SPECIAL WATER QUALITY SURVEY OF THE PECOS AND GALLINAS RIVERS BELOW THE VIVEASH AND MANUELITAS FIRES

2000

Photo courtesy of Sarah A. Frazier

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for
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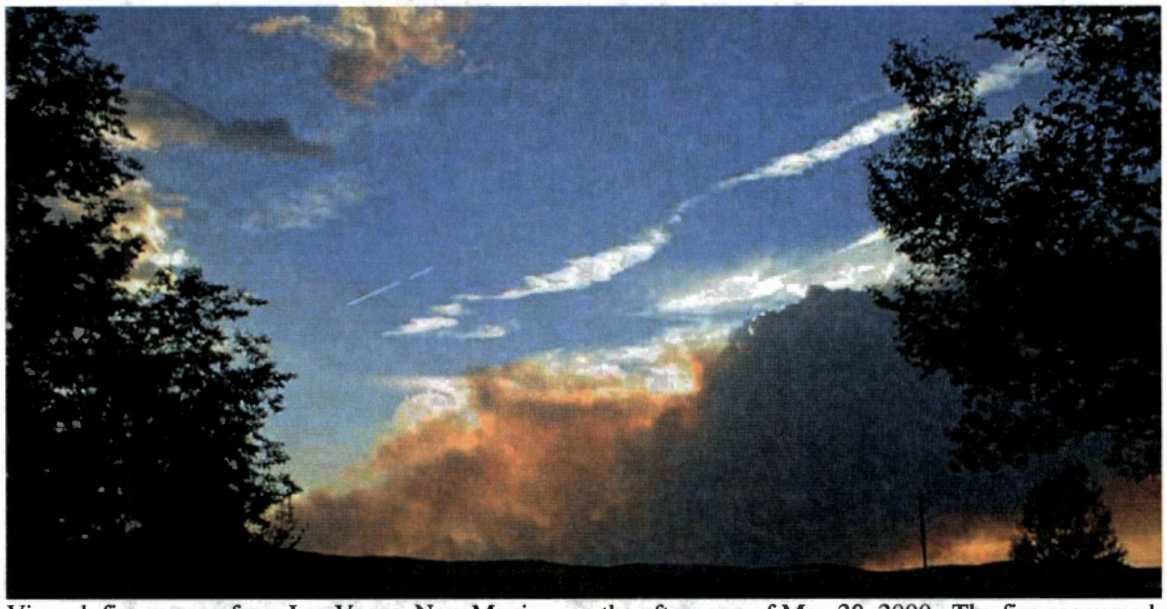

The Viveash fire as seen from Las Vegas, New Mexico, on the afternoon of May 30, 2000. The fire consumed 20,000 acres on that day. Photo courtesy of Sarah A. Frazier.

Abstract

Subsequent to the 29,000 acre Viveash wildfire (See map, Figure 1), staff of the Surface Water Quality Bureau of the New Mexico Environment Department conducted water quality studies of the Pecos and Gallinas rivers downstream of the Viveash fire. The Viveash fire did extensive damage to the Cow Creek watershed in the south central Sangre de Christo Mountains. Large quantities of ash, sediment and debris entered the Pecos River from Cow Creek, potentially destabilizing the Pecos system. The initial sampling run was conducted in response to citizen complaints of fish kills and black, ash-laden water. Of particular concern was recently received information indicating that sodium ferrocyanide ($Na_4Fe(CN)_6 \cdot 10\ H_2O$) (MSDS, 2001) may have been a constituent of the fire retardant slurry used to combat this fire (Little and Calfee, 2000). Additional water samples were taken at selected locations below the Manuelitas fire, again in response to citizen complaints. Sampling efforts were coordinated, to the extent possible, with runoff events from the watersheds of interest.

This report is not intended to be an exhaustive examination of the data, but rather a brief review of the available information. More detailed data sets will be developed in the course of the 2001 intensive water quality survey of these watersheds.

