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The Future of Uranium Production in Wyoming: A Public Forum on In-Situ Recovery

University of Wyoming, School of Energy Resources

University of Wyoming Conference Center
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Executive Summary

On August 4, 2010, 281 people participated in *The Future of Uranium Production in Wyoming: A Public Forum on In Situ Uranium Recovery*, sponsored by the School of Energy Resources (SER) at the University of Wyoming, as part of a series of activities related to uranium production undertaken by SER with support and guidance from the Wyoming State Legislature. The Public Forum was designed primarily as an educational event for the general public and to provide individuals concerned about uranium production an opportunity to share and discuss concerns. The program was informed by a statewide telephone survey of Wyoming households.

Background

Wyoming has the largest uranium ore deposits in the United States. Only one mining site in Wyoming is active, the Smith Ranch-Highland in-situ recovery (ISR) facility operated by Cameco. ISR, a process developed in the 1960s, reverses the historic process through which uranium is deposited in sandstone. Oxygenated water pumped into the ore body dissolves the uranium. It is then pumped back to the surface and uranium is precipitated out of the water, collected, and shipped as yellowcake to conversion and enrichment facilities. ISR does not involve the unearthing, blasting, tailings, grinding, or crushing, associated with conventional mining. ISR accounts for 86% of total US uranium production, and the increasing number of federal mining claims indicate renewed interest in uranium production.

Future production in Wyoming includes one ISR facility on standby to be restarted in 2011, three licensed but not yet built facilities, five at the permitting stage, and three at the pre-permitting stage; two conventional mines are also at the pre-permitting stage. The primary factors affecting future production are the quality of the deposits, state and federal regulatory requirements, and the price of yellowcake. Based on historic high and low prices, Wyoming can expect in the future between 5 and 12 mines operating, producing between 5 and 12 million pounds, annually.

It is estimated that every five 900-pound drums of yellow cake produced in Wyoming supports approximately one job, provides $59,000 in labor income, and generates almost $9,000 in Wyoming states taxes and royalties.

Regulation

Safety oversight for ISR facilities is a shared responsibility between federal and state agencies. The Land Quality Division (LQD) of the Wyoming Department of Environmental Quality (DEQ) issues mining permits for uranium that, in accordance with EPA standards, require groundwater restoration to the pre-established baseline concentrations or the maximum contaminant level, whichever is higher. The permit application is very comprehensive, costly, and time consuming to complete, requiring extensive testing and contingency planning. DEQ reports improvements in the quality of ISR permit applications as well as in practices at ISR facilities in recent years. Higher quality materials and better well completion practices have resulted in fewer mechanical integrity test failures; historical drill holes in some locations have been identified and properly plugged; current plugging practices are improved; and, monitoring plans have resulted in fewer spill incidents. Operators must post a bond to insure groundwater restoration and site reclamation. ISR site restoration has been successful at Bison Basin, Irigaray, and Smith Ranch, among others.

A significant rise in activities required to maintain existing permits and an increase in new permit applications, is dramatically expanding the work load of LQD. LQD's human resources remain the same, resulting in a backlog in processing applications and maintenance actions since 2005.

In addition to the state permitting process, new ISR facilities must be licensed by NRC. The process includes technical, safety and environmental reviews, as well as work with stakeholders and other parties. NRC anticipates an increase in applications over the next several years for new and expanded ISR facilities in Wyoming.

Some in the environmental community are concerned about the adequacy of current NRC regulations for groundwater restoration, NRC's capacity to inspect ISL operations in Wyoming, DEQ's capacity for permitting and enforcement, and the Wyoming Mining Association's proposal to allow consultants to carry out permitting functions.

Health and Environmental Considerations

Studies to date indicate that *radiation* from ambient exposure to naturally occurring uranium in Wyoming does not present a hazard for humans or animals. There is evidence of *chemical* toxicity to the kidneys from ingested or inhaled uranium. Conceivable routes of exposure from ISR are contact with wastes or evaporation ponds, spills, broken pipes, and drying and drumming of yellow cake. Exposure pathways to the public via ambient air or soil are well studied and demonstrated to be not likely for a variety of reasons. Exposure via groundwater is suggested by some as a potential pathway for residents living nearby. While there are federal drinking water standards for uranium, private wells generally are not tested or regulated. Radon and radium, both more radioactive than uranium, may be mobilized from the ore along with uranium during ISR, as may other metals,

including arsenic and selenium. Exposure to these elements may be the greatest risks associated with ISR.

Concerns about the possible impact of increased ISR in Wyoming relate to both groundwater and land. There is a risk of connectivity between zones of exploration and production and the aquifers used for drinking water. The overriding concern of landowners and residents in production areas is the protection of groundwater, including its restoration to pre-mining quality after production is complete. Past incidents at ISR facilities, as well as abandoned exploration wells, have caused concern about the effectiveness of regulatory oversight and enforcement. Related concerns include: reclassifying aquifers from domestic or livestock to commercial use; mining where good, confining layers are not present; and, high water consumption.

Land and habitat disturbance, including sage grouse habitat, is a concern, as is the risk that ISR facilities will contribute to potential sage grouse endangered species listing, along with the accompanying economic impact to the state. The cumulative impact of energy development, and the longevity of these impacts, are of concern.

From an industry perspective, the advantages of ISR include minimal environmental impact – protection of water, wildlife, and livestock – exceptional health and worker safety, and the economical recovery of very low grade ores. At the one active facility in Wyoming, Smith Ranch – Highlands, Cameco conducts more than 20,000 tests annually for groundwater monitoring and restoration activities, and inspects well fields daily. Additional standard work practices include topsoil segregation and management, surface reclamation (e.g., contouring, seeding), drainage control/management, quarterly surface/groundwater sampling (e.g., stockponds, water wells), and spill detection and response.

Two well fields at Smith Ranch – Highland have been restored and are in the process of final approval. Several other well fields are in various stages of restoration. Cameco is in the process of significantly increasing the size of the bond for the facility to provide assurance of adequate restoration at the site. DEQ and NRC have approved the restoration of nine well fields at the Irigaray facility, where 90% of the parameters monitored were restored to baseline.

Industry and environmental groups have different perspectives on groundwater excursions at ISR facilities to date, and the nature of the risk when excursions occur.

The Future of Uranium Production in Wyoming

The forum concluded with a roundtable discussion on the future of uranium production in Wyoming. Forum participants also engaged in tabletop discussions.

Marion Loomis, Wyoming Mining Association: Industry is concerned about the time frame for permits, duplication of requirements among agencies, and the cost of obtaining permits. The Wyoming statutes have clear mandates on time frames for permits that are not being met. As the increased work load for DEQ to process permits is expected to last only a few years, using consultants may make sense.

Regulators should be very clear about what is required for the permit at the outset and identify issues early on so that applications can be deemed complete before the technical review. Issues important to the agency must be addressed, but should be raised early in the process.

Larry Claypool, Bureau of Land Management: The job of the regulators is to efficiently execute the application process for approval. This requires extensive coordination between all parties. BLM will do everything it can to assist with applications for ISR facilities on BLM land to ensure their success. Duplication and coordination issues need to be addressed.

