



SMC Martin Inc.

**EVALUATION OF THE INVENTORY
OF CLASS V INJECTION WELLS
IN THE STATE OF WYOMING**

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EVALUATION OF THE INVENTORY
OF CLASS V INJECTION WELLS
IN THE STATE OF WYOMING

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EXECUTIVE SUMMARY

An inventory of Class V injection wells in Wyoming was reviewed and evaluated by SMC Martin as part of U.S. EPA Contract #68-01-6288. The inventory was compiled under a contract between the Wyoming Department of Environmental Quality (DEQ) and Professional Solutions, Inc., of Cheyenne, Wyoming. The methodology utilized in compiling the inventory is well conceived and comprehensive. This inventory has been tailored to the needs of the DEQ, however, and does not represent a complete inventory as defined by EPA. Recommendations are made in this report for the completion and maintenance of the inventory.

Approximately 700 injection wells are listed in the inventory, including at least 445 septic systems with drain fields. These septic systems are not defined by the EPA as injection wells (40 CFR 146.03). In addition, although SMC Martin has confirmed their existence in Wyoming, no aquifer recharge wells or in situ hydrocarbon (e.g., shale oil) extraction related wells are listed in the inventory. These departures from EPA's inventory requirements were apparently built into the inventory by Wyoming DEQ. The DEQ believes that its files on injection wells used for aquifer recharge and oil shale extraction are complete and accurate, and that its files on sanitary waste disposal contain data gaps. The DEQ directed the inventory contractors to concentrate on septic systems at

the expense of other areas such as oil shale and aquifer recharge wells. With this in mind, it appears that integration of DEQ's existing files with the Professional Solutions' inventory should result in a largely complete and accurate account of Wyoming injection wells.

Several additional problems were noted with regard to existing inventory information. There are 131 unverified wells listed in appendices to the inventory report. The type, status, and number of these wells should be confirmed and they should be added to the inventory where appropriate. In addition, a number of duplicate entries, multi-well projects showing incorrect numbers of wells, and wells whose status, as reported in that inventory, has changed were noted. It is felt that rigorous application of previously-employed inventory methodology to the unverified wells, coupled with integration of the DEQ files, should allow Wyoming's inventory to be completed to the satisfaction of both the EPA and the DEQ. Once complete, the inventory can be regularly updated if the state enacts permit requirements for Class V wells which are currently out of its jurisdiction. The state Class V permit file can then be monitored periodically.

INTRODUCTION

The Underground Injection Control (UIC) program was developed in order to prevent or reduce deterioration of quality in potential or current underground sources of drinking water (USDWs). According to UIC regulations, an injection well is "bored, drilled or driven shaft, or a dug hole, whose depth is greater than the largest surface dimension" used for the "subsurface emplacement of fluids" (40 CFR 146.03).

These wells may be utilized for a variety of purposes including heat pump return flow, aquifer recharge, mineral resource production, hydrocarbon storage, and waste disposal. Properly designed and applied injection wells may impact ground-water resources. Injection facilities that are improperly designed, constructed, operated, and/or abandoned can pose a serious threat to underground drinking water sources.

Five classes of injection wells have been defined in the UIC program. Class V wells include those used for heat pump return flow, aquifer recharge, non-hazardous waste disposal, experimental technologies, mine backfill, and in situ oil shale recovery.

Though Class V wells are reported to account for more than 61 percent of all injection wells in the United States, there is presently little information on the actual numbers, operation, and impact of wells in this class. This lack of information has prevented the development of a regulatory system appropriate to

Class V wells. Therefore, Class V well inventories have been commissioned by the EPA.

Under the auspices of the UIC program, an inventory of Class V injection wells was developed by Wyoming, which has assumed primacy over its UIC program. On September 26, 1983, the State of Wyoming's Department of Environmental Quality (DEQ), Water Quality Division (WQD) contracted Professional Solutions, Inc., of Cheyenne, Wyoming, to perform the required Class V inventory. The completion date for the inventory is listed as July 1, 1984.