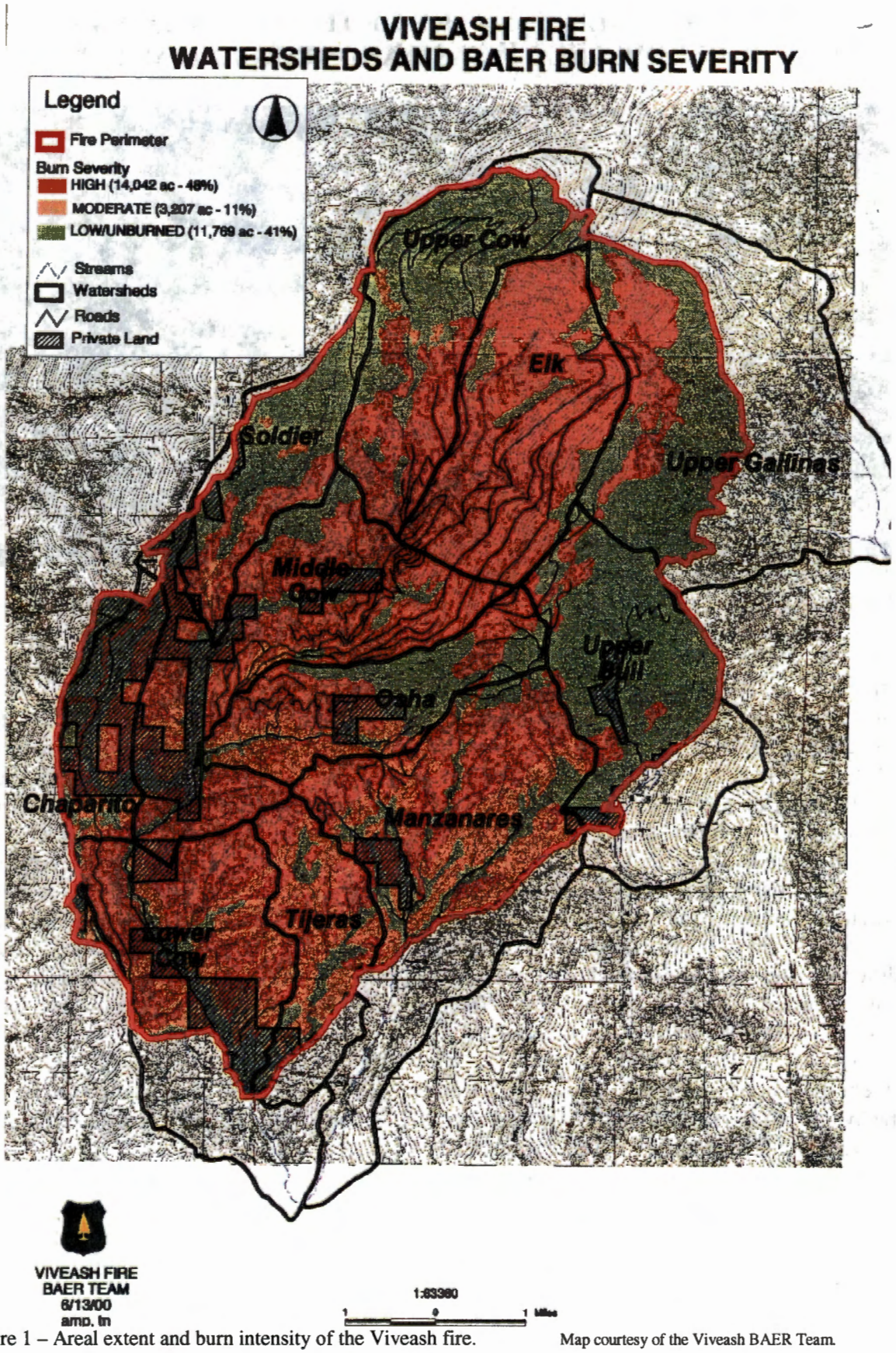

Figure 1 – Areal extent and burn intensity of the Viveash fire. Map courtesy of the Viveash BAER Team.

Introduction

Catastrophic wildfires have a devastating effect on aquatic ecosystems. High concentrations of ash and sediment washing off the denuded, hydrophobic landscape effectively exterminate most, if not all, aquatic life. The potential presence of cyanide (CN^-) compounds in the runoff at the time of sampling was a matter of considerable concern. Sodium ferrocyanide is added to fire retardants as an anticorrosive agent, counteracting effects of highly corrosive ammonium and phosphate compounds that are used as the actual fire suppressants (Little and Calfee, 2000). Compared to many other cyanide compounds, sodium ferrocyanide is not particularly toxic (MSDS, 2001; Moore, 1990) The CN^- anions are complexed with the sodium/iron molecule and are not biologically available. On exposure to ultraviolet radiation from sunlight, or extreme temperatures however, sodium ferrocyanide has been shown to release CN^- ions leading to the formation of hydrogen cyanide (HCN) (Little and Calfee, 2000). Aquatic organisms are especially susceptible to cyanide toxicity (Moore, 1990), and it is possible that any survivors of the ash flows and subsequent high sediment loadings succumbed to cyanide poisoning.

Due to limited resources, chemical analyses were restricted to reaches downstream of burned areas. The Pecos River was sampled at a newly established station just upstream from Interstate 25, below the confluence with Cow Creek, which drains the southern end of the area burned by the Viveash fire. Streamside measurements were taken at an existing station on the Pecos River above State Highway 63 bridge near the north end of the Village of Pecos. Because of municipal water supply, irrigation and primary contact concerns on the Gallinas River, samples were drawn at several locations situated to define contamination levels at relevant locations in that watershed. No above-impact comparison stations were established on the Gallinas River because the Viveash fire entered the watershed in its uppermost reaches.

In addition to sampling conducted in watersheds draining the Viveash burn area, samples were taken at three locations receiving runoff from areas affected by the smaller, but no less intense, Manuelitas fire. The Manuelitas fire samples were obtained from two stock ponds and a spring in arroyos receiving runoff from the east flank of the burned area. Both ponds had accumulated heavy deposits of ash. On the initial visit (July 21, 2000), the upslope pond showed no evidence of life: there was no sign of insects, fish or amphibians. Swallows, which are obligate insectivores, were conspicuously absent from the area. The lower pond, in contrast, appeared to support a normal fauna. The spring was selected for sampling because a dog belonging to a local resident had been found dead in the spring shortly after the fire.

Several accounts of livestock deaths were received after the Manuelitas fire. Of these, only one producer is known to have invested in autopsies. The attending veterinarian determined that the mortalities were due to pulmonary edema attendant to smoke inhalation. (Ben Nelson, DVM, pers. com.). Cyanide toxicity was not indicated by the findings of the autopsies.

Stations	STORET	Lat/Long
Pecos River above State Highway 63	UPR084	35.5872/-105.6739
Pecos River above I-25	--	35.4027/-105.4756
Gallinas River at end of F.R.263	UPR212.002530	35.7236/-105.1083
Gallinas River at USGS gage,	HP34	35.6519/-105.3183
Gallinas River at Storrie diversion	--	35.6535/-105.2406
Ortiz pond 1	--	35.7819/-105.2647
Ortiz pond 2	--	35.7809/-105.2602
Ortiz spring	--	35.7832/-105.2634

Water Quality Standards

Applicable general standards for the protection of designated and attainable uses are set forth at 20 NMAC 6.1.1105 (2/23/2000). Segment-specific standards and designated uses are listed at 20 NMAC 6.1.2213 for the Pecos River above I-25. Designated uses for segment 2213 include irrigation, livestock watering, wildlife habitat, marginal coldwater fishery and secondary contact. Segment specific standards and designated uses are listed at 20 NMAC 6.1.2214 for the Pecos River above State Highway 63. Designated uses for segment 2214 include domestic water supply, fish culture, high quality cold water fishery, irrigation, livestock watering, wildlife habitat and secondary contact. Segment specific standards and designated uses are listed at 20 NMAC 6.1.2212 for the Gallinas River at the USGS gage near Montezuma and the Gallinas River at the end of Forest Road 263. Designated uses for segment 2212 include domestic water supply, high quality cold water fishery, irrigation, livestock watering, wildlife habitat, municipal and industrial water supply and secondary contact. Segment specific standards and designated uses are listed at 20 NMAC 6.1. 2305.3 for the (reportedly) perennial Ortiz spring and other drainages in the area. Designated uses for segment 2305.3 include marginal coldwater fishery, warmwater fishery, secondary contact, irrigation, livestock watering and wildlife habitat. The State of New Mexico does not apply water quality standards to irrigation conveyances (Gallinas River at end of Storrie diversion). Numeric standards applicable to the attainable and designated uses assigned to the above segments are set forth at 20 NMAC 6.1.3100.

