An Overview of Uranium Production in Wyoming

White Paper

School of Energy Resources, University of Wyoming

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Preface

This paper has been developed to provide background for the speakers who will present at *The Future of Uranium Production in Wyoming: A Public Forum on In-Situ Recovery*. The forum is one of many events sponsored by the University of Wyoming's School of Energy Resources to examine a wide range of energy sources and options. It will also be publicly available to assist members of the community and the press in preparing for the forum. This paper has been reviewed and edited by the forum steering committee and to the best of our collective knowledge provides an accurate high level overview of the current status of in-situ recovery (ISR) of uranium in Wyoming. It is not intended to be a comprehensive review of all issues pertaining to ISR of uranium in Wyoming.

Introduction

According to the Energy Information Administration (EIA), Wyoming contains the largest reserves of uranium in the United States[1]. With market prices for Uranium Oxide (U3O8) increasing, and a political climate in which expansion of nuclear energy production is emerging as an option for the future, Wyoming is poised for increased exploration and mining.

The Future of Uranium Production in Wyoming: A Public Forum on In-Situ Recovery, convened by the School of Energy Resources of the University of Wyoming, will offer participants from the uranium industry, associated agencies, and interested citizens and groups an opportunity to interact and share their knowledge and concerns about uranium mining in Wyoming. Professionals will provide information on the in-situ process, regulation, and potential impacts on Wyoming, as well as answer questions. This forum will provide an interface among industry, agencies and the public in the state containing the largest uranium reserves in the United States at a time when nuclear electrical generation is increasingly part of the discussion about the US energy future.

The forum will be convened in accordance with State of Wyoming House of Representatives legislative session 2009 Enrolled Act. No.105, which appropriated $1.6 million to the School of Energy Resources (SER) of the University of Wyoming for the uranium research center. The School of Energy Resources is charged in part under the Abandoned Mine Land (AML) funding with providing information on in-situ recovery of uranium exploration, development and production.

This paper is intended to provide an overview of uranium production in Wyoming to assist presenters and others in preparing for the forum.

A Brief History of Uranium in Wyoming

Uranium deposits were first discovered in silver and copper tailings as early as 1918 near Lusk, Wyoming[2]. Commercial mining, however, did not begin until 1953, two years after geologists Dr. John David Love, Dick Hose, and Franklyn B. Van Houten discovered significant uranium deposits near Pumpkin Buttes in the Powder River Basin (PRB)[3]. At the time, the U.S. Atomic Energy Commission (AEC), looking to further develop its nuclear program, quickly showed interest in purchasing the Wyoming ore and multiple mines were opened for business[3].

