December 2011

Proposed Coles Hill Virginia Uranium Mine and Mill: An Assessment of Possible Socioeconomic Impacts

Executive Summary

Prepared for

Danville Regional Foundation
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Danville, VA 24541

Prepared by

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Acknowledgment

RTI would like to thank the Danville Regional Foundation, and its President/CEO Karl Stauber, for the opportunity to conduct this challenging and important study. We would also like to express our deep gratitude to the members of our Community Advisory Panel:

Larry Campbell, Danville City Council

Laurie Moran, President, Danville Pittsylvania County Chamber of Commerce

Jeff Liverman, Director, Danville Science Center

Martha Walker, Community Viability Specialist, Virginia Cooperative Extension Service

Their insights into the values, aspirations, and concerns of the stakeholders of the study region provided invaluable help in shaping our study.

In addition, RTI would like to thank residents and stakeholders of the region, for their engagement interest in the issues, and their willingness to talk with us. We hope we've answered some of your questions.

Executive Summary

ES.1 Introduction

In late 2009, the Danville Regional Foundation (DRF) decided to fund a comprehensive, independent assessment of the possible impacts of establishing a uranium mine and mill at Coles Hill, near the towns of Gretna and Chatham in Pittsylvania County, Virginia. Virginia Uranium, Inc. (VUI) has begun efforts to mine a deposit of an estimated 119 million pounds of uranium ore that had initially been discovered and evaluated approximately 30 years ago. At that time, the Commonwealth of Virginia established a moratorium on uranium mining in Virginia[1]; because of declining market prices for uranium, interest in developing the resource waned and the moratorium remains in effect today. Conditions in the uranium market have strengthened, and VUI has begun additional assessments of the ore body, in hopes of being able to mine and mill the ore. Today, the Commonwealth is considering lifting its 27-year moratorium on uranium mining. This statewide consideration is under the jurisdiction of the Coal and Energy Commission of the Virginia Legislature.

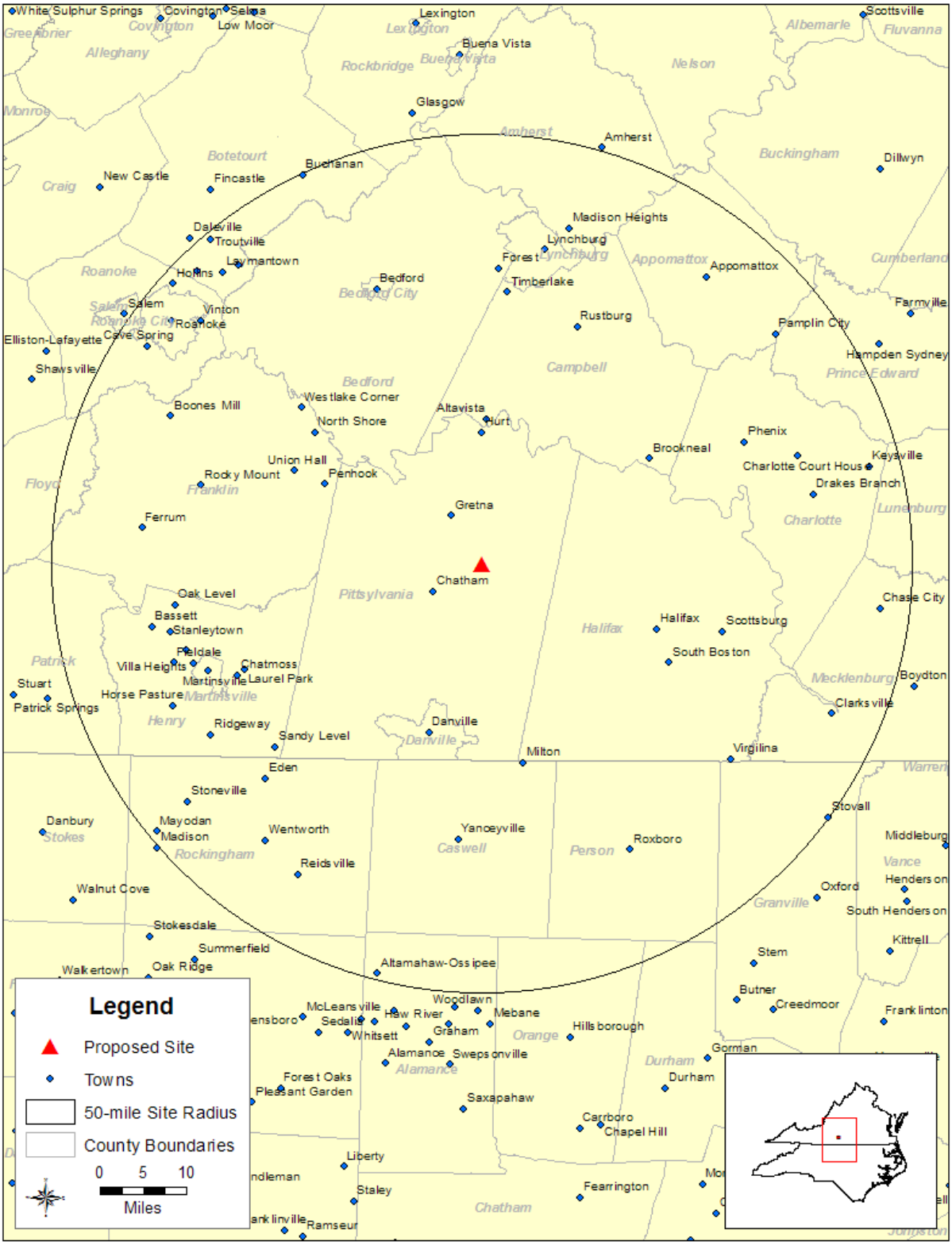
Established in 2005, DRF is a nonprofit organization that serves a region including the City of Danville and Pittsylvania County in Virginia, and Caswell County, North Carolina. Its mission includes development, promotion, and support of activities, programs, and organizations that address the region's health, education, and well-being, with a focus on economic transformation, educational attainment, health and wellness, and civic engagement. In keeping with this mission, DRF requested a comprehensive, independent study to provide area decision-makers and residents with sound, scientific information on potential environmental impacts regarding differing mining, milling, and waste management technologies and extraction methods and how pollutants might move through the environment. In addition, DRF requested an objective assessment of potential positive and negative socioeconomic impacts, including impacts on employment, regional business development and competitiveness, and reputation from the development and operation of Coles Hill. Finally, DRF requested information on possible impacts the mine and mill might place on county and local government services, and on county and local government finances.