Methods

Water quality sampling methods were in accordance with the Quality Assurance Project Plan for Water Quality Management Programs (NMED, 2000), except that some water chemistry analyses that would normally be performed on whole water were performed on filtered water due to the nature of the sample matrix. Where turbidity exceeded 1,000 NTUs, values were estimated by dilution.

Water Quality Assessment

Measurements were taken of dissolved oxygen (DO), pH, specific conductance and turbidity at most stations on all sampling runs. Stations downstream of burned areas were sampled for nutrients (nitrate (NO_3), total ammonia (NH_3), total Kjeldahl nitrogen (TKN), total phosphorus (TP) and total organic carbon (TOC)); twelve ionic constituents (including chemical oxygen demand (COD)), and 27 metals in both the total and dissolved fractions. Water and sediment samples were collected for cyanide analyses at most stations. One sediment sample was taken for metals analysis.

On the first sampling run to the Pecos River (June 21, 2000), the water was black and smelled distinctly of smoke. During subsequent sampling efforts water color had changed to dark brown and the odor of smoke was not as evident. With the exception of the sampling effort on August 7, turbidity, TSS, TDS, TP, TKN, sulfate and COD were greatly elevated (see Table 4) in the Pecos River above I-25. Phosphorus concentrations appear to be related to turbidity as a measure of suspended sediment loading (see Figure 2). The standard for TDS (250 mg/L) was exceeded on June 21, June 28 and July 13. The standard for sulfate (25 mg/L) was exceeded on June 21 and June 28. While several metals were seen at elevated concentrations in the total fraction, notably mercury (see Table 2), only aluminum (dissolved chronic (87 µg/L)) and mercury (total chronic (12 ng/L)) exceeded standards in the Pecos River above I-25. No other metals exceeded the chronic or acute standards at that station. There were no metals exceedences of any kind on the Gallinas River (see Table 2).

The presence of mercury at 400 ng/L (ppt) in the Pecos River samples is problematic. Mercury did not appear in ashy samples – mercury is a gas at 300°C and would not be expected in samples containing high levels of ash. Once the ash had been replaced by a suspended solids load consisting primarily of mineral sediment however, mercury appeared in highly elevated concentrations. The source(s) of this mercury remains unexplained. Two theories have been put forth to account for these elevated levels of mercury; both remain entirely speculative. The first is that a substantial quantity of mercury was stored in one of the structures that was destroyed in the fire. The second is that mercury was drawn towards the soil surface by the heat of the fire, condensed there as the soil cooled and later washed out of the burned area as erosion cut deeper into the soil surface. Plans to try to isolate the source of this contaminant are being incorporated into the 2001 upper Pecos water quality study.

Cyanide was found in both water and sediment at the Pecos River above I-25 station (see Table 1), most of it probably bound to suspended sediments in water (see Figure 2). While some cyanide is produced naturally in wildfires (Yokelson,R. J., *et al.*, 1997), it is most likely that the cyanide found in the course of this survey was derived from fire retardant slurry. The degree of toxicity attributable to the levels of CN^- found in the Pecos River is difficult to determine. Free cyanide is acutely toxic to salmonids at concentrations ranging from 30 µg/L (ppb) to 160 µg/L, depending on species. Other species of freshwater fish are somewhat more tolerant (Moore, 1990). The above values were developed using free CN^-; the cyanide used in fire retardants is strongly bound to the sodium/iron complex and is therefore minimally biologically available. Moreover, bioavailability is further reduced by adsorption to fine particulates (see Figure 2). Concentrations seen in water were potentially high enough to elicit toxic reactions in aquatic life, but actual levels of free CN^- and HCN are not known. Observed levels were not high enough in water or sediment to produce toxicity in terrestrial organisms. It is unlikely that any aquatic life could have survived the exceedingly high concentrations of ash long enough to have succumbed to cyanide toxicity.

In an effort to provide comparison data to the Cerro Grande fire, samples were collected for radionuclides on two occasions (see Table 3). The initial sample (July 20, 2000) was a composite of Pecos and Gallinas river water. The second sample (August 7, 2000) was Pecos River water. No exceedences of radiological standards were found. In general, levels of radionuclides found below the Viveash fire were lower than those associated with the Cerro Grande fire (Ralph Ford-Schmid, NMED DOE Oversight Bureau, pers. com.).

Only one sampling run was conducted on the Gallinas River. On that day only one station (Gallinas R. at end of Forest Road 263) had ash deposits substantial enough to sample (see Figure 13). With the exception of trace amounts of cyanide (3.0 µg/L), no water quality parameters were found to be elevated. Despite finding the highest level of sediment cyanide (2,225 ug/kg) seen in the course of this investigation, the level of cyanide seen in whole water at the time of sampling was insufficient to kill aquatic organisms (see Table 1). Trout were observed feeding during the sampling effort, and a cursory examination of the benthic macroinvertebrate community revealed a diverse and healthy community structure. Water samples taken from the Gallinas River at the USGS gage near Montezuma and at the end of the Storrie diversion (CN^- only) yielded no water quality standards exceedences.

In response to citizen complaints of water quality problems, two sampling runs were conducted below the 1,300 acre Manuelitas fire. Three reports of discolored well water were received by the SWQB. Only two complainants responded to NMED efforts to sample their wells (an effort mounted by staff of the Ground Water Bureau) and of those two, only the first had a functional

well. The second well had been filled by sediments carried by runoff from the Manuelitas fire and no longer produced water. As stated above, the uppermost of a series of stock ponds appeared, on cursory inspection, to have been effectively sterilized. Bank-side ash deposits and aqueous cyanide levels indicate that conditions prior to the initial sampling effort were potentially antagonistic to the maintenance of aquatic life. The second pond in the series, while ringed with deposits of fine ash, showed no obvious signs of biologic impairment. Mosquitoes, chironomids (midges) and assorted odonates (dragon flies) were abundant, as were swallows. Frogs were heard calling. This pond is approximately 300 linear feet below the first, and the distinct difference between the two remains unexplained. It may be that the worst of the material from the initial flows washing off the burned area were trapped in the upper pond.

