OVERVIEW OF
IN SITU RECOVERY (ISR) PROJECT DEVELOPMENT

The exploration, development, mining of a uranium ore body, and subsequent restoration/reclamation, by in situ recovery (ISR) is generally a lengthy, iterative process. During initial exploration, very little surface and subsurface information may be known about an area, so the area can only be described in very generic terms. However, as additional knowledge is gained through drilling, testing, and collection of baseline data, the descriptions can be more specific and the economic and environmental feasibility of a project can be evaluated. The permitting generally follows a similar trend. Permitting of (and reclamation bonds for) exploration work generally allows for limited work, and it generally involves only one or two agencies. If the exploration work indicates the potential for viable project, then the data gathering and project design expand to provide sufficient information to support permit-to-mine documents and project construction and operation. Even after permit approval and project start-up, monitoring continues to provide information as to whether projections are met, and the monitoring information must be reported periodically (e.g. annual reports) and permit revisions obtained (if necessary). This monitoring, reporting, and permit updating continues until the project is reclaimed, with agency approval, and the reclamation bond released.

Exploration

Initial exploration for a uranium ore body is based on a geologist's model of what he or she believes is required for an ore body. For example, most models address: a host rock; a source of ore: and a geochemical mechanism to concentrate the metal-bearing fluid in the host rock. [*In the area of the Lost Creek Project, the sandstones of the Battle Spring Formation held promise as a host rock; the Granite Mountains were considered a source for the ore; and the change from oxidizing to reducing conditions as groundwater moved into the Great Divide Basin could result in ore deposition.*] Once a model is established, the geologist will begin 'desk top' exploration to look for a region that may fit the model. If the geologist can locate such a region, and funding and a land position (e.g., claims and/or leases) are obtained, a field exploration program may be started.

Exploration programs for other resources, such as oil and gas, often involve seismic testing or other procedures that can provide relatively detailed subsurface information on reservoirs before drilling begins. However, to delineate uranium deposits, very few tools are available other than drilling to obtain cores and geophysical data. For ISR, the first step in the field is typically to drill a series of holes on wide-spaced 'fences' to characterize the local geology. These holes are generally hundreds to thousands of feet apart. [*In the area of the Lost Creek Project, these fences were drilled in the late 1970s/early 1980s by TexasGulf.*] As the understanding of the regional geology

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improves, the geologist will begin to reduce the spacing of the fences to focus efforts on areas of greater potential. With years of hard work, good analysis and some luck a mineralized zone may eventually be discovered. In Wyoming, exploration drilling (after the early 1970s) was generally permitted through a Drilling Notification (DNs) with the Wyoming Department of Environmental Quality - Land Quality Division (WDEQ-LQD). [*The Texas Gulf exploration was done under DN #47.*] Similar to exploration permits for other resources, these DNs are held confidential because the information on ore location and grade could be used by other potential operators to adversely affect the land position of the DN holder or other aspects of project development.

Development

After the discovery of a mineralized zone, the geologist will recommend more closely-spaced drilling (e.g., drilling with spacing of fifty to a few hundred of feet apart) to characterize the extent, grade, and amenability of the mineralized zone in situ mining. Bench-scale testing of lixiviants and ore recovery rates may also occur. At some point during the developmental drilling and testing, the geologist will have enough data, and therefore confidence, to calculate resources. If the resource is sufficient and the economics are desirable, the zone will be classified as an ore body. Development drilling may occur immediately after exploration drilling, or a significant period of time may elapse between exploration and development drilling, depending on economic conditions, developer resources, and changes in land positions. [*In the Lost Creek area, over 20 years elapsed between the Texas Gulf exploration and the development drilling by Lost Creek ISR, LLC (LC ISR, LLC).*]

Because the project design is still being formulated and the impacts are still limited to those associated with drilling, only one or two agencies are generally involved at this stage of permitting. However, if the results of the development drilling continue to indicate the potential for a viable ISR project, then the operator may begin discussions with primary agencies to keep them informed, determine permitting requirements, and give agencies a heads-up on potential work load. [*LC ISR, LLC began meeting with agencies in 2005.*]

Depending on the site conditions and regulatory changes over the years, more specific surface information (e.g., archeological surveys) may also need to be collected to allow for the more closely spaced drilling. At this stage, because of the dependence of the ISR process on ground water pumping and re-injection, collection of the hydrologic information necessary for project development is also generally started. The operator also considers selection of an appropriate area for the permit application. In addition, because data for some disciplines must be collected over the course of a year to determine seasonal impacts (e.g., meteorological data), this data collection may also start. [*The development drilling by LC ISR, LLC is being done under WDEQ-LQD DN #334*

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and BLM Notice # WYW-166224. Although wells were installed by Texas Gulf, and pump testing and water quality sampling occurred, this information was not considered sufficient for project design and development. Therefore, additional drilling and pump testing was started. One of the main subsurface features at the Lost Creek site is a subsurface fault. Multi-day pump testing was conducted on both sides of the fault to determine overall aquifer characteristics and the influence of the fault on ground water movement.]

Mining and Reclamation

Once sufficient information is available and resources are determined to be viable for production, an application for a permit to mine is prepared. The initial stage in the permitting process is to collect even more data to support the permit document which will ultimately be used by regulators to determine if mining can be performed without undue degradation of the environment. After collection and compilation of the baseline data, the permit application is submitted to the respective agencies for consideration. Even at this stage, drilling continues to further define the resource and locate additional mineralization. In fact, drilling will continue throughout the project as the focus changes from regional information (on the scale of thousands of feet) to well pattern installation (on the scale of tens to hundreds of feet).