ES.1.1 Study Scope and Purpose

The purpose of this year-long socioeconomic study was to evaluate the potential impacts of developing and operating a uranium mine and mill on a region within 50 miles of Coles Hill. Figure ES-1 shows areas included within the study region. This report is intended to serve as a resource for all interested parties as they consider the variety of ways that this potential development may affect their communities and environment. As such, the primary goal of the study is to enable stakeholders to

[1] In 1982, the Virginia General Assembly passed Statute 45.1-283, which states that "permit applications for uranium mining shall not be accepted by any agency of the Commonwealth prior to July 1, 1984, and until a program for permitting uranium mining is established by statute."

Figure ES-1. The Study Region, a 50-Mile Radius around Coles Hill, Virginia



formulate informed opinions, to make the best collective decision possible, and in the case of an eventual mine and mill project, to be aware of questions and concerns they may want to investigate further or monitor going forward. The focus is on anticipating what might be entailed in the proposed mining and milling project, and on identifying possible ramifications of the project in social, economic, and environmental terms. To do this, our efforts are targeted toward providing realistic information about the types of possible impacts and which important factors of the project will drive these impacts, as opposed to providing extensive mathematical projections of specific metrics. Some modeling and projections will be used to describe the upper and lower bounds of potential impacts across a number of parameters. However, it should be noted that these numerical forecasts are intended to place the qualitative assessments in context and allow this report to serve as a useful reference document as the stakeholders of the region prepare themselves with the best available information to understand this important decision.

The study does not reach any conclusions or make any recommendations as to the advisability of lifting the moratorium and allowing mining and milling of uranium in Virginia. Instead, the study is designed to provide a repository of information about the various types of impacts that may be experienced if the mine and mill are developed.