The owner of the property surrounding the two ponds reported that a dog belonging to one of his tenants had died unexpectedly and had been found in a spring rising in an arroyo draining the east face of the area affected by the Manuelitas fire. This spring, once clear and cold, was found to be yellow and turbid following the passage of several flash floods down the arroyo. A sample taken to test for cyanide showed no concentration of cyanide compounds at the time of sampling that could be considered dangerous to terrestrial vertebrates (see Table 1).

Conclusions

There are no tributaries involved in the Viveash fire between the Village of Pecos and Cow Creek. Fire-related inputs to the Pecos River must then have come from the Cow Creek drainage. Time and resource limitations allowed for only one visit to the Cow Creek watershed. During that visit (August 7, 2000) Cow Creek was found to have incised approximately two feet into the alluvium of the canyon floor (Figures 4 – 10). Extensive areas of recently exposed colluvial deposits were visible where the channel contacted the canyon wall. Many ephemeral tributary drainages had already begun to rejuvenate (head cut). No fish were observed during this visit. A cursory examination of the macro-benthic community indicated that benthic invertebrates had been completely extirpated. Deposits of ash and sediment were one to two meters deep in some low gradient areas below the burned area (see Figures 4, 6). It has been reported by staff of the Forestry Division of the New Mexico Energy, Minerals and Natural Resources Department that by fall of 2000, Cow Creek had cut its channel another two to three feet deep (Charlie Wicklund, pers. com.). Future runoff events and monsoon storms will almost certainly exacerbate this situation. It is reasonable to assume that where the channel is eroding the canyon wall there will be significant episodes of mass wasting in the unsupported colluvium, accompanied by extensive rejuvenation of existing side drainages (See Figure 7).

The sediment moving through Cow Creek has the potential to produce significant impacts in the Pecos River, both in terms of water quality and hydrology. Inputs of large quantities of bed load to the Pecos River channel will likely force channel adjustments as the river re-establishes equilibrium between its discharge, channel morphology and increased bed load. While in a state of disequilibrium, the Pecos River channel will likely undergo a period of widening to accommodate flow through a shallower thalweg. This widening will generate a reduction in sinuosity, (a measure of channel length relative to valley length). A reduction in sinuosity will increase the slope of the channel relative to the slope of the valley floor, generating, to a greater or lesser degree, an episode of down cutting. Local increases in gradient will move both up- and down stream, traveling until they meet a grade control such as bedrock or a diversion dam.

As the Pecos River below the Village of Pecos is already in a state of adjustment (disequilibrium), as indicated by many eroding, vertical banks (see Figure 11), the effects of additional sediment loading may be intensified. Channel adjustments can result in significant

losses of floodplain. Increases in mobile sediments can also have serious impacts on the irrigation infrastructure, damaging diversion works and filling conveyances with mud. It is conceivable that sediments mobilized during the period of re-adjustment will be of sufficient quantity to significantly reduce the storage capacity of Santa Rosa Reservoir.

The presence of relatively large quantities of mercury in Pecos River water poses an additional problem for Santa Rosa Reservoir and other impoundments downstream. Every major reservoir on the Pecos River mainstem is currently under a fish consumption advisory for mercury. The additional inputs of highly bio-accumulative mercury to these systems will most likely increase the levels of mercury in the tissues of fish in these reservoirs. The Surface Water Quality Bureau is developing plans to monitor fish tissue mercury concentrations and other contaminants in these reservoirs during the 2001 sampling season.

While there may be increases of turbidity in the Gallinas River due to the Viveash fire's encroachment into the upper watershed, it appears at this time that the damage was insufficient to cause the type of extreme impacts observed in the Cow Creek watershed (see Figures 5, 6, 7, 10 and 13). Some ash was mobilized and traveled through Las Vegas, but the massive quantities of ash and sediment seen in Cow Creek were not evident. Careful monitoring is called for, however. Surveys conducted by the Viveash fire Burned Area Emergency Rehabilitation (BAER) team determined that, while nearly 800 acres of the Gallinas watershed were heavily damaged (Robbie *et al.*, 2000), no drainages directly feeding the Gallinas River were seriously impacted.

There are no perennial tributaries impacted by the Manuelitas fire entering either Sapello or Manuelitas creeks. It is nevertheless likely that ash and sediment will continue to be entrained in runoff from the burned area for some time. The presence of stock ponds in most, if not all, of the arroyos draining the Manuelitas fire will serve to interdict much of the sediment before it can get to perennial waters.

Management of the aftermath of the Viveash and Manuelitas fires will fall primarily to staff of the Santa Fe National Forest. The Tierra y Montes Soil and Water Conservation District, the New Mexico State Forestry Division, the Natural Resources Conservation Service, the City of Las Vegas, NM and numerous private landowners are also active in rehabilitation efforts. The timeframe for a return to an equilibrium condition in the Cow Creek and Pecos River systems depends, to a considerable degree, on the extent and success of rehabilitation efforts. The longer a state of disequilibrium exists, the greater the costs of damage to property and the environment will be. It is critical that responsible agencies provide the resources and direction necessary to stabilize these burned watersheds.

Figure 2 - Comparison of Total Phosphorus vs Turbidity in Viveash Runoff, Summer 2000

