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GROUND-WATER GEOCHEMISTRY POJOAQUE PUEBLO, NEW MEXICO

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Cover Artwork A butterfly symbolizes the re-emergence of the Pueblo of Pojoaque in 1932 as a sovereign and culturally distinct entity after more than two centuries of dormancy.

EXECUTIVE SUMMARY

Northern Santa Fe County has long been known for indoor radon problems. Radon is a radioactive by-product of uranium decay. In 1995, the New Mexico Environment Department (NMED) discovered a number of private wells in the area contaminated with uranium exceeding the proposed U.S. Environmental Protection Agency (EPA) drinking-water standard of 20 parts per billion (ppb). The source of uranium is natural mineral deposits in the Tesuque Formation. Mutually concerned about this problem, the Pueblo of Pojoaque (PoP)[1] received an EPA grant to fund NMED to perform a geochemical investigation.

Water produced by the eight PoP-owned supply wells sampled is generally of excellent quality, containing little or no uranium. All other constituents, except for fluoride in one well, are within EPA primary drinking-water standards. Five PoP wells had pH values greater than the secondary standard of 8.5. These waters can be corrosive to metallic plumbing material and may cause lead to leach into drinking water. A testing program for lead in the PoP water-distribution system is recommended. PoP wells, generally 500' deep or deeper, seem protected from uranium deposits leaching into the shallow aquifer and from other near-surface sources of contamination.

Nine of 18 private wells tested within the Pojoaque Pueblo checkerboard area "checkerboard wells", however, contain uranium in excess of 20 ppb. Two wells contain 900 ppb uranium, the highest naturally-occurring levels in a drinking-water source anywhere in New Mexico. Uranium-excessive wells are shallow (200' deep or less) relative to deeper PoP wells. Uranium in drinking water can cause kidney disease and an increased lifetime risk of cancer.

One PoP well and two checkerboard wells contained fluoride at levels (eg. 13.1 mg/L) exceeding the drinking water standards of 2 mg/L (secondary) and 4 mg/L (primary). Fluoride in drinking water can be assimilated into teeth and bones. Fluoride exceeding 2 mg/L can cause dental fluorosis, resulting in mottling of teeth. Fluoride exceeding 4 mg/L can cause skeletal fluorosis, causing weakening of the bones.

Pojoaque Pueblo is in a region of demonstrated vulnerability to ground-water contamination from septic tanks and other near-surface sources. Elevated nitrate and chloride were detected in one private well indicating septic-tank contamination.

The water-quality problems encountered by checkerboard wells could migrate and someday affect existing PoP wells or could be encountered by new PoP wells drilled in the future. Sampling of additional checkerboard wells and creation of a long-term monitoring network are recommended.

A Health Advisory regarding potential water-quality problems in this region is attached as Appendix A. All checkerboard wells in the area should be tested for uranium, fluoride, nitrate and pH. Well users with excessive uranium, fluoride or nitrate are advised to consider either an appropriate water-treatment unit or an alternate source of drinking water. Well users with pH greater than 8, and lead, copper or galvanized plumbing, should test for lead. All homes in the area should be tested for indoor radon.

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[1]For the purpose of this report, "Pueblo of Pojoaque" refers to the Pueblo government. The term "Pojoaque Pueblo" refers to the area within the rectangular external Pueblo boundary including privately owned "checkerboard" areas.

INTRODUCTION

Northern Santa Fe County, particularly near Pojoaque and Nambe, has long been known for indoor radon problems. Radon is a radioactive by-product of uranium decay. In 1995, NMED discovered a number of private domestic wells in the area contaminated with uranium in excess of the proposed EPA drinking-water standard of 20 ppb. A NMED investigation determined that the uranium was of natural origin and very widespread (McQuillan and Pine, 1995). Of 72 checkerboard wells tested in the region, 37 (52%) contained uranium exceeding 20 ppb, including nine of 18 (50%) located within Pojoaque Pueblo. NMED and the N.M. Department of Health issued a Health Advisory in 1995 warning area residents of the problem and providing advice to those affected. A revised Health Advisory is attached as Appendix A.

NMED and PoP have a long history of cooperation and mutual effort to study water quality and abate problems. Mutually concerned about the uranium problem, NMED and PoP entered a Joint Powers Agreement in 1997 (Appendix B). PoP received an EPA grant to fund NMED to perform a geochemical investigation on Pojoaque Pueblo. This report presents the investigation results.

GEOLOGIC SETTING

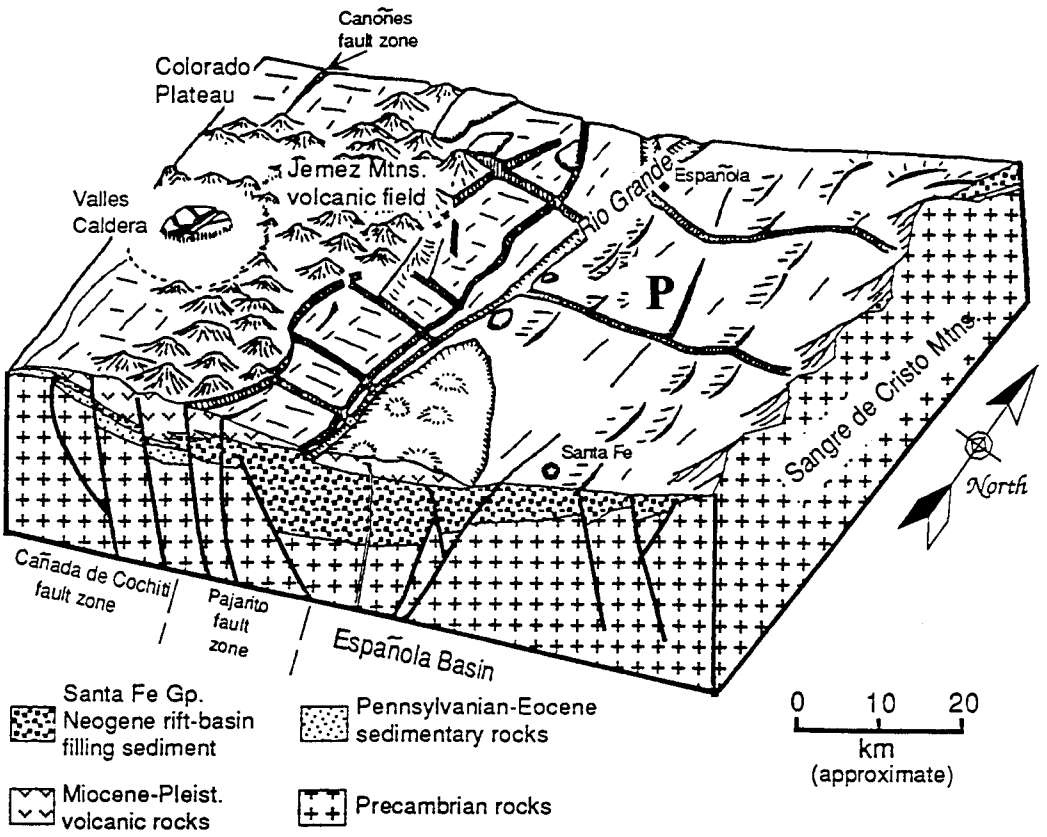
Pojoaque Pueblo is located on the east limb of the Espanola Basin, an asymmetric west-tilting graben (Figure 1). The Basin is bounded by Precambrian uplifts on the east and west, and is connected to other basins of the Rio Grande Rift on the north and south (Figure 2). The Pueblo is underlain by the Miocene Tesuque Formation. Quaternary alluvium overlies the Tesuque along the Pojoaque and Tesuque Rivers and along tributary arroyos.

Tesuque sediments dip westward in the Pueblo area between 5 to 22° and have been displaced by several north-south trending normal faults. The Tesuque consists of three Members the oldest of which, Nambe, a coarse-grained to conglomeratic arkosic unit, crops out east of the Pueblo. The eastern Pueblo area contains the middle Skull Ridge Member, a fine to medium grained sandstone interbedded with minor mudstone and volcanic ash. The ash beds are in various stages of alteration, and some have been completely devitrified. The Skull Ridge bears late Miocene fossils of vertebrate animals. The central and western Pueblo areas contain the upper Pojoaque Member, fine to medium grained sandstones interbedded with considerable mudstone and some gravel. Some Tesuque sandstones and conglomerates contain low-grade peneconcordant uranium deposits occurring as mineral coatings. (Baltz, 1978; Galusha and Blick, 1971; Golombek et al., 1983; Hilpert, 1965; Kelley, 1978; Kottlowski, 1995; Manley, 1978)

REGIONAL GROUND-WATER CONDITIONS

Ground water occurs in unconfined conditions in both the alluvium and in shallow Tesuque units. Confined aquifers occur deeper in the Tesuque. The saturated thickness of the Tesuque increases from about 1500 feet in the eastern Pueblo area to about 3000 feet in the west. Ground water flows west to northwest across the Pueblo with a hydraulic gradient of approximately 0.01 to 0.02 (Figure 3). (Mourant, 1980; Lewis and West, 1995)

Dominant ground-water ions are sodium-bicarbonate to sodium-bicarbonate-sulfate in the vicinity of Pojoaque Pueblo, while calcium-bicarbonate is dominant in Chimayo, Cundiyo and



P Pojoaque Pueblo

Figure 1. Block diagram illustrating the general structure and stratigraphy of the Espanola Basin (Kottlowski, 1995, as modified from Golombek et al., 1983)

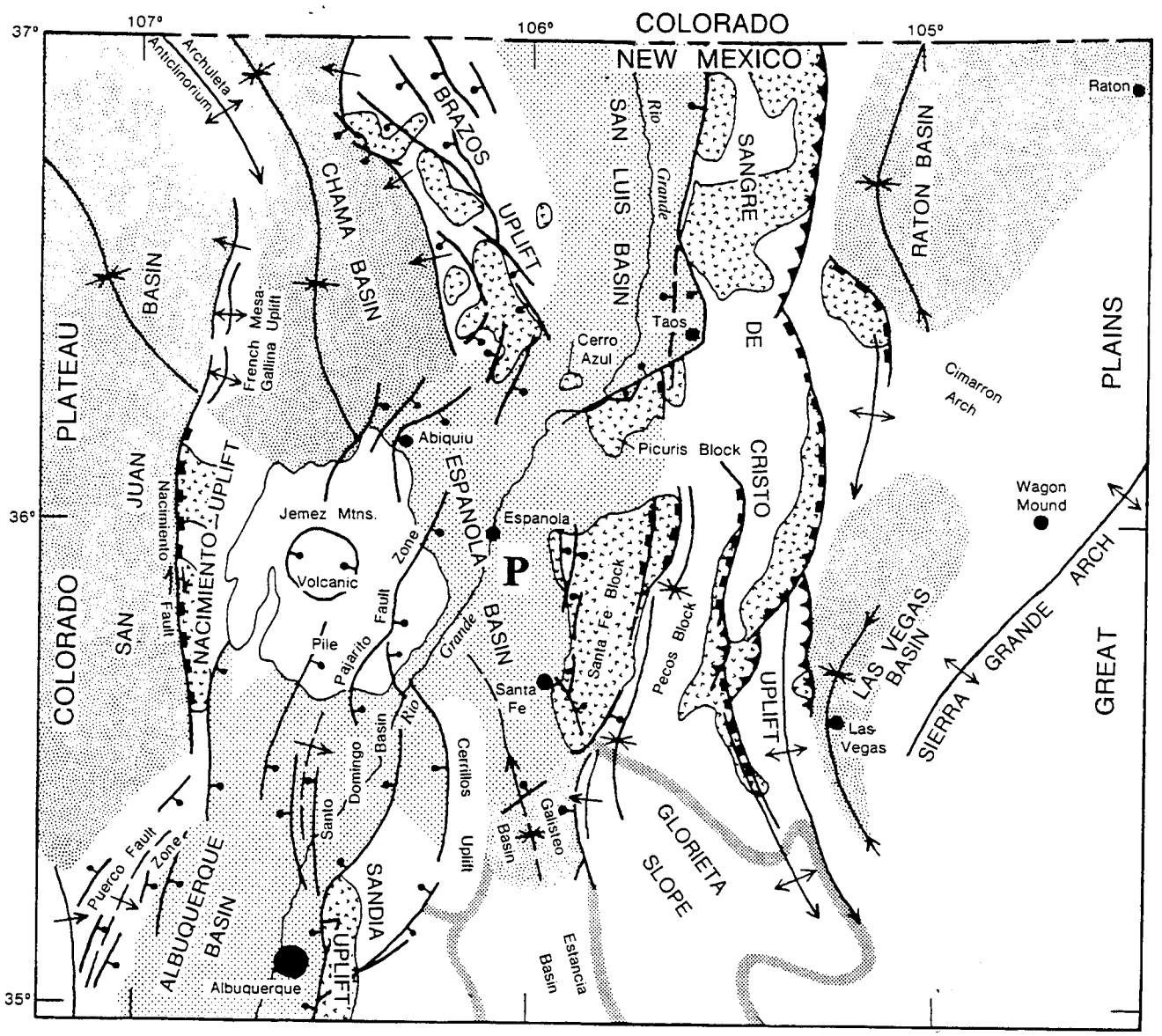


Figure 2. Major tectonic elements of North-Central New Mexico (Baltz, 1978)