METHODOLOGY

The methodology which Professional Solutions, Inc., used to conduct the Wyoming inventory was stated as follows:

"The inventory of Class V wells in Wyoming was initiated by interviewing State and Federal government agencies and reviewing available records. Representatives from each government agency were asked to review the list of Class V injection well categories and provide any information they could regarding the presence of these well types in Wyoming. Local government offices were then contacted regarding the presence of Class V injection wells within their jurisdiction.

For each well category, potential owners of injection wells were identified, as well as businesses likely to install or service such wells. These persons and/or businesses were then contacted for information.

When potential well owners or information sources could not be reached, an extensive telephone and letter follow-up system was employed. Due to the number and diversity of information sources used throughout the inventory, meticulous recordkeeping was essential. Records of persons contacted, information provided, and persons yet to be contacted were kept on computerized text editor files. These records were frequently updated throughout the course of the inventory." (Professional Solutions, Inc., 1984).

This methodology is similar to that developed by SMC Martin for inventories of Class V injection wells in other states.

SMC Martin has reviewed and evaluated the Wyoming inventory as part of EPA Contract #68-01-6288. In accordance with the work plan for this task, a representative sample of well owners, operators, and other information sources was contacted in order

to verify the accuracy of the inventory data. The owners and/or operators of 24 of 32 facilities with 215 of 254 inventoried non-septic system wells were contacted. The Wyoming DEQ, Highway Department, Geological Survey, and County Health Services were among governmental agencies contacted. Private sector contacts included well drillers and a variety of businesses and individuals listed as well owners. By direction of Region VIII of the EPA, none of the septic system entries were checked by SMC Martin since they are not classified by the EPA as injection wells and because this data was collected from state and local government sources which are considered to be reliable. Professional Solutions contacted owners of septic systems in the course of their inventory study to verify the data.

ANALYSIS OF INVENTORY

A total of 699 Class V wells at 366 facilities were inventoried in the Wyoming study. An additional 131 entries were listed in that study as possible, but unverified, wells or well sites. Table 1 summarizes the Wyoming study findings. Telephone contacts made during this evaluation/assessment process provided revisions and updates of existing inventory information. This information is summarized in Table 2. SMC Martin's analysis and comments regarding the inventory effort and its findings are presented in the following pages by topic.

DEQ Vs. EPA Class V Well Definitions

A comparison of EPA versus Wyoming descriptions of Class V wells are presented in Table 3. EPA's Class V well descriptions, as they apply to required inventory activities, are given in 40 CFR 146.05. In the contract between Wyoming DEQ and Professional Solutions, Inc., Item 4 does not follow the EPA definition as it appears in Table 3. It seems likely that the latter part of Item 5 was transposed to become part of Item 4. This error was traced back as far as the Request for Proposal, issued August 10, 1983 by the Wyoming Department of Administration and Fiscal Control, Purchasing and Property Control Division. This wording should be modified to prevent the possible incorrect classification of injection wells in the State of Wyoming.

TABLE 1

CLASS V INJECTION WELL INVENTORY FOR WYOMING,
PROFESSIONAL SOLUTIONS, INC.

Well Type Description	Number of Facilities	Number of Wells
Heat pump (air conditioner) return flow	5	7
Backfill	5	75
Cesspools	3	3
Drainage	3	6
Dry Wells	4	33
Experimental Technology	10	116*
Septic Systems	334	445*
Solution Mining of Conventional Mines	2	14
Total of Verified Systems	366	699
Total of Unverified Systems	131	131

* Some sites have an unknown number of wells present.