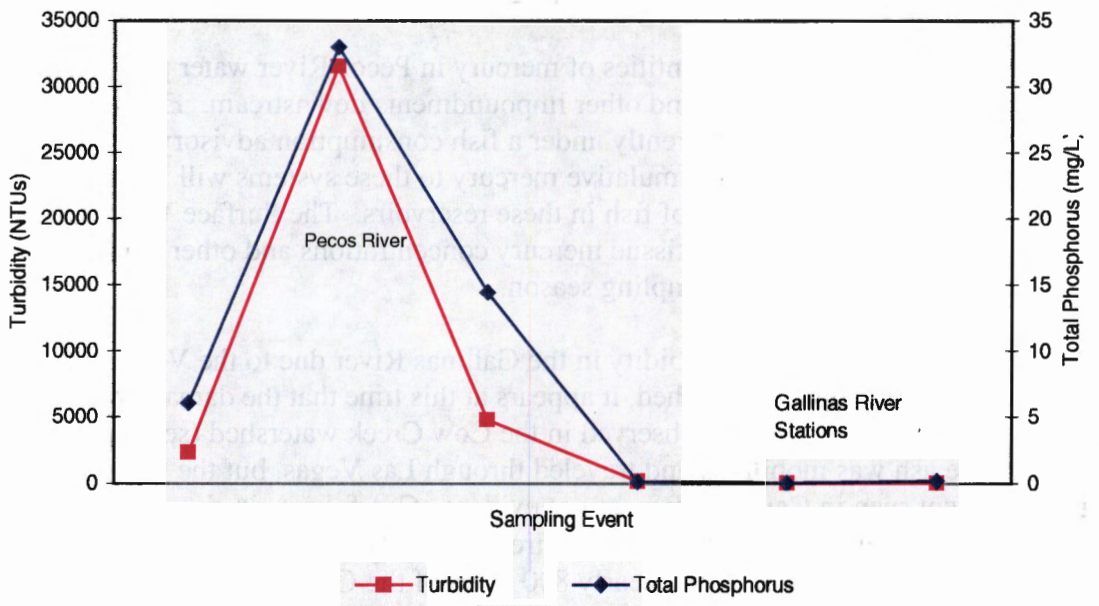

Figure 3 - Comparison of CN vs Turbidity in Viveash Fire Runoff, Summer 2000

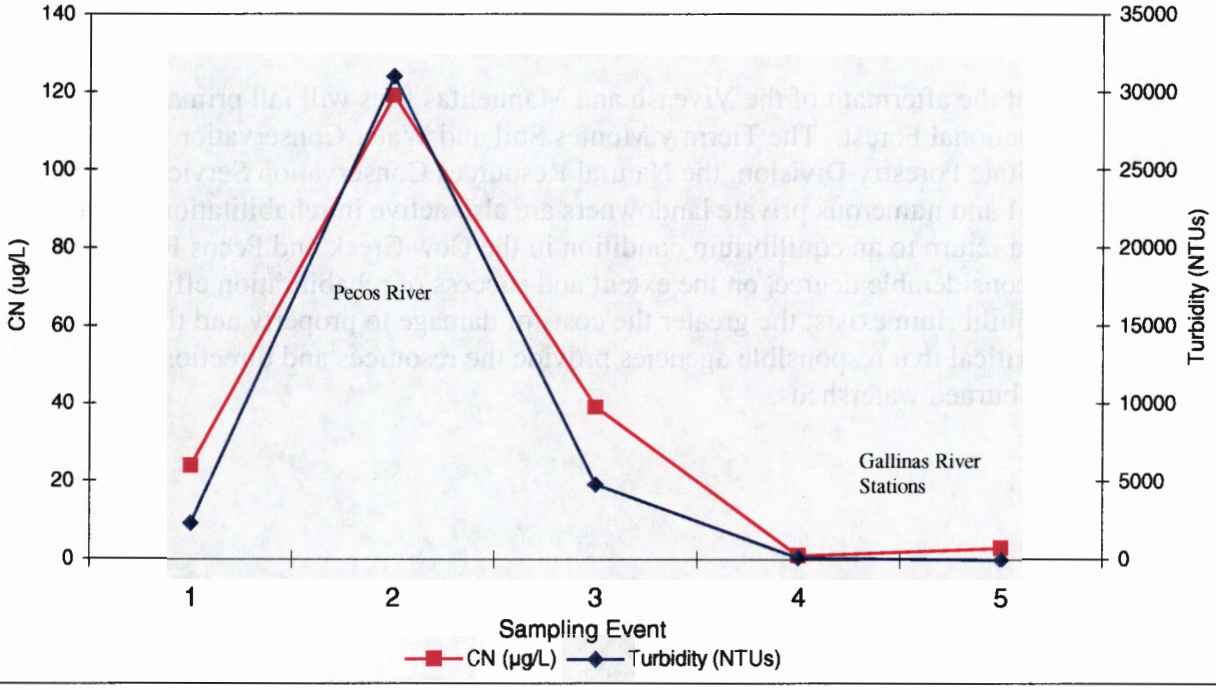

Figure 4 – Upper Cow Creek, June 2000. Photo courtesy of Charlie Wicklund, New Mexico Div. Of Forestry.

Figure 5 – Upper Cow Creek, June 2000. Photo courtesy of Charlie Wicklund, New Mexico Div. Of Forestry.

Figure 6 – Upper Cow Creek, June 2000. Photo courtesy of Charlie Wicklund, New Mexico Div. Of Forestry.

Figure 7 – Upper Cow Creek, June 2000. Rejuvenation of a side drainage. Photo courtesy of Charlie Wicklund, New Mexico Div. Of Forestry.

Figure 8 – Cow Creek in flood below Santa Fe National Forest. Photo courtesy of Charlie Wicklund, New Mexico Div. Of Forestry.

Figure 9 – Upper Cow Creek, June 2000. Severe erosion of low gradient uplands. Photo courtesy of Charlie Wicklund, New Mexico Div. Of Forestry.

Figure 10 – Upper Cow Creek, June 2000. Photo courtesy of Charlie Wicklund, New Mexico Div. Of Forestry.

Figure 11– Pecos River, June 2000. View down stream. Note vertical bank in background. Photo courtesy of Dan Davis, NMED.

Figure 12 – Pecos River, June 2000. View upstream. Note ash bar at left. Photo courtesy of Dan Davis, NMED.

Figure 13 – Gallinas River, June 2000. Note ash bar behind log. The banks are not eroding and there is no sign of flooding. Photo courtesy of John Tingle, US Army Corps of Engineers.

Table 1. Cyanide Concentrations in the Pecos River Watershed following the Viveash fire, Summer, 2000