Steve Jones, Wyoming Outdoor Council: Energy development is the cause of the greatest environmental impacts in Wyoming. We have a long history of uranium development in the state, but it is not good. Current proposed projects are a cause for concern. Though some imply that there is always a confining layer above and below the ore body, at the Lost Creek site, for instance, there is actually a fault running through the project area. A comprehensive cradle-to-grave approach to uranium is needed to ensure that groundwater is protected and surface activities are carefully monitored and controlled. One comprehensive environmental impact statement (EIS) should assess all cumulative impacts. Federal agencies, most importantly the BLM and the NRC, need to coordinate their efforts so that one comprehensive EIS is produced covering all environmental impacts. The current practice of separate agencies preparing separate EISs does not serve the interests of environmental protection. Draft supplementary EIS's conducted by NRC in March were found "inadequate" by the EPA, and NRC is now working on revisions. We are not opposed to industry; we want to ensure that things get done right.

Rob Hurless, Governor's Office: There is global competition for energy, and the U.S. needs to take advantage of every

source of energy, including conservation. Every energy source has risk associated with it. The question is not whether Wyoming will produce uranium, but how best to do so. We need a quantitative basis to effectively assess risks, trade-offs, and externalities of energy production. This is a challenge as much of the public is not comfortable with numbers. The media can help educate the public so that it has the knowledge to consider trade-offs in a rational way.

John V. Corra, Wyoming Department of Environmental Quality: DEQ must ensure that we carry the public's trust in fulfilling our role. The reason we are having a long permitting process is that it's important that we get it right the first time. DEQ and the industry have been on a steep learning curve. Though there numerous challenges with the uranium permits, we're working through them. We do not want to have to readjust our policies and strategies multiple times. We also want to provide a level playing field.

Groundwater must be restored to its former class of use. That doesn't mean that it's chemically exactly like what it was before. Applicants will not get a permit from us unless they demonstrate that they can accomplish that.

We appreciate the input of all parties as we strive to get things right. It's important for us to hear from everybody. Good input has been received from all sides and that helps us make good decisions.

Making sure we have necessary capacity is important. Since the number of uranium permit requests is doubling, we intend to take a close look at processes inside LQD. Though all agency budgets have been reduced, demand for DEQ services has not decreased. DEQ will be requesting an increase for LQD in the next budget cycle.

Key Questions

Key questions raised, but not addressed, at the forum may serve as the basis for future dialogue, research, and/or other activities, such as the following:

Protecting the environment and public health

- What is the evidence regarding whether or not ISR presents a real risk to drinking water? If so, how much risk is reasonable?
- In what cases might restoration of groundwater to class of use prior to mining be inadequate? How close to baseline is close enough?
- If 90 percent of restoration can be achieved with 10 percent of the water, does it make sense to restore beyond that point?
- What is the evidence regarding the impact of ISR on wildlife? Is evidence from oil and gas field a reasonable proxy for likely impacts of ISR?
- What opportunities are there to better understand the impacts of ISR facilities to date and to identify solutions to reduce risks?
- To what extent should challenges with ISR operations to date be taken as an indicator of likely future challenges? What adjustments to or changes in operations have been made that would prevent recurrence of prior violations?
- How might cumulative impacts on the landscape and water resources (e.g., from multiple kinds of energy development) best be planned for and managed?
- Nuclear energy is a non-renewable transition source of energy. How long are we going to have uranium to use in nuclear reactors? What kind of damage might be done in this transition?
- How might abandoned holes be found and plugged?

Economic impacts

- What is the relative value of uranium production for Wyoming in comparison to the value of sage grouse habitat (i.e., avoidance of listing of sage grouse as endangered)?

Working together to solve problems

- How might the regulatory process be coordinated and streamlined in a manner that increases effectiveness and efficiency for both industry and regulators?
- How can "Three Mile Island syndrome" be overcome so that we can make rational decisions about nuclear energy? What are the best strategies for educating the public about the actual, rather than perceived, risks of ISR?
- How can industry and the environmental community work together to find a middle ground?
- How can the risks of ISR be quantified in a manner that can be effectively communicated to the public?

Dr. Mark Northam, director of the School of Energy Resources, indicated that the school would seek to help address these questions through its continuing efforts to advance research and education regarding in-situ recovery of uranium in Wyoming.

1. Introduction and Background

On August 4, 2010, 281 people participated in *The Future of Uranium Production in Wyoming: A Public Forum on In Situ Uranium Recovery*, sponsored by the School of Energy Resources (SER) at the University of Wyoming. This full day event, which took place at the University of Wyoming Conference Center in Laramie, was organized as part of a series of activities related to uranium production undertaken by SER with support and guidance from the State Legislature (see Chapter 159 – Wyoming Session Law 2009 Section 339[c]iii). The primary previous activity was organizing a two-day workshop in September, 2009, *Research Priorities for In-Situ Uranium Recovery in Wyoming*. At this workshop, members of the industry, regulatory, and university communities together developed a research agenda to address questions related to in situ recovery of uranium and to make recommendations regarding the organization of a forum on uranium production for the public. Forthcoming activity will include issuance of a request for proposals to conduct research in fulfillment of the research agenda developed at the workshop. (See Workshop Report).

Purpose and Goals

The Public Forum was designed primarily as an educational event for the general public. The program was developed by a steering committee that included representatives of the university; industry, the environmental community, and the public health community (see Forum Program for a list of the steering committee). The steering committee, which was supported by staff of the School of Energy Resources and a professional facilitator from the Colorado-based Meridian Institute, identified three goals for the forum:

- Provide interested members of the public an opportunity to learn about *in situ* uranium production as well as the benefits and risks associated with uranium production from leading experts in health, environmental protection, and uranium extraction;
- Provide an opportunity for individuals concerned about uranium production to share and discuss their concerns with representatives of industry, government, health and environmental protection organizations, and the academic community; and,
- Provide members of the public and individuals across a broad spectrum of sectors with diverse perspectives and experiences an opportunity to learn about each other's interests and concerns.

Public Opinion Survey

Conducting a survey to understand the knowledge and concerns of the Wyoming public regarding uranium production was one of the recommendations developed at the September, 2009, research priorities workshop. With support from the School of Energy Resources, the steering committee engaged the Wyoming Survey and Analysis Center (WYSAC) of the University of Wyoming to conduct a statewide telephone survey of 935 Wyoming households. The purpose of this project was to help the steering committee design a forum that truly addresses the stated concerns and knowledge gaps of the Wyoming citizenry.

