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Groundwater Re-injection at Fernald
Its Role in Accelerating the Aquifer Remedy

By

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Groundwater Re-injection at Fernald

ITS ROLE IN ACCELERATING THE AQUIFER REMEDY

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A successful field-scale demonstration of the use of groundwater re-injection at the Fernald Environmental Management Project (FEMP) was recently completed, bringing the U.S. Department of Energy one step closer to achieving an accelerated site remediation. The demonstration marks the end of a several-year effort to evaluate (a) whether re-injection could be conducted efficiently at Fernald and (b) whether the approved aquifer remedy at Fernald would benefit from incorporating re-injection.

Evaluation of re-injection technology included technical considerations and the participation and cooperation of regulators and other stakeholders. The demonstration is considered to be unique in that it was integrated into the design of the current approved aquifer remedy and it utilized existing remediation infrastructure. Information collected during the demonstration indicates that re-injection wells can be operated efficiently at Fernald and that the current approved groundwater remedy should be modified to include the use of re-injection. Groundwater modeling predictions indicate that the use of re-injection will shorten the predicted time needed to remediate the aquifer by approximately seven years. It is currently anticipated that Fernald, by coupling re-injection with other DOE site remediation acceleration efforts, will accomplish remediation of the aquifer approximately 17 years earlier than originally predicted.

Fernald is a National Priorities List site. Prior to October 1991, Fernald was a large-scale integrated facility for the production of high-quality uranium metal to support