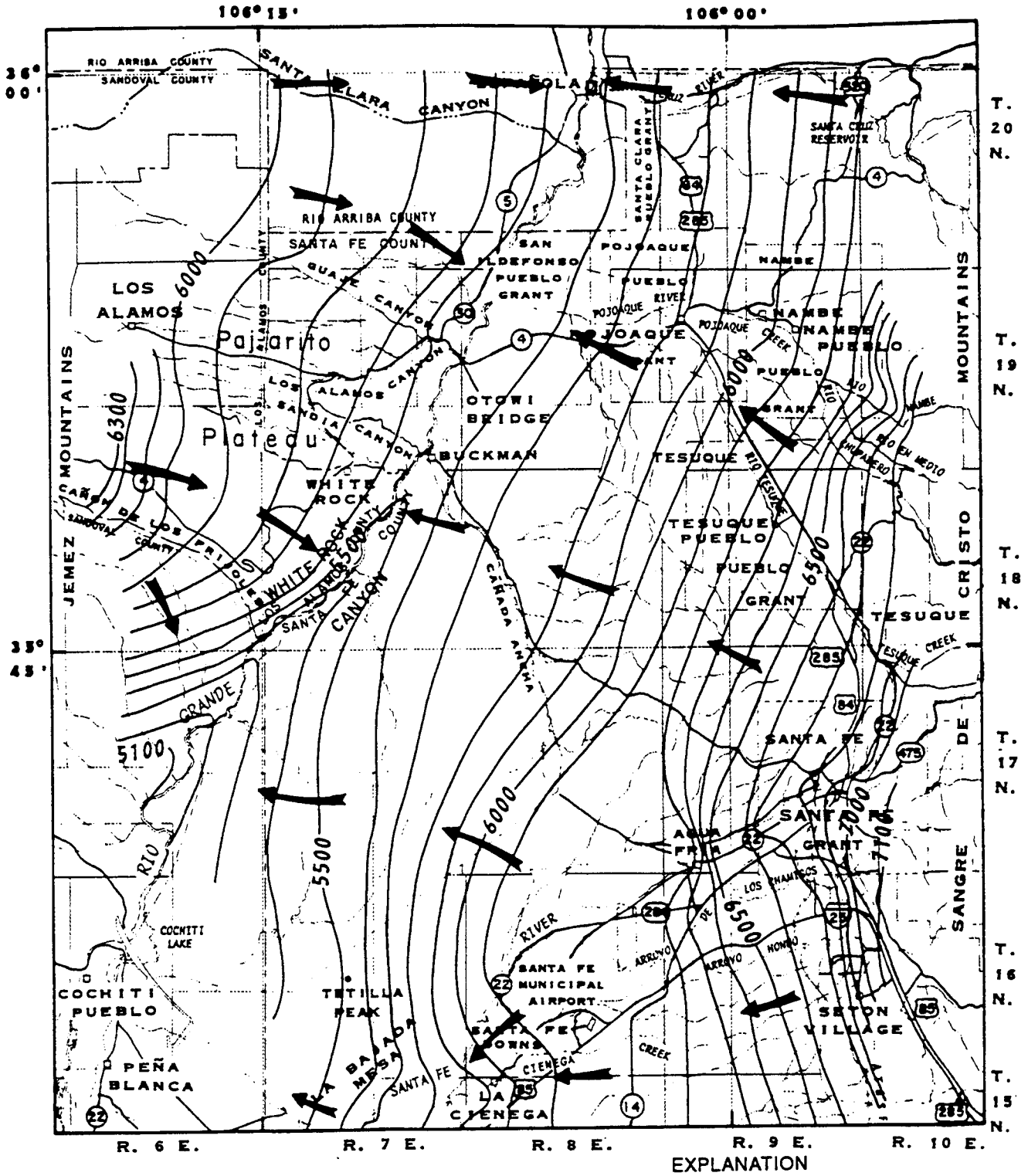


Figure 3.--Predevelopment potentiometric surface of the Tesuque aquifer system (modified from McAda and Wasiolek, 1988, figure 6).

metropolitan Santa Fe. Both oxidizing and reducing ground-water conditions exist in the area. In the region, septic tanks have contaminated ground water with nitrate in oxidizing environments. In reducing environments the ammonia in septic-tank effluent is unable to oxidize to nitrate, but the effluent can make the ground water even more reducing thereby causing levels of iron, manganese and sulfide to increase.

PREVIOUS WORK

NMED periodically conducts "Water Fairs" in communities around New Mexico. A mobile laboratory is set up and private well users in the area are encouraged to bring water samples for testing of nitrate, iron, sulfate, specific conductance and organic vapor. Water Fairs provide valuable surveillance data on regional ground-water quality. Water Fairs were conducted in Pojoaque in 1988, 1994 and 1997. Six wells in the region contained nitrate-N between 5-10 mg/L, and two wells contained greater than 10 mg/L.

As part of it's regional investigation of the uranium problem, NMED sampled 18 checkerboard wells in the Pueblo, or within ½ mile of the eastern (up-gradient) Pueblo boundary, during 1995. As a courtesy to PoP, and at their request, NMED sampled PoP wells 4, 5, and 8, and collected a water-system composite sample on July 27, 1995. The field and laboratory methods for this previous work were identical, or very similar, to the methods described below. Results of these previous tests are incorporated into this report.

During the regional investigation, NMED initially analyzed for general chemistry, nitrogen species, uranium, radium, radon, and heavy metals. Radon was ubiquitous in area ground water, with no apparent correlation to other constituents. Radium and heavy metals were not found at significant concentrations. Consequently, testing for radon and heavy metals was discontinued. Radium testing is conducted only when there is evidence (eg. sulfide odor) of reducing conditions.

METHODS

Based on the results of previous work NMED and PoP decided to test water samples for general chemistry, nitrate and uranium. Eight Pueblo-owned wells were available for sampling: wells 4, 5, 7, 8, 9 and 10, the Tapia (formerly Hugh's) Building well and the Quintana windmill (Figure 4). The PoP Environment Department provided information on well completion. Samples were collected as close to the well head as possible. Samples came directly from the well, before any treatment system, and not from a storage tank. If wells had not already been running at the time of sampling, they were purged.

A sample from each well was tested in the field for temperature and conductivity using a YSI meter. Samples from each well were collected for laboratory analysis of uranium (U), nitrate (NO_3^-), and general chemistry which includes sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), carbonate (CO_3^{2-}), bicarbonate (HCO_3^-), chloride (Cl^-), sulfate (SO_4^{2-}), fluoride (F^-), total dissolved solids (TDS) and pH. Three one-quart cubitainers were filled from each well. One was preserved with 2 mL of sulfuric acid and analyzed for nitrate, one was preserved with 5 ml of nitric acid and analyzed for uranium, and the third was not preserved and was analyzed for general chemistry. Laboratory analyses were done by the Scientific Laboratory Division of the New Mexico Department of Health located in Albuquerque.

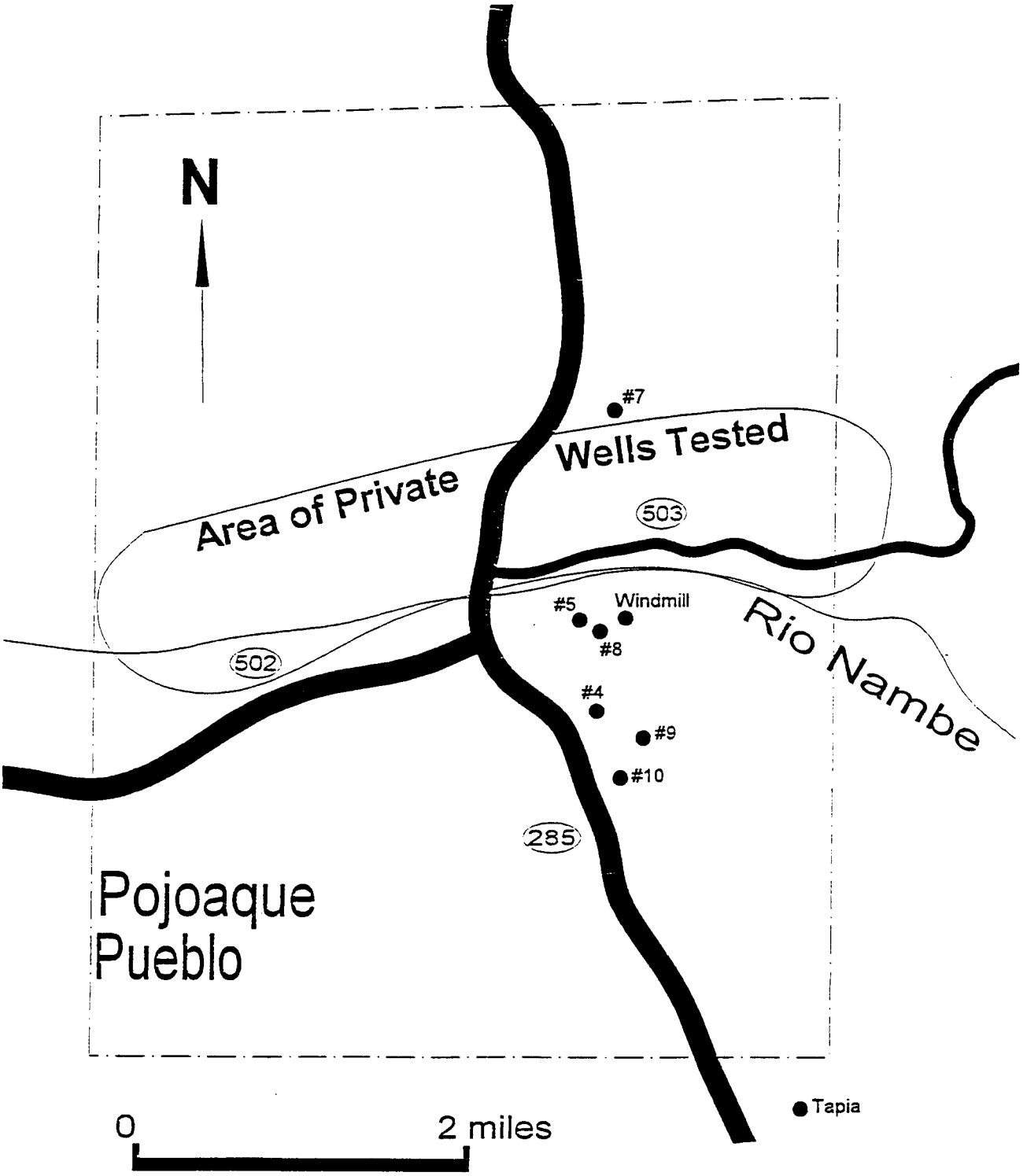


Figure 4. Well locations.

A PoP representative accompanied, and was trained by, NMED staff during field activities on PoP lands. NMED and PoP also conducted two geological field trips to examine and study Tesuque Formation Members, uranium deposits, ash beds and faults.

RESULTS

Physical properties of samples from PoP wells are listed in Table 1. Analytical data for samples from PoP wells are listed in Table 2. All PoP wells produce sodium-bicarbonate water with low calcium, no detectable magnesium or nitrate, little if any uranium, and less than 350 mg/L TDS. Carbonate was usually detectable at up to 20.6 mg/L, and chloride was very low, less than 15 mg/L. The Tapia Building well contained fluoride in excess of drinking-water standards.

Analytical data for samples from checkerboard wells located within, or within ½ mile up-gradient of, Pojoaque Pueblo are listed in Table 3. The analyses are listed in order of descending uranium concentration. The dominant ions in these waters vary from sodium-bicarbonate-sulfate, to sodium-bicarbonate, to calcium-bicarbonate. Nine wells produce water with uranium in excess of the proposed drinking-water standard of 20 ppb, with the highest concentration at 920 ppb. Magnesium and nitrate were typically detectable at less than 10 mg/L in the uranium-excessive wells. The geochemistry of water samples with less than 20 ppb uranium was often similar to that of the Pueblo-owned wells, discussed above.

