responsibilities that take time away from water management. They often found it difficult to get the PAM applied correctly when automatic applicators were not used. Most of the PAM applied directly to the head end of the furrows consisted of as little as one tablespoon per corrugate.

One farmer had PAM applied at the upper, middle, and end of a field. Erosion control did not seem any better than with the same total quantity applied at the upper end. Achieving good application timing is difficult for the irrigators and may not be a priority with all of their other responsibilities. Any fields found to be eroding, imhoff cone samples were taken, reading soil loss in ml/l, and flow rates in cfs to calculate tons/acre/irrigation eroded. PAM seems effect sediment loss calculations with the imhoff cone because of sediment flocculation.

Imhoff cone measurements may show greater soil loss with PAM applied to a field than what is actually eroded. The PAM seems to alter the soil settling and create additional space around the soil particles, giving greater soil loss estimates.

Problems encountered during the demonstration were few, but getting a clear picture of total drain inflow was difficult. The five-gallon bucket and stop watch were the most appropriate tools for determining field outflows at most sites except ten. Flow rates at these ten sites were estimated. All measured and estimated flow rates were subtracted out of the drain flow rates to quantify ground water contributions. One half of the flow seemed to come from ground water recharge as shown in.

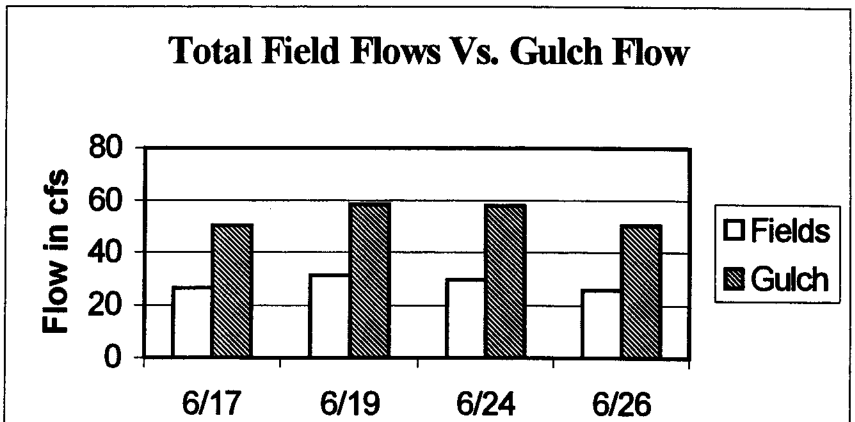


Figure 3 Flow Rates

The Black Canyon Irrigation District had cleaned the entire drain in 1996. The dredged soil was laid on the side of the drain, away from flowing water. The bottom of the drain is generally stable and because of the impervious soil layers found in the area. Grasses and leafy vegetation grow along the sides of the drain, stabilizing the banks along most reaches of the drain. By cleaning the drain in such a way, the drain does not continue to erode and impact the drain with sediment.

Summary

PAM is a very effective tool in reducing erosion if used correctly and with other conservation practices. It did not appear to negatively impact water quality in the Conway Gulch under the current PAM application management. It appears that the majority of the PAM is applied at rates less than what is recommended by the ARS.

Most of the excessive erosion seems to be caused mostly by poor water management. PAM and other conservation practices can help reduce erosion and sedimentation, but poor water management will reduce these practices' effectiveness on erosion control.

Ground water contributions seem large, possibly contributing half of the total outflow in Conway Gulch during the month of June. Additional studies need to be done to determine actual ground water contributions throughout the year

Field erosion rates were low during the demonstration period and the water clarity in the drain was good. Towards the end of the demonstration period, water turbidity began worsen because of bean irrigation. It was also noted that one or two erosive fields can tremendously impact turbidity.

Conclusions

It is best to apply PAM in solution or with an automatic applicator directly into the irrigation water. Applying it right before or just after setting the irrigation water is very important. The PAM amount needed for adequate erosion control is variable. It is extremely important to adjust the amounts and application method to the irrigation water quality and field conditions. PAM types also may be a factor in erosion control, as some products seem to have greater effects on erosion than others. Where there are high inflow rates or accidental ditch breaks, additional conservation measures are needed to reduce erosion and sedimentation. Sediment ponds, pump-back ponds, drip irrigation systems, surge irrigation systems, and sprinkler irrigation systems are some of the best erosion control and sedimentation practices.

Water management is critical for erosion control, with or without PAM application. Irrigators need to be applying PAM correctly to obtain best sediment control. Granular PAM quantity needs increased when applied directly in corrugates. A substantial amount of PAM may be wasted when it was applied late in the irrigation set. PAM applied late may slow erosion for an hour or so, but will not hold the soil throughout the irrigation period. Pam needs to be part of the initial watering front in order to react with the soil and reduce erosion throughout the irrigation period

Acknowledgments

The Canyon Soil Conservation District would like to thank the following agency staff and participants for contributing a great amount of work and time to this demonstration and apologizes for anybody missed:

- David F. Ferguson, SCC
- John Gleim, NRCS
- Jim Schmollinger, NRCS
- Scott Koberg, Volunteer, NRCS
- Peter Sinclair, NRCS
- Jan Tuma, NRCS
- Don Monteith, NRCS
- Tim Stieber, University of Idaho
- Rodrick Lentz, Ph.D., ARS
- Robert Sojka, Ph.D., ARS
- Kirk Campbell, ISDA
- George W. Davis, CSCD
- Lori Kent, CSCD
- Lorraine Mann, SCD
- Roy Orr, Black Canyon Irrigation District
- Jason Radford, UAP Northwest
- Bob Huzinga, Wilbur-Ellis
- Marvin Miller, Integrated Biological Systems
- Dave Bowers, Cyanamid
- Richard Cole, Allied Colloids
- Leonard Andrew, farmer
- Jim Bailey, farmer
- Dennis Batie, farmer
- Delmar Billings, farmer
- Paul Braun, farmer
- William Brock, farmer
- Allen Brock, farmer
- Leonard Burris, farmer
- Sam Burris, farmer
- Donald A. Caldwell, farmer
- Donald F. Caldwell, farmer
- Orville Evans, farmer
- Dennis Evans, farmer
- Sid Freeman, farmer
- Loren Freeman, farmer
- Robert Goodell, farmer
- Mike Goodell, farmer
- Larry Green, farmer
- Bob Hultz, farmer
- Charles Javaux, farmer
- Curt Krantz, farmer
- Dennis Lammey, farmer
- Ronald Lammey, farmer
- J. A. Marchbanks, farmer
- Nathan McKinney, farmer
- Brian Smith, farmer
- Roland Suess, farmer