TABLE 2

EVALUATION OF CLASS V INJECTION WELL INVENTORY FOR WYOMING

ac = active ab = abandoned *facilities with unknown number of wells are inventoried

Well Description	Facilities/wells Inventoried by Professional Solutions	Facilities/wells from Inventory Contacted by SMC Martin	Facilities/wells as Revised by SMC Martin	Comments
Heat Pump Return Flow	5/7	4/6 ac	5/6 ac	C-V Ranch has 2, not 3, return flow wells. The third well is for extraction.
Backfill	5/75	5/75 ac	5/75 ab	No changes. A new project with about 57 wells is planned (Appendix A).
Cesspool	3/3	2/2 ac	3/3 ac	No change.
Drainage Well	3/6	3/6 ac	2/5 ac	Wycon Chemicals has 2, not one, wells but both are classed by the DEQ as Class I.
Dry Well	4/33	4/33 ac	3/23 ac 5 ab	Roger Hessler has one 5-well project, now abandoned; not 2 active 5-well facilities.
Experimental Technology	10*/116*	3/77	14/129	Sequoyah Fuels (Kerr McGee) has two projects with 21 total wells, not one 10 well project. Cleveland Cliffs has 44, not 41, wells.
Septic System	334*/445*	0/0	0/0	None contacted.
Solution Mining of Conventional Mines	2/14	2/14	2/7	Sequoyah Fuels (Kerr McGee) has 2 projects, but with 7, not 14, wells.

TABLE 2 · (Continued)

EVALUATION OF CLASS V INJECTION WELL INVENTORY FOR WYOMING

ac = active ab = abandoned *facilities with unknown number of wells are inventoried

Well Description	Facilities/wells Inventoried by Professional Solutions	Facilities/wells from Inventory Contacted by SMC Martin	Facilities/wells as Revised by SMC Martin	Comments
Aquifer Recharge	0/0	0/0	2/3+	Teton Village Sewage has 3 wells Caspar Reclamation project could not be confirmed.
<u>In Situ</u> Hydrocarbon (e.g., shale oil) Recovery	0/0	0/0	estimated 1/ unknown	Preliminary contacts only, no substantive information was received at the time of this report writing.

TABLE 3

EPA AND WYOMING CLASS V WELL DESCRIPTIONS:
DRAINAGE WELLS AND DRY WELLS

EPA Description (40 CFR 146.05 amended February 3, 1982)	Wyoming Description DEQ Contract for Services for Class V Well Inventory
4. Drainage wells used to drain surface fluid, primarily storm runoff into a subsurface formation.	4. Drainage wells used for the injection of wastes into a subsurface formation.
5. Dry wells used for the injection of wastes into a subsurface formation.	5. Dry wells used for the injection of wastes into a subsurface formation.

Note the difference between EPA and Wyoming Type 4.

Septic Systems

Note that of the 699 verified wells, about 445 are listed as septic system injection wells. Nearly all of these 'wells' are leach field septic systems, which are wider than they are deep, thus they do not qualify as underground injection wells according to EPA's definition. This conclusion was confirmed by SMC Martin via contacts with some listed owners/operators and government officials. A separate category of Class V wells (dry wells) was used in the inventory to account for septic systems with well injection. Contact with Mr. Jake Strohman and Mr. Dick Lennox of the Wyoming DEQ indicated that the septic systems were inventoried at the state's request. Appendix A documents the DEQ's desire to include all large septic systems in the inventory.

Unverified Wells

There are 131 unverified wells listed in appendices to the inventory report but not included in the 699 inventoried wells. The number, type, and status of these wells must be established in order to complete the inventory. The potential margin of error for the inventory implicit in this number of unverified wells (Table 1) is too great to allow them all to remain as unknowns. Many of the listings for unverified wells suggest that only a limited amount of effort was expended in trying to obtain information (e.g., only a single telephone call). It is, therefore, suggested that the number of unverified wells could

be reduced by following more rigorously the methodology utilized for the inventory.

Eight suspected well owners are listed who would not provide information that could verify their wells. Most of the pertinent information for their evaluation can be derived from state or local permits. These wells should be added to the inventory, if they are in fact Class V wells.