Examples of the various water-quality types occurring on Pojoaque Pueblo are illustrated in Stiff diagrams in Figure 5. Appendix C contains additional Stiff diagrams sorted into the following groups: PoP wells, wells with > 200 ppb uranium, wells with 20-200 ppb uranium, wells with 5-20 ppb uranium, wells with 1-5 ppb uranium, wells with high fluoride, and wells with sodium-bicarbonate-sulfate water.

DISCUSSION AND CONCLUSIONS

EPA drinking-water standards for the parameters tested during this investigation are listed in Table 4.

PoP Wells. The geochemistry of water produced by the eight PoP wells sampled is remarkably similar (Appendix C, PoP wells). The water is generally of excellent quality, containing little or no detectable uranium. All other constituents, except for fluoride in the Tapia well, are within drinking-water standards. The low chloride levels in these wells indicate that they have not yet been impacted by human activity.

Although the Pueblo was able to provide depth information on only three of the eight wells sampled, the nearly identical geochemistry suggests that the other wells are completed at similar depths. The low calcium and absence of magnesium in these wells indicate that the ground water has undergone cation exchange (discussed below) during its migration from the recharge area located to the east.

Checkerboard Wells. The geochemistry of water from checkerboard wells varied widely, but a number of significant conclusions can be drawn. There is a correlation between TDS and excessive uranium (Figure 6). This is consistent with the hypothesis (discussed below) that the

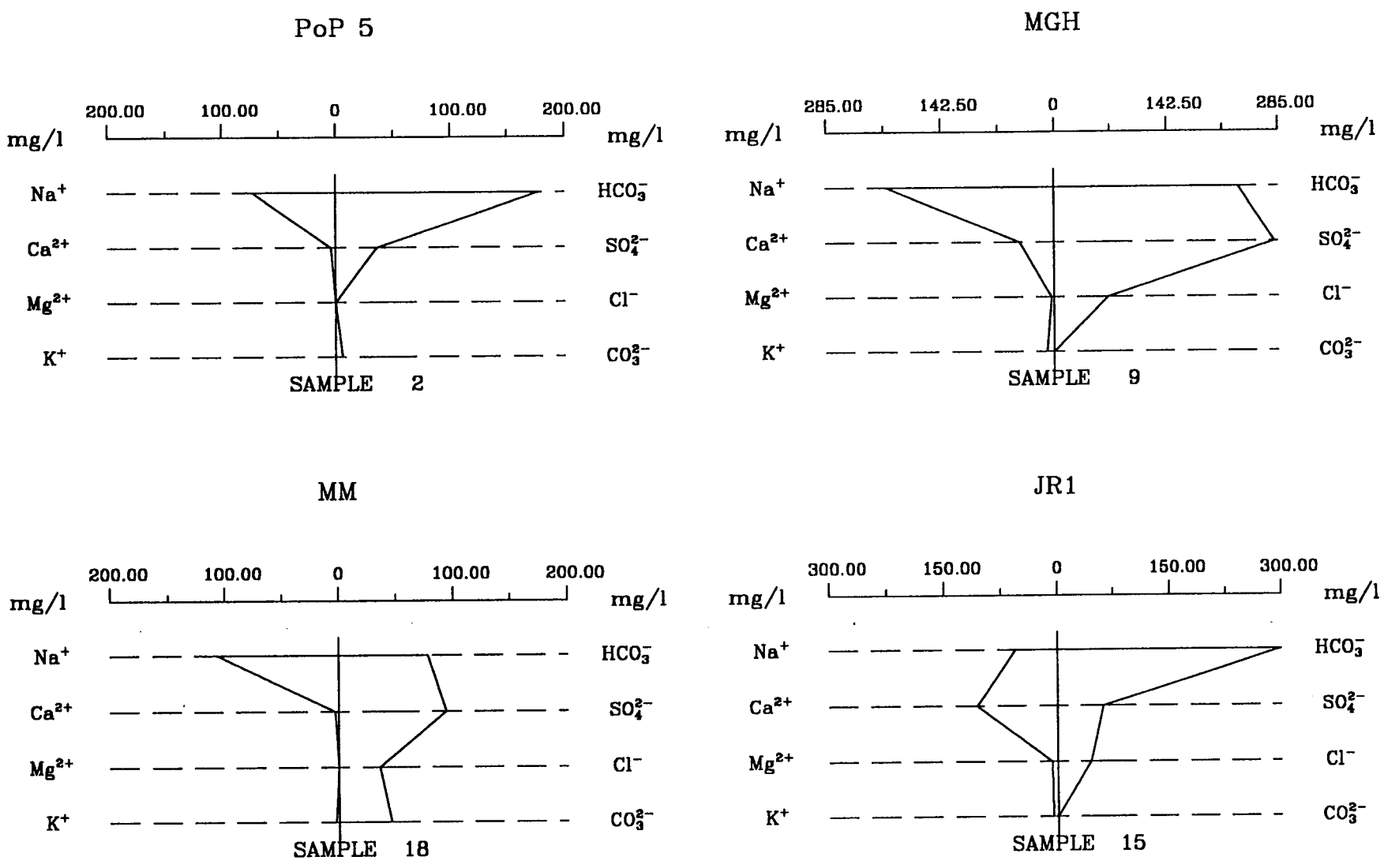


Figure 5. Stiff diagrams for examples of water-quality types.

PoP 5, Na–HCO3
MM, high F

MGH, Na–HCO3–SO4
JR1, Ca–Na–HCO3

TABLE 1. Physical Properties of PoP Well Waters. S.C. is specific conductance (umho/cm).

	WELL 4	WELL 5	WELL 7	WELL 8	WELL 9	WELL 10	Tapia	Windmill
Temp	18.5° C	22.5° C	21° C	17° C	19° C	21° C	15° C	19° C
S.C.	415	380	350	350	300	320	320	345
pH	8.49	8.67	8.71	8.16	8.6	8.43	9.34	8.69

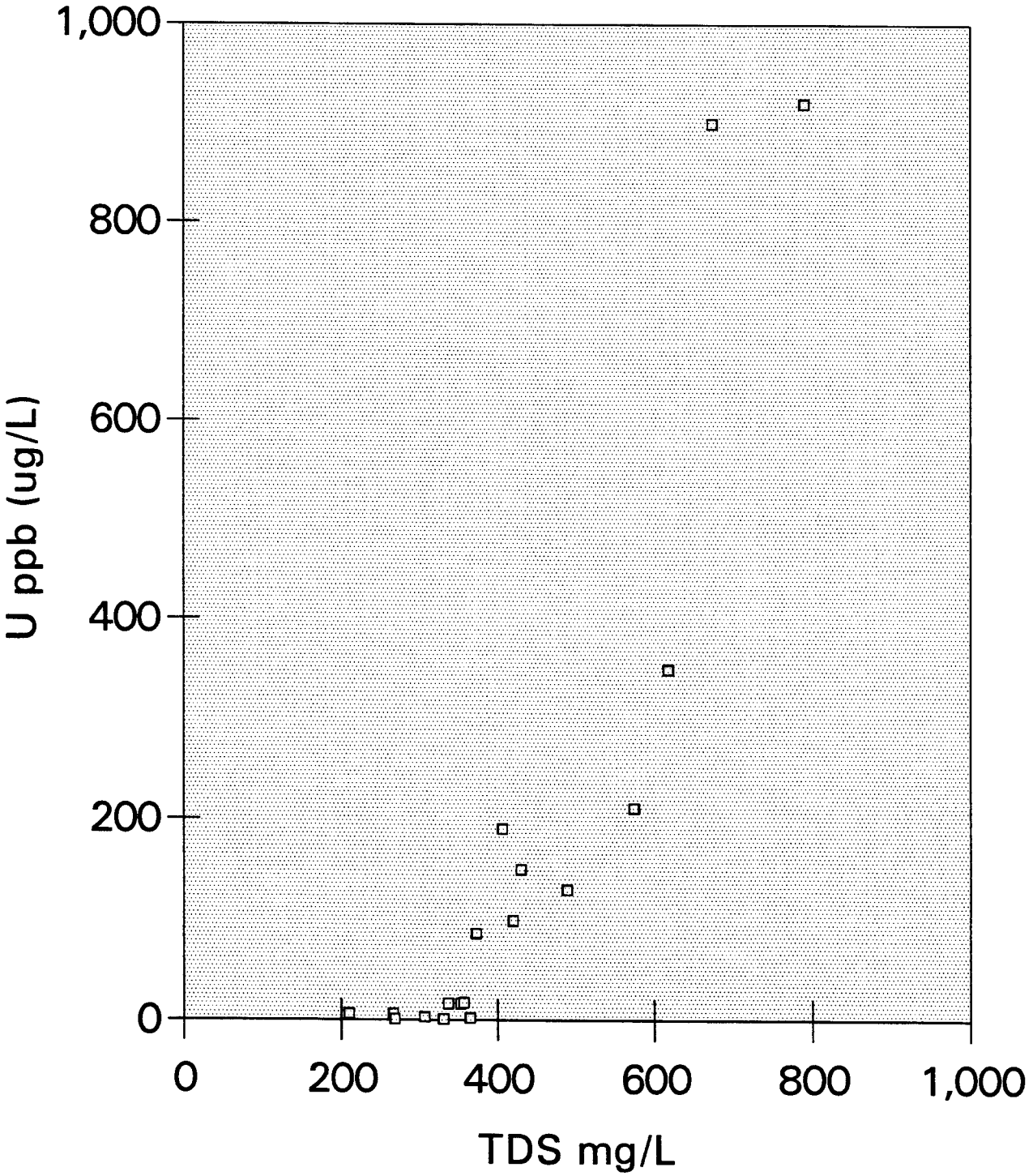
TABLE 2. PoP Well Water Analyses. All concentrations are mg/L, except for U (ppb equals ug/L). Abbreviations: "Comp." means composite sample; "r" means reported well depth.

Well	Depth	Date	Ca	Mg	Na	K	HCO_3	CO_3	Cl	SO_4	F	NO_3-N	U	TDS
Comp.		7/27/95	< 5	< 5	86	4	181	3.4	8	38	0.5	< 0.1	< 1	258
4	500'	7/27/95	< 5	< 5	83	4	174	7.9	8	36	0.5	< 0.1	< 1	264
4	500'	8/15/97	8.4	< 1	88	6.3	174	3.6	12	61.5	1	<0.1	1	330
5	510'	7/27/95	< 5	< 5	84	4	198	4.6	7	34	0.5	<0.1	< 1	260
5	510'	8/15/97	4.5	< 1	73	< 5	178	6	< 10	36.3	0.6	<0.1	< 1	250
7		8/15/97	3.3	< 1	71	< 5	130	7	13	47.7	1.1	<0.1	< 1	240
8		7/27/95	< 5	< 5	84	4	179	4.8	8	37	0.5	<0.1	< 1	268
8		11/17/97	7	<1	76	< 5	184	0	8.1	35.7	0.5	<0.1	< 1	282
9		8/15/97	2.9	< 1	69	< 5	159	4.3	< 10	30.4	0.4	<0.1	< 1	210
10		8/15/97	12	< 1	64	< 5	176	2.4	< 10	28.5	<0.4	<0.1	6	210
Tapia	1200'r	10/17/97	1.4	< 1	80	1	128	21	7.1	31.3	13	<0.1	< 1	264
Wind.		10/17/97	4.7	< 1	78	3.4	178	7.2	8	35.9	0.6	<0.1	< 1	272

TABLE 3. Private Well Water Analyses. All concentrations are mg/L, except for U (ppb); "r" means reported well depth.