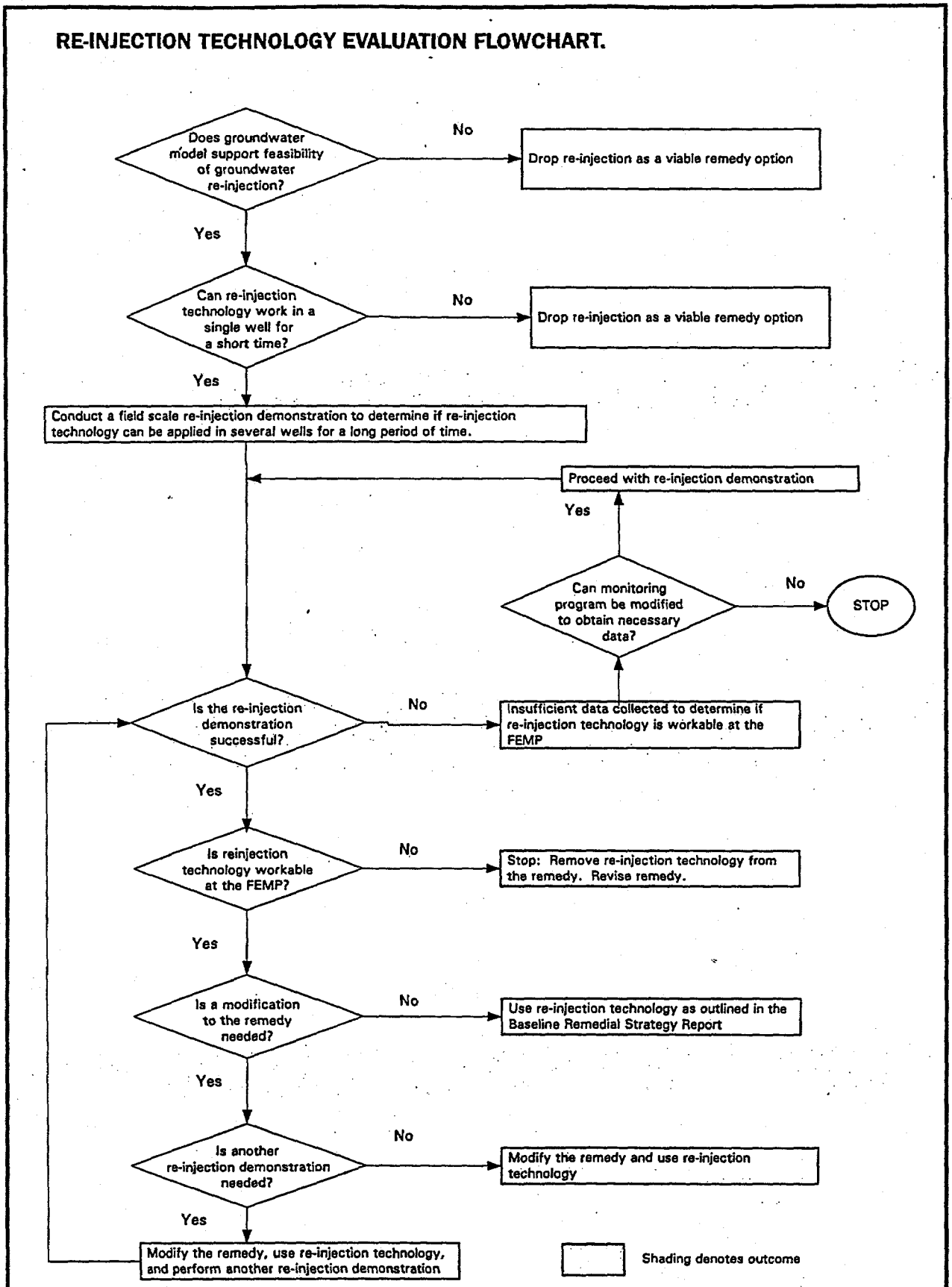
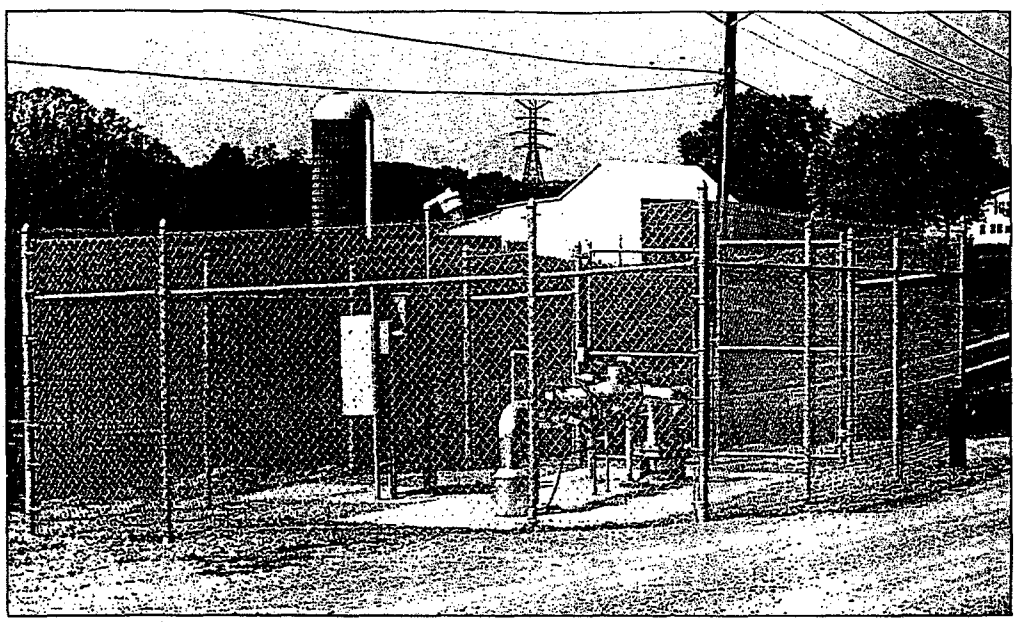


Figure 1-3 Re-injection Technology Evaluation Flowchart



◀ *Reinjection, along with other early start initiatives and refinements in the understanding of the uranium desorption process, will not only reduce the aquifer cleanup by years but will also save millions of dollars.*

the U.S. Department of Defense weapons programs. Since October 1991, the Resource Conservation and Recovery Act and the Comprehensive Environmental Response, Compensation, and Liability Act response actions have directed the central mission to implementation of waste management and environmental restoration initiatives, including groundwater remediation.