Aquifer Recharge Wells

Aquifer recharge wells were found to be missing from the existing state inventory. Contacts with state officials identified two aquifer recharge projects: Teton Village Sewage System and the Casper Reclamation Project. Only the former project was confirmed and a total of three wells were identified at Teton Village. The Casper Reclamation Project could not be verified because the information from the contractor was not received in time for this report.

In Situ Extraction Wells

The Wyoming inventory included no wells used for in situ recovery of lignite, coal, tar sands, and oil shale. However, it is stated in the inventory report that "Several such operations have been conducted in the state; however, they involved only the injection of air and/or steam and small amounts of tracer." If this is the case, then these are in fact injection wells which should be inventoried.

It is recognized that both aquifer recharge and in situ wells were omitted from the inventory at Wyoming DEQ's direction to permit the inventory authors to concentrate on septic systems in their work. Contact with the DEQ indicated that these omissions were expected and acceptable since the state files in these, and other, areas are complete and accurate. Therefore, the omissions from the inventory of aquifer recharge and in situ wells is only a shortcoming with regard to fulfillment of EPA inventory requirements. Augmentation of existing inventory findings with state files on these specific types of injection wells should remedy this situation.

Backfill Project Wells

Mr. George Barnes (Land Quality Division, DEQ) indicated that another backfill project, in addition to those inventoried, using injection for subsidence control is scheduled to begin in the summer of 1985. A total of approximately 57 injection boreholes are prepared for this project: 17 for fly ash injection and about 40 for portland cement group injection. This project should be monitored so that its injection wells can be inventoried.

Minor Updates/Corrections

In addition to the problem area of uninventoried wells, both unverified and omitted, a few relatively minor mistakes were found in specific inventory entries during SMC Martin's

verification effort. A heat pump installation at the C-V Ranch, for instance, was listed in the inventory as having three injection wells for return flow. Contact with the owner revealed that one of the three wells was for extraction purposes. In another case, one individual (Roger Hessler) was listed as the owner of two sites with five active wells each. The owner indicated that only one site with five wells, now shut down, existed. Apparently, two sites were listed because the operation had both state and county permits and each permit was thought to represent a different site. A number of well status changes were also noted, reflecting changes that have occurred in the months since the Wyoming inventory was completed (Table 2).

In addition, one injection well, the Wycon Chemical Company well, was incorrectly classified as a drainage well. This well is classified by the state as a Class I injection well because of its deep injection of industrial waste. A second Class I well, similar to the inventoried well, has recently been put into operation at Wycon.

Based on the sample of well owners contacted, SMC Martin estimates that about 10 percent of the entries in the inventory contain minor errors. This estimate does not take into account the non-inventoried wells. It should be noted that verification of inventory entries was greatly facilitated by the listing of reliable contact names and telephone numbers for each well in the inventory.

POTENTIAL ENVIRONMENTAL IMPACTS OF CLASS V INJECTION WELLS IN WYOMING

Class V injection wells in Wyoming have varied potential environmental impacts that relate primarily to the functions of the wells. For discussion of environmental impact potential, wells will be grouped as follows: 1) heat pump return flow wells; 2) backfill wells; 3) cesspools and dry wells; and 4) wells used for solution mining.

Heat Pump Return Flow Wells

No adverse environmental impacts have been reported for any heat pump return wells in Wyoming. Wells of this type do have the potential for a variety of adverse environmental impacts, which, based on past research (SMC Martin, 1983), are generally limited and localized. Injection of heat pump effluent can change ground-water temperatures. If the heat pump was being used for heating, as opposed to air conditioning, the effluent or discharge fluid would have a lower temperature than the initial ground-water temperature. Change in temperature could affect the aquifer by changing chemical reaction rates, altering the stability of mineral phases and influencing ground-water biota. These temperature changes and impacts, however, are generally limited to the vicinity of the well bore.