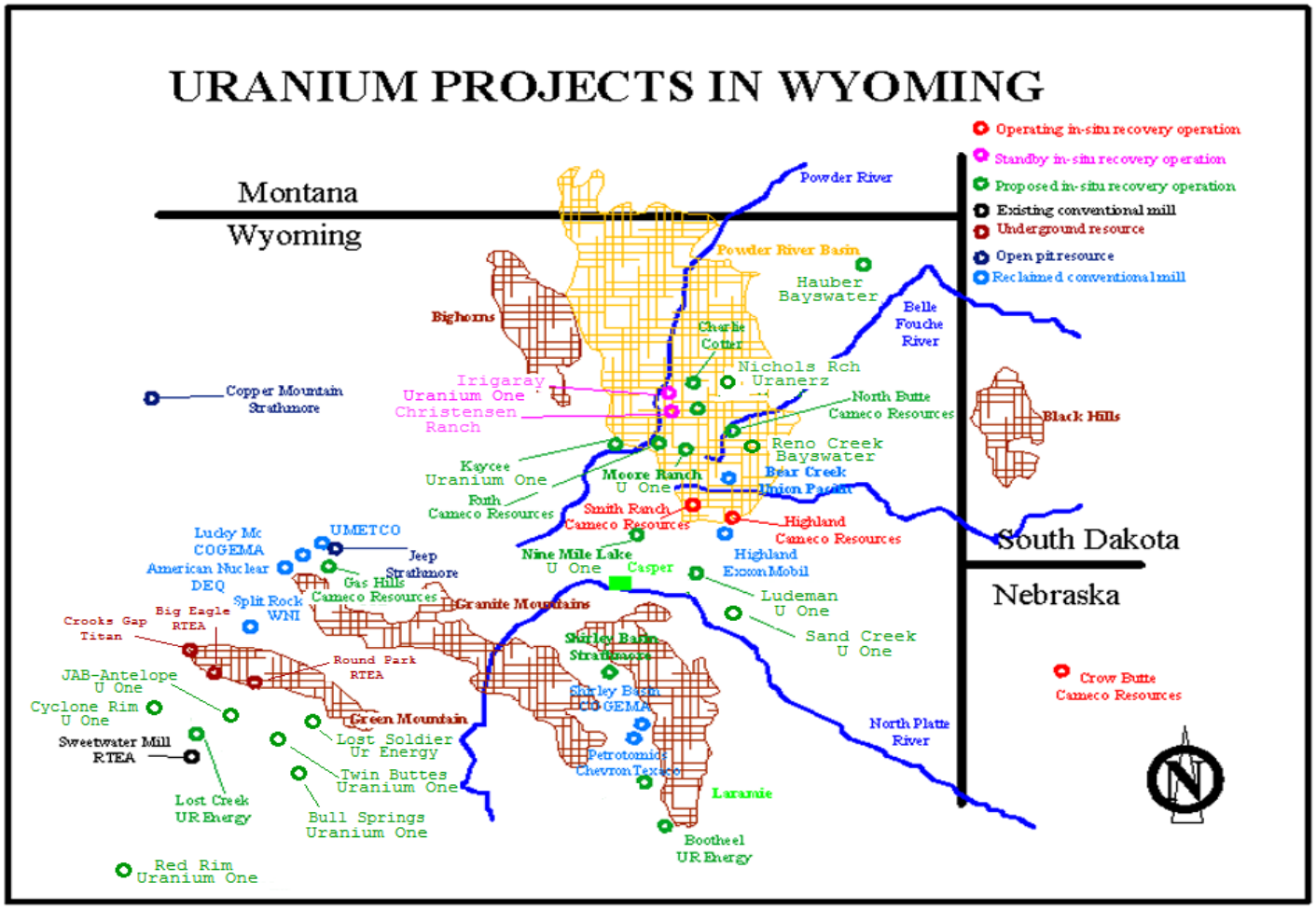
Soon after the discovery of uranium in Pumpkin Buttes, Neil McNeice discovered significant deposits in the Gas Hills of Wyoming. Further discoveries followed in Crook's Gap (Great Divide Basin) and the Shirley Basin[3]. By 1980, nine uranium mills were in operation in Wyoming, employing some 5,300 people[3].

Open-pit mining was the primary extraction method employed until in-situ recovery (ISR) began in 1961. Wyoming was the first state to use in-situ leaching technology in the US[5]. The Wyoming Department of Environmental Quality (DEQ) documents twenty-four mines to have been in working operation in the State since 1953. Appendix A offers a list of these operations and their status of reclamation.

As is the case with many extractive industries, uranium mining can experience "boom and bust" cycles; the story of Jeffery City is a well-known example in Wyoming. In 1957, the Western Nuclear Corporation opened the Split Rock mine near Jeffery City. The town grew rapidly during the uranium boom, driven by growth in the U.S. nuclear defense program[5]. The early 1970's was another boom period, and the town grew to a total population of 4,000[3]. However, after the Three Mile Island incident in 1979, uranium prices plummeted, and within three years Jeffery City had lost 95% of its population[6]. The town remains almost entirely deserted today.

Since 1995, Wyoming has led the country in uranium production, with two licensed in situ recovery facilities in operation, the Smith Ranch-Highland property and Christensen Ranch. Today, the Smith Ranch-Highland in-situ recovery operation in Converse County is the only active uranium production facility in Wyoming, and is the largest such facility in the U.S. The Christensen Ranch ISR facility is undergoing refurbishment and is expected to resume operations in 2011. According to the Wyoming DEQ, five permits for new uranium facilities are currently under review (see appendix B).

Sites for potential future uranium production exist in the Powder River Basin, the Wind River Basin, the Gas Hills along the Natrona-Fremont County line, the Little Mountain district west of the Bighorn Mountains, the Great Divide Basin, Green Mountain, Crooks Gap, and Shirley Basin.



