IN THE MATTER OF SPARTON TECHNOLOGY, INC.
U.S. EPA DOCKET NO. RCRA-V1-001 (h)-96-H

REPORT OF GARY L. RICHARDSON, P.E. ON THE USE OF INJECTION WELLS AT GROUNDWATER REMEDIATION SITES

February 3, 1997

I am outlining the information which I have concerning the performance of injection wells at groundwater remediation sites in New Mexico. This information is based on the literature, my own experience, and on conversations I have had with employees of Rodgers & Co., Inc., a local drilling contractor which has had involvement in construction and maintenance at these sites. There are three sites in the Albuquerque, New Mexico area for which I have information.

General Electric Superfund Site

The G.E. Superfund site is located in Albuquerque's south valley near Rio Bravo and I-25. The groundwater at that site is contaminated with chlorinated solvents. There are 1 - 6" x 400'± and 9 - 8" x 400'± injection wells at the site.

The 6" well was first constructed to dispose of development and test water at the site. It is my understanding that it was necessary to redevelop the well after 2 - 3 million gallons of water was reinjected. It was determined that bacterial fowling was mostly responsible for the problems.

The additional 9 - 8" injection wells were constructed to dispose of treated groundwater from the remediation system. The total injection capacity of the ten wells is reported to be around 820 gpm. Since the wells were placed into operation in April 1996, reinjection has averaged about 560 gpm or about 2/3 of capacity. Even at this reduced capacity, one well is showing signs of plugging and is scheduled for redevelopment.

Chevron Site

The Chevron site is located adjacent to the G.E. site. The groundwater at that site is contaminated with petroleum hydrocarbons. There are 4 - 8" x 120'± injection wells at the site constructed to dispose of treated groundwater. The total injection capacity is about 160 gpm, which is about 84 million gallons per year. The injection wells have been completed for about one year. During that time only 5 million gallons of water have been injected. This represents about 6% of the annual capacity. No problems have been reported with the injection wells, however, they have received only very limited use. The wells have not been used enough to determine if problems will develop.

Fina Station Site
This site is located south of Rio Bravo and west of Isleta in Albuquerque. The groundwater at the site was contaminated with petroleum hydrocarbons. Several driven injection wells were installed at this site. In less than 6 months, it was necessary to pull the wells to remove mineral deposits from the well screens. The inside of the wells were also filled with mineral deposits having the consistency of corn meal.

In addition to the local problems that have been experienced with injection wells, many shortcomings and problems are reported in the literature.

Numerous technical papers identify problems associated with operation of injection wells. Injection wells are much more likely to fail than are typical water wells (Driscoll, 1986). According to Olsthoorn (1982), clogging of screens is the serious problem in injection well operation. Signor (1976) adds that recharge through injection wells usually requires stringent water quality considerations, and recharge operations are generally less successful than in spreading basins because suspended sediment in the recharge water clogs the formation near the well. Once the formation is clogged, it is difficult to remove enough sediment to completely rejuvenate the well.

The principal causes of clogging mentioned in reports concerning recharge through wells are:

1) Suspended particles in the recharge water.

   In an injection well, fine sediment contained in the injection water will continuously collect in the formation or filter pack outside the well screen. Over time the formation slowly becomes clogged, reducing the capacity of the aquifer to receive water (Driscoll, 1986). Smith (1980) indicates that sand, even in concentrations of one part per million, can be sufficient to clog injection wells in a relatively short time.

2) Bacterial contamination of the aquifer by the recharge water and subsequent clogging by bacterial growths.

   Bacterial growth can be promoted by the change in temperature caused by injection, especially when warmer water is added to a cool aquifer (Smith, 1980).

3) Chemical reactions between the groundwater and recharge water of different quality causing precipitation of insoluble products.

4) Mechanical jamming of the aquifer, caused by particle rearrangement when the direction of water movement through the aquifer is reversed.

5) Swelling of clay colloids in the aquifer.

6) Incrustation created by injection water which is high in mineral content.

7) Ion exchange reactions that could result in clay-particle dispersal.

8) Precipitation of iron in the recharge water as a result of aeration.

9) Injection tubing corrosion.

   Owens (1975) reports that differential oxygen cell corrosion occurs in carbon steel injection tubing. For stainless steel, stress cracking is a problem. For fiberglass plastics, softening by sorption of fluids can occur.

10) Biochemical changes in the recharge water and groundwater involving iron reducing bacteria or sulfate-splitting organisms.

11) Gas binding or air entrainment in the aquifer.

    Smith (1980) explains that when air is entrained with injection water, serious interference with permeability and transmissivity can be expected because air molecules can effectively block the passage of water by plugging pore space within the aquifer.

12) Change in viscosity of recovered groundwater due to temperature difference between recovered groundwater to be reinjected and receiving groundwater.

Based on the cited literature (see enclosed references) and the experiences in Albuquerque's south valley, we can expect to have to overcome all 12 problems listed above if we choose to use injection well(s) at Sparton's Coors Road Plant.