If the source and disposal aquifers in a ground-water heat pump system are different, mixing of waters from different aquifers could have adverse results. Changes in ground-water

quality in the receiving aquifer is the most serious potential impact of mixing.

Injected heat pump effluent may also have the effect of plugging pore spaces in the receiving aquifer. The introduction of solids and/or air can cause plugging as can the action of bacteria carried by the effluent. Plugging of aquifers would be a serious problem since paths for ground-water flow would be thereby restricted and hydrologic parameters (e.g., transmissivity) of the aquifer affected. Here again, however, potential would generally be limited to the vicinity of the wellbore. If the heat pump system construction is faulty or fails during use, contaminants such as Freon could be introduced to the ground-water system.

Although a variety of potential environmental impacts of heat pump systems using injection wells have been identified, all are generally minor and limited in areal extent within the aquifer. This has been found to be true even where there is a high concentration of systems, such as in the Tidewater, Virginia area (SMC Martin, 1983). The small total number of heat pump return flow wells in Wyoming (only five were identified) further reduces the potential environmental impact of this group of wells.

Backfill Wells

The inventory identified 75 backfill wells in Wyoming, concentrated in the city of Rock Springs. These now-abandoned

sites were used for injection of backfill to stop surface subsidence into mined-out, underground coal workings beneath the city. Cased holes drilled into mine voids were used for the injection of material: 22 of the wells introduced a dry sand slurry; 45 wells injected fly ash in an air slurry. The potential environmental impact of the backfill wells at Rock Springs and backfill wells in general is significant and, for the most part, beneficial. First and foremost, the reduction of surface subsidence into mine voids is an important and positive impact, particularly in a developed area such as Rock Springs.

The injection of fly ash, the residue from coal-burning operations, is in itself beneficial, since it is essentially a waste product that would alternatively require some other means of disposal. Fly ash is alkaline in chemistry, generally with a pH greater than 8.5. Ground water which moves through the fly ash backfill in the mine workings will become alkaline, perhaps neutralizing any acid that may be leaching from pyritic coal wastes or roof rock materials remaining in the mine voids. One unlikely adverse feature is that the fly ash backfill has the potential to introduce very fine-grained solids into the ground water resulting in possible plugging of aquifers. Sand used for backfill is generally not perceived as having any significant impacts on the environment. Further site specific evaluations are required to assess the environmental impacts of backfill injection at any given site.

Cesspools/Dry Wells

In Wyoming, the three cesspools are garage floor drains while the 28 dry wells are used for sanitary wastewater disposal. The major potential impact of this group of wells is the introduction of bacterial and viral contaminants into ground water. Other household wastes which have been introduced through the system may also enter the ground water. Effluent from sanitary waste disposal systems can infiltrate into aquifers, carrying with it pathogens and other substances that have escaped the treatment processes in the septic tank.

Effluent from septic tanks which drain into cesspools/dry wells does not undergo treatment and filtering in a leach field. For this reason, cesspools/dry wells have a greater potential environmental impact than leach fields. However, the potential statewide impact of these wells in Wyoming is limited by their low total number. Outside of a single 20-hole facility used for seasonal disposal of gray water from RVs, there are only 11 cesspools/dry wells in Wyoming. Further study is needed to evaluate the environmental impact of these specific facilities.

The 440+ septic systems, which do not use injection wells, were included in the inventory by DEQ to permit evaluation of potential environmental impacts. Those systems which may significantly impact ground-water resources will be classified as Class V injection wells.

Solution Mining Wells

All of the wells in this group, including experimental technology wells used for this purpose, inject fluids designed to mobilize mineral resources so that they can be pumped to the surface. The potential environmental impact of these wells is significant; but projects utilizing them are carefully screened initially and monitored during operation to prevent serious environmental problems.