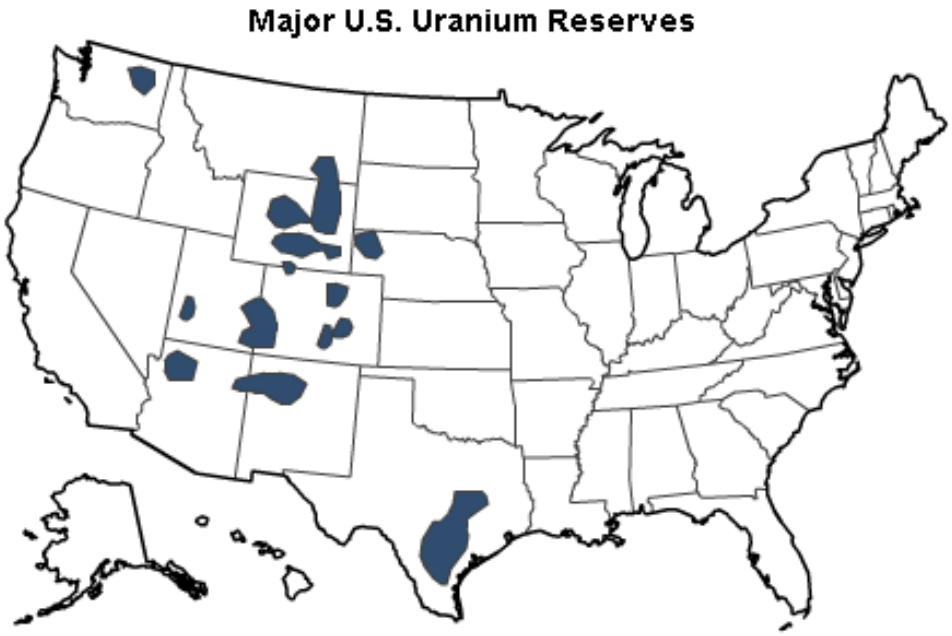
(Source: http://www.wma-minelife.com/uranium/umap0002/umap0002.htm Modified to reflect changes in status of some facillities.)

Current Resources, Reserves, and Market Prices

The U.S. Energy Information Administration (EIA) issued an updated report in July, 2010, on uranium reserves in the U.S., as of year-end 2008:

> At the end of 2008, U.S. uranium reserves totaled 1,227 million pounds of U_3O_8 at a maximum forward cost (MFC) of up to $100 per pound U_3O_8. At up to $50 per pound U_3O_8, estimated reserves were 539 million pounds of U_3O_8. Based on average 1999-2008 consumption levels (uranium in fuel assemblies loaded into nuclear reactors), uranium

reserves available at up to $100 per pound of U_3O_8 represented approximately 23 years worth of demand, while uranium reserves at up to $50 per pound of U_3O_8 represented about 10 years worth of demand. Domestic U.S. uranium production, however, supplies only about 10 percent, on average, of U.S. requirements for nuclear fuel, so the effective years' supply of domestic uranium reserves is actually much higher, under current market conditions. [1]



Source: EIA. http://www.eia.doe.gov/cneaf/nuclear/page/reserves/ures.pdf.

The EIA indicates that the U.S. uranium reserves recoverable through in-situ recovery are between 230 and 289 million pounds of U_3O_8, at $50 and $100 per pound, respectively.[1]

According to the EIA, Wyoming has uranium reserves of approximately 220million pounds of U_3O_8 at up to $50 per pound, and 446 million pounds at up to $100 —the most of any state in the U.S. [1] If that ore is produced and sold for $50 per pound, that equates to $11 billion, and, at $100 per pound, equates to $44.6 billion.

The United States is sixth in total global reserves behind Canada, South Africa, Russia, Kazakhstan, and Australia. Projected global reserves of uranium, considering current extraction costs, are predicted to supply energy needs well into the next century[8]. Wyoming has the potential to be a significant participant in meeting the needs of our nation's nuclear fuel supply requirements.

In 2008, a total of 53 million pounds of U3O8 was purchased by the 104 commercial nuclear facilities in the U.S., contributing to 19.6% of the total national electricity supply[7]. Only fourteen percent of the 53

million pounds of U3O8 purchased by the U.S. originated from domestic sources, selling at an average price of $59.55 [8]. The remaining 86% was imported, at an average price of $43.47[8].

Currently, the market price for uranium hovers around $42.00 per pound. Prior to 2005, uranium prices were consistently below $20/lb. Between 2005 and 2007 the price of uranium skyrocketed, reaching $136/lb in the first quarter of 2007 (partially triggered by the flooding of the Cigar Lake Mine in Canada). Since the third quarter of 2008, the price for uranium has held moderately steady between $40 and $55 per pound[9].