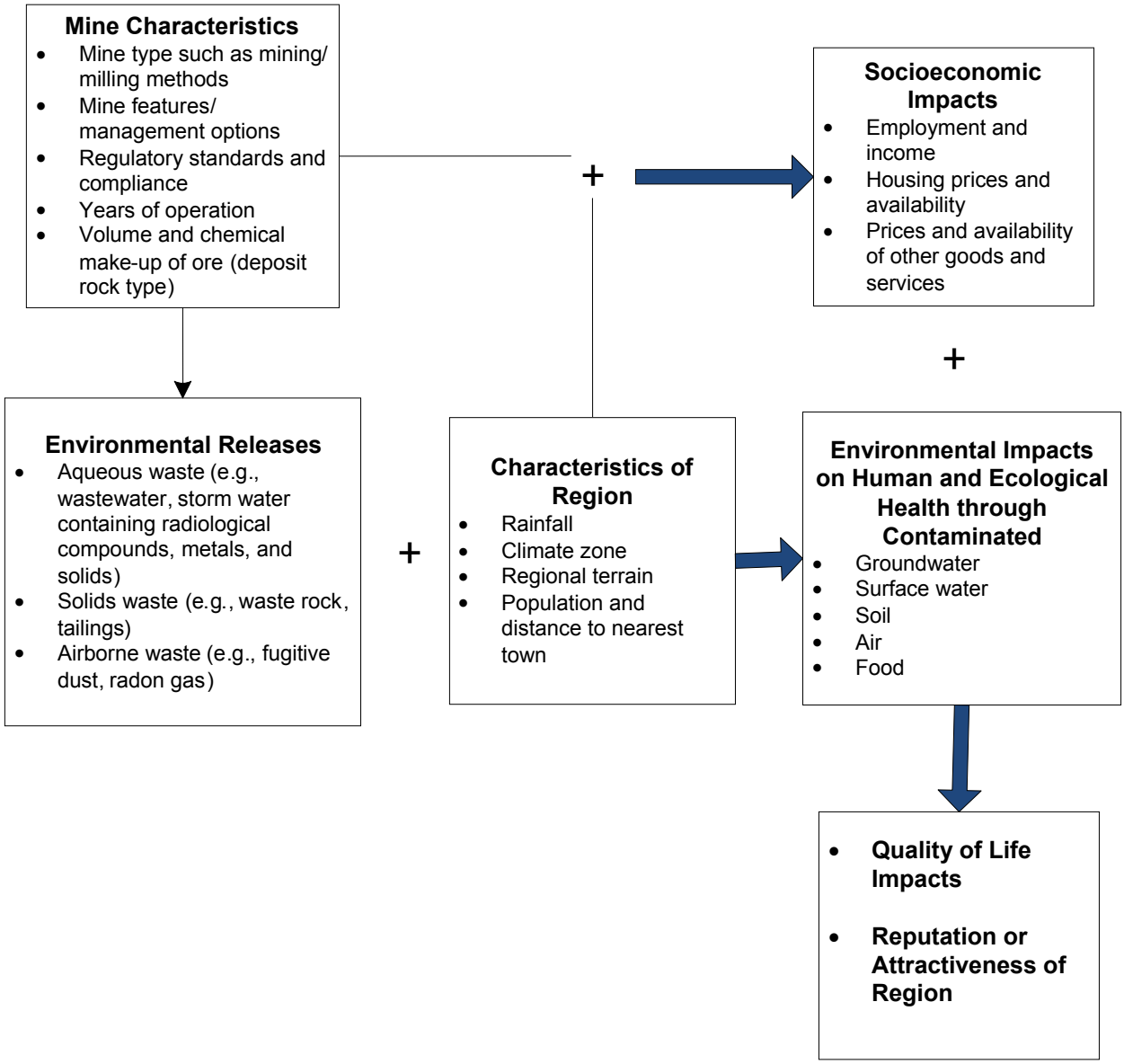
ES.1.3 Study Methods

To ensure that our study meets the goal of serving as a reference document for the residents of the region, our approach must (1) identify and address the interests and concerns of regional residents and (2) provide as much well-documented, defensible information as feasible (subject to assumptions and data availability). Thus, our study combines an assessment of possible impacts predicted by environmental and social sciences, with an investigation of stakeholder interests and concerns within the study region. Our qualitative research into residents' interests and concerns helps us to specify the environmental and economic impact assessments. In addition, we provide illustrative information based on case studies of other mines and mills (U.S. and international) along with their surrounding regions.

ES.1.3.1 Overall Analytical Framework

Our analysis is structured on a model of the interactions between households, firms, and the environment. Where the objective is to make the region the best place to live that it can be, the outcome depends not only on production, consumption, employment, and income, but also on other nonmarket conditions such as environmental quality and the availability of high-quality public services, recreation, etc. In this sense the assessment of environmental impacts of the proposed mine and mill is a part of the overall assessment of socioeconomic impacts. Broadly speaking, conditions in the region's economy can be represented by the characteristics of the set of households and firms in that region. The other major components characterizing an economy consist of environmental amenities and other public amenities such as education, health care, safety, and transportation. In the event that a mine or mill is established at Coles Hill, these are the different parts of the regional economy that may be impacted. Changes in the condition of the region result from numerous interactions and feedback mechanisms among these different entities. This is illustrated in Figure ES-2. Within each box are a set of variables that could be affected by the establishment of the mine and mill. Characteristics of the mine include not only the mining, milling, and tailings management methods, but also production rate, hiring decisions, regulations that apply and extent of compliance with the regulations. These all combine to determine likely pollutant

Figure ES-2. Analytical Framework for Assessing Socioeconomic Impacts



releases to the environment, which combined with baseline environmental conditions in the region surrounding the mine, determine likely environmental impacts. Narrowly defined socioeconomic impacts (employment, income, output levels within the region) are determined by operations at the mine and mill and socioeconomic characteristics of the region, which include not only characteristics of households and firms, but also tax rates, provision of public services, and other market and nonmarket characteristics. Finally, the overall impact of the proposed Coles Hill uranium mine and mill on the region's quality of life and reputation depend on both the socioeconomic impacts and the environmental impacts of the project.