Sample ID	Sample Location	Medium	Date	Time	CN Total µg/L	CN Amenable µg/L	CN WAD µg/L	Turbidity NTUs	TOC mg/L
	Pecos R. abv I-25	Water	06/21/2000	1230	24	24*	nd	2,300	14.3
	Pecos R. abv I-25	Water	06/28/2000	1045	119	119*	nd	31,000	5K
	Pecos R. abv I-25	Water	07/13/2000	1200	nd	nd	39*	4780	5K
	Pecos R. abv I-25	Water	08/07/2000	1030	nd	nd	1	130	5K
	Gallinas R. @ end FR 263	Water	07/20/2000	1150	nd	nd	3	6.76	5K
	Gallinas R. @ USGS Gage, Montezuma	Water	07/20/2000	915	nd	nd	5K	10.8	6.67
	Gallinas R. @ End of Storrie Diversion	Water	07/20/2000	1410	nd	nd	5K	15.8	nd
	Ortiz Pond # 1	Water	07/21/2000	930	nd	nd	6*	nd	nd
	Ortiz Spring	Water	07/21/2000	1015	nd	nd	2	nd	nd
					ng/g				
	Pecos R. abv I-25	Sediment	07/13/2000	1200	100				
	Pecos R. abv I-25	Sediment	08/07/2000	1030	737				
	Gallinas R. @ end FR 263	Sediment (ash)	07/20/2000	1150	2,250				
	Ortiz Pond # 1	Sediment (ash)	07/21/2000	930	880				
	Ortiz Pond # 2	Sediment	08/07/2000	1400	664				
UV 01	Upper Viveash - Cow Creek	Sediment	08/10/2000	nd	1,730				
UV 02	Upper Viveash - Cow Creek	Sediment	08/10/2000	nd	1,870				
UV 03	Upper Viveash - Cow Creek	Sediment	08/10/2000	nd	1,330				
UV 04	Upper Viveash - Cow Creek	Sediment	08/10/2000	nd	1600.00				
UV 05	Upper Viveash - Tijeras Cr.	Sediment	08/10/2000	nd	1800.00				

Remark Codes: K – less than; C – calculated; * - water quality standards exceedence; nd – no data / not done

Table 2 Metals Concentrations in the Pecos River Watershed following the Viveash fire, Summer, 2000

Pecos R. abv I-25
35.4027/-105.4756
35047 New Mexico San Miguel
NM-2203.A_00

Dissolved Metals

DATE	TIME	Medium	1106 Al Diss (µg/L)	1095 Sb Diss (µg/L)	1000 As Diss (µg/L)	1005 Ba Diss (µg/L)	1010 Be Diss (µg/L)	1020 Bo Diss (µg/L)	1025 Cd Diss (µg/L)	82036 Ca Diss (µg/L)	1030 Cr Diss (µg/L)	1035 Co Diss (µg/L)	1040 Cu Diss (µg/L)	1046 Fe Diss (µg/L)	1049 Pb Diss (µg/L)
06/21/2000	1230	Water	110*	1K	3	100K	1K	100K	1K	56,000	1K	1K	10K	100K	1K
06/28/2000	1045	Water	200*	1K	6	100	1K	100	1K	56,000	2	1K	50K	100	1K
07/13/2000	1200	Water	80	1K	3	100K	1K	100K	1K	49,000	1K	1K	50K	100K	1K
08/07/2000	1030	Water	70	1K	1K	100K	1K	100K	1K	44,000	1K	1K	10K	100K	1K

			82037 Mg Diss (µg/L)	1056 Mn Diss (µg/L)	1060 Mo Diss (µg/L)	1065 Ni Diss (µg/L)	1145 Se Diss (µg/L)	1140 Si Diss (µg/L)	1075 Ag Diss (µg/L)	1080 Sr Diss (µg/L)	1057 Tl Diss (µg/L)	1100 Sn Diss (µg/L)	22703 U-nat Diss µg/L	1085 V Diss (µg/L)	1090 Zn Diss (µg/L)
06/21/2000	1230	Water	6,000	95	2	10K	5K	3,900	1K	200	1K	100K	2	2	10K
06/28/2000	1045	Water	8,000	310	4	10K	5K	4,300	1K	300	1K	100K	3	5K	100K
07/13/2000	1200	Water	5,000	200	2	10K	5K	3,300	1K	200	1K	100K	3	3	10K
08/07/2000	1030	Water	4,000	16	1K	10K	5K	3,500	1K	200	1K	100K	1	2	10K

Remark Codes: K – less than; C – calculated; * - water quality standards exceedence; nd – no data / not done

Table 2, cont. Metals Concentrations in the Pecos River Watershed following the Viveash fire, Summer, 2000

Pecos R. abv I-25
35.4027/-105.4756
35047 New Mexico San Miguel
NM-2203.A_00

Total Metals

DATE	TIME	Medium	1105 Al Total (µg/L)	1097 Sb Total (µg/L)	1002 As Total (µg/L)	1007 Ba Total (µg/L)	1012 Be Total (µg/L)	1022 Bo Total (µg/L)	1027 Cd Total (µg/L)	82032 Ca Total (µg/L)	1034 Cr Total (µg/L)	1037 Co Total (µg/L)	1042 Cu Total (µg/L)	1045 Fe Total (µg/L)	1051 Pb Total (µg/L)	82033 Mg Total (µg/L)
06/21/2000	1230	Water	47,000	5K	20	1,200	5K	100K	5K	150,000	60	32	100	47,000	120	18,000
06/28/2000	1045	Water	200,000	5K	43	5,000	9	1000K	6	380,000	170	110	240	200,000	520	67,000
07/13/2000	1200	Water	83,000	10K	10K	2,400	10K	1000K	10K	260,000	70	70	80	74,000	200	26,000
08/07/2000	1030	Water	4,200	1K	2	100	1K	100K	1K	49,000	4	2	10K	4,000	7	5,000

			1055 Mn Total (µg/L)	71900 Hg Total (µg/L)	1062 Mo Total (µg/L)	1067 Ni Total (µg/L)	1147 Se Total (µg/L)	1142 Si Total (µg/L)	1077 Ag Total (µg/L)	1082 Sr Total (µg/L)	1059 Tl Total (µg/L)	1102 Sn Total (µg/L)	28011 U Total (µg/L)	1087 V Total (µg/L)	1092 Zn Total (µg/L)
06/21/2000	1230	Water	5,200	0.2K	5K	70	5K	62,000	5K	6000	5K	100K	5K	68	390
06/28/2000	1045	Water	17,000	0.4*	5K	210	5K	78,000	5K	1,600	5K	100K	19	280	970
07/13/2000	1200	Water	13,000	0.4*	10K	100	5K	90,000	10K	800	10K	100K	10K	100	700
08/07/2000	1030	Water	260	nd	1K	10K	5K	11,000	1K	200	1K	100K	1	8	20

Remark Codes: K – less than; C – calculated; * - water quality standards exceedence; nd – no data / not done

Table 2, cont. Metals Concentrations in the Pecos River Watershed following the Viveash fire, Summer, 2000