The Aquifer

The 1050-acre DOE site at the FEMP lies over the Great Miami Aquifer, which is a sole source aquifer, one of the largest sources of drinking water in the nation. Approximately 136 acres of the site were directly involved in the production process. Approximately 220 acres of the underlying Great Miami Aquifer have been contaminated with uranium above a concentration of 20 parts per billion. Reducing the level of uranium in the groundwater to the proposed U.S. Environmental Protection Agency health-protective concentration limit of 20 ppb is a primary goal of the FEMP, managed since 1992 by Fluor Fernald Inc.

The demonstration is considered to be unique in that it was integrated into the design of the current approved aquifer remedy and it utilized existing remediation infrastructure.

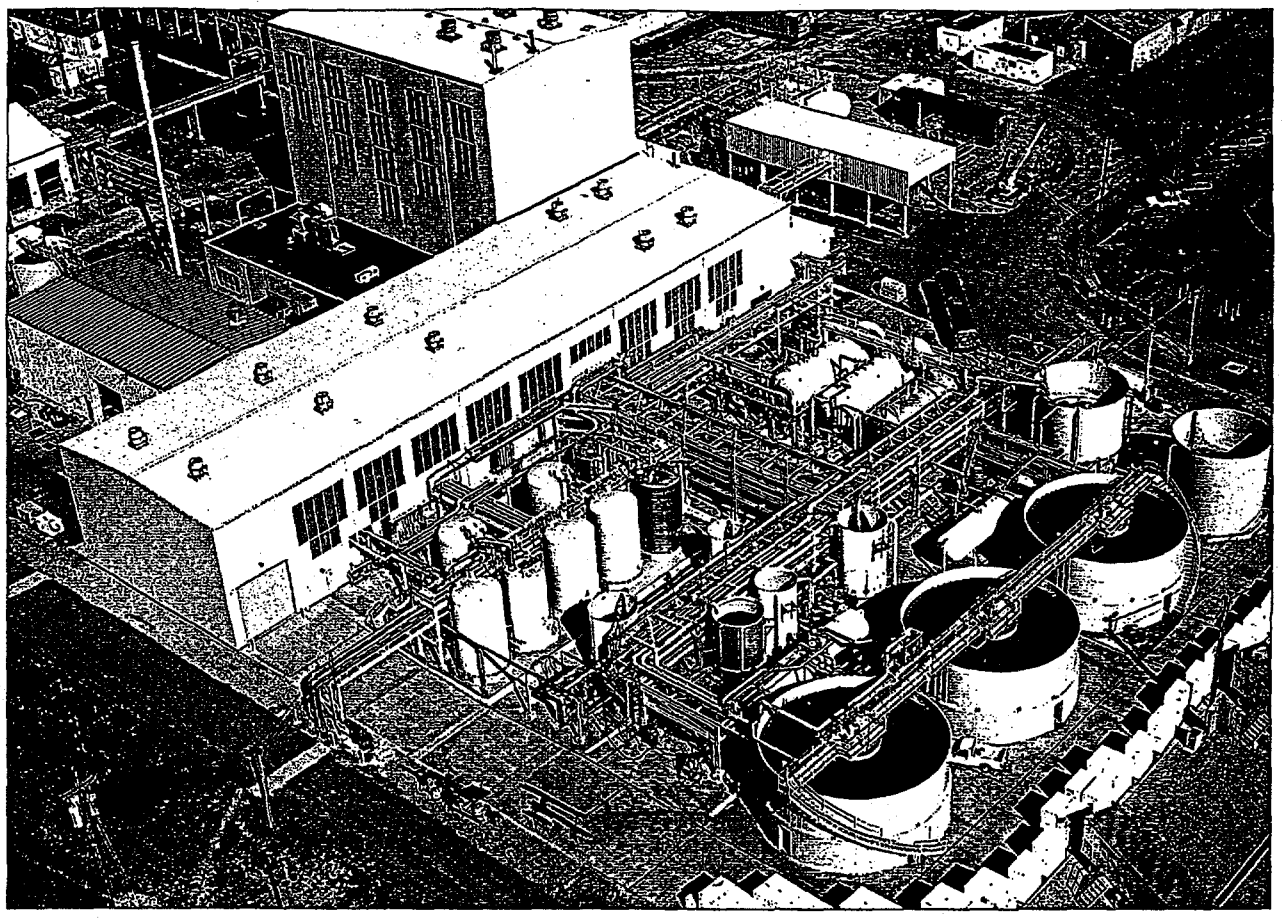
The Record of Decision (ROD) for Operable Unit 5 (OU5) calls for restoring the aquifer by 2023 using "pump-and-treat" technology. The ROD presents a 28-well extraction system, which operates at a maximum rate of 4000 gallons per minute. In the OU5 ROD, the DOE agreed to continue evaluating innovative technologies that might enhance the approved aquifer remedy and considered re-injection of treated groundwater to be one such innovative technology.