ES.1.3.2 Understanding Interests and Concerns of the Region's Residents

Borrowing a framework from the field of decision analysis, our study draws on the interests of the community to help define the fundamental structure of the analysis, ensuring that the questions pursued and impacts assessed will address the questions and reflect the values of the affected communities. A decision analysis approach has been used to guide information collection, facilitate the involvement of multiple stakeholders, and understand the characteristics of the linkages identified in Figure ES-2, above.

Unlike a decision-making approach that begins by identifying alternatives (e.g., to develop the mine vs. to take steps to ban the development of the mine), the decision analysis approach steps back to first identify the values underlying the decision and translate those values into objectives that the ultimate decision should support. Alternative decisions can then be evaluated with respect to how well they will meet these stakeholder-defined objectives. By then considering alternatives with respect to their effects on the objectives at hand, tradeoffs between the alternatives can be more clearly understood. Often, more alternatives are identified than were originally under consideration, because the focus on objectives allows for creative thinking.

In pursuit of this values-based approach, we sought the opinions and viewpoints of multiple stakeholders as we structured the analysis. The concerns and interests of those to be affected by this decision have been gathered and organized into a hierarchy of objectives articulated by the community. A hierarchy of regional objectives was assembled based on an amalgamation of opinions from across a wide range of stakeholders, including community leaders, business owners, and a broad spectrum of citizens in multiple counties and communities. In addition to serving as a facilitative tool for incorporating the views and communication desires of multiple stakeholders, this hierarchy of community objectives (the decision analytic framework) highlights the interconnectivity of many of the decisions facing the community, and can be used to explore and possibly uncover alternative steps the affected communities could take to achieve their objectives.

ES.1.4 Qualitative Research on Community Characteristics and Concerns

To better understand potential social and economic impacts from introducing uranium mining and milling in the Southside region of Virginia, RTI conducted qualitative research into people's shared or collective notions of the region and its communities, and research into how residents of the region potentially see aspects of the community as changing or being affected as a result of the introduction of uranium mining in their community. RTI used three primary data collection activities in conducting the qualitative research: (1) Community Advisory Panel (CAP), (2) Key Stakeholder Interviews (KSIs), and (3) Focus Groups:

- *Community Advisory Panel*: The CAP engaged five community leaders[2] from the study area to review the design of the project's research activities and provide guidance on working in

[2] CAP members included Larry Campbell, Danville City Council; Jeff Liverman, Danville Science Center; Laurie Moran, Danville-Pittsylvania Chamber of Commerce; Dan Sleeper, Pittsylvania County Administrator; and Martha Walker, Community Viability Specialist with the Cooperative Extension Service. Mr. Sleeper was asked to step down from the CAP by the Board of Supervisors, so for the last several months of the project, there were four CAP members.

the communities around the proposed mine. The CAP members provided critical guidance and information about the region's strengths, challenges, and concerns.

- *Key Stakeholder Interviews*: Individuals participating in the KSIs were chosen because their knowledge, previous experience, or position in a community was thought to offer a unique or specialized perspective on the issue of the mine in the community and included community leaders and representatives in areas of business, community development, community advocacy, economic development, education, environment, health, religion, and government. In addition to interviews, the KSI participants were asked to complete a Structured Ethnographic Questionnaire that asked participants to rate the impact of the mine and mill on specific qualities or features in the areas of economic, environmental, and community issues

- *Focus Groups*: Focus groups were use to develop a more nuanced understanding of the values and concerns of individuals in different communities within the region. The focus groups were conducted with convenience samples of citizens from five communities in the Southside region. Participants in the focus groups were recruited through a local recruitment firm that phoned households in the targeted areas. An RTI interviewer and notetaker facilitated the discussions. Focus group participants were also asked to complete the same Structured Ethnographic Questionnaire as provided in the KSIs.

The KSI and focus group information was analyzed using qualitative data reduction techniques, where detailed interview and focus group notes were reduced to main themes. The analysis was aided by software for qualitative analysis (Nvivo 9). The structured ethnographic survey responses were analyzed using descriptive statistics.

ES.2 Baseline Conditions in the Region Surrounding Coles Hill

To characterize baseline conditions in the study region, we combined data from publicly available sources (U.S. Census Bureau, Bureau of Labor Statistics, and others) with qualitative information gathered from stakeholders within the region. This characterization sets the context against which to compare the possible impacts that we estimate could result from the proposed mine and mill.