For purposes of analysis, the population of the state was divided into two regions: one comprised of the counties that have uranium deposits, and the other of the counties without uranium deposits. Key findings from the survey report include:

- Fewer Wyoming residents support continued uranium development compared to oil and gas, coal, and wind development. However, over half (53.0%) of the respondents from the non-uranium counties indicate knowing nothing about ISR, as do 31.1% of respondents in the uranium counties.
- The degree of support for continued uranium development is strongly associated with beliefs about potential problems that might be caused by uranium recovery. Specifically, those who are in support of continued uranium development are less likely to think that uranium recovery might cause groundwater contamination, pollution from wastewater spills, land disturbance from exploration and recovery, and increased risk to public health, than those who are neutral or opposed to continued uranium recovery.
- Among those who believe uranium recovery will cause potential problems, over half are

very concerned about groundwater contamination and pollution from waste water spills. These results suggest that the public considers Wyoming's water resources, both groundwater and surface water, to be very important. We recommend these topics along with increased risk to public health be thoroughly vetted in the public forum.[1]

The full survey report can be found at Survey. The presentation of research findings given at the conference can be found provided by Brian Harnisch.

2. Uranium: An Overview

A brief introduction to uranium geology, geography, extraction, and use was provided by **Robert Gregory, Geologist with the Wyoming Geological Survey**

Historically, uranium was used primarily as a coloring agent until radioactivity was discovered around the turn of the 20th century. The modern day uranium industry was not born until the Manhattan project and development of nuclear weapons in the 1940s. The radioactive properties of uranium make it useful for weapons, electricity production, powering naval vessels, medicine, and determining the age of rocks. The density of uranium makes it useful also for armor and armor piercing bullets (depleted uranium), and for ballast for ships.

Uranium is found in three types of deposits: conglomerates, unconformity deposits, and sand stone hosted deposits (most common type in Wyoming). Sandstone deposits hold low concentration ores deposited by water over geological time. Oxygenated water mobilized uranium from a more concentrated source, flowed through the ground, and when it encountered a reductive environment (one with organic matter or gas, or sulfide minerals), the uranium precipitated out as crystals into the pore spaces. This generally occurred in sandstone.

Uranium was first discovered in Wyoming in 1918, in Lusk, and discoveries of ore in different locations across the state continued through the 1950s. Wyoming has the largest uranium ore deposits in the United States. Other states with sizable deposits include New Mexico, Arizona, and Texas (in order of size of reserves). Colorado, Nebraska, South Dakota, and Utah also have uranium deposits. Currently, uranium mining is taking place in Nebraska and Texas, in addition to Wyoming, which has one active mine (Smith Ranch-Highland).

During Q&A it was pointed out that low concentrations of uranium are very commonly found, including in groundwater, surface water, seawater, and various kinds of rocks.

3. In-Situ Uranium Recovery: The Production Process

An overview of in-situ uranium recovery from exploration through site restoration was presented by **Tom Cannon , General Manager of Cameco Resources' Smith Ranch – Highland Operation** (the only uranium in situ recovery facility operating in Wyoming, and the largest in the U.S., producing approximately two million pounds of uranium annually):

In situ recovery essentially seeks to reverse the historic process through which uranium is deposited in sandstone by moving groundwater. The ISR process pumps oxygenated water into the ore body and dissolves the uranium. The uranium-rich water is then pumped back to the surface and through a series of steps and chemical treatments, the uranium is precipitated out of the water and collected. One advantage of ISR is the lack of tailings, blasting, grinding, crushing ore, or unearthing associated with conventional mining.

By drilling exploratory wells, mining sites are identified where layers of shale above and below the sandstone ore deposit can confine the mining area so that the liquid pumped into the ore body does not leave the mining area. Aquifer stress tests are completed during the permitting process. Overlying and underlying layers are closely assessed. After a body has been delineated by depth and

[1] Public Opinion in Wyoming about In Situ Uranium Recovery Statewide Survey 2010. Wyoming Survey and Analysis Center, Technical Report No. SRC-1004. Revised August, 2010. http://www.uwyo.edu/sersupport/docs/conferences/2010/uraniumforum/WYSAC_Uranium_Report_201008_SRC-1004.pdf

by horizontal perimeter, economic viability is determined, followed by an extraction plan.

Once boundaries are established, injection and extraction wells are designed. Extraction wells are used to remove fluid from the aquifer, and are surrounded by three to six injection wells, through which native groundwater with small amounts of added oxygen, carbon dioxide, and/or baking soda is pumped. This fluid dissolves uranium (and other metals) from the ore body and is pumped back to the surface.

The risk of uranium-laden water leaving the mining areas is minimized by designing the system to create a cone of depression, drawing in small quantities of groundwater into the mining zone and pumping out more water from the ore body than in is injected into it. Before putting a well into operation, the operator must prove the mechanical integrity of the well and demonstrate that there are no leaks between the surface and the mining zone. At Smith Ranch – Highlands, an extensive pressure, moisture, and leak detection system alerts managers to leakages at any point in the system, and includes automatic shut-downs and isolation valves. In addition, monitoring wells encircle the mining unit to detect any horizontal movement of water during the mining process.

Once uranium rich fluid is pumped back to the surface, it is put through a water softening process to collect the uranium onto resin beads. The uranium-rich beads are trucked to a central processing plant and the uranium is extracted from the resin, precipitated, dried, and shipped as yellowcake to conversion and enrichment facilities in the US and Canada.

Annual radiation exposure of employees at the Smith Ranch-Highlands facility is far below limits set by the US Nuclear Regulatory Commission (NRC) and only slightly above the exposure of the average US resident. Indeed, by living at a higher elevation, all residents of Wyoming expose themselves to higher levels of radiation.

With respect to protecting wildlife, top soil is stabilized and vegetation re-established after well-fields are installed. Land disturbance is minimized during operations, and wildlife are not precluded from the area during mining operations (though livestock are).

After mining has concluded, the land is returned to its pre-mining use and groundwater is restored to prior class of use. Restoration included groundwater sweep and reverse osmosis – ion filtration. This generates clean water, which is the injected back into the aquifer. As radon, radium, and/or uranium always is present in higher than acceptable levels for drinking water before mining begins, thus water is not cleaned to drinking water standards but to the prior class of use as required by Wyoming regulations.

The advantages of ISR include minimal environmental impact – protection of water, wildlife, and livestock, exceptional health and worker safety, and the economical recovery of very low grade ores.

During the question and answer period, the following points were made by participants and Mr. Cannon:

Regulation:

- Permit applications, including requests to designate aquifers as exempt from the Safe Drinking Water Act, go through the WYDEQ (and EPA) as much as up to a year in advance of putting the mine unit into operation.
- There is duplication among regulatory agencies which adds to timelines for development.

Land disturbance

- Surface impacts of ISR facilities are small compared to conventional mining. Mines average 40 to 50 acres of fenced areas, of which 40% of the surface is impacted.
- Smith Ranch-Highland is not part of the core area of sage grouse habitat.

Groundwater

- Cameco mines where it is economical to do so. Across the zones it mines, there is ore at varying levels. Though some ore areas are hydrologically isolated and some not, there are confining layers.

Production levels

- Cameco seeks 80% recovery of ore; sometimes it is well above, sometimes below. As mineralogy varies, the mining period lasts between three and five years.
- Permits allow for 5 million pounds of annual production, though currently production averages 2 million pounds. Cameco has plans to expand operations in Wyoming, at Smith Ranch as well as other parts of the state.