Pecos R. abv I-25
35.4027/-105.4756
35047 New Mexico San Miguel
NM-2203.A_00

Sediment Metals

DATE	TIME	Medium	Al Total (ug/g)	Sb Total (ug/g)	As Total (ug/g)	Ba Total (ug/g)	Be Total (ug/g)	Bo Total (ug/g)	Cd Total (ug/g)	Ca Total (ug/g)	Cr Total (ug/g)	Co Total (ug/g)	Cu Total (ug/g)	Fe Total (ug/g)	Pb Total (ug/g)	Mg Total (ug/g)
07/13/2000	1200	sediment	9,900	1K	1.7	120	0.5K	50K	0.5K	9,700	11	4.2	9	9,000	12	2,300

DATE	TIME	Medium	Mn Total (ug/g)	Hg Total (ug/g)	Mo Total (ug/g)	Ni Total (ug/g)	Se Total (ug/g)	Si Total (ug/g)	Ag Total (ug/g)	Sr Total (ug/g)	Tl Total (ug/g)	Sn Total (ug/g)	U Total (ug/g)	V Total (ug/g)	Zn Total (ug/g)
07/13/2000	1200	sediment	470	0.04K	0.5K	9	0.3	100	0.5K	26	0.5K	5K	0.9	14	37

Remark Codes: K – less than; C – calculated; * - water quality standards exceedence; nd – no data / not done

Table 2, cont. Metals Concentrations in the Gallinas River at end of Forest Road 263 following the Viveash fire, 2000

UPR212.002530
Gallinas R. @ End FR 263
35.7236/-105.1083
35047 New Mexico San Miguel
NM-2213_00

Dissolved Metals

DATE	TIME	Medium	1106 Al Diss (µg/L)	1095 Sb Diss (µg/L)	1000 As Diss (µg/L)	1005 Ba Diss (µg/L)	1010 Be Diss (µg/L)	1020 Bo Diss (µg/L)	1025 Cd Diss (µg/L)	82036 Ca Diss (µg/L)	1030 Cr Diss (µg/L)	1035 Co Diss (µg/L)	1040 Cu Diss (µg/L)	1046 Fe Diss (µg/L)	1049 Pb Diss (µg/L)
07/20/2000	1150	Water	30	1K	1K	100K	1K	100K	1K	32,000	1K	1K	50K	100K	1K

			82037 Mg Diss (µg/L)	1056 Mn Diss (µg/L)	1060 Mo Diss (µg/L)	1065 Ni Diss (µg/L)	1145 Se Diss (µg/L)	1140 Si Diss (µg/L)	1075 Ag Diss (µg/L)	1080 Sr Diss (µg/L)	1057 Tl Diss (µg/L)	1100 Sn Diss (µg/L)	22703 U-nat Diss µg/L	1085 V Diss (µg/L)	1090 Zn Diss (µg/L)
07/20/2000	1150	Water	2,000	70	1	10K	5K	4,900	1K	100K	1K	100K	1K	1K	10K

Remark Codes: K – less than; C – calculated; * - water quality standards exceedence; nd – no data / not done

Table 2, cont. Metals Concentrations in the Gallinas River at end of Forest Road 263 following the Viveash fire, 2000

UPR212.002530
Gallinas R. @ End FR 263
35.7236/-
105.1083
35047 New Mexico San Miguel
NM-2213_00

Total Metals

DATE	TIME	Medium	1105 Al Total (µg/L)	1097 Sb Total (µg/L)	1002 As Total (µg/L)	1007 Ba Total (µg/L)	1012 Be Total (µg/L)	1022 Bo Total (µg/L)	1027 Cd Total (µg/L)	82032 Ca Total (µg/L)	1034 Cr Total (µg/L)	1037 Co Total (µg/L)	1042 Cu Total (µg/L)	1045 Fe Total (µg/L)	1051 Pb Total (µg/L)	82033 Mg Total (µg/L)
07/20/2000	1150	Water	380	1K	5K	100K	1K	100K	1K	31,000	2	1K	50K	300	4	3,000

DATE	TIME	Medium	1055 Mn Total (µg/L)	71900 Hg Total (µg/L)	1062 Mo Total (µg/L)	1067 Ni Total (µg/L)	1147 Se Total (µg/L)	1142 Si Total (µg/L)	1077 Ag Total (µg/L)	1082 Sr Total (µg/L)	1059 Tl Total (µg/L)	1102 Sn Total (µg/L)	28011 U Total (µg/L)	1087 V Total (µg/L)	1092 Zn Total (µg/L)
07/20/2000	1150	Water	120	0.2K	1	10K	5K	5,500	1K	100K	1K	100K	1K	5K	10K

Remark Codes: K – less than; C – calculated; * - water quality standards exceedence; nd – no data / not done

Table 3 Radionuclide Concentrations in the Pecos and Gallinas watersheds following the Viveash fire, 2000

Station	Date	Time	Medium	-- G-Alpha Am-241 pCi/L	-- Sigma	80029 G-Alpha U-nat pCi/L	1502 Sigma	-- G-Beta Cs-137 pCi/L	-- Sigma	80049 G-beta Sr/Y-90 pCi/L	3502 Sigma
Viveash Composite	07/20/2000	NA	Water	2	0.6	2.5	0.7	7.3	1	7.1	0.9
Pecos abv I - 25	08/07/2000	1030	Water	5.2	0.8	6.6	1.1	9.4	1	9.1	1

Station	Date	Time	Medium	22606 U - 234 Alpha Spec. pCi/L	22607 Sigma	22601 U - 238 Alpha Spec. pCi/L	22602 Sigma	22012 Pu - 238 Alpha Spec. pCi/L	22013 Sigma	-- Pu - 239+240 Alpha Spec. pCi/L	-- Sigma
Viveash Composite	07/20/2000	NA	Water	0.78	0.06	0.42	0.04	-0.01	0.01	-0.04	0.02
Pecos abv I - 25	08/07/2000	1030	Water	1.12	0.08	0.54	0.04	0	0.01	-0.04	0.02

Station	Time	9501 Ra-226 total pCi/L	9502 Sigma	11501 Ra-228 total pCi/L	11502 Sigma	11503 Ra 226 + 228 total pCi/L	11504 Sigma	11504 Ra 226 + 228 error	-- Am - 241 Alpha Spec. pCi/L	-- Sigma
Viveash Composite	N/A	0.18	0.04	1.2	0.3	1.38	0.34	0.03	0	0.03
Pecos abv I - 25	1030	0.28	0.02	0.65	0.15	0.93	0.17	0.15	0.08	0.03