Three uranium ISR facilities currently operate in the United States (as of May, 2010). Texas, Nebraska and Wyoming each host one active ISR facility (see appendix C); all three utilize the in-situ recovery method of uranium extraction. When operations resume at the Christensen Ranch ISR facility in 2011, there will be four active uranium ISR facilities in the U.S. In addition, Denison Mines operates the White Mesa mill near Blanding, Utah processing alternate feed material and ore from the companies' Colorado Plateau mines[3a].

The Smith Ranch-Highland ISR operation in Converse County, Wyoming, sits in the southern portion of the Power River Basin, northeast of Casper. Smith Ranch-Highland is operated by Cameco Resources, a subsidiary of Cameco Corporation of Saskatoon, Saskatchewan, Canada. The operation currently employs 147 people, uses 50 full-time contractors as well, and produced 1.2 million pounds in 2008 and 1.8 million pounds of uranium in 2009[4].

The Wyoming state revenue from mineral taxes for uranium production in Wyoming in 2008 was $1.15 million[4a].

Recovery Processes

"Conventional" mining refers to open-pit and/or underground mining processes. The open-pit process is used where deposits lie up to 100 meters below the surface. Underground mining occurs where deposits lie deeper. Both involve digging and removing rocks and soil, and use of explosives to liberate ore-bearing rock. This rock is then transported to a mill where it is crushed, ground and processed (uranium is dissolved out of the rock). Significant environmental hazards of open-pit mining include the uranium depleted rock (mill tailings), considerable surface disturbance, and costly reclamation efforts. Underground mining produces mill tailings as well. Potential health impacts of being exposed to the dust created in the mining process as well as land disturbance have contributed to a legacy of public concern about uranium mining.

The in-situ recovery method of extracting uranium is the most widely used technique today in the U.S. Used primarily where uranium is deposited in sandstone, the process involves injecting a groundwater solution (fortified with oxygen and carbon dioxide) into the ore body through cased wells. The solution permeates the porous rock, dissolving the uranium from the ore, and is pumped to the surface through other cased wells. The uranium-rich solution is then transferred to a water treatment facility where the

uranium is removed from solution by adhering to ion exchange resin beads. The barren groundwater solution exiting the ion exchange system is refortified with oxygen and carbon dioxide and then sent back to the injection wells for reuse.

Ion exchange resins have a finite capacity to capture and hold uranium in molecular complexes. The resins in a fully loaded bed are removed from service so the uranium can be stripped from the resins, restoring the holding capacity of the resins for re-use. The removed uranium solution is further concentrated in tanks through a process of precipitation to produce a slurry form of uranium. This slurry is then dewatered, dried and shipped.

ISR utilizes a closed water system; groundwater circulates repeatedly. Once a well field has yielded its full production, the groundwater within the depleted ore body is treated to meet regulatory standards. According to Wyoming Statute 35-11-103(f)(iii), "'Groundwater restoration' means the condition achieved when the quality of all groundwater affected by the injection of recovery fluids is returned to a quality of use equal to or better than, and consistent with the uses for which the water was suitable prior to the operation by employing the best practicable technology." Levels of constituents may exceed the actual levels of constituents of the water before production, but the water must be restored to a quality sufficient to be used for same purposes allowable before operations. Wastewater produced in the extraction and groundwater cleanup process is re-injected into a deeper non-potable formation through a disposal well (see appendix D).

The ISR process is the preferred method in the U.S. for extracting uranium as it produces considerably less land disturbance than conventional mining, no mining dust, and no tailings. However, ISR is not without risks. "Potential groundwater impacts at an ISR facility can result from: (1) residual constituent concentrations in excess of baseline concentrations after the restoration of the production aquifer; (2) a migration of production liquids from the production aquifer to the surrounding aquifers during operation; (3) a mechanical failure of the subsurface well materials releasing production fluids into the overlying aquifers; and (4) movement of constituents to groundwater outside the licensed area."[9c] Additional risks include spills, excessive consumption of groundwater, and land disturbance.