The approximately 7,850-square mile study region lies partly in Virginia and partly in North Carolina, including all or part of 28 counties and six independent cities. The proposed mine and mill site is located between the towns of Chatham and Gretna, in Pittsylvania County, Virginia. This is a rural area, within a relatively rural county. The nearest cities are Danville, approximately 25 miles to the south, and Lynchburg, approximately 45 miles to the north. The nearest towns, Chatham and Gretna, each have fewer than 1,500 residents. Population for the region as a whole is projected to grow by approximately 5.3% between 2010 and 2030, although some counties within the region are projected to grow more or less slowly, and a few jurisdictions (Charlotte County and Henry County, and the cities of Bedford, Roanoke, and Salem) are projected to experience falling population. The population of Pittsylvania County is projected to grow by less than 1% over the 20-year period. Based on information from the National Land Cover Dataset (NLCD), the majority of the land in the study region is used for agriculture or is forested. Specifically, the predominant land uses in the study region are deciduous forest, grassland, and pasture/hay. However, several cities and many small towns in the study region are home to a population long tied to the land and associated commerce in agricultural-based products. The region has a

long tradition of agriculture, and includes counties that are leading producers of tobacco, pigs, beef cattle, and dairy products.

Interviews and focus groups conducted in communities within the study region helped us better understand the region and what people living there value about it. Insights from this qualitative research included the following:

- People valued a strong sense of community they felt in their towns and cities, and a less stressful rural lifestyle that still permeates the region. The communities were credited with having good schools and being safe places for families to raise children.

- Many participants also valued the natural resources of the region for its aesthetics and recreation opportunities, such as its parks and lakes.

- Although many participants in the research recognized that the region's economy has been struggling with the loss of several major industries, they felt the region has the right ingredients in terms of an available workforce, quality of living, necessary infrastructure, and proximity to major cities to attract new business and develop a vibrant economy. Some looked to tourism as a potential growth area for communities and jobs.

- Some challenges for the region, particularly for the region's economic prospects, mentioned by participants included loss of younger people because of a lack of jobs, attitudes in the community that resist change, a traditionally lower value on higher education, and an undertrained workforce.

- For the future, people are hoping the area will attract more businesses, ideally in clean industries, with more high-paying jobs. In addition, they would like to see the region gain some of the social and cultural resources that will help attract or retain the younger population.

Data from the Census Bureau's American Community Survey for 2005–2009 confirm that the region is overall somewhat poorer and has somewhat lower educational attainment relative to both the Commonwealth of Virginia and the United States. During the 2005–2009 period, per capita income in the region was $6,000 lower on average than for the nation, and $10,000 lower than for Virginia. Sectors in which the region's employment increased faster than national employment included health care, retail trade, and management. Manufacturing and construction employment, however, did not fare well within the region. Manufacturing has historically been more important to the region's economy than it is to the national economy; over the period 2001 to 2009, manufacturing employment fell faster within the region than it did nationally. Overall, manufacturing employment fell by 43% within the region over that period, and some counties (including Caswell and Person Counties in North Carolina, and Charlotte, Henry, and Pittsylvania Counties in Virginia) experienced even steeper declines. These data emphasize the need to grow or attract new businesses in the region; at the same time, the comparatively low educational attainment of the workforce may hamper efforts to recruit high-paying jobs.

The region has 24 employers with more than 1,000 employees, including nine school systems, four hospitals, and two nuclear fuel manufacturing facilities in the Lynchburg area. However, job growth in the region has been fueled largely by firms with fewer than 10 employees. Overall, our examination of

current conditions in the study region shows an area with many natural and cultural assets, and one seen by its residents as having much value and potential. However, the decline of traditional textile and furniture manufacturing and tobacco farming poses economic challenges for the region, which badly needs additional employment opportunities.

ES.3 Insights from Case Studies

Potential impacts of developing and operating a uranium mine and mill include a combination of environmental and socioeconomic impacts and both of these affect residents' quality of life. These impacts result from the complex interplay of various factors. Case studies can provide valuable insights into the experiences of other communities with uranium and other hard rock mines. They can also be useful in providing context for assumptions used by RTI in economic and environmental modeling.

It should be noted that lack of data on baseline characteristics (before the mine and mills went into operation) and detailed information on other regional changes that might have occurred at the same time as the opening of mines and mills prevent us from separating out effects of the mines and mills from other influences in these locations. Thus, no attempt is made to attribute the socioeconomic characteristics of the surrounding region directly to the mine and mill. More detailed information and rigorous statistical analysis would be necessary for this.