Well	Depth	Date	Ca	Mg	Na	K	HCO_3	CO_3	Cl	SO_4	F	NO_3-N	U	TDS
MGH	120'	3/14/95	43	3.3	210	9	235	0	69	281	0.75	0.3	920	790
MN	140'	4/24/95	36	< 5	207	7	412	0	15	181	1	0.7	900	674
DD		3/14/95	50	4.3	151	10	500	0	19	74	1	2.5	349	618
MSL		3/14/95	27	6.1	99	6	443	0	22	70	0.7	1.6	211	574
SD	30' r	11/8/95	7	5.4	63	4	358	0	6	30	0.8		190	406
CL	170' r	10/25/95	34	6.6	110	6	255	0	18	67	1		150	430
JR1	200'	10/25/95	106	7.8	55	6	299	0	45	62	0.5	6.8	130	489
MI	68'	3/14/95	24	5.9	51	6	373	0	9	28	0.7	1.2	99	420
AM		4/24/95	17	< 5	101	6	146	0	23	105	1	0.4	86	372
MWM	230' r	3/14/95	5	0.2	104	5	144	4.3	24	63	5.7	0.2	17	356
MD	168'	3/14/95	10	0.7	101	7	138	0	23	90	1.5	<0.1	16	352
JR2	410'	10/25/95	7	0.7	113	5	173	5.3	11	94	1.6	<0.1	16	336
DC	133' r	11/8/95	5	1.3	85	1	161	2.9	11	50	1.2		6	266
OG	100'	11/8/95	16	2.9	95	5	177	0	20	86	0.4		3	306
MO	260'	3/14/95	9	0.8	113	5	255	5.3	10	42	1	<0.1	2	364
GG	110'	11/8/95	8	1.9	87	4	177	0	13	57	0.5		1	268
MM	545'	3/14/95	3.4	0.1	106	3	78	46	36	94	9.8	<0.1	< 1	328
MMH	200'	3/14/95	26	2.8	164	6	199	0	16	264	0.3	<0.1	< 1	626

FIGURE 6. URANIUM vs TDS IN GROUND WATER.
For all wells, PoP and private, where U is detectable.



uranium leached from soluble mineral deposits in the Tesuque Formation. Uranium-excessive wells typically contain detectable nitrate, indicating an oxidizing environment needed for uranium dissolution. High uranium occurs in all water varieties identified except those that are calcium depleted with high fluoride (Appendix C). The generally higher chloride in checkerboard wells is most likely related to their shallower depths and influences from septic-tank discharges. One well had elevated chloride and nitrate, further indicating septic-tank contamination.

Table 4. EPA Drinking-Water Standards for Inorganic Constituents of Concern to PoP.

Parameter	Drinking-Water Standard
chloride	250 mg/L
fluoride	2 mg/L (secondary); 4 mg/L (primary)
lead	0.015 mg/L (action level)
nitrate as nitrogen	10 mg/L
pH	6.5-8.5 units (secondary)
sulfate	250 mg/L (secondary)
TDS	500 mg/L (secondary)
uranium	20 ppb (ug/L) (proposed)

Uranium Occurrence. Vitric volcanic ash, a form of glass, is very unstable over geologic time. When in contact with ground water ash can undergo devitrification, an alteration from glass to clay minerals. Metals including uranium can be released from the glass during devitrification.

The natural uranium ore bodies in the Tesuque Formation occur in the same area as the volcanic ash beds, some of which have been devitrified. This proximity suggests that uranium may have been released from devitrifying ash. Erosion of Precambrian crystalline rocks located to the east is another potential source of uranium.

Uranium, released from whatever original source, migrated in ground water until encountering reducing conditions, such as caused by decaying plant and animal matter in the aptly-named, fossiliferous Skull Ridge Member of the Tesuque Formation. Reducing environments caused the uranium to precipitate as a mineral coating on Tesuque sediments. Subsequent erosion of the Tesuque and exposure of the uranitic rock at the surface created oxidizing conditions which re-mobilized the uranium for ground-water migration, and contaminated shallow aquifers. The uranium, dissolved or precipitated, provides the source of radon that is ubiquitous in area soil vapor and ground water.

Cation Exchange. Sodium is the predominant cation in almost all ground water tested (Appendix C). Calcium is virtually depleted in some water. These waters have undergone varying degrees

of cation exchange, a process whereby calcium and magnesium dissolved in ground water are exchanged with sodium and potassium from the sediment. This "natural water softening" was likely caused by zeolitic and bentonitic alteration by-products of volcanic ash, which have high cation-exchange potential.

Fluoride Occurrence. The occurrence of high fluoride is related to cation exchange discussed above. All fluoride-excessive waters have very low calcium. When calcium has been virtually depleted from solution by cation exchange, it is unavailable to bond with aqueous fluoride and precipitate the solid mineral fluorite. High fluoride occurs in both sodium-bicarbonate and sodium-bicarbonate-sulfate waters (Appendix C).

Ground-Water Quality and Public Health Concerns. Excessive uranium in drinking water can cause kidney disease and an increased lifetime risk of cancer. The ubiquitous radon in area ground water is not a human hazard threat unless it contributes to an indoor air problem.

Fluoride in drinking water can be assimilated into teeth and bones. Fluoride exceeding 2 mg/L can cause dental fluorosis, mottling of teeth. Fluoride exceeding 4 mg/L can cause skeletal fluorosis, a weakening of the bones.

The high pH values in water produced by several PoP wells could be corrosive to lead, copper and galvanized plumbing material, and cause lead to leach into drinking water. The highest lead concentrations will occur when water has been stagnant in the piping for overnight or longer. Lead exposure, even at low levels, can cause serious health problems in children including brain damage, lower IQ, shortened attention span, behavioral problems, poor learning ability, and hearing and kidney damage.

Pojoaque Pueblo is in a region of demonstrated vulnerability to ground-water contamination from septic tanks and other near-surface sources. One private well within the Pueblo contained elevated chloride and nitrate, providing strong evidence of impact from septic-tank effluents.

RECOMMENDATIONS

Sampling of Additional Checkerboard wells. While the PoP wells produce water generally of excellent quality, uranium is a problem in 50 % of the checkerboard wells tested, and there is evidence of septic-tank contamination. The water-quality problems encountered by checkerboard wells could possibly migrate and someday affect existing PoP wells or could be encountered by new PoP wells drilled in the future. Since only 18 checkerboard wells have been tested, sampling of additional checkerboard wells is recommended to further define ground-water quality and identify problems within the Pueblo boundary. PoP may wish to include tests for volatile organics, not a focus of this study, particularly in wells near Highway 285 where gas stations and other industrial facilities are located. Reliable instruments could be purchased by PoP to enable it to perform field determinations for specific conductance (related to TDS), nitrate, and organic vapor thereby reducing laboratory expenses. While there is no field test for uranium, wells could be screened for specific conductance (TDS) which is correlated with uranium in this study (Figure 6).

Long-Term Monitoring. After existing water quality has been further defined, a long-term monitoring program is recommended to track water-quality trends and contaminant migration. Existing wells with known contamination problems would be logical candidates for such a monitoring network. PoP may wish to consider drilling nested observation wells that would provide more discrete and depth-specific data rather than relying solely on existing supply wells. PoP also should consider developing a Geographic Information System for water-quality data, contamination sources, etc.

Lead Testing. Because of the high pH of water produced by several PoP wells, a testing program for lead within the PoP water-distribution system is recommended. Areas served by lead, copper or galvanized water piping should be targeted for sampling. Worst-case samples such as the "first draw of the morning" should be collected.

Public Education. Public education is an important tool for preventing water pollution, and for dealing with existing problems. PoP is encouraged to freely copy and distribute the Health Advisory appended to this report. Additionally, a number of NMED open-file reports on septic-tanks and other sources of pollution are available.

Advice for Private-Well Users. A revised Health Advisory regarding potential water-quality problems in this region is attached as Appendix A.

All homes in the area should be tested for indoor radon. If radon is greater than 4 pCi/L, then the contribution from well water should be evaluated. If radon in well water is greater than 1000 pCi/L, granular activated carbon filtration should be considered.

All private domestic wells in the area should be tested for uranium, fluoride, nitrate and pH. If uranium, fluoride or nitrate exceed 20 ppb 2 mg/L or 10 mg/L respectively, an appropriate treatment unit or use of an alternate water source should be considered. The N.M. Department of Health, Dental Program (827-7518) provides free tests for fluoride in private well water. If pH is greater than 8, and lead, copper or galvanized plumbing exists, lead also should be tested for. If lead exceeds 0.015 mg/L, an appropriate treatment unit or use of an alternate water source should be considered.

ACKNOWLEDGEMENTS

NMED and PoP have a long history of cooperation and mutual effort to study water quality and abate water pollution. This Joint Powers Agreement and resulting investigation was the idea of the PoP Environment Department. PoP received an EPA grant to fund this project. Rob Pine, formerly of NMED, and Linda Freedman of the PoP Environment Department contributed to the design and implementation of this investigation. Dr. Ron Vorhees of the New Mexico Department of Health and Jim Horner, Birgit Landin, Beiling Liu and Jennifer Parker of NMED reviewed a draft of this report and made suggestions for its improvement.

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Appendix A

HEALTH ADVISORY
FOR PRIVATE WELL USERS IN NORTHERN SANTA FE COUNTY

August 1998

Prepared by

New Mexico Environment Department
and
New Mexico Department of Health

Elevated uranium and radon have been detected in some wells in the Pojoaque-Nambe-Arroyo Seco area. Indoor radon gas problems have long been known to occur in this area. These contaminants originate from natural uranium minerals occurring in sediments of the Tesuque Formation. Radium and radon are decay products of uranium, but only radon has been found in water at levels of concern. Additionally, some wells in the area have high fluoride, nitrate and/or pH. The latter can make water corrosive, causing lead to leach out of metallic plumbing material.

All wells in the area should be tested for uranium, fluoride, nitrate and pH. The potential health effects of uranium, radon, pH/lead, fluoride and nitrate are discussed separately below, along with solutions to problems with these constituents. These recommendations apply only to private domestic wells. Households served by public water may contact the Environment Department (see below) to inquire about their water quality.

URANIUM

Uranium ingested in drinking water is deposited primarily in the bone and kidneys, and can cause kidney disease and an increased lifetime risk of cancer. EPA has proposed a drinking water standard for uranium of 20 parts per billion (ppb equal to ug/L).

All wells within ½ mile of Rio Nambe, between Nambe and Pojoaque, should be tested for uranium. If uranium exceeds 20 ppb, an appropriate water-treatment system or use of an alternate source of drinking water should be considered. Point-of-use reverse-osmosis (RO) units have been used by private well owners in the area to reduce uranium concentrations. Other household treatment technologies, such as distillation and anion exchange, may be effective in reducing uranium. The owner of a mobile home park with 58 water-service connections installed an anion-exchange system that successfully reduced uranium from 85 ppb to 0.4 ppb. Boiling water will increase, not reduce, the amount of uranium.

RADON

Radon is a colorless, odorless radioactive gas. If inhaled, it can decay to non-gaseous radioactive elements that become trapped in the lung. These trapped elements decay further and

release bursts of energy which damage lung tissue and increase the risk of lung cancer. Domestic water supply can be a significant exposure pathway for radon gas.

Indoor radon testing is recommended for all houses in the area. If indoor radon is less than 4 pCi/L, well-water testing for radon is not recommended. If indoor radon is greater than 4 pCi/L, testing the well-water for radon is recommended. If the radon in well-water is greater than 1000 pCi/L, granular-activated carbon (GAC) filtration of the water should be considered. The GAC filter should be a point-of-entry (into the house), not a point-of-use (kitchen sink) unit so that radon is removed from all household water, including bathrooms.

FLUORIDE

Fluoride in drinking water can be assimilated into teeth and bones. Fluoride exceeding 2 mg/L can cause dental fluorosis (mottling of the teeth). Fluoride exceeding 4 mg/L can cause skeletal fluorosis, causing weakening of the bones.

If fluoride exceeds 2 mg/L, an appropriate water-treatment unit or use of an alternate source of drinking water should be considered. Boiling water will increase, not reduce, the amount of fluoride.

pH/LEAD

Lead exposure, even at low levels, can cause serious health problems in children including brain damage, lower IQ, shortened attention span, behavioral problems, poor learning ability, and hearing and kidney damage. Children under age 6 are most affected because their developing brains and growing bodies absorb lead faster than adults. Most children have no symptoms so the only way to know if a child is lead-poisoned is through a blood test. Children between 6 months and 6 years old should be tested for lead poisoning. The N.M. Department of Health provides case management services for lead-poisoned children.

Most well or city water does not naturally contain lead. Water usually picks up lead from household plumbing including lead pipe, lead solder in copper pipe, galvanized pipe, and brass fixtures. PVC plumbing material is not a source of lead. Water will contain more lead if it has sat for a long time in the pipes, is hot, or has a naturally high or low pH. Boiling water will increase, not reduce, the amount of lead. Bathing is not a problem because lead does not enter the body through the skin.

All wells in the area should be tested for pH. If pH is greater than 8, and if metallic plumbing materials are present, the water should be tested for lead. The initial test should be a worst-case "first draw of the morning" sample of water that has been stagnant in the pipe overnight. If lead is less than 0.015 mg/L, no problem is indicated. If lead is more than 0.015 mg/L, a follow-up sample should be collected after the water line has been flushed for 2 minutes or until the water feels as cold as it will get. If the follow-up sample contains less than 0.015 mg/L lead, the water line should be flushed before drawing water for drinking or for foods that require the addition of water during preparation. If the follow-up sample contains more than 0.015 mg/L of lead, an appropriate water-treatment unit or use of an alternate source of drinking water should be considered.