Regulation

The uranium industry is regulated by multiple entities. Companies in Wyoming are required by law to obtain a 'source material' license from the U.S. Nuclear Regulatory Commission (NRC) to "possess, transfer, deliver, or receive uranium, radioactive material, including ore, and tailings"[3]. The NRC does not regulate mining operations, but does oversee the processing of the ore for its uranium content at a mill. Thus, NRC has oversight responsibility for conventional mills. NRC considers ISRs to be milling, as opposed to mining and, therefore, has regulatory authority over all aspects of uranium recovery at ISR facilities. Wyoming has the option of becoming an NRC "agreement state" and assuming regulatory authority over uranium source materials (uranium ores), byproducts (tailings, wastes), and/or enriched uranium.

The Occupational Health and Safety Administration (OSHA) provides regulatory oversight of worker safety at ISR facilities in Wyoming. The NRC, US Environmental Protection Agency, and the Wyoming Department of Environmental Quality's Land Quality Division all oversee water quality issues with in-situ mining. Permits are also obtained from the WYDEQ Water Quality Division for disposal wells, and the WYDEQ Air Quality Division for drying the uranium slurry. Use of groundwater resources are additionally regulated at ISR well-field operations by the Wyoming State Engineer's Office.

Companies mining uranium in Wyoming are required in the permitting process to post an NRC-approved bond with the Wyoming Department of Environmental Quality (DEQ) to insure reclamation is completed. Where activities are to take place on BLM administered lands, the BLM and DEQ agree on a reclamation bond amount under an MOU payable to both the State of Wyoming and Secretary of the Department of the Interior.

Quarterly and annual reports are prepared to ensure all uranium facilities are compliant with DEQ standards during the active status and reclamation stages of the mine. The NRC and DEQ oversee decommissioning of operations, including the reclamation of mill tailings impoundments in the case of conventional uranium mining and groundwater restoration, decommissioning, and surface reclamation with ISR operations.

In Wyoming, most of the time uranium is a "locatable" mineral under the General Mining Law of 1872. It is not leased or subject to federal royalty payments unless acquired lands are involved (see 43 CFR Part 3500). On Bureau of Land Management (BLM) administered lands uranium claimants must file a notice prior to exploration and development of uranium with the Field Office and receive approval. On Stock Raising Homestead Act patented lands the operator must file a plan of operation only if they do not obtain surface owner consent to operate. Within Wyoming the BLM, NRC and DEQ work together closely under memorandums of understanding. Within Wyoming the BLM, NRC and DEQ work together closely under memorandums of understanding. [9d]

Both the NRC and the BLM conduct environmental analyses (usually Environmental Impact Statements) with respect to their concurrent jurisdictions over uranium production, and the EPA has an oversight role in insuring that the National Environmental Policy Act is followed. The NRC has already completed a "generic EIS" with respect to uranium ISR facilities in the West, and has also published for comment three draft Supplemental EISs (SEIS) for proposed uranium ISR facilities at Lost Creek, Moore Ranch, and Nichols Ranch in Wyoming[9a]. In its March, 2010, review of the Supplemental EIS's, EPA raised concerns about "(1) the narrow range of the wastewater disposal alternatives analysis along with the limited discussion regarding waste management impacts; and (2) the lack of information regarding air pollutants and the impacts of those emissions."[9b] EPA rated the SEIS's "Inadequate." "This rating indicates EPA's belief that these draft SEISs do not meet the purposes of NEPA and should be formally revised and made available for public comment in a supplemental or revised SEIS. [9b] Over the past several months, NRC has been working with EPA to address its concerns on the three SEISs. This effort has included a face-to-face meeting in Denver and periodic calls to discuss the actions NRC is taking to address EPA's concerns.

Status of Regulatory Action on Wyoming ISR Facilities

The aforementioned Smith Ranch-Highland operations has been released from conditional penalties resulting from the DEQ's 2008 citations for violating permit conditions, extending production, and not meeting reclamation schedules[10]. The DEQ and Cameco Resources settled without litigation. The company agreed to increase the size of the reclamation bond to $80 million, expend an additional $8 million for restoration and reclamation, pay $500,000 for future state environmental projects, and pay a $900,000 fine ($400,000 to be suspended pending satisfaction of the settlement agreement)[11]. DEQ has substantially increased the frequency of its monitoring of the Smith Ranch-Highland facility. The company has met its requirements under the agreement, and was released from the conditional $400,000 fine in 2010.