As defined in the OU5 ROD, re-injection would only be applied to the remedy with the specific approval of the EPA. The problem was that groundwater re-injection at Fernald was unproven. The challenge, therefore, was how to proceed with designing and implementing the approved pump-and-treat aquifer remedy while simultaneously evaluating the use of groundwater re-injection as a means of improving the remedy.

The evaluation of re-injection technology at Fernald was sponsored by the DOE's Office of Science and Technology (OST) Subsurface Contaminants Focus Area, at the request of DOE-Fernald. The figure opposite illustrates the evaluation strategy followed. To begin the evaluation, several different modeling scenarios were conducted by modifying the approved remedial design for the pump-and-treat remedy to include strategically positioned re-injection wells. The modeling predicted that re-injection would provide the following benefits:

- Shorten the remedy by approximately seven years.
- Produce faster pore-volume turnover, helping to reduce stagnation and accelerating the rate at which uranium would be flushed to extraction wells.
- Minimize the cumulative drawdown effect of numerous extraction wells.
- Help to provide a hydraulic barrier to continuing migration of the plume.

As a result of the favorable modeling outcomes, we at Fernald decided to conduct a small, single-well re-injection test to determine what physical and chemical challenges would need to be overcome for a successful re-



▲ *The Advanced Wastewater Treatment facility has a treatment capacity of 2900 gallons per minute. The combined well extraction systems at Fernald pump more than a billion gallons of water from the aquifer each year.*

injection operation. A small test was all that could be conducted because the infrastructure needed for a larger test did not exist. Two tests were conducted. The first test showed that the re-injection wells would be susceptible to iron plugging due to iron bacteria unless the water was treated. The second test showed that proper treatment of the water being re-injected into the aquifer could alleviate the plugging problem.

Continued use of re-injection could result in a predicted (net present value) cost savings of $14.3 million dollars.

Into the Field

Following the small, short-term tests, all that remained to prove the technology at Fernald was a long-term, field-scale test. Two major concerns with the field-scale use of re-injection at Fernald were how much—and how often—the re-injection wells would be inoperative due to plugging problems and what the resulting costs would be to keep the wells operating. The major problem with obtaining long-term field-scale information was the lack of required infrastructure. Rather than fund and conduct a field-scale demonstration separate from the approved groundwater remedy, only to have wasted infrastructure following the demonstration that might not be able to be used in the remedy, the decision was made to incorporate the field-scale demonstration into the ongoing aquifer remedial design effort. This cost-conscious measure would allow for the immediate incorporation of re-injection technology into the aquifer remedy, should the field-scale demonstration show that re-injection was viable at Fernald. If not viable, the remedy strategy would revert back to the approved ROD remedy, and other efforts to shorten the time frame would be pursued.