Unless similar tests are performed on the hot water tap, it should not be used for drinking or for foods that require the addition of water during preparation.

NITRATE

Infants under six months of age who drink water with more than 10 mg/L nitrate-N can get methemoglobinemia, a rare but potentially serious disease also known as the "blue baby syndrome". If nitrate in drinking water exceeds 10 mg/L, an appropriate water-treatment unit or use of an alternate source of drinking water should be considered. Boiling water will increase, not reduce, the amount of nitrate. A detailed brochure about nitrate is attached to this health advisory.

WHERE TO GO FOR ASSISTANCE AND SERVICES

The New Mexico Environment Department (NMED) is conducting a regional geochemical investigation of the problem, but does not have the resources to provide radiological water testing on demand. NMED maintains a computerized database of ground water geochemistry in the area, however, and makes that information available to the public. Anyone who has their well tested by a private laboratory is encouraged to share the data with NMED. When providing information to the public, NMED keeps the property address and owner's name confidential. Data are released, instead, grouped into general geographic areas.

General Questions, Information, and Water Testing

Ray Montes or Jim Horner
NMED Ground Water Quality Bureau
Harold Runnels Bldg.
1190 St. Francis Dr.
Santa Fe, NM 87502
(505) 827-2886

Also, consult the telephone directory under "Environmental Services", "Laboratories" and "Radon Testing".

Public Water Supply System Information

Barbara Giesler
NMED Drinking Water Bureau
525 Camino de los Marquez
Suite 4
Santa Fe, NM 87502
(505) 827-7536

Radon Testing

Chris Serazio
NMED Hazardous and Radioactive Materials Bureau
2044 Galisteo
Santa Fe, NM 87505
(505) 827-1564

Also, consult the telephone directory under "Environmental Services", "Laboratories" and "Radon Testing".

Lead-Poisoning Prevention

Martha Applegate or Randy Merker
NM Dept. of Health
Harold Runnels Bldg., Rm. N-1350
1190 St. Francis Dr.
Santa Fe, NM 87502
(505) 827-0006

Fluoride Testing

NM Dept. of Health, Dental Program
Pinon Bldg., Rm. 124
1220 St. Francis Dr.
Santa Fe, NM 87505
(505) 827-7518

Water Treatment Systems

Consult the telephone directory. Before buying a unit, ask for references of customers who share the same water-quality problem. Beware of high-pressure sales tactics and scare tactics. Do not buy treatment options that are not needed to correct the problem, unless desired for peace of mind. If in doubt, contact the NMED Ground Water Quality Bureau (above) for an independent interpretation of test results and of the need for water treatment. All treatment units require periodic maintenance which, if neglected, can degrade water quality and create possible health hazards beyond those posed by untreated water.

NITRATE in Drinking Water

Nitrate and Your Diet

Nitrate (NO_3) is a compound of nitrogen and oxygen and is found in many food items in your every-day diet. Generally, the concentration in ground water is low. The major source of nitrate for adults is food rather than water. Vegetables such as spinach, lettuce, beets, and carrots have significant nitrate concentrations. Drinking water normally contributes only a very small percentage of the total nitrate intake.

Nitrate Levels In Drinking Water

Although low levels of nitrate occur naturally in water, sometimes higher levels which are potentially dangerous to some infants are discovered. New Mexico has adopted a drinking water standard of 10 milligrams per liter (mg/l) for nitrate (as nitrogen). This standard is mandatory for public water supplies and is used as a guide for private water supplies. The U.S. Environmental Protection Agency also uses the 10 mg/l as a mandatory national standard for public supplies under the Safe Drinking Water Act passed by Congress.

Sources of High Nitrates

It is often difficult to pinpoint sources of nitrate because there are so many possibilities.

Sources of nitrogen and nitrate may include the following:

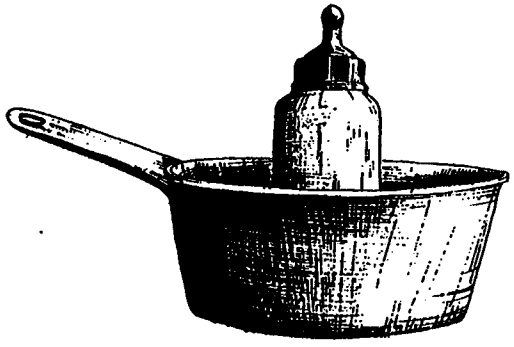
- cesspools
- septic tanks and leachfields
- refuse dumps
- animal feed lots
- runoff or seepage from fertilized agricultural lands
- municipal and industrial wastewater
- urban drainage
- decaying plant debris.

The geologic formations, depth to ground water, and directions of ground water flow influence the possibilities of nitrate contamination from a particular source.

Health Concerns

Since 1945, health officials have known that high nitrate levels in drinking water disrupt the normal body processes of some infants. Their concern is that high nitrate concentrations may cause *methemoglobinemia*. This condition has been rare in New Mexico.

Questions have been raised as to whether nitrate can lead to other health problems such as cancer in healthy adults and birth defects, but definitive studies are lacking.



The toxicity of nitrate to infants occurs when nitrate is converted to nitrite (NO_2), a process that can occur in the stomach as well as in the saliva. Nitrite acts in the blood to change the hemoglobin to methemoglobin, which reduces the ability of the red blood cells to carry oxygen to the tissues.

Infants under six months of age are most susceptible; however, because of individual differences in infants, some may not be affected. If an infant is affected, the skin takes on a bluish cast similar to the color of the blood vessels located close to the skin. If this condition is observed, seek medical help immediately. The infant is suffocating because oxygen cannot be transported by the changed blood cells. Prompt medical attention normally results in quick recovery of the infant. Lack of medical attention can be fatal.

Why Are Infants More Susceptible?

Adults can consume large quantities of nitrate in drinking water or food without experiencing the same health effects as infants. The adult stomachs, which contain strong acids, do not promote the growth of bacteria which convert nitrate to the more toxic nitrite. Infants, however, are more susceptible because their stomach juices are less acidic, and therefore more favorable for the growth of these bacteria.

Remember, not all infants are affected by high nitrate.

Recommended Precautions and Procedures

When water with nitrate exceeding the drinking water standard has been discovered, a number of important points should be remembered:

1. **Do not give the water to infants under six months of age** either direct or in formula. Use only safe water from a known low nitrate source.
2. **Do not boil high nitrate water** to reduce the nitrate level. Boiling actually increases the nitrate due to evaporation of the water.
3. **Seek medical help** if the skin of an infant takes on a bluish tone or tint.

Testing for Nitrate

Federal law requires the testing of public water systems, but high nitrate can occur in any well. If infants will be consuming water from a private well, an inexpensive water test for nitrate should be requested, in addition to a normal bacteriological test. Water samples can be tested at private laboratories. Look for listings in the Yellow Pages under "laboratories-testing."

Ask your local EID office if there is a day of free well water testing scheduled for your community.

Appendix B

JOINT POWERS AGREEMENT BETWEEN THE NEW MEXICO ENVIRONMENT DEPARTMENT AND THE PUEBLO OF POJOAQUE

RECEIVED
SEP 15 1997
By

THIS AGREEMENT is made and entered into by the NEW MEXICO ENVIRONMENT DEPARTMENT (NMED) and the PUEBLO OF POJOAQUE (PUEBLO) pursuant to the New Mexico Joint Powers Agreement Act, Sections 11-1-1 et seq. NMSA 1978, in order to conduct a geochemical investigation and to present a written summary and interpretation of that investigation.

WHEREAS, the Pueblo is a sovereign tribal government, recognized as such by the Secretary of the Interior of the United States of America; and

WHEREAS, the Pueblo is interested in assessing the quality of and discerning potential threats to groundwater upon reservation lands; and

WHEREAS, the Pueblo finds that NMED has the technical expertise in assisting in the determination of water quality and advising of potential threats to that quality; and

WHEREAS, NMED, as a constituent agency of the New Mexico Water Quality Control Commission, may receive and expend funds allocated for purposes consistent with the New Mexico Water Quality Act, Sections 74-6-1 through 74-6-12, and;

WHEREAS, it is the mutual desire of the Pueblo and NMED to work in harmony for the common purpose of protecting the groundwater and soil of the Pueblo and the State from contamination;

NOW, THEREFORE, The Pueblo and NMED agree that the method by which this purpose shall be accomplished is as follows:

1. **Purpose:** The Pueblo shall fund a geochemical investigation of groundwater on reservation lands to be conducted by NMED which shall present a written summary and interpretation of that investigation upon completion of that investigation.

2. **NMED shall:**

   a. Collect samples from twenty (20) Pueblo wells.
   b. Train a Pueblo representative in sampling protocol and the use of field instruments.
   c. Use field instruments to determine pH, specific conductance and dissolved oxygen level.
   d. Arrange for geochemical analysis of samples by State Scientific Laboratory

Division including uranium, major ions, total dissolved solids, nitrate/nitrite and fluoride.

e. Summarize, map and interpret the field data and geochemical analyses in a draft report to be submitted to the Pueblo for review and comment.

f. Be present to answer questions and discuss the draft report.

g. One month after the draft report issue the Pueblo five copies of the final report. The final report shall be issued to the Pueblo no later than December 31, 1997.

3. The Pueblo shall:

a. Provide a representative to accompany NMED staff while on reservation lands to assist with field work and become educated in sampling protocol and use of field instruments.

b. Provide funding for the geochemical investigation in the amount of $13,977.00. The Pueblo shall make one payment to NMED at following address:

New Mexico Environment Department
Harold Runnels Building N2300
1190 St Francis Drive
Santa Fe, New Mexico 87502

within fifteen days of signing this Agreement and shall be for the total agreed amount as detailed in the attached Exhibit A, "Pojoaque Pueblo Water-Sampling Budget."

4. Strict Accountability:

There shall be strict accountability for all funds expended pursuant to this Agreement. All accounting records related to this Agreement shall be subject to annual audit and inspection by the Pueblo, the Department of Finance and Administration and the State Auditor. The Pueblo shall have the right to audit after payment; payment under this Agreement shall not foreclose the right of the Pueblo to recover excessive or illegal payment.

5. Term:

THIS AGREEMENT SHALL NOT BECOME EFFECTIVE UNTIL SIGNED BY THE PARTIES AND APPROVED BY THE SECRETARY OF THE NEW MEXICO DEPARTMENT OF FINANCE AND ADMINISTRATION. THIS AGREEMENT shall expire on December 31, 1997, or upon the expenditure of all funds for the geochemical investigation or upon distribution of the final report to the Pueblo whichever comes first, unless terminated pursuant to Section 6, below.

6. **Termination:**

This Agreement may be terminated by either party on thirty (30) days written notice to the other. By such termination, neither party shall avoid obligations for performance already incurred prior to the noticed date of termination.

7. **Unexpended and Unencumbered Project Balances:**

Any unexpended or unencumbered balances from the Pueblo payment remaining after the project termination shall revert to the Pueblo.

8. **Equal Opportunity Compliance:**

The Pueblo and NMED agree to abide by all federal and State laws and regulations pertaining to equal employment opportunity. In accordance with those laws and regulations, the Pueblo and NMED agree to assure that no person in the United States shall, on the ground of race, color, national origin, sex, sexual preference, age or handicap. be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination in performance of this Agreement.

9. **Amendment:**

This Agreement shall not be altered, changed or amended except by written instrument executed by the parties hereto and approved by DFA.

IN WITNESS WHEREOF, the parties have herein below set their hand.