ES.3.1 Insights into Environmental Impacts and their Drivers

Key factors contributing to environmental impacts include characteristics of the mine such as mining and milling methods, management options, volume and chemical makeup of ore, regulatory standards determining pollutant releases, and geographical characteristics of the region such as rainfall, climate zone and regional terrain. Distance to population centers and population density consequently determine human and ecological exposures to constituents of concern (contaminants are chemically reactive and can potentially cause cell damage).

Examining publicly available data on these key factors and the documented environmental impacts of other mines yields several broad insights:

- Common environmental impacts include presence of particulate matter and radon gas concentrations in the air; groundwater and surface water contaminated with radionuclides and heavy metals and associated radiation; subsidence issues; and contaminated soils and sediments.

- There is no mine and mill that mirrors the characteristics of the proposed VUI mine and mill and its surrounding area. Thus, it is not possible to make direct predictions of impacts of the proposed Coles Hill mine and mill based on mines and mills elsewhere. For example, some mines and mills are similar in geographical characteristics such as precipitation or terrain but may differ in the mine type. Others may be close to dense population centers but may differ in the nature of the mineral and mining method. There is also no other operating uranium mine or mill that is close to a city with a population that compares with the area surrounding Coles Hill. Most mines and mills are located in sparsely populated areas. Thus, the selection of mines and mills RTI gathered information about are aimed at providing a wide range of

experiences to draw from rather than provide a prediction of what is to be expected for the proposed mine and mill.

- Closed mines and mills provide some insights into postclosure releases and management procedures for cleanup. However, it should be noted that some of them may be both operational and older and reflective of different technology and regulation stringencies.

- Superfund sites provide useful lessons in terms of reclamation activities and postclosure releases and management procedures for cleanup. However, they also have high levels of contamination associated with them and are not reflective of average mines and mills.

- Other "heavy" metals provide interesting insights on similar contamination issues, such as acid rock drainage. One of these (although closed) is also the only mine that is surrounded by a more densely populated area that is more similar to Coles Hill as compared to the other mines and mills included in the case studies.

ES.3.2 Insights into Socioeconomic Impacts, Quality of Life, and their Drivers

Insights into socioeconomic impacts and quality of life changes experienced by other communities were also explored. Some of the more important factors for gaining potential comparable insights for Coles Hill are operational mines' and mills' proximity to an existing population center and location that has an existing industry base other than mining and milling. The mines and mills most relevant for comparison in this section are the Arizona 1 Mine (United States), the White Mesa Mill (United States), Rabbit Lake Mine (Canada), and the Ranger Mine (Australia). These mines and mills were selected because they are currently in operation (and thus reflect newer mining technologies), use underground and surface mining methods, and are subject to regulations comparable in stringency to those that would be developed for the proposed mine and mill. In addition, Ranger Mine and Mill are located in an area affected by monsoons; their experience provides insights into possible impacts of hurricanes or other heavy rainfall situations at the Coles Hill location. It is important to note that analysts did not identify an active uranium mine that is similar in all aspects to the proposed mine and mill.

Much of the information in this section is gleaned from publically available research and interviews from these nearby communities. Social and economic impacts are mixed in these cases on the whole and many of the impacts experienced cannot be directly attributed to the presence of the mining and milling. There are eight themes pertaining to social and economic impacts which may provide useful insights for the communities within the study area to understand. They are (1) experiences related to job creation, (2) environmental and community health, (3) revenues to local governments, (4) industry spillovers and local business growth, (5) community reaction, (6) lessons learned, (7) socioeconomic trends and (8) community development and quality of life. Each theme is discussed briefly below.

Job Creation

- Employment impacts from these mines range from 60 to over 500 depending on the size of the mine and mill and fluctuations resulting from changes in the value of uranium and related production rates. There is typically a split between locals hired and workers coming in from outside the area to work at the mine and mill. Most cited positive employment impacts but some claimed that these gains came at a cost to the broader community.

Environmental and Community Health

- Of the operating mines and mills selected for deeper social and economic examination, only one has reported adverse health effects: Ranger Mine in Australia, where workers were made ill by drinking water accidentally contaminated with uranium in 2004. In another incident at Ranger, heavy equipment was allowed to leave the site while still contaminated with uranium, resulting in contamination which then had to be cleaned up. In the other locations there was no documentation of environmental or health-related incidents, although some regulatory violations (reporting discrepancies, etc.) had occurred. Interviewees from these communities confirmed that environmental and human health impacts had not occurred.

Revenues to Local Governments

- From the U.S. mines local governments reported positive impacts from mining and milling in the form of property taxes and income taxes. At White Mesa, the county experiences most of the benefits from property taxes of the mill itself. The towns tend to see benefits through increases in payroll and sales taxes. In nearby towns it is the employees, not the mine or mill, that generate the most positive impact on local finances.