In Wyoming, the uranium resources of interest for ISR occur usually occur in long, narrow, sinuous deposits called 'roll fronts'. These roll fronts are within sandstones interlayer with shales, and there may be economic quantities of ore in a single sandstone layer or multiple layers. Because of the geometry of the ore deposits, the permit defines the general shape of the ore body(ies) of interest, the layer(s) in which the ore body(ies) is (are) located and the overlying and underlying shales and sandstones. [*For the Lost Creek Project, the ore body is in the HJ Horizon. Although mineralization occurs in almost all of the sandstone in the Permit Area, only mining of the HJ is considered economic at present.*]

When the permit is initially submitted, the focus shifts from regional to more localized information. At this time, a series of mine units (or wellfields) is defined within the Permit Area. Because the permit documents represent the state of knowledge at the time they are submitted, additional documentation (Mine Unit Package) is submitted for each mine unit as the specifics become known and the operator wants to begin production from that mine unit. [*LC ISR, LLC submitted the permit to WDEQ-LQD in December 2007, and the locations of six mine units were identified. Plate OP-1 and Figure OP-2a originally showed a conceptual location of Mine Unit 1 as well as subsequent Mine Units 2 through 6. However, additional information has been collected during the permit review, resulting in the outline of Mine Unit 1 being revised. Consequently, the areas of the remaining mine units were consolidated, thereby changing the total count of mine*

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units from six to three. The OP and RP have been revised to show the consolidation of the mine units; however, some portions of the application, such as the wildlife section, still refer to six mine units. The area of planned production has not changed, only the names and number of mine units. The conceptual and actual locations of Mine Unit 1 are shown as an overlay in Plate OP-1 and Figure OP-2a. The details of the Mine Unit 1 layout are shown on the figures and plates in the mine unit package.]

After the requisite permits are acquired, the mining process may begin. During the installation of the production and injection wells, the geologists will gain even more information and may make minor adjustments to the area to be mined. Even during mining, more will be learned about the ore body's geology and hydrologic characteristics. The operation of the mine will test the hypothesis forwarded by the scientists involved from exploration through permitting. Therefore, the permit includes information on monitoring and responses that may be taken based on the monitoring information. In addition, if the monitoring information indicates conditions substantially different from what was anticipated, then a permit revision may also be necessary. *[The Lost Creek permit application includes the required provisions for excursion monitoring and also outlines the engineering controls that will be used to ensure equipment is operating within specified parameters.]*

For ISR, reclamation involves both ground water restoration and reclamation of surface impacts. Even during this process, additional knowledge may be gained about subsurface conditions. For example, use of bioremediation during ground water restoration is a relatively new technology and is apparently amenable for some constituents but not others. [*The possibility of bioremediation has been considered for the Lost Creek Project; however, the decision to use this technology will depend on the state of knowledge about both the technology and the subsurface conditions after groundwater restoration by more conventional methods.*] Therefore, the process of monitoring and permit revision continues. Once restoration is completed and the wells are abandoned, surface reclamation, including a minimum of 2 years for vegetation re-establishment, is necessary. Even after restoration and reclamation are approved, and the reclamation bond is released, there is a requirement of a deed notice to indicate the project location, primarily because of the potential for future drilling to encounter the plugged wells.

The permitting process goes through many iterations with numerous agencies. In the future, the approved permit will be revised as required to ensure it contains the current state of knowledge. Revisions will be made through annual reports, bond calculations, mine unit data packages and minor or significant permit revision requests as required. [*Table ADJ-1 shows the Lost Creek permitting requirements that must be completed prior to mining. WDEQ-LQD has requested that copies of four of these permits be included in the WDEQ-LQD permit to mine application. These are the WDEQ-AQD Permit*

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(Attachment ADJ-1); UIC Class 1 Well Permit (Attachment ADJ-2); Storm Water Pollution Prevention Plan (Attachment ADJ-3); and Septic System Permits (Attachment ADJ-4).]

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Table ADJ-1 List of Regulatory Requirements (Page 1 of 2)

REGULATORY AUTHORITY	PERMIT OR LICENSE	STATUS	COMMENTS
Federal			
NRC	Source and Byproduct Material License	Application Submitted 10/30/07.	Application included both a Technical Report (TR) & an Environmental Report (ER). LC ISR, LLC has responded to all the NRC Requests for Additional Information (RAIs) on the TR and the ER.
EPA	UIC Class I & Class III Wells	--	See WDEQ permits as Wyoming has primacy for all applicable EPA programs.
	Aquifer Exemption	Being prepared.	Selection of exemption boundaries under discussion between EPA & WDEQ. LC ISR, LLC will submit request to WDEQ which will in turn submit request to EPA.
BLM	Plan of Operations	Being prepared.	Required per discussions between NRC and BLM as to NEPA responsibilities.
State			
WDEQ - AQD	Air Quality Permit	Submitted June 5, 2008. LC ISR, LLC is performing a BACT analysis to satisfy an AQD comment.	Once this permit is approved, the permit number will be listed in Section D4.2.2 of Appendix D4 of the LQD UIC Class III Permit.
WDEQ - LQD	License to Mine	Application submitted 12/21/07, assigned TFN 4 2/628.	In Adjudication File of LQD Permit-to-Mine
	LQD Permit-to-Mine and Underground Injection Control Permit (Class III ISR wells)	Application submitted 12/21/07, assigned TFN 4 6/268.	Because LQD has primacy for UIC Class III wells, the UIC permit serves as the Permit-to-Mine.

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