FOR:
State of New Mexico Environment Department (NMED)

BY: _____
(Secretary)
Date: 8/11/97

FOR:
Pueblo of Pojoaque (Pueblo)

BY: _____
(Governor)
Date: Sept 8, 1997

Approved:
New Mexico Department of Finance and Administration

_____ **Date:** 9/13/97
(Secretary)
9/18/97

Approved for form and legal sufficiency:

_____ **Date:** 8/11/97
(NMED Office of General Counsel)

Pojoaque Pueblo Water-Sampling Budget

04-Aug-97

SUMMARY

$7,795.41	Personal Services
$400.00	Field Supplies
$3,540.00	Laboratory (geochemical analyses by SLD)
$2,241.46	NMED Administrative Overhead (@ 19.1% Personal Services & Supplies)
$13,976.87	Total

DETAIL

SLD LABORATORY COSTS

$45.00	Uranium
$108.00	Major ions & TDS
$12.00	Nitrate & Nitrite
$12.00	Fluoride
$177.00	Total per Sample

Total for 20 Samples **$3,540.00**

FIELD SUPPLIES (Sample bottles, chemical reagents) **$400.00**

NMED PERSONAL SERVICES

Staff Salary per hour:

Geologist (Geo)	$17.837
Program Manager (PM)	$22.493
Management Analyst (MA)	$16.478

Project tasks to be performed

Create & Administer Budget

PM @ 20 hrs.	**$450**
MA @ 46 hrs	**$758**

Sampling: (well gauging, sample collection, field testing, filtration, acidification & lab delivery) for 20 samples:

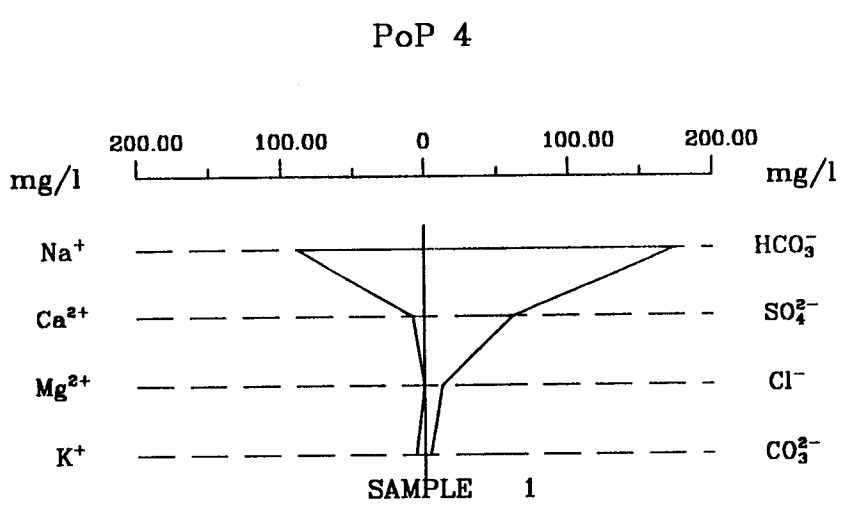
Geo @ 40hrs.	**$713**

Data interpretation, report preparation & presentation to Pueblo officials:

Geo @ 120 hrs	**$2,140**
PM @ 80 hrs	**$1,799**

Total Salary	**$5,861.21**
Benefits @ 33%	**$1,934.20**
TOTAL PERSONAL SERVICE	**$7,795.41**