Public Concerns

A recent survey conducted by the Wyoming Survey & Analysis Center of 935 Wyoming households found nearly half (48.5%) of respondents in non-uranium mining counties know "nothing" about ISR, while 27.6% reported they know a lot or a moderate amount) about the process. Approximately a third (35.5%) in counties with uranium facilities reported knowing nothing about the process and a third reported knowing a lot or a moderate amount (35.8% combined).[12]

The same survey revealed 61.4% of respondents are in favor of continued development of uranium extraction as an energy option, while 29.0% are neutral, and there is a correlation between prior knowledge of ISR and support for continued development. At the same time, those who favor uranium production in Wyoming also express concerns about the process.

Overwhelmingly, groundwater contamination (76.5%) and waste water spills (71.7%) are the major risks perceived by those surveyed. More than half also believe land disturbance as a result of exploration and recovery (57.5%) and increased risk to public health (52.9%) to be potential problems associated with in-situ uranium mining. Nearly one-third (30.9%) are concerned with transport of uranium on roadways as possibly unsafe.

Groundwater and waste water concerns were also reflected in research priorities identified at a September, 2009, uranium workshop sponsored by the University of Wyoming School of Energy Resources and attended by industry, agency, and university representatives. Overlapping jurisdiction in terms of regulating industry was another concern noted in the workshop. Participants corroborated a need for closer collaboration and increased streamlining in coordination between state and federal agencies[13]. The UW School of Energy Resources will soon release a request for proposals for research on topics identified as research priorities at the September, 2009, workshop. Funds for the workshop and research were granted by the Wyoming State Legislature in the same measure cited in the introduction.

WORKS CITED

[1] Energy Information Administration. (July 2010). *U.S. Uranium Reserves Estimates*. Retrieved from: http://www.eia.doe.gov/cneaf/nuclear/page/reserves/ures.html on July 22, 2010.

[2] Dobson, G.B. (January 6, 2004). *Wyoming Tale and Trails*. Retrieved from: www.wyomingtalesandtrails.com/lusk1a.html.

[3] Gregory, R. (March 2010). *WSGS Uranium*. Retrieved from: www.wsgs.uwyo.edu/WSGSgroups/Uranium/Default.aspx.

[3a] http://www.denisonmines.com/SiteResources/ViewContent.asp?DocID=96&v1ID=&RevID=652&lang=1

[4]Information provided by David Taylor, University of Wyoming, and Kenneth Vaughn, Investor, Corporate & Government Relations, Cameco Resources, via email on July 23, 2010..

[4a] State of Wyoming, Department of Revenue, 2009 Annual Report, http://revenue.state.wy.us

[5] Wyoming Mining Association. (March 2010). *History of Uranium Mining*. Retrieved from: www.wma-minelife.com/uranium/general/genfrm.htm.

[6] Amundson, Michael . (1995). "Home on the Range No More: The Boom and Bust of a Wyoming Uranium Mining Town". *Western Historical Quarterly*. P.483-205. Retrieved from: http://www.sublette-se.org/files/jeffrey_city2.pdf.

[7] Energy Information Administration. (June 26, 2009). *Nuclear Energy Review*. Retrieved from: http://www.eia.doe.gov/emeu/aer/pdf/pages/sec9.pdf.

[8] Energy Information Administration. (May 26, 2009). *Uranium Marketing Annual Report.* Retrieved from: http://www.eia.doe.gov/cneaf/nuclear/umar/summarytable1.html

[9] Nuclear Energy Agency. (June 3, 2008). *Uranium 2007: Resources, Production, and Demand*. Retrieved from: http://www.nea.fr

[9a] The generic and supplementary EIS's can be found at www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1910/

[9b] EPA's comments on the Supplemental Environmental Impact Statements may be found by searching the database at http://yosemite.epa.gov/oeca/webeis.nsf/ .

[9c] Memorandum to NRC Comissioners conveying staff report, "Data on Groundwater Impacts of Existing ISR Facilities." July 10, 2009. http://denr.sd.gov/powertech/GW/Appendix_C_1_Memo_Re_GW_Impacts.pdf

[9d] See Memorandum of Understanding between BLM and Wyoming DEQ, supplement dated November 10, 2003, at http://www.blm.gov/pgdata/etc/medialib/blm/wy/programs/minerals.Par.51222.File.dat/3809_MOU.pdf. The March, 2003, Memorandum of Understanding between BLM and NRC (national in scope) can be found at http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/national_information/2010/IB_2010-051.html.