Assuming one 8" x 400' injection well with pretreatment including filtration, pH control, air removal and chlorination, could be used to reinject 200 gpm at the Sparton site, I believe that optimistically the anticipated capital cost would be $500,000 and the operation and maintenance cost would be $200,000 per year. These costs are high because the injected water chemistry must be controlled very carefully and the injection wells must be redeveloped and replaced periodically. If additional problems were encountered, the cost could be several times the anticipated costs.

Based on the potential for problems and anticipated high costs, I recommend that injection wells not be used at the Sparton site. Rather, I recommend that the water be discharged to the Calabacillas Arroyo via the storm sewer. The cost to discharge to storm sewer would be less than $10,000.

Based on an infiltration test conducted in the Calabacillas Arroyo by METRIC Corporation in November 1996, I estimate that 97% to 99% of the water discharged to the arroyo will infiltrate back into the normally dry arroyo bottom and ultimately back into the aquifer. The remaining 1% to 3% will evaporate from the arroyo bottom.

I state under penalty of perjury that the foregoing is true and correct.

Executed on February 4, 1997.

METRIC Corporation

Gary L. Richardson

Gary L. Richardson, P.E.
Executive Vice President

GLR/rkh
Enclosure

REFERENCES

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QUALIFICATIONS OF GARY L. RICHARDSON, P.E.
CIVIL ENGINEER/HYDROLOGIST

New Mexico State University, M.S. in Civil Engineering, 1972

New Mexico State University, B.S. in Civil Engineering, 1970

New Mexico Registered Professional Engineer (cert. no. 6436)

Texas Registered Professional Engineer (cert. no. 73867)

Arizona Registered Professional Engineer (cert. no. 26091)

Sigma Tau Engineering Honorary Fraternity

Chi Epsilon Civil Engineering Honorary Fraternity

New Mexico Water Well Drillers License No. WD-1088

Texas Water Well Drillers License No. 2610W

Gary L. Richardson serves as Director, Executive Vice President, and Hydrologist/Civil Engineer for METRIC Corporation from 1980 to present. His technical responsibilities are in conducting ground and surface water hydrology studies, hydraulic design, erosion and sedimentation investigations, supervision, drilling, and installation of water wells, aquifer testing, and dewatering system design. Mr. Richardson serves as project manager for all hydrology projects. In particular, he provided well design, drilling and completion supervision, aquifer testing, and hydrologic analysis for production wells at Santa Ana and Zia Pueblos for the Bureau of Indian Affairs, Tijeras Land Estates, Tesuque Pueblo, Sandoval County Regional Soccer Park, Reeves Generating Station, and American RV Park. He has designed dewatering plans for ponds at San Juan Generating Station and Plains Escalante Generating Station. Mr. Richardson has conducted bedrock and water table delineation using borehole and well drilling techniques in the McDermott Arroyo vicinity at La Plata Mine, and along the Shumway Arroyo near San Juan Mine and San Juan Generating Station in San Juan County. He has prepared diversion, flood control, and haul road designs for industrial facilities, conducted proceedings for groundwater acquisition, prepared mine discharge plans and permit applications, and prepared air quality analyses for permit applications and for PSD exemption.

Mr. Richardson has provided expert witness testimony regarding ground and surface water analyses at mine permit hearings for the Lee Ranch Mine, La Ventana Mine, Black Diamond Mine, South Hospah Mine, Gateway Mine, Bisti Mine, De-Na-Zin Mine, and La Plata Mine. He was a primary witness for Sunbelt Mining Company at the unsuitability petition hearing for the Gateway Mine. Mr. Richardson also provided expert witness testimony for Arco Pipeline Company in U.S. District Court.

Mr. Richardson served as project engineer for Earth Environmental Consultants, Inc., Albuquerque, New Mexico, from 1978 to 1980, conducting investigations in groundwater hydrology, supervision of water well installation, aquifer testing, hydraulic design, surface water hydrology, discharge analyses, erosion control and sedimentation, and water resources management in New Mexico. In particular, he conducted ground and/or surface water analyses at the Lee Ranch Mine, Amcoal Mine, Mentmore Mine, San Juan Mine, La Ventana Mine, La Plata Mine, Black Lake Mine, Black Diamond Mine, Star Lake Mine, South Hospah Mine, Arroyo No. 1 Mine, Gateway Mine, De-Na-Zin Mine, in northwestern New Mexico. He installed wells, piezometers, stream gauges, and sediment samplers, and prepared water monitoring plans for a number of coal project areas.

From 1972 to 1978, Mr. Richardson served as hydrologic engineer with the Soil Conservation Service, Albuquerque, New Mexico. Among his project responsibilities, he was involved in locating water sources and securing water rights in Anthony, Espanola, and Santa Cruz areas for use in the construction of floodwater retarding dams. As an SCS engineer, Mr. Richardson also performed surface water hydrology and hydraulics for small watershed projects, river basin studies, and hydraulic designs, drawings, and specifications for irrigation structures, erosion and sediment control structures, floodwater retarding dams, and floodwater diversion structures.