Restoration

- Smith Ranch –Highland has a number of well fields in later stages of production. Two have been restored and are in the process of getting final approval. Several other well fields are in various stages of restoration.

4. Potential Production and Long Term Impacts on Wyoming

Three presenters addressed the potential volume and economic and environmental impacts of future uranium production in Wyoming.

Glenn Catchpole, CEO of Uranerz Energy Corporation, reviewed the history of uranium prices over the past forty years and proposed some rough scenarios for possible levels of future production based on historic high and low prices:

Yellowcake, sold by the pound, peaked at $43.80/lb in 1979, and U.S. production peaked in 1980 at 12 million pounds. Production dropped after Three Mile Island and the 1980s recession, and has varied widely since. Prices are currently very low: the current spot price of uranium, in 1979 dollars, is $15.33. The all time high price was $138, in 2007 (uranium spot prices spiked for a period).

In order to be economically and safely mined through ISR, uranium deposits must be of good grade, good permeability, not too deep, and in a sandstone formation that is an aquifer. Today 36% of global uranium production is from ISR, which began in the late '60s, after oil and gas companies applied well-field engineering techniques to the extraction process. In Wyoming today, 100% of uranium production is ISR, as is 86% of total US production.

Increase in the number of active federal mining claims (from 5,425 in 2001 to 39,518 in August, 2010) provides evidence of the renewed interest in uranium production. Though only one ISR facility is currently operating, one is on standby and will be restarted in 2011 (Uranium One's Christensen Ranch facility), three are licensed but not yet built, five are at permitting stage, and three at pre-permitting stage. Two conventional mines are also at the pre-permitting stage.

The primary factors affecting future production are the quality of the deposits, regulatory setting, and the price of yellowcake. At the current price, Wyoming likely can expect five mines operating producing five million pounds annually. At $80, a middle of the road estimate of future price, production likely would increase to eight mines producing eight million pounds. If the price returned to the peak level in 2007, $138, Wyoming likely would have 12 mines producing 12 million pounds. Production at these levels might be sustained for 20 or more years, bringing significant employment, economic activity, and tax revenue to the state.

Dr. David "Tex" Taylor, Professor of Agriculture and Applied Economics at the University of Wyoming, projected potential economic contributions of ISR to Wyoming based on the economic impacts of the currently operating Cameco facility at Smith Ranch – Highlands:

Cameco spends approximately $40 million annually in Wyoming, including wages, taxes, royalties, and purchase of goods and services. These direct expenditures generate 301 jobs. There is another $17 million in secondary economic activities employing 143 people resulting from Cameco's expenditures. This suggests that every uranium mining job is associated with another 1.7 jobs scattered throughout the Wyoming economy. The average income of all jobs associated with mining activity is over $56,000/year (above state and US averages).

Cameco's plans to develop three additional mining facilities (Reynolds Ranch, North Butte, and Gas Hills) would generate 655 good-paying job years over three years for construction and other capital expenditures. Expansion of production to 3.6 million pounds annually would result in 842 long-term jobs, $48 million in annual wages, and $7 million in state taxes and royalties. Every five 900-pound drums of yellow cake produced in Wyoming supports approximately one job, provides $59,000 in labor income, and generates almost $9,000 in Wyoming states taxes and royalties.

Erik Molvar, Wildlife Biologist with the Biodiversity Conservation Alliance, offered a perspective on the potential impacts to land and water of increased ISR in Wyoming:

Given the increasing challenge of maintaining oil and gas production at historic levels, the carbon emissions associated with coal, and the limited capacity of

renewables, uranium may well be seen as an increasingly important source for meeting rising energy demands and shifts in policy may cause pressure for Wyoming to develop its reserves.

Concerns about the possible impact of increased ISR in Wyoming relate to both groundwater and land. There is a risk of connectivity between zones of exploration and production and aquifers used for drinking water. Even when everything is done correctly by producers, sealed shale layers are prone to fracturing and faulting and therefore are not actually impermeable. The ISR process mobilizes compounds found with uranium that also are toxic, such radon, radium, arsenic, selenium, chromium, and molybdenum, and there is a poor record of returning aquifers to former levels of constituents of concern. Under its former operator, the Smith Ranch-Highland facility was cited for violation of numerous DEQ regulations. Other projects, near Douglas, spilled over a million gallons of contaminated fluids on the surface.

With respect to land and habitat disturbance, treasured landscapes have experienced uranium production and disturbance in the past. The habitat of sage grouse and associated species is also a concern with ISR. Oil and gas production has led to reduced lek populations and nesting success, and has disrupted some winter ranges and migration corridors. Increased uranium production could contribute to habitat fragmentation, depending on development density. The cumulative impact of all development needs to be considered as energy resources are developed, as does the longevity of the impact. Given that the impacts of uranium production can last thousands of years, and that uranium is a small portion of potential energy production in Wyoming, it may not be a preferred option.

During the question and answer period, the following points were made by participants and presenters:

Uranium Market

- As industry economic studies have not accounted for a federal royalty, the addition of a royalty might destroy the economics of ISR facilities already planned.
- Uranium is a global commodity that has the same characteristics regardless of where it is produced. There is a spot market (20%) and a long term market (80%). Currently, the long term price is $60 per pound and the spot price is $43.
- The uranium market is susceptible to secondary supply, i.e., use of the uranium from decommissioned nuclear weapons for energy production. DOE holds a vast inventory of uranium in various forms and sells it into the market at times, depressing prices. However, demand is expected to increase significantly with are 58 nuclear energy plants under construction around the world today, and hundreds more in the permitting or planning phases (including two in the U.S.).
- Uranerz and Cameco both give a preference to Wyoming vendors.

Risk of groundwater contamination

- There was disagreement between industry and environmental group representatives regarding the extent of excursions at ISR facilities to date, and the nature of the risk if/when excursions occur. It was noted that uranium is ubiquitous in the environment and that some municipalities that are not near any uranium recovery operations have to treat their drinking water for uranium. No evidence of an ISR facility contaminating a municipal drinking water supply was provided.
- Cameco has recognized that bonding for the Smith-Ranch Highlands site has been insufficient and is in the process of submitting a new bonding calculation that will significantly increase the bond.

Comparative costs

- Wyoming has 50 percent of the country's sage grouse. The economic impact of the species being listed as endangered could be very large given potential restrictions on oil and gas production. The lost revenue from oil and gas could be far in excess of the potential revenue from uranium. It is important to consider the potential impact of uranium production on listing of the sage grouse and the economic impact that would have.

5. The American Energy Future

Dr. J. Stephen Herring, Laboratory Fellow at the Idaho National Laboratory, gave a broad overview of the energy future of the United States and the potential role of nuclear power alongside other energy sources in addressing energy needs:

In a future in which demand for energy continues to grow, uranium is a vital component of a diversified energy security strategy. In addition, increasing concern about CO2 emissions and reducing the carbon footprint of energy will drive increased use of uranium for power. The NRC currently has 29 applications for new nuclear reactors. The U.S. Department of Energy is studying uranium reserves to determine if there is sufficient supply to build light water reactors with a 60-80 year lifespan, given the fact that the uranium market is global and the dramatic expected rise in global use of uranium, which in 2060 will be at least triple what is today and possibly ten times as much. Thorium is almost four times as abundant as uranium and could be a significant long term fuel source for nuclear plants (though it requires some U-235 to drive fission). Though light water reactors will continue to dominate for the next 60 to 80 years, high temperature gas reactors, as well as small and medium size reactors, may become viable in that timeframe.