Industry Spillovers and Local Business Growth

- Most communities reported experiencing additional business and industry impacts in two ways: through an increase to their service industry and through additional mines located nearby. Interviewees commented that the mines and mills did not attract other associated industries or businesses to the area.

Community Reaction

- Communities we examined had a mixed response in terms of embracing or rejecting uranium mining operations. In some communities it seems to have created a culture and tradition around mining that brings them together, while in others it has reportedly left parts of the community feeling disenfranchised, or disrupted traditional lifestyles.

Lessons Learned

- Interviewees were asked about insights they would offer to other communities considering uranium mining and milling. Two interviewees stated the importance of the owners and managers of the mine being local to the community. Another interviewee said that it was very helpful in his community when residents and stakeholders take the emotion out of the issue and focus on the facts and risks instead. A strong advocate and supporter for mining and milling in another community recommended that those in the Coles Hill region never discount the environment. The participant said the community should set up the mechanisms and monitor air and water quality itself so that the community can satisfy itself with the facts about any changes to the local environment.

Socioeconomic Data Trends

- Analysts at RTI also reviewed trend data for socioeconomic conditions in some of the mining and milling communities to track what these areas have experienced in terms of data points such as housing costs, population change, and employments rates. The data reported in this section cannot be attributed in any way as a result of mining and milling in these communities. Instead they describe socioeconomic trends in these communities over a time period in which mining and milling has occurred. Each region had a different experience. On the whole, housing prices jumped significantly and average weekly wages increased,

although it was not possible to distinguish the effect of the mine and mill from broader trends. Data such as number of business establishments and overall employment tended to stay stagnant.

Community Development and Quality of Life

- Community and quality of life factors were often not discussed in reports. Additionally, it is not possible to attribute these reported impacts to mining or milling without a detailed statistical analysis, which was beyond our scope. Thus, these insights should be interpreted as stakeholder opinion on impacts from mining and milling. First, in several of the mine and mill locations there are indigenous populations that are most affected by the mining and milling. It was reported that even if these groups benefited with job opportunities, they often came at costs such as reduced quality of life and negative impacts on traditional hunting and fishing practices. According to interviewees in Saskatchewan, the mining lifestyles in the region was said to be disruptive to the community's way of life.

- Another negative perceived impact is that irregular work patterns (either because of uranium market fluctuations or because of 2 week on-2 week off work schedules) have negative social consequences, including increased heavy or binge drinking. Although there is no documented causal connection to the mill, Blanding Utah also noted an increase in nonviolent crime over the past 5 years.

- Some community members in Utah and Arizona, however, report positive experiences to their communities and civic life as a result of mining and milling. Increased participation in civic activities by the influx of workers from outside the community and greater job opportunities to their region were factors to this positive experience. These towns also have long histories of mining so a local culture supportive of the industry is present. Fluctuation in demand for housing and housing prices, as a result of fluctuating production rates at the mine or mill, was the main issue described as somewhat difficult for local officials to manage.

ES.4 Characterization of the Mine and Mill and Possible Environmental Releases

Potential environmental releases from the proposed Coles Hill uranium mine are related to the chemical composition of the host ore and surrounding earth, the mining and million methods used, waste management practices employed, and regulatory standards and limitations.

The Coles Hill Uranium ore deposit was discovered in 1978 and has been extensively studied. There is an estimated 60,000 tons of total uranium (as U_3O_8), of which 32,000 tons are minable from two deposits. The uranium concentration and economic factors dictate the amount of minable ore. The estimated 32,000 minable tons are based on a cutoff grade of 0.06%. The two deposits are each about 1,150 feet long and 800 feet wide and have a depth of 1,500 feet below the surface. The mine is expected to be in operation for 35 years and produce 1 million tons of ore per year.

The primary uranium-containing ore mineral at the Coles Hill site are coffinite ($USiO_4$) and uraninite (UO_2, UO_3). Additional metallic species are also present in the host ore, although not at an economically recoverable concentration. Some of these elements can potentially have a negative environmental impact. Therefore, proper management and treatment of waste associated with these

constituents is critical to ensure safe mining operations. Listed below are selected metallic constituents of interest that have been identified within the ore of the Coles Hill site.