[10] Letter from WY DEQ (John Corra) to John McCarthy, PRI. March 10, 2008. RE: In-Situ Uranium Permits **603** and **633,** Notice of Violation, Docket No. 4231-08. http://adamswebsearch2.nrc.gov/idmws/doccontent.dll?library=PU_ADAMS^PBNTAD01&ID=080840269

[11] Settlement Agreement. July 8, 2008. http://deq.state.wy.us/out/downloads/LQ%20SA%204231-08.pdf

[12] Wyoming Survey & Analysis Center. (2010). *Public Opinion in Wyoming About In Situ Uranium Recovery,* by N.M. Nelson, B. Harnisch, & B. Anatchkova. (WYSAC Technical Report No. SRC 1004). Laramie, WY: Wyoming Survey and Analysis Center, University of Wyoming.

[13] Meridian Institute. (October, 2009). *Research Priorities for In-Situ Uranium Recovery in Wyoming: A Report to the University of Wyoming School of Energy Resources.* Dillon, CO.

APPENDICES

KEY

ISR = In-situ Recovery

OP = Open Pit

UG = Underground (mine)

FAC = Mill facility

R&D = Pilot Test

LQD = Land Quality Division (of the Wyoming Department of Environmental Quality)

AML = Abandoned Mine Lands

NO = Never Operated

Appendix A:

Wyoming Operational Permitted Facilities & Non-Operational Permitted/Historical Sites & Status

Note: Permit numbers refer to Wyoming Department of Environmental Quality (DEQ) designated mine permit number. These are public records and can be reviewed at the Cheyenne offices of the DEQ's Land Quality Division.

Operational Permitted Facilities:

	Name	Company	DEQ Permit	Type	Location
1.	Smith-Highland (2 permits)	Cameco	630 & 633	ISR	Converse

Non-Operational Permitted/Historical Sites & Status

	Name	Type	DEQ Permit	Status	Location
1.	Bear Creek	OP	399	Reclaimed	Converse
2.	Pathfinder-Lucky MC	OP	356	Reclaimed	Fremont
3.	Pathfinder-Shirley Basin	OP	345	In Reclamation	Carbon
4.	Umetco Minerals Corp. Gas Hills	OP	349	Reclaimed	Fremont
5.	ANC Tailings Site (forfeited)	OP	352	In Reclamation by LQD	Fremont
6.	Sweetwater	OP	481	In Reclamation	Sweetwater
7.	Christensen/Irigaray(1 permit)*	ISR	478	Operational 2011	Johnson

8.	Ruth	ISR	631	R&D Johnson	
9.	North Butte	ISR	632	Never Operated	Campbell
10.	Exxon-Mobile Highland	OP	218	in Reclamation	Converse
11.	Cameco Buss Pit	OP	438	Reclaimed	Fremont
12.	Cameco Gas Hills**	ISR	687	Never Operated	Fremont
13.	Big Eagle	OP	451	In Reclamation	Fremont
14.	Sheep Mountain	OP/UG	381	In Reclamation	Fremont
15.	Spook	OP		Now DOE site	Converse
16.	Petratomics	OP	342	Now NRC site	Carbon
17.	Walker Jenkins	OP		AML closed site	Fremont
18.	Western Nuclear Split Rock	FAC		NRC tailings site	Fremont
19.	Day Loma	OP		AML reclamation	Fremont
20.	Smith Ranch	UG		Reclaimed	Converse
21.	Golden Eagle	UG		Reclaimed	Converse
22.	Sullivan	OP		Reclaimed by AML	Carbon
23.	Cotter-Charlie	OP	489	Reclaimed	Johnson
24.	Bison Basin	ISR	504	R&D, LQD Reclaimed	Fremont

* Mine Unit 7 wellfield package in review & facilities being refurbished for operation in 2011.