Nuclear energy can supply both electricity and support production of liquid fuels (through process heat and hydrogen production). In terms of transportation, nuclear energy both can provide power to charge electric vehicles (particularly at night, during off-peak hours, cars can be charged at a tiny fraction of the cost of equivalent power from gasoline or diesel) and also can be used to produce hydrogen (which is now used to refine and enhance gasoline, diesel and jet fuel and in the future likely will be used directly as a fuel source). In considering long term energy strategies, it will be important to consider relative carbon emissions, water use, and safety records of various energy sources. It is also important to consider how different energy sources can fit into a functional system. For example, nuclear reactors will have to interface with wind, solar, and other non-dispatchable sources.

The following points were made by Dr. Herring and forum participants during the Q&A following the keynote:

- Use of U238 and thorium could multiply current reserves by a factor of 50 or 100. It will it be cheaper to mine new uranium or reprocess it. It is not economical; the overall price of fuel is a minor cost of electricity.
- France, which generates 80% of their electricity from nuclear power, reprocesses spent fuel. They use the plutonium and then store most of their second generation fuel though some is processed into glass.
- The availability of expertise in the U.S. to design and build nuclear power plants is limited. There is a need for more parts manufacturers, nuclear engineers, health physicists and reactor operators. too. The French have found they don't have people trained for pouring concrete like they did in the 80's.

6. Uranium and Health

Dr. Susan Griffin, Senior Toxicologist with the United States Environmental Protection Agency and based in Denver, gave an overview of the potential human health effects of uranium production:

Uranium, a naturally occurring metal, is composed of three isotopes – all of which have the same chemical but different radioactive properties. For use in energy production and weapons, uranium is "enriched" – increasing the ratio of U234 to U235 isotopes. "Depleted" uranium has a decreased ratio of U234 to U235 and is used for armor. Natural and depleted uranium are not very radioactive. They primarily release "alpha" radiation, which cannot penetrate a piece of paper. This is not a health consideration unless it is inhaled or swallowed and there is no evidence to date of toxicity from *radiation* for humans or animals from naturally occurring uranium. There is evidence of *chemical* toxicity to the kidneys from uranium that is ingested or inhaled, and this is the primary health concern associated with exposure to unenriched uranium.

The conceivable routes of exposure to uranium from ISR would be through contact with wastes or evaporation ponds, spills, broken pipes, and drying and drumming of yellow cake. Worker safety and health is stringently regulated and urine and blood samples are taken regularly to monitor exposure. The limit for worker exposure is 5 rem per year. The limit for annual public exposure as a result of an ISR facility is 0.1 rem. Average annual exposure from natural sources in the U.S. is 0.6 rem. Exposure to the public via ambient air or soil is not likely since these facilities are closed to the public. Exposure to groundwater could be a potential pathway for residents living nearby. Liquid wastes from ISR are disposed of in deep underground injection wells permitted by the designated regulatory agency. Typically, these wastes cannot be injected into an aquifer defined as an underground source of drinking water. However, if this

condition cannot be met, the regulatory agency can exempt a portion of a drinking water aquifer for waste disposal. EPA has some concerns that we may be injecting waste water into or near future underground sources of drinking water.

While there are federal drinking water standards for uranium, private wells generally are not tested. Radon and radium are of greater concern than uranium as they emit gamma radiation, which can penetrate the skin. Radon and radium may be leached from ore along with uranium during ISR. Other metals may also be leached, including arsenic and selenium. Thus the greatest risks associated with ISR may be radioactivity and toxicity of elements other than uranium which are leached from rocks during the ISR process.

Ben Wise, a graduate student in Veterinary Sciences at the University of Wyoming, presented research underway regarding the effects of uranium and other constituents mobilized during ISR on livestock and wildlife:

It has been founded that uranium chemical toxicity to the kidneys is a significantly greater risk than radiation from naturally occurring uranium. Virtually no large animal studies exist, through rodent studies are available.

The following points were made by Dr. Griffin and forumparticipants during the Q&A:

- Soluble uranium in animal feeding studies has been demonstrated to have a significant effect on the renal system.
- Cases of renal damage from uranium exposure are most frequently people drinking water high in naturally occurring uranium from private wells.
- The difference between exposure limits for workers and the general public is built on the premise that the worker accepts more risk because of the direct benefits received.

7. Assessing and Addressing the Risks

Individuals representing the Wyoming state government, the federal government, the environmental community, and industry addressed the regulation and management of risks from ISR. **Don McKenzie, Administrator, Land Quality Division (LQD), Wyoming Department of Environmental Quality (DEQ)**, gave an overview of the regulatory roles of the agency with respect to ISR.

LQD issues mining permits for uranium that require reclamation to pre-mine use. National Environmental Policy Act (NEPA) guidelines for allowing for public input on permitting decisions are followed. Numerous other agencies also are involved in the process:

- Wyoming Department of Game & Fish (sage grouse habitat)
- U.S. Fish & Wildlife Service (endangered species review)
- State Historic Preservation Office (cultural)
- Water Quality Division (ground water classification)
- State Engineer (ponds, potable water, water rights)
- USEPA (approve minor program revisions, aquifer exemptions)
- Nuclear Regulatory Commission (federal license)
- Bureau of Land Management (federal mineral and /or surface manager, conducts its own NEP processes for development of BLM lands)

The permit application is very comprehensive, costly, and time consuming, requiring extensive testing of baseline water quality, well integrity tests, pump tests of lateral communication in the ore zone and to determine confinement, identifying problem drill holes, assessing expected impacts and their mitigation, developing maintenance plans, installation of monitoring wells to identify excursions, developing a protocol and operator plan for excursions, and posting of a bond until restoration is complete. ISR applicants have been voluntarily conducting additional baseline studies on private wells and mitigating impacts appropriately based on findings.

There have been improvements in the quality of ISR permit applications as well as in practices at ISR facilities in recent years. ISR site restoration has been successful at Bison Basin, Irigaray, and Smith Ranch. Higher quality

materials and better completion practices for wells has resulted in less mechanical integrity test failures; historical drill holes in some locations have been identified and properly plugged; current plugging practices are improved; and, monitoring plans have resulted in lower incidence of spills.

The outlook for production in the state include ongoing production and the Smith Ranch – Highlands facility (holds two permits); start-ups of two previously permitted sites is expected (Christensen, Gas Hills); five applications for new ISR facilities have been received by DEQ (Lost Creek, JAB/Antelope, Nichols, Moore, Ludeman); and, several others ISR projects have been proposed. However, overall exploration has dropped off since 2009. A significant rise in actions required to maintain existing permits, along with an increase in new permit applications, is dramatically expanding the work load of LQD. As LQD's human resources remain the same, there has been a backlog in processing applications and maintenance actions since 2005. Other growing responsibilities include implementation of the sage grouse stipulations as well as processing and addressing the increasing level of public involvement and citizen complaints.