Of the (at least) 136 solution mining wells in Wyoming (Table 2), nearly all are or were utilized for uranium extraction. In this process, an alkaline liquid (e.g., sodium bicarbonate solution) with an added oxidizing agent (e.g, hydrogen peroxide) is injected into uranium-bearing formations. Uranium is oxidized to the +6 valence state by the oxident and is taken into solution by the alkaline liquid. The "pregnant" solution is then pumped out through extraction wells.

The contamination of ground water by any of the chemical species in the solution is the primary potential environmental impact. This impact potential is reduced greatly by carefully maintaining equivalent fluid injection and fluid extraction volumes. This balance prevents waste of fluid and helps maintain the cost effectiveness of solution mining projects. In addition, numerous monitoring wells positioned around the solution mining projects identify any ground-water contamination before it migrates past the project area. Finally, all of the

experimental projects have ended, or will end, with a restoration phase during which cleanup of the mined region takes place. At least 129 wells are part of experimental projects; the other seven wells are used for solution mining of a conventional mine. Overall, although the environmental impact of this group of wells could be significant, it is limited in Wyoming by the economic and regulatory constraints imposed on solution mining. Further site specific study would be needed to evaluate the actual environmental impacts of these projects.

CONCLUSIONS AND UPDATING SUGGESTIONS

Of the 254 Class V wells at 32 facilities inventoried by Professional Solutions, Inc. (excluding the septic system drain fields), SMC Martin has confirmed 215 wells at 24 facilities. Two tasks are required before the inventory can be considered complete: 1) the injection wells in the files of the Wyoming DEQ must be integrated into the inventory; and 2) the 131 unverified wells need to be substantiated and added to the inventory, where appropriate. This can be done by following more persistently the methodology developed by the contractor who produced the inventory.

Once the inventory is complete and correct, there should also be a means to regularly update it. The Wyoming DEQ is planning to permit all Class V wells at the state level. The inventory can then be updated by periodic reference to the relevant state permit files.

APPENDIX A

EXPLANATION FOR THE INCLUSION OF SEPTIC SYSTEMS IN THE WYOMING INVENTORY



Department of Environmental Quality
Water Quality Division

HERSCHLER BUILDING

CHEYENNE, WYOMING 82002

TELEPHONE 307 777 7781

February 19, 1985

David Weiss
SMC Martin Corporation
9000 West Valley Forge Road
Valley Forge, PA 19482

Dear Mr. Weiss:

In response to your question concerning why the class V well inventory conducted for the State of Wyoming contained so many septic systems, I offer the following:

1. From Water Quality Rules and Regulations Chapter IX, a well is defined: "'Well' means an opening, excavation, shaft, or hole in the ground allowing or used for a subsurface discharge or for the purpose of extracting a fluid, mineral, product or pollutant from the subsurface or for monitoring".
2. From the State Engineers Regulations and Instructions Part III, a well is defined as: "Well means any artificial opening or excavation in the ground, however constructed, by which groundwater is sought or from which it flows under natural pressure or is artificially withdrawn. An excavation for the purpose of artificial recharge to the groundwater body, or for the disposal of industrial or municipal wastes, is also considered a well."

Based on the fact that the majority of Wyoming communities are established in close proximity to waterways which have associated shallow groundwater regimes that can be significantly affected by faulty septic systems; the decision was made to include in the class V well inventory all septic systems of a residential or non-residential nature that either received wastes other than sanitary waste or had a capacity greater than 2000 gallons per day; i.e., 20 persons x 100 gallons per person per day.

Therefore, in light of the way wells are defined by Wyoming and the usefulness of the information towards administering the state's groundwater protection program ample justification to have septic systems included in the inventory existed.

Should you have any further questions on this matter, please feel free to contact the undersigned at (307) 777-7781.

Sincerely,

A handwritten signature in cursive script, reading "Richard J. Lennox".
Richard J. Lennox
Engineering Evaluator

RJL/pjb
cc: Jake Strohman, WQD
A. J. Mancini, WQD