**Permit update under review

(Source: Don McKenzie, WYDEQ, April 2010)

Appendix B:

Wyoming DEQ/LQD Uranium Recovery Facility Applications Under Review

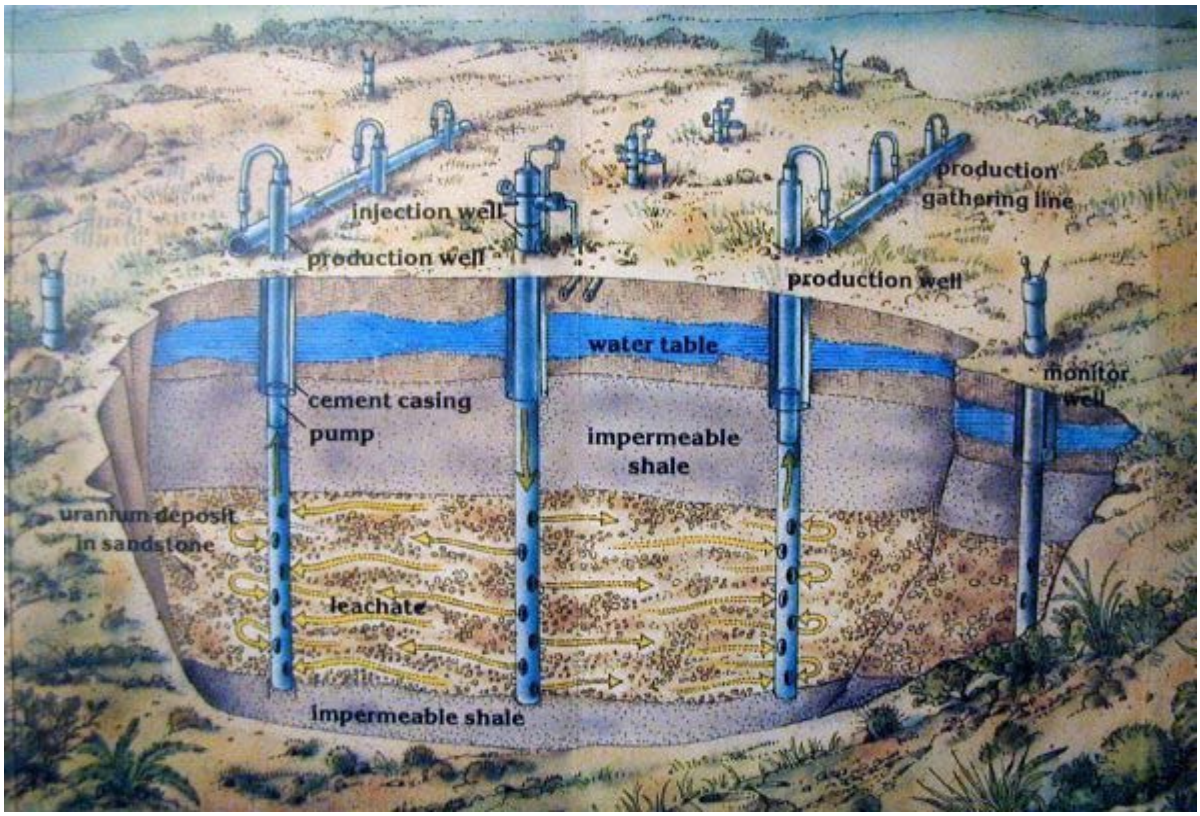
	Name	Location	Company	Type
1.	Lost Creek	Sweetwater	UR-Energy	ISR
2.	JAB & Antelope*	Sweetwater	Uranium One	ISR
3.	Moore Ranch	Converse	Uranium One	ISR
4.	Nichols Ranch	Campbell & Johnson	Uranerz	ISR
5.	Ludeman	Converse	Uranium One	ISR

* The operator has requested deferral of NRC review of this application.

Appendix C: 2010 U.S. Operating Uranium Mines

Location	**Mine Name**	**Owner/Operator**
Wyoming, Converse County	Smith Ranch-Highland ISR operation	Power Resources Inc., a subsidiary of Cameco Corporation of Saskatoon, Saskatchewan, Canada
Nebraska	Crow Butte	Cameco Corporation
Texas	Alta Mesa	Mestena Uranium, LLC

Appendix D: Uranium In-Situ Recovery Process



(source: http://www.uraniumproducersamerica.com/situ.html)

Note: Though this diagram illustrates a typical ISR facility, operations inject leachate at different depths depending on the structure of the formation. In addition, shale above ore deposits may vary in depth and is not always impermeable. As noted in the report of the workshop on ISR research sponsored by the School of Energy Resources in September, 2009:

> Federal agencies commonly have found in recent applications for ISR unconfined conditions (lack of impermeable rock layers to prevent migration of lixiviant [leachate] from ore body), particularly faulting going through the extraction zone. Unusual geological site conditions require additional attention and detailed analysis to determine if NRC / DEQ have the technical basis for issuing a license.[13]