Dr. Keith McConnell, Deputy Director, Decommissioning and Uranium Licensing Directorate, Nuclear Regulatory Commission, reviewed the role of the NRC in licensing ISR facilities:

Safety oversight for ISR facilities is a shared responsibility between federal and state agencies. Although NRC does not have oversight responsibility for uranium mining, it does oversee uranium milling, and ISR is considered milling. Licensing of a new ISR facility usually takes two years, and decommissioning can last several years. During operations and decommissioning, inspections occur frequently to ensure standards for decommissioning are met over time. Pre-licensing meetings are open to the public, and the process includes technical, safety and environmental reviews, as well as work with stakeholders and other parties. Focus areas include radiation health and safety, hydrogeology, and facility engineering. ISR groundwater protection regulations (10 CFR Part 40) are derived from EPA standards, and the licensee has to restore groundwater to the pre-established baseline or the maximum contaminant level, whichever is higher. Currently the NRC is overseeing the decommissioning of 38 legacy uranium recovery sites, mostly conventional mills. In addition, two ISR facilities are operating, one is licensed but not yet operating, and one is licensed but not yet constructed. Five applications for new licenses are under review, three of which are in Wyoming. (One is on hold because of sage grouse concerns and one has been withdrawn.) NRC expects to receive in the next couple of years an additional eight application for new ISR facilities (seven in Wyoming), ten application to expand ISR facilities (six in Wyoming), and two facilities where uranium would be leached from ore in large piles (one in Wyoming). Additional ISR activities can occur in other states (e.g., Texas) that have agreements with the NRC to take over regulatory responsibility for these facilities.

Shannon Anderson, Organizer, Powder River Basin Resource Council, presented the concerns of members of the Council:

Powder River Basin Resource Council members are not opposed to ISR development in their region, but want to ensure that is done safely. As landowners who do not own minerals in their land, there is very little they can do to stop development, but they do want to protect themselves and their environment. The overriding concern of residents is the protection of groundwater, including its restoration to pre-mining quality after production is complete. Past incidents at ISR facilities, including spills, leaks, excursions, pond leaks, and well casing failures, have caused concern about the effectiveness of regulatory oversight and enforcement. At three ISL sites, in Wyoming and Nebraska, 88 wells have been placed on excursion status – including both horizontal and vertical excursions – and some of these have last more than eight years. No ISL operation to date has restored groundwater to pre-mining levels of dangerous constituents – only to class of use levels. Aquifers can be reclassified from domestic or livestock use to commercial because of the uranium presence in the aquifer, which has a different restoration standard. Mining occurs in shallow aquifers that are used for drinking and stock water purposes – horizontal from mining operations. Baselines in such areas should not be averaged, but should be localized to protect local water sources. Existing water sources are at risk from exploration wells that have been abandoned without proper plugging.

We need to determine how to effectively mitigate the risk of uranium production as part of the permitting process. Industry should work with regulators to determine the appropriateness of each site given its particular specifications, including conducting extensive testing, drilling only where good confining layers are present,

collecting localized baseline data, and making restoration a priority. New well fields should not be brought into production until restoration is achieved at current operations.

In addition to groundwater quality, water consumption and land disturbance also are of concern. Multiple mines in one area can use a very large volume of water, and processing facilities have a large footprint. Energy production can turn ranches in rural Wyoming into industrial areas, with loss of privacy, traffic, land disturbance, and noise impacts. Industry needs to be respectful, honor a good surface use agreement.

Current NRC regulations are insufficient. NRC rulemaking for groundwater restoration should be compliant with EPA requirements and prevent or mitigate environmental impacts. NRC does not believe it is subject to the White House Council on Environmental Quality's regulations governing the National Environmental Protection Act. Currently, NRC does not have an office in Wyoming and has inadequate staff to inspect ISL operations. Wyoming DEQ also is under-staffed for permitting and enforcement, and the Wyoming Mining Association's proposal to allow consultants to carryout permitting functions is not an adequate solution.

Other options for energy production, including investments in energy efficiency, are available now and are cost effective, low-risk investments for the public.

Angelo Kallas, Safety, Health, Environment and Quality Manager, Smith Ranch – Highland Operation, offered an industry perspective on assessing and mitigating risks from ISR:

Safety, health, environment, and quality are top Cameco priorities. The company is committed to keeping all risks as low as reasonably achievable (ALARA) and continuously improving its practices. The industry is highly regulated by state and federal agencies. NRC regulates public and workforce health, licensing and bonding, and byproduct disposal; WYDEQ regulates water and air quality, solid and hazardous waste, and land quality; the State Engineers Office regulates cased wells; BLM approves plans of operations and coordinates with state and federal wildlife agencies; EPA regulates aquifer exception and tier II reporting on chemical storage; the US Occupational Health and Safety Administration regulates employee, contractor, and visitor safety and health; and, the US Department of Transportation regulates shipments of yellowcake.

Cameco's environmental management system is ISO-14002 certified, and the corporation both conducts corporate audits of safety, environment, and radiation programs and undergoes an annual third party ALARA audit. Cameco is proactive in addressing the many layers of regulation. There is regular monitoring for radiation exposure of workers and offsite monitoring. More than 20,000 tests are conducted annually for groundwater monitoring and restoration activities, and there are daily well field inspections. Additional standard work practices include topsoil segregation and management, surface reclamation (e.g., contouring, seeding), drainage control/management, quarterly surface/groundwater sampling (e.g., stockponds, water wells), and spill detection and response.

The following points were made by panelists and forum participants during the Q&A:

- BLM is responsible for six million acres, and is required to manage public lands for multiple uses, including grazing, recreation, cultural, visual, historical, oil and gas resources, and others. BLM's NEPA process is designed to identify a proposed project's impacts on all of these uses. This is not duplicative of the NRC's NEPA process, as BLM seeks to determine if impacts on the lands it manages have been adequately addressed. (John Kominsky, BLM)
- According to the Atomic Energy Act, the NRC is permitted to relinquish its authority for overseeing uranium milling (which includes ISR facilities) to a state agency. Colorado, Texas, and Utah have opted to take responsibility for licensing facilities. NRC provides support, but the states are responsible.
- NRC is an independent federal agency that reports directly to Congress rather than to the executive branch. NRC is subject to NEPA, but not to the Council on Environmental Quality guidelines regarding implantation of NEPA for federal agencies.
- Junior companies often do exploration, and it is the practices of these companies that is of greatest concern, not the practices of the large uranium companies.
- Examples of recently reported spills at the Christianson Ranch operation cited by Shannon Anderson were explained by Donna Wichers, Uranium One. A pond leak spill was reported in July related to

the spillage of clean water occurring during valve replacement on a trunk line. The pond leakage reported was discovered after cleaning of an evaporation pond and filling it with clean water.
- It was noted that nine well fields at the Irigaray facility were restored and approved by DEQ and NRC. 90% of the parameters monitored were restored to baseline.
- Quantities of groundwater used during ISR operations can be found both in NEPA and DEQ documents.
- Concerns about the use of consultants to review permits, as proposed by the Wyoming Mining Association, is not related to the qualifications of the consultants but to a desire to maintain the independence of the regulatory agencies. NEPA procedures require that consultants cannot have a financial stake in the mining project, but the current bill proposing use of consultants has no conflict of interest provision. In addition, there is concern that correspondence between consultants and mining companies may not be subject to the Public Records Act.