Remark Codes: K – less than; C – calculated; * - water quality standards exceedence; nd – no data / not done

Table 3, cont Radionuclide Concentrations in the Pecos and Gallinas watersheds following the Viveash fire, 2000

Station	Date	Time	Medium	-- K - 40 Gamma Spec. pC/L	-- Co - 60 Gamma Spec. pC/L	-- Zn - 65 Gamma Spec. pC/L	-- Cs - 134 Gamma Spec. pC/L	-- Cs - 137 Gamma Spec. pC/L	-- Mn - 54 Gamma Spec. pC/L	-- Sb - 125 Gamma Spec. pC/L	-- Eu - 152 Gamma Spec. pC/L
Viveash Composite	07/20/2000	NA	Water	60K	3.9K	8K	3.2K	3.6K	3.8K	10K	6.6K
Pecos abv I - 25	08/07/2000	1030	Water	56K	3.8K	7.8K	3.5K	3.9K	3.5K	9.3K	6.6K

Station	Date	Time	Medium	-- Eu - 154 Gamma Spec. pC/L	-- Th - 234 Gamma Spec. pC/L	-- Pb - 214 Gamma Spec. pC/L	-- Bi - 214 Gamma Spec. pC/L	-- Pb - 210 Gamma Spec. pC/L	-- Ac - 228 Gamma Spec. pC/L	-- Pb - 212 Gamma Spec. pC/L	-- Bi - 212 Gamma Spec. pC/L
Viveash Composite	07/20/2000	NA	Water	4.6K	44K	7.8K	7.6K	60K	15K	6.6	52K
Pecos abv I - 25	08/07/2000	1030	Water	4.7K	45K	7.7K	7.9K	59K	15K	6.5K	51K

Station	Date	Time	Medium	-- Tl - 208 Gamma Spec. pC/L
Viveash Composite	07/20/2000	NA	Water	3.8K
Pecos abv I - 25	08/07/2000	1030	Water	3.8K

Remark Codes: K – less than; C – calculated; * - water quality standards exceedence; nd – no data / not done

Table 4 Water Chemistries in the Pecos and Gallinas Watersheds following the Viveash Fire, 2000

STATION	DATE	TIME	Medium	10 Water Temp (C)	95 Spec Cond (uhmo)	300 DO (mg/L)	400 pH Field (S.U.)	82079 Turb Field (NTU)	665 Total P (mg/L)	630 Nitrate + ite N (mg/L)	610 Total NH3 (mg/L)	640 T I N 630 + 610 (mg/L)	625 Kjeldahl N (mg/L)	605 T O N 625 - 610 (mg/L)	600 Total N 640 + 605 (mg/L)	680 Total Org C (mg/L)
Pecos R. abv I-25	6/21/00	1230	Water	21	315	6.48	8.10	2300	6.06	0.1K	0.1K	0.2KC	12.5	12.4LC	12.6KC	14.3
Pecos R. abv SR 63	6/21/00	1330	Water	20.5	205	7.20	8.26	2.17								
Pecos R. abv I-25	6/28/00	1045	Water	18.8	336	5.28	7.66	31560	33	0.127	0.693	0.82C	102	101.31C	102.13C	5K
Pecos R. abv SR 63	6/28/00	1130	Water	18.7	221.5	7	8.17	8.27								
Pecos R. abv I-25	7/13/00	1045	Water	18.7	255.6	7.86	6.9	4780	14.4	0.1K	0.268	0.368KC	49.2	48.93C	49.3KC	5K
Pecos R. abv SR 63	7/13/00	1200	Water	18.1	192	8.77	7.39	1.26								
Pecos R. abv I-25	8/7/00	1030	Water	20.3	243.3	7.27	8.00	130	0.163	0.1K	0.1K	0.2KC	0.206	0.106LC	0.306KC	5K
Gallinas @ Gage	7/20/00	0915	Water	14.2	190	8.42	8.24	10.8	0.05K	0.1K	0.1K	0.2KC	0.3	0.2LC	0.2KC	5.29
Gallinas @ FR 263	7/20/00	1150	Water	12.4	176.8	7.88	8.31	6.76	0.2	0.1K	0.1K	0.2KC	0.4	0.3LC	0.5KC	5K

STATION	DATE	TIME	70300 TDS (mg/L)	530 TSS (mg/L)	900 Total Hardness (mg/L)	915 Ca (mg/L)	925 Mg (mg/L)	935 K (mg/L)	930 Na (mg/L)	410 Alk (mg/L)	440 Bicarb (mg/L)	445 CO3 (mg/L)	940 Chloride (mg/L)	946 Sulfate (mg/L)	COD (mg/L)
Pecos R. abv I-25	6/21/00	1230	286*	1470	164	56.3	5.76	5K	5K	318	388	0	10K	26.4*	98
Pecos R. abv SR 63	6/21/00	1330													
Pecos R. abv I-25	6/28/00	1045	356*	5090	193	62.7	8.86	10.2	5K	402	491	0	10K	32*	76.6
Pecos R. abv SR 63	6/28/00	1130													
Pecos R. abv I-25	7/13/00	1045	352*	7310	175	60.5	5.73	6.98	5K	565	689	0	10K	15.8	49
Pecos R. abv SR 63	7/13/00	1200													
Pecos R. abv I-25	8/7/00	1030	202	107	128	44.5	4	5K	5K	122	147	1.92	10K	13.5	5K
Gallinas @ Gage	7/20/00	0915	172	8	96.4	33.8	2.95	5K	5K	84.2	101	1.44	10K	10K	
Gallinas @ FR 263	7/20/00	1150	164	15	90.1	31.6	2.71	5K	5K	76.6	93.5	0	10K	10.8	

Remark Codes: K – less than; C – calculated; * - water quality standards exceedence; nd – no data / not done

UNITS

mg/L	milligrams per liter	parts per million (ppm)
µg/L	micrograms per liter	parts per billion (ppb)
ng/L	nanograms per liter	parts per trillion (ppt)
mg/g	milligrams per gram	parts per million (ppm)
ng/g	nanograms per gram	parts per billion (ppb)
pC/L	picoCuries per liter	2.22 disintegrations per minute

REMARK CODES

Remark codes are Legacy STORET or SWQB data qualifiers.

K – less than
L – greater than
J – estimated
Q – exceeded holding time
*- standards exceedence
nd – no data

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