Uranium (U)	Copper (Cu)
Zinc (Zn)	Tin (Sn)
Lead (Pb)	Barium (Ba)
Strontium (Sr)	Zirconium (Zr)
Molybdenum (Mo)	Manganese (Mn)
Yttrium (Y)	Nickel (Ni)
Arsenic (As)	Cobalt (Co)
Silver (Ag)	Vanadium (V)
Thorium (Th)	Beryllium (Be)
Chromium (Cr)	Cadmium (Cd)

The proposed Coles Hill project would consist of both mining and milling operations. The end product known as yellowcake (uranium oxide) would be transported off-site to a processing facility.[3] There are multiple mining and milling methods available to the operator and they are selected based in part on the following criteria to make the operation viable: (1) concentration of uranium in the ore; (2) geology; (3) location; (4) cost of mining; (5) cost of processing; (6) waste management practices; (7) social/community acceptance; and (8) uranium market price. Uranium mining methods typically include underground mining, surface mining, in situ leaching (ISL), or a combination of each approach. Milling operations include the crushing and grinding of the ore and leaching the uranium by either an acid or alkaline solutions. Based on a preliminary analysis, VUI is proposing an underground mine and an alkaline leaching process. This approach produces much less overburden material that requires management compared to surface mining. VUI has not ruled out surface mining, or a combination of surface and underground mining; thus, we consider both methods in estimating environmental releases. The geology at the site is not favorable for ISL, and VUI is not considering ISL.

Waste emissions from uranium mining and milling operations can be classified into three primary classes: (1) aqueous waste (e.g., wastewater, storm water); (2) solids waste (e.g., waste rock, tailings); and (3) airborne waste (e.g., fugitive dust, radon gas). In general, solid waste generated at the proposed site will be treated and disposed on site. The largest solid waste stream from the mining operation is typically overburden. An estimated 30 million tons of overburden can be generated per year by surface mining while 1.5 to 16 million tons per year can be generated by underground mining. Although controlled, potential exists to emit air contaminants in the form of fugitive dust and radon gas and water containing radiological compounds, metals, and solids. An estimated 2,833 tons per day of waste tailings will be generated from the milling operation. As required by the NRC, the tailings will be mixed with cement and stored in at least six impoundments. The resulting paste tailings process results in the stabilization and solidification of the tailings and will result in dramatically reducing the potential of contaminants transported from the site.

[3] VUI estimates that at full production during years 1 through 21, it would mine 3,000 tons of ore per day (1,050,000 tons per year); data in the Lyntek/BRS Scoping Study (Lyntek/BRS, 2010a) indicates that at full production, it would produce approximately 1,760,000 pounds of yellowcake per year.

The facility will generate, treat, and discharge wastewater to the environment. The sources of water from the site include (1) mine water, (2) process water, (3) tailings water, and (4) storm water runoff. Based on the most recent information, an estimated 182 to 300 gallons per minute will be discharged from the wastewater treatment facility and 232 to 2,173 gallons per minute will be discharged from the storm water and mine water treatment system. Using the lower and upper discharge flow rates above, and assuming that the facility complies with effluent discharge limits based on EPA's Effluent Limitations for Mine Drainage of New Uranium Mines,[4] we estimated a range of constituent discharge rates to surface water, shown in the table below.

Constituent	Low-Impact Scenario	High-Impact Scenario
Chemical Oxygen Demand (COD)	90 kg/day	452 kg/day
Zinc	0.9 kg/day	4.5 kg/day
Radium 226 (dissolved)	31 pCi/s	57 pCi/s
Radium 226 (total)	105 pCi/s	189 pCi/s
Uranium	1.8 kg/day	9 kg/day
Total Suspended Solids (TSS)	18 kg/day	90 kg/day

There are a variety of control technologies to remove uranium or radium from wastewater. The technologies range in complexity from simple precipitation and sedimentation to advanced membrane processes and range in effectiveness from 50% to 99% removal of pollutants.

Groundwater at the site will be regulated by EPA or the agreement state as defined in Code of Federal Regulations 40 Part 92. Contaminant concentrations that exceed the limits established in the regulation trigger remediation (i.e., cleanup).

The primary air emissions from the proposed mine and associated mill are dust (PM_{30}) and radon gas. Estimates were made based on the best available information about the proposed site and established EPA methods. Estimated dust emissions from the mine and mill conducting open-pit mining range between 379.8 and 2,138 kg/yr, while an underground operation would range between 302.1 and 1,544 kg/yr. Estimated radon emissions rates based on the open-pit mining scenario for the overburden storage area ranged between 5.46×10^6 and 1.64×10^8 pCi/s and 1.59×10^6 and 1.59×10^7 pCi/s from the tailings management area.

Dust control measures include management strategies that limit dust emissions, wetting agents to prevent dust formation, and control technologies that remove dust from the air. The effectiveness of these measures range from low (10% to 30% dust removal efficiency), moderate (30% to 50%) and high (50% to 75%).

Uranium mines and mills are regulated by both federal and state agencies. EPA, NRC, and DOE each have specific mining and milling activities they are responsible for regulating. Due to a moratorium

[4] Actual pollutant discharge limitations are facility-specific, based on the National Pollutant Discharge Elimination System permit (NPDES) issued the facility. EPA regulation may be found at 44Code of Federal Regulations Subpart C.