8. Perspectives on the Future of Uranium Production in Wyoming

The forum concluded with a roundtable discussion among leaders of agencies and organizations who were asked to reflect on the future of uranium production in Wyoming. Forum participants also engaged in tabletop discussions during this program.

Marion Loomis, Executive Director, Wyoming Mining Association

Even without the expected increased demand for electricity, nuclear energy will have to play a big role. We use about 45 – 50 million pounds annually in the US and we will need that going forward. Since the Three Mile Island incident, utilities stockpiled uranium, and Russia has dumped its reserves. These sources have largely been consumed and demand soon will increase. We should not rely on imports for all of our needs. Wyoming is the leading reserve holder. To develop the resource, industry needs permits. We're concerned about the time frame for permits, duplication of requirements among agencies, and the cost of obtaining permits. The legislation proposed to use consultants to expedite permitting is one tool the state should look at. We anticipate significantly increased demands on the WDEQ. Once coal leases are made, they will need to be permitted. Existing mine plans may need to be modified because of the delays. On top of that are the permit applications for uranium. This will result in a bubble hitting DEQ in a few years. If the expected work load in the next several years were continuous, it would make sense to staff up DEQ. As it will only be for a few years, consultants may make sense. The Wyoming statutes have clear mandates on time frames for permits. The DEQ has sixty days in which to deem an application complete. Any issues should be brought up by DEQ in that period, before the technical review, for which 150 days is allotted, starts. We have seen additional issues crop up all the way through the process. Consequently, permits that should be completed within a year, submitted in 2007, still are not finalized. Regulators should be very clear about what is required for the permit at the outset and identify issues early on so that applications can be complete before the technical review. We want to make sure that the issues important to the agency are addressed, but it should not come towards the end of the permitting process.

Larry Claypool, Deputy State Director, Minerals and Lands, Bureau of Land Management– Wyoming State Office

Wyoming is an energy mecca for the country: number one in oil, gas, coal, and uranium on federal land, and 50% of class 6 and 7 winds in the country. One out of every five lights in the US is powered by Powder River Basin coal. We export to 40 states, with 1.5 million tons leaving the Basin every day. 150 towers are gathering wind to date, and eight wind farms are under review. Last year, federal royalties returned to the state totaled more than $1 billion. The job of the regulators is to facilitate the application process for approval. This requires extensive coordination between all parties. BLM will do everything it can to assist with applications for ISR facilities on BLM land to ensure their success. Frustrations expressed about the ISR permitting process, including duplication and coordination issues, need to be addressed. The extended timeframe of coal leasing permits is related to the transition to a new Washington Administration.

There is a lot of attention being given to shale gas, and its potential to serve as a transitional energy source. Little is

heard about uranium sources in Wyoming. Outreach and education is needed.

Steve Jones, J.D., Watershed Protection Program Attorney, Wyoming Outdoor Council

The Wyoming Outdoor Council is focused on energy development because it is the cause of the greatest environmental impacts in Wyoming. We look at all kinds of energy development and seek to ensure that it is done right. Based on the presentations today, there are reasons to be very concerned. It is welcome news that some of the problems are being addressed and getting better, but we do not have a long history of good uranium development in the state. Old drill holes are a real problem, not just from uranium but also oil and gas development– chunks of the state look like a cribbage board. Wells have not been properly plugged and abandoned, and nobody here today has said that we know how to find and deal with these wells.

Smith Ranch-Highlands had a major spill in 2007, and they worked out a settlement with DEQ. DEQ was concerned enough that a $900,000 fine was justified [$400,000 of this was suspended due to timely compliance with the settlement agreement]. More recently, the draft supplementary environmental impact statements (EIS) conducted by NRC in March were found "inadequate" by the EPA. EPA has stated that if they are not substantially revised, they will be referred to the Council on Environmental Quality. We understand that NRC is now working on revisions.

Current proposed projects are a cause for concern. Though some presentations today seemed to imply that there is always a confining layer above and below the ore body, at the Lost Creek site there is actually a fault running through the project area. The duplicative processes of the BLM and NRC are of concern. Issues can fall through the cracks without one, comprehensive, EIS that assesses all cumulative impacts. A comprehensive cradle-to-grave approach to uranium is needed. We need to make sure we protect groundwater and carefully control and monitor surface activities.

Rob Hurless, Energy & Telecommunications Advisor, Governor's Office - Wyoming

China has passed the US in total energy consumption, though their per capita their consumption is one fifth of ours. There is global competition for energy, and the U.S. needs to take advantage of every source of energy, including conservation. Wyoming is an energy commodity state, accounting for over 10 quads of energy that the country consumes.

Every energy source has risk associated with it. The question is not whether Wyoming will produce uranium, but how best to do so. Facing competition means we have to work together. Wyoming's small population can be an advantage as we can easily assemble the necessary stakeholders and work through problems.

John V. Corra, Director, Wyoming Department of Environmental Quality:

DEQ is in the business of permitting and ensuring that as things happen in Wyoming, the impacts to the environment are managed and reclamation is achieved to the extent that we can. DEQ has five areas of work: one is permitting (a contract between the state and the operator that spells out the way things are to be done and issues dealt with). We must ensure that we carry the public's trust in fulfilling our role. After permitting, DEQ monitors compliance with permits and standards through reporting and inspection. If something is out of compliance, DEQ has an enforcement responsibility. DEQ also handles remediation and reclamation. Uranium permitting has been messy. DEQ and the industry have been on a steep learning curve, and it has not been a pleasant ride for industry or DEQ staff.

To use an analogy: DEQ is in the business of issuing something like a driver's license. We make sure the vehicle he chooses to drive conforms to all the rules, but we don't tell him how to drive. We don't have much control over the way he chooses to drive or road hazards or surprises he encounters. It is not a perfect science. That's why we have monitoring, inspecting, and enforcing. I have high confidence that the drivers are competent and will get the job done right and I want to publicly compliment the industry for working with us as we review and approve ISL permits. The reason we are having a long permitting process is that it's important that we get it right the first time. Though there are numerous challenges with the uranium permits, we're working through them. We do not want to repeat our experience with coal bed methane, in which we had to readjust our policies and strategies multiple times. We also want to provide a level playing field. Wastes must be stored, under certain conditions and

parameters. We want to make sure we haven't inadvertently given something away by setting any good or bad precedents as we go forward. We appreciate the input of all parties as we strive to get things right.