EXHIBIT A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mg/l
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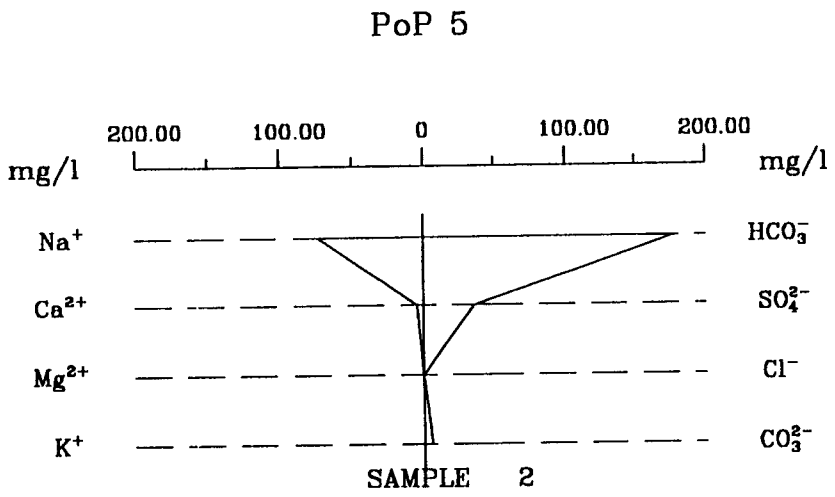
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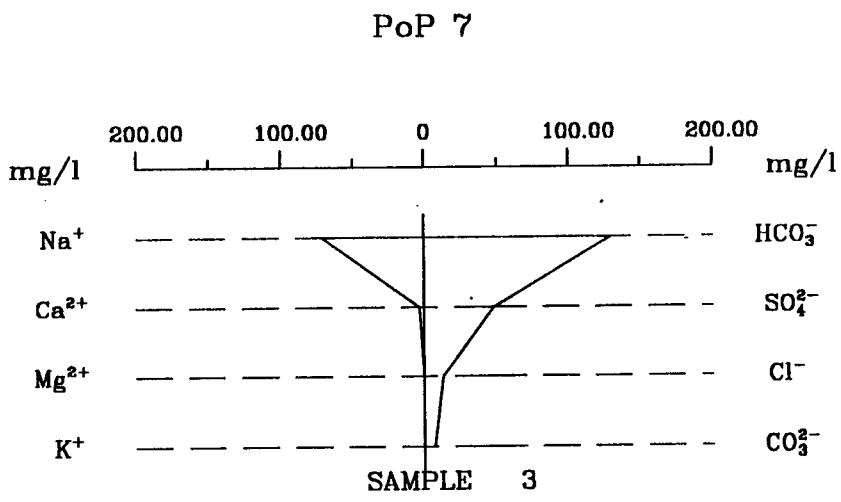
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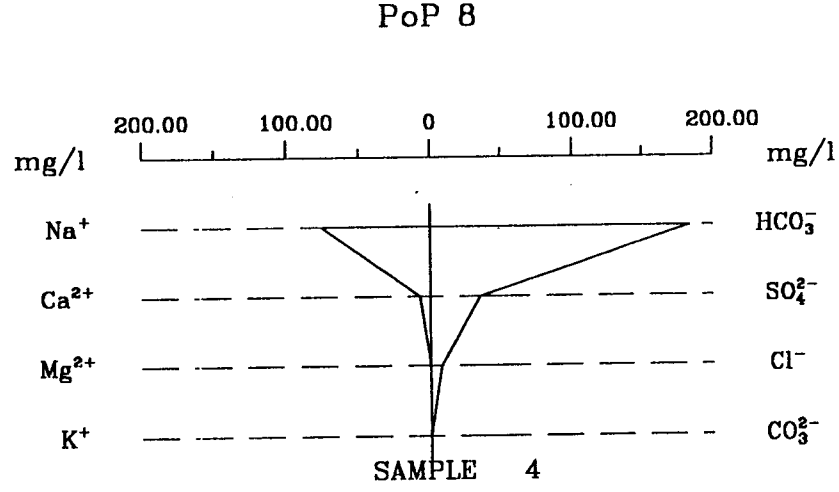
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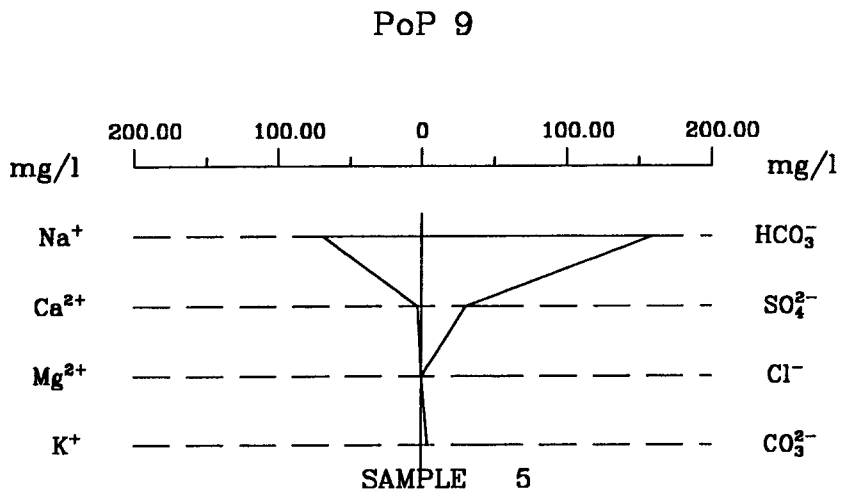
PoP Wells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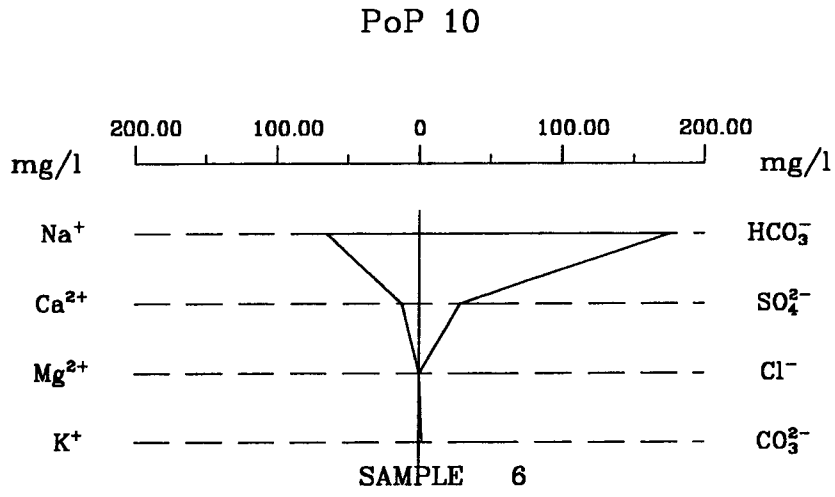
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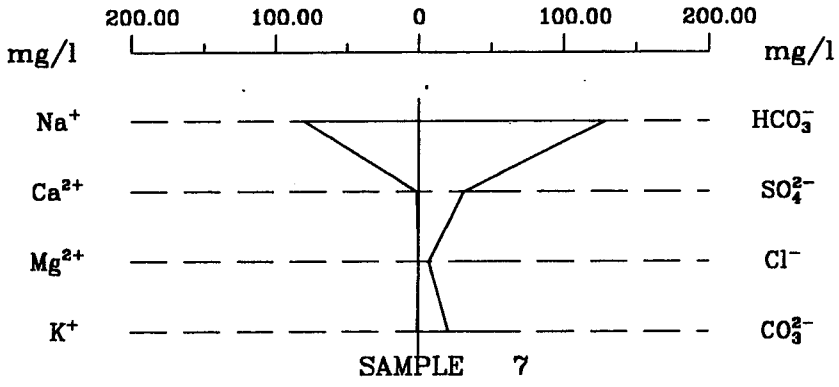
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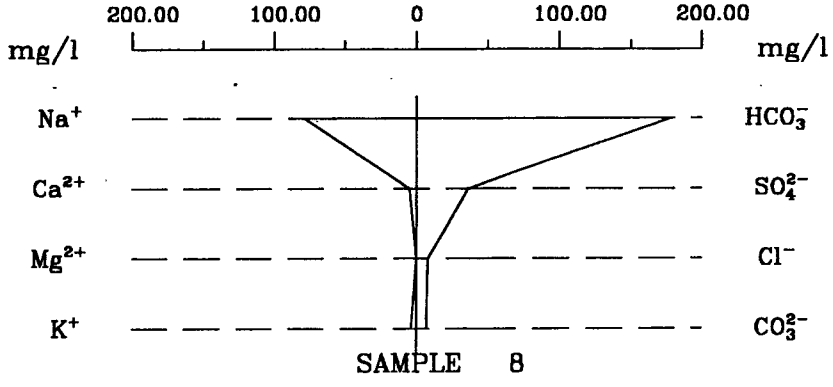
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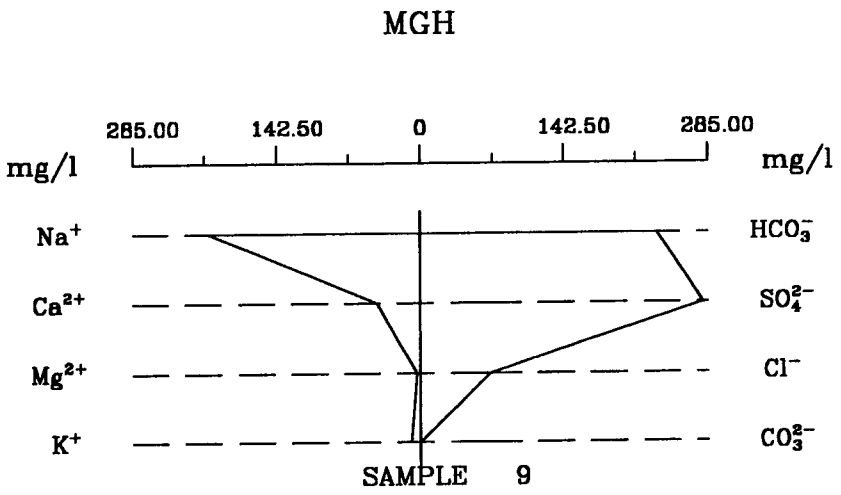
PoP cont.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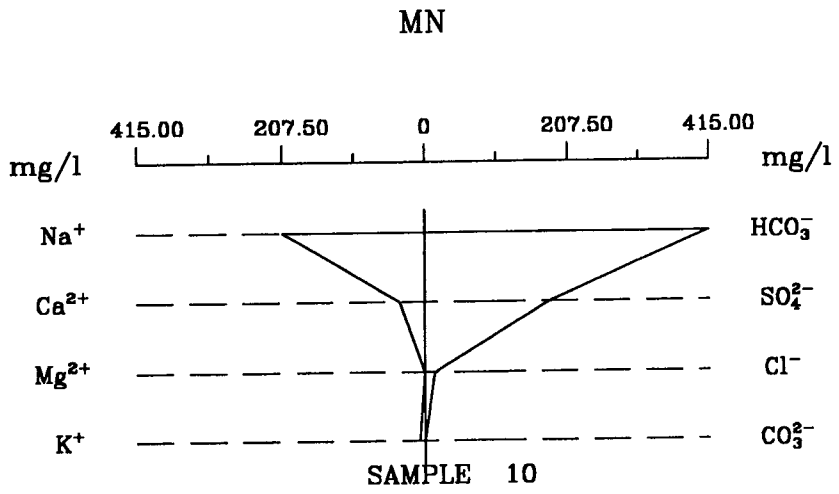
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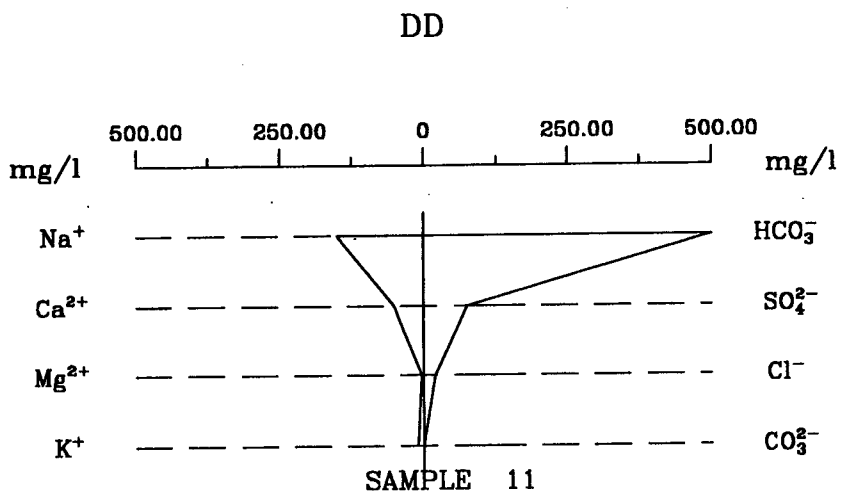
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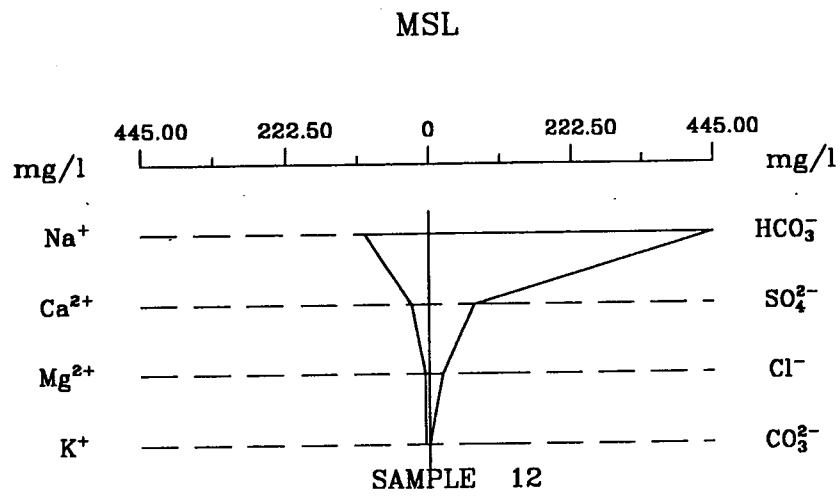
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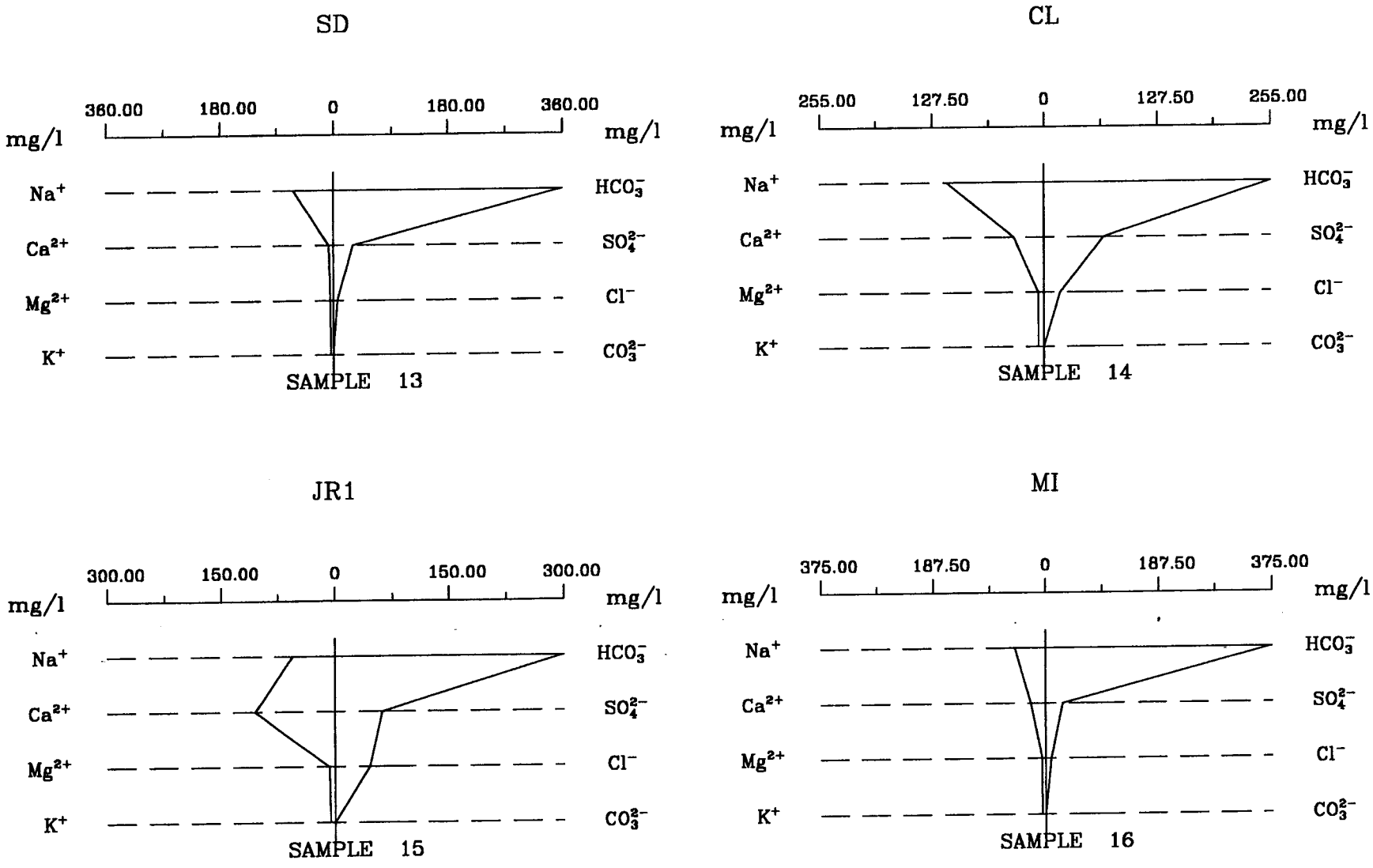
U >200 ppb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CO32-
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mg/l
mg/l
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Mg2+
K+
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CO32-
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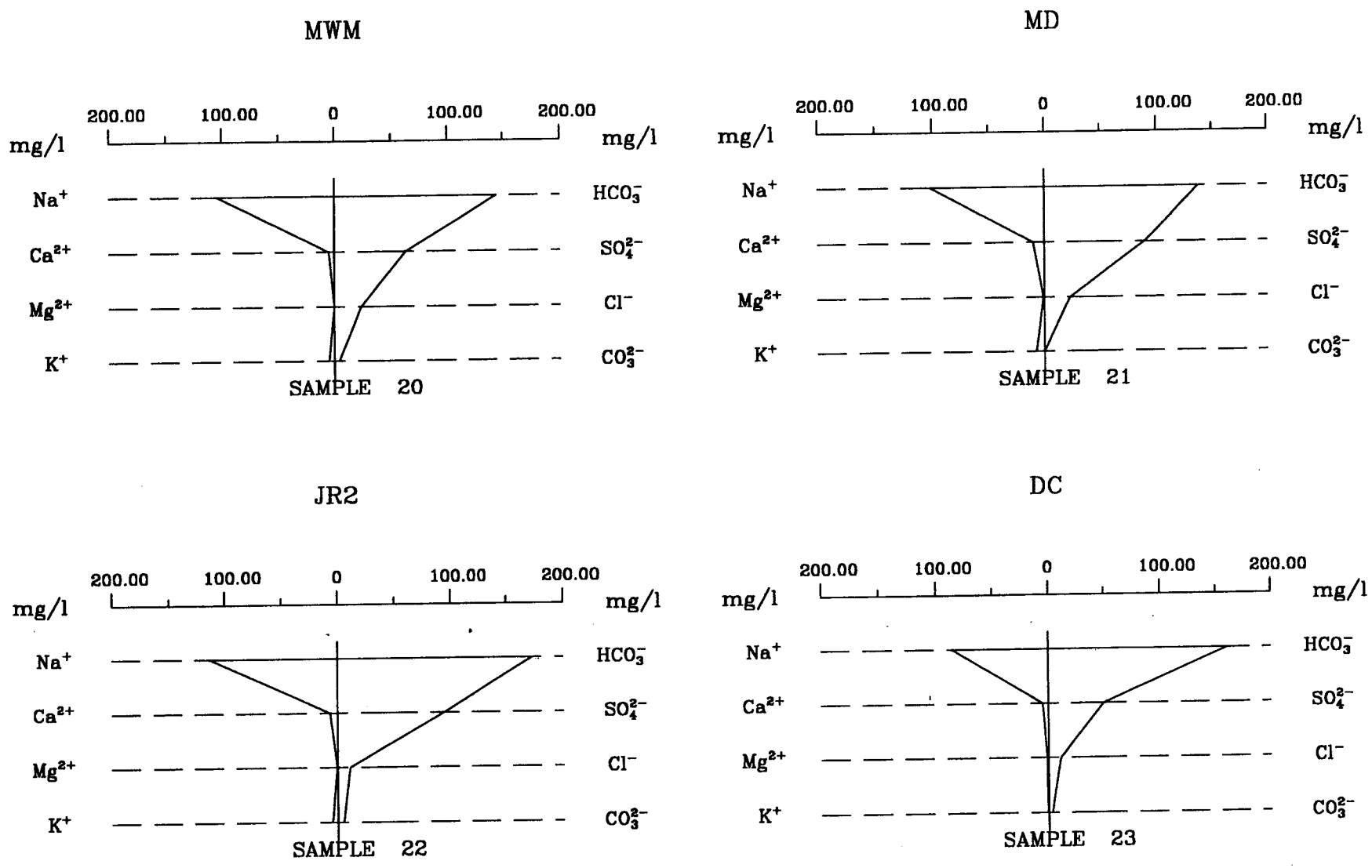
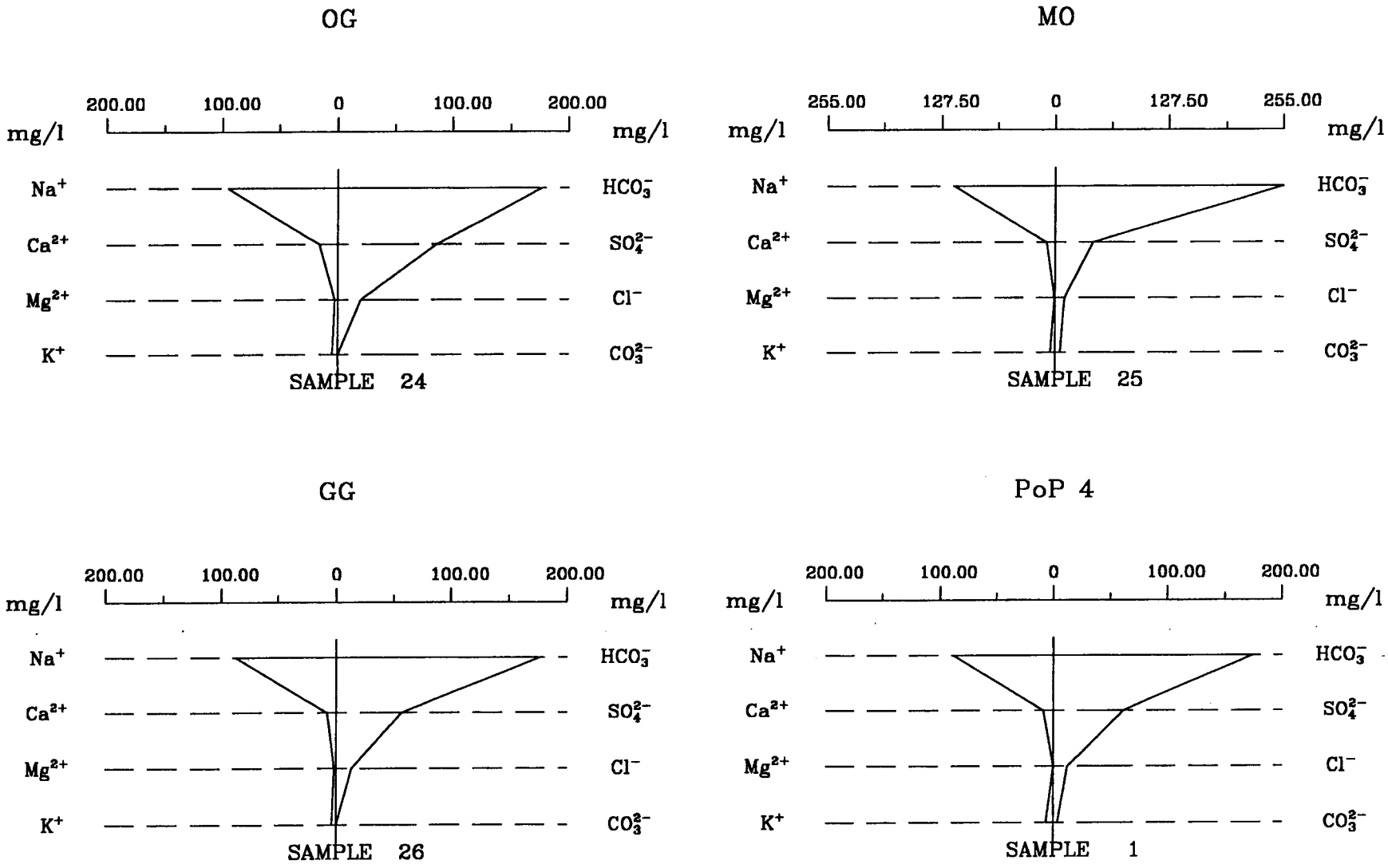
187.50
0
187.50
375.00
mg/l
mg/l
Na+
Ca2+
Mg2+
K+
HCO3-
SO42-
Cl-
CO32-
SAMPLE 16