With approval from the regulators and support from the OST's Subsurface Contaminants Focus Area, a one-year field-scale re-injection demonstration began in September 1998. Treated groundwater was re-injected back into the aquifer through five strategically placed wells at the combined rate of 1000 gal/min. The water was treated via an expansion of the site's Advanced Wastewater Treatment (AWWT) facility. This facility began operation back in 1995 treating storm water and site wastewater, with a design capacity of 1100 gal min. Ion exchange reduces uranium concentration in the treated water to less than 20 ppb. To support groundwater treatment needs, the treatment capacity of the AWWT was expanded by 1800 gal/min in 1998. Only treated groundwater is re-injected.

During the re-injection demonstration, extraction was also taking place through 16 pumping wells. Four of these wells have been operating since August 1993; the other wells had begun operating only a month or so prior to the start of the re-injection demonstration. During the demonstration, water quality and water level data were collected to assess capture of the uranium plume and progress toward remediation of the plume.

The Results

September 2, 1999, marked the completion of the one-year demonstration. Information collected during the demonstration indicates that the current groundwater remedy should be modified to include the use of re-injection. The following conclusions were reached:

- Continued use of re-injection could result in a predicted (net present value) cost savings of $14.3 million dollars. This assumes that the use of re-injection will reduce the OU5 ROD approved aquifer remediation by seven years.
- A reliable source of injection water that is protective of the aquifer can be maintained.
- The costs for maintaining the re-injection wells appear reasonable.
- Treatments used to address plugging in the re-injection wells appear adequate under conditions experienced during the demonstration.
- Re-injection appears to be working as modeled to remediate the aquifer.

A draft final report titled "Re-Injection Demonstration Test Report for the Aquifer Restoration and Wastewater Project" was issued to the federal and Ohio EPAs in May 2000. The report presents the findings of the demonstration and concludes that re-injection technology should be incorporated into the aquifer remedy at Fernald. The DOE anticipates that the EPA will concur with the findings and conclusions of the report. Once the DOE receives EPA concurrence on the incorporation of re-injection, it will become an official component of the approved remedy. In the interim, however, while the DOE awaits EPA concurrence, all five re-injection wells continue to operate.

The aquifer remediation system at Fernald currently consists of 18 extraction wells and 5 re-injection wells. Since pumping operations began in the four initial extraction wells in August 1993, through March 31, 2000, approximately 5.4 billion gal of water and 1728 pounds of uranium have been pumped from the aquifer. Since re-injection began on September 2, 1998, more than 0.6 billion gal of water have been re-injected back into the aquifer.

The challenge, therefore, was how to proceed with designing and implementing the approved pump-and-treat aquifer remedy while simultaneously evaluating the use of groundwater re-injection as a means of improving the remedy.

Incorporation of re-injection technology into the aquifer remediation at Fernald supports a nationwide DOE effort to accelerate the remediation and closure of DOE sites. At Fernald, the DOE is currently targeting a 10-year aquifer remediation rather than the 28-year cleanup originally defined in the OU5 ROD. As mentioned earlier, incorporation of groundwater re-injection into the aquifer remedy is expected to shorten the aquifer remediation by seven years.

The predicted achievement of a 10-year pump-and-treat remediation of the aquifer is based on two additional factors:

- Other operable units' completion of their accelerated cleanup objectives so that surface access is available for aquifer remediation wells. The accelerated removal of source terms will allow recovery wells to be located closer to the center of uranium plumes.
- The assumption that uranium present in the aquifer will not become fixed to the aquifer sediments and can be readily pumped out of the aquifer.

More information about this and other Fernald cleanup projects is available on the FEMP's web site at www.fernald.gov.

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