Making sure we have necessary capacity is important. In 2003, DEQ had 215 employees; currently there are 268. Over that time frame only two or three people have been added to LQD. It is difficult to read where the demand is and for how long it will continue. As uranium permits are doubling, we intend to take a close look at the processes inside the LQD. Despite our nation's economic condition, DEQ has not seen a decrease in demand for our services, though we, along with every other agency, have reduced our budget. DEQ will be requesting an increase for LQD in the next budget cycle.

I have been in the mining business in Wyoming for a long time, and I see solutions being generated every week when my staff and industry work together.

Forum participants made the following points after the tabletop discussions:

Working together to solve problems

- There seems to be a great divide between industry and the environmental movement. Industry seems to be trying to move to the middle but environmentalists are not. How will a middle ground be found?
- It has been reported that there are 18,000 unpermitted water wells in the Powder River Basin. If citizens concerned about uranium production can get those water wells permitted, some of the ISR permitting would be a lot easier.
- Permits need to give comfort both to the public and to investors. If everybody worked together it would streamline, not short circuit, the process.

Protecting the environment

- Contamination of groundwater is a continuing concern, despite assurances. We need to work toward a solution.
- Nuclear energy is a non-renewable transition source of energy. How long are we going to have uranium to use in nuclear reactors? What kind of damage could we do in this transition?
- "Spills" are inevitable in the industry, but it is water that is being spilled. After spills, soil is tested, and 90 percent of the soil we test shows no contaminant.
- Prior to 1970, plugging of holes wasn't required. Perhaps soil can be graded and 90 percent found and plugged, and the other 10 percent can be found through pump tests.
- If we achieve 90 percent of restoration with 10 percent of the water, does it make sense to restore beyond that point?

Educating the public about the actual risks of nuclear energy

- As a nation we continue to live at a certain standard that we'd like to maintain. To do so, we need to produce energy. How can "Three Mile Island syndrome" be overcome so that we can move forward with nuclear energy?
- Regarding the "Three Mile Island syndrome," the real issue is to understand and quantify risk. No one was killed or made ill by that incident. People accept much greater risks every time they drive. Getting past perception will help us to understand what the real risks are.
- The lack of public education has caused problems to the industry. Can SER help us to educate the public? How can the industry get our message to people who don't care enough to learn the facts but have an opinion?

Members of the roundtable panel offered concluding comments:

John Corra: From a DEQ perspective, it's important for us to hear from everybody. The divide between industry and environmentalists is not a concern; good input has been received from all sides and that helps us make good decisions.

The rule with respect to groundwater restoration is that it has to be restored to its former class of use. That doesn't mean that it's chemically exactly like what it was before, just that that water will be capable of being used just as it was capable of being used before mining. You can't disturb something underground and get it back to its exact former chemical designation. The permitting process is designed around the applicant proving to us that he can return the water to its former class of use. Applicants will not get a

permit from us unless they demonstrate that they can accomplish that.

Larry Claypool: BLM also lives in the middle - getting knocked on the head by both sides. That's how we gauge if we're in the right place. But the public needs education, and we need assistance from SER to create educational tools for ISR.

***Marion Loomis*:** Industry has proven that it can restore water to pre-mining conditions. Furthermore, uranium is not just a stop gap. Nuclear energy should be considered a permanent energy source given the projected ability to extend reserves. Renewables cannot meet demand and they require tremendous resources just to make them.

Steve Jones: With regard to the allegation that environmentalists don't want to move to the middle: Milton Friedman, a well-known economist, said "there is no such thing as a free lunch," and in terms of how I see my role, as someone who worries about protecting the environment, one important aspect is to to prevent pollution, which is really a market externality, from occurring. Without adequately addressing such consequences of development as pollution and land disturbance, market externalities will abound, and the uranium industry will get a "free lunch" -- which the public will really be paying for. We don't want to prevent development entirely, but we want to ensure that things get done right and done well.

Rob Hurless: We need a quantitative basis to effectively assess risks, trade-offs, and externalities of energy production. This is a challenge as much of the public is not comfortable with numbers. The media can help educate the public so that it has the knowledge to consider trade-offs in a rational way.

Key questions raised but not definitively addressed at the forum may serve as the basis for future dialogue, research, and/or other activities. Among these are:

Protecting the environment and public health

- What is the evidence regarding whether or not ISR presents a real risk to drinking water? If so, how much risk is reasonable?
- In what cases might restoration of groundwater to class of use prior to mining be inadequate? How close to baseline is close enough?
- If 90 percent of restoration can be achieved with 10 percent of the water, does it make sense to restore beyond that point?
- What is the evidence regarding the impact of ISR on wildlife? Is evidence from oil and gas field a reasonable proxy for likely impacts of ISR?
- What opportunities are there to better understand the impacts of ISR facilities to date and to identify solutions to reduce risks?
- To what extent should challenges with ISR operations to date be taken as an indicator of likely future challenges? What adjustments to or changes in operations have been made that would prevent recurrence of prior violations?
- How might cumulative impacts on the landscape and water resources (e.g., from multiple kinds of energy development) best be planned for and managed?
- Nuclear energy is a non-renewable transition source of energy. How long are we going to have uranium to use in nuclear reactors? What kind of damage might be done in this transition?
- How might abandoned holes be found and plugged?

Economic impacts

- What is the relative value of uranium production for Wyoming in comparison to the value of sage grouse habitat (i.e., avoidance of listing of sage grouse as endangered)?

Working together to solve problems

- How might the regulatory process be coordinated and streamlined in a manner that increases effectiveness and efficiency for both industry and regulators?
- How can "Three Mile Island syndrome" be overcome so that we can make rational decisions about nuclear energy? What are the best strategies for educating the public about the actual, rather than perceived, risks of ISR?
- How can industry and the environmental community work together to find a middle ground?
- How can the risks of ISR be quantified in a manner that can be effectively communicated to the public?

Epilogue: Future Activities of the School of Energy Resources

Mark Northam, Director, School of Energy Resources, offered some concluding thoughts:

This event has been very informative. SER intends to be a source of education and outreach about ISR. We saw today the breadth of knowledge relevant to ISR, from impacts on jobs and the economy to impacts on the environment, from technology development to the potential role of uranium production in Wyoming in a broad national energy strategy. All of that is information we need to pass on.

SER is carefully looking at the expert opinions received in last year's workshop on developing priorities for an ISR research agenda, feedback from this forum, and the public opinion survey. We'll put that together and support education from kindergarten through graduate programs. Don Roth, our Associate Director for Academics for SER is working with Mary Byrnes, out Outreach Director, on developing an outreach program to reach into our public education system.

Specific ideas for follow up to this forum include:

- Surveying participants in the forum regarding its impact on your knowledge and perceptions.
- Issue an RFP for ISR-related research to address gaps in our knowledge. This will include groundwater issues, an area of strength at UW. It will also address how to reduce the disruption and costs of exploration for ore deposits including adapting techniques from other fields.
- A technical forum in two years to review the results of this state funded research and also invite other, international research in uranium recovery.