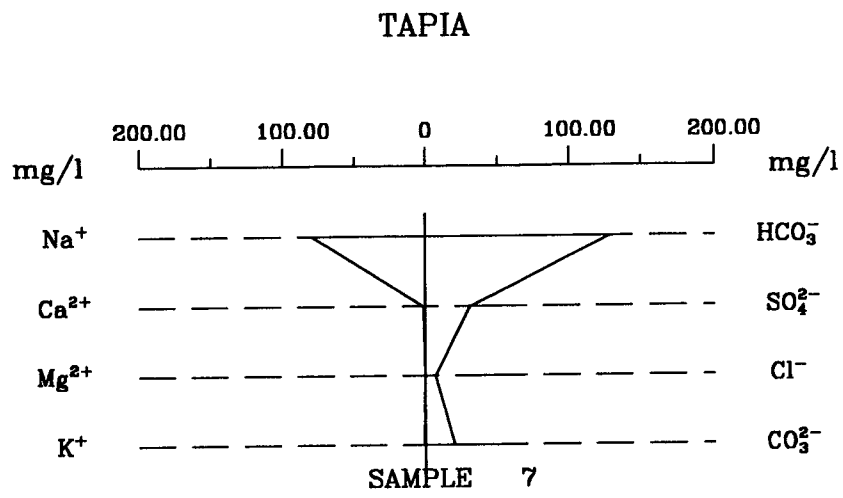
U 20–200 ppb

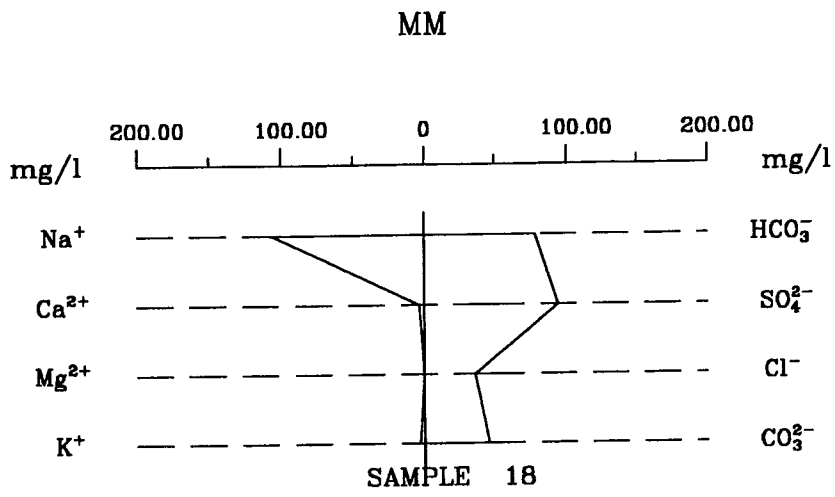

MWM
200.00
100.00
0
100.00
200.00
mg/l
mg/l
Na^+
Ca^{2+}
Mg^{2+}
K^+
HCO_3^-
SO_4^{2-}
Cl^-
CO_3^{2-}
SAMPLE 20
MD
200.00
100.00
0
100.00
200.00
mg/l
mg/l
Na^+
Ca^{2+}
Mg^{2+}
K^+
HCO_3^-
SO_4^{2-}
Cl^-
CO_3^{2-}
SAMPLE 21
JR2
200.00
100.00
0
100.00
200.00
mg/l
mg/l
Na^+
Ca^{2+}
Mg^{2+}
K^+
HCO_3^-
SO_4^{2-}
Cl^-
CO_3^{2-}
SAMPLE 22
DC
200.00
100.00
0
100.00
200.00
mg/l
mg/l
Na^+
Ca^{2+}
Mg^{2+}
K^+
HCO_3^-
SO_4^{2-}
Cl^-
CO_3^{2-}
SAMPLE 23

U 5–20 ppb

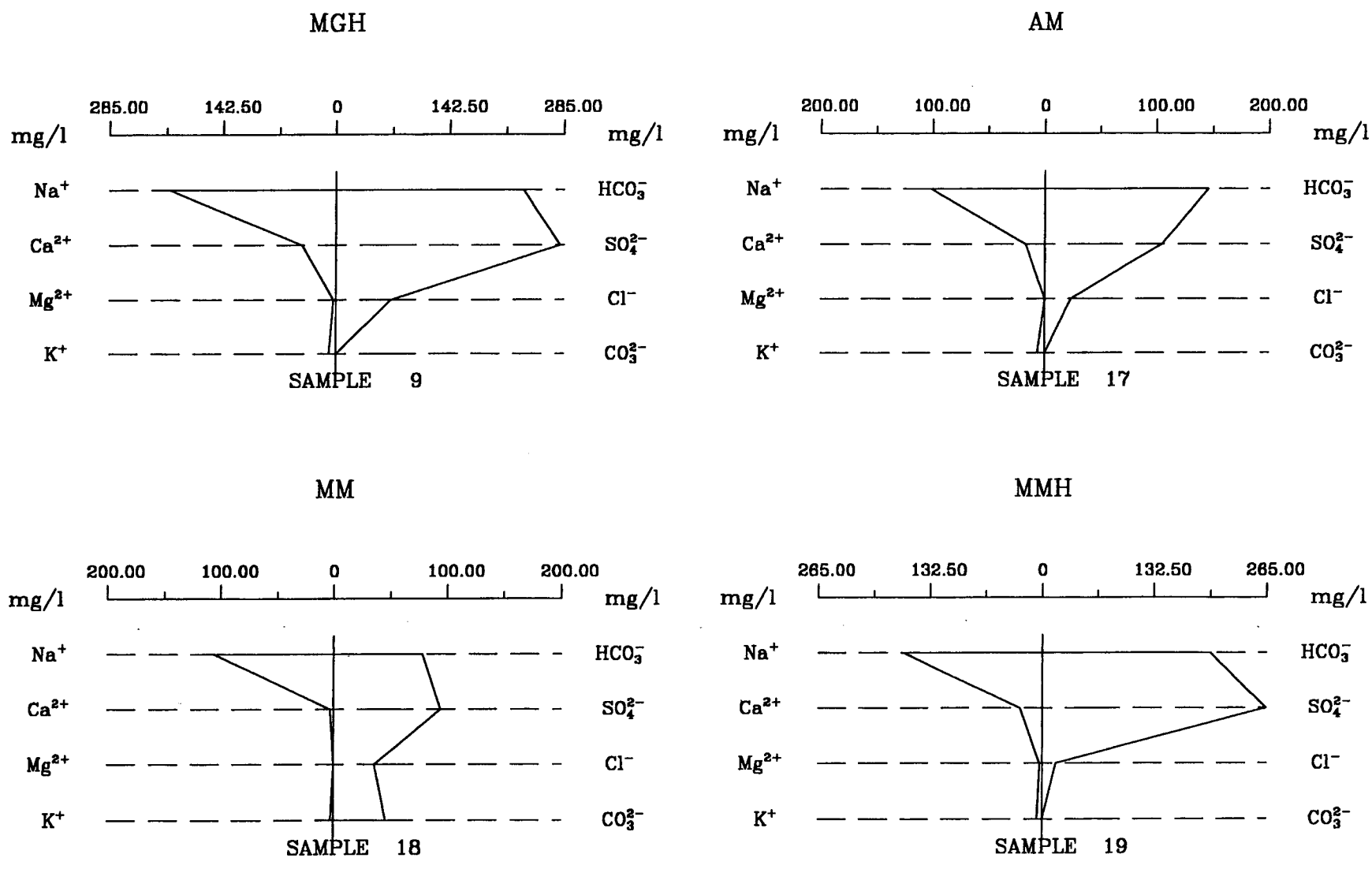

OG
200.00
100.00
0
100.00
200.00
mg/l
mg/l
Na^+
Ca^{2+}
Mg^{2+}
K^+
HCO_3^-
SO_4^{2-}
Cl^-
CO_3^{2-}
SAMPLE 24
MO
255.00
127.50
0
127.50
255.00
mg/l
mg/l
Na^+
Ca^{2+}
Mg^{2+}
K^+
HCO_3^-
SO_4^{2-}
Cl^-
CO_3^{2-}
SAMPLE 25
GG
200.00
100.00
0
100.00
200.00
mg/l
mg/l
Na^+
Ca^{2+}
Mg^{2+}
K^+
HCO_3^-
SO_4^{2-}
Cl^-
CO_3^{2-}
SAMPLE 26
PoP 4
200.00
100.00
0
100.00
200.00
mg/l
mg/l
Na^+
Ca^{2+}
Mg^{2+}
K^+
HCO_3^-
SO_4^{2-}
Cl^-
CO_3^{2-}
SAMPLE 1

U 1–5 ppb


TAPIA
200.00
100.00
0
100.00
200.00
mg/l
mg/l
Na+
Ca2+
Mg2+
K+
HCO3-
SO42-
Cl-
CO32-
SAMPLE 7


MM
200.00
100.00
0
100.00
200.00
mg/l
mg/l
Na+
Ca2+
Mg2+
K+
HCO3-
SO42-
Cl-
CO32-
SAMPLE 18

High F


MGH
285.00
142.50
0
142.50
285.00
mg/l
mg/l
Na+
Ca2+
Mg2+
K+
HCO3-
SO42-
Cl-
CO32-
SAMPLE 9
AM
200.00
100.00
0
100.00
200.00
mg/l
mg/l
Na+
Ca2+
Mg2+
K+
HCO3-
SO42-
Cl-
CO32-
SAMPLE 17
MM
200.00
100.00
0
100.00
200.00
mg/l
mg/l
Na+
Ca2+
Mg2+
K+
HCO3-
SO42-
Cl-
CO32-
SAMPLE 18
MMH
265.00
132.50
0
132.50
265.00
mg/l
mg/l
Na+
Ca2+
Mg2+
K+
HCO3-
SO42-
Cl-
CO32-
SAMPLE 19

Na–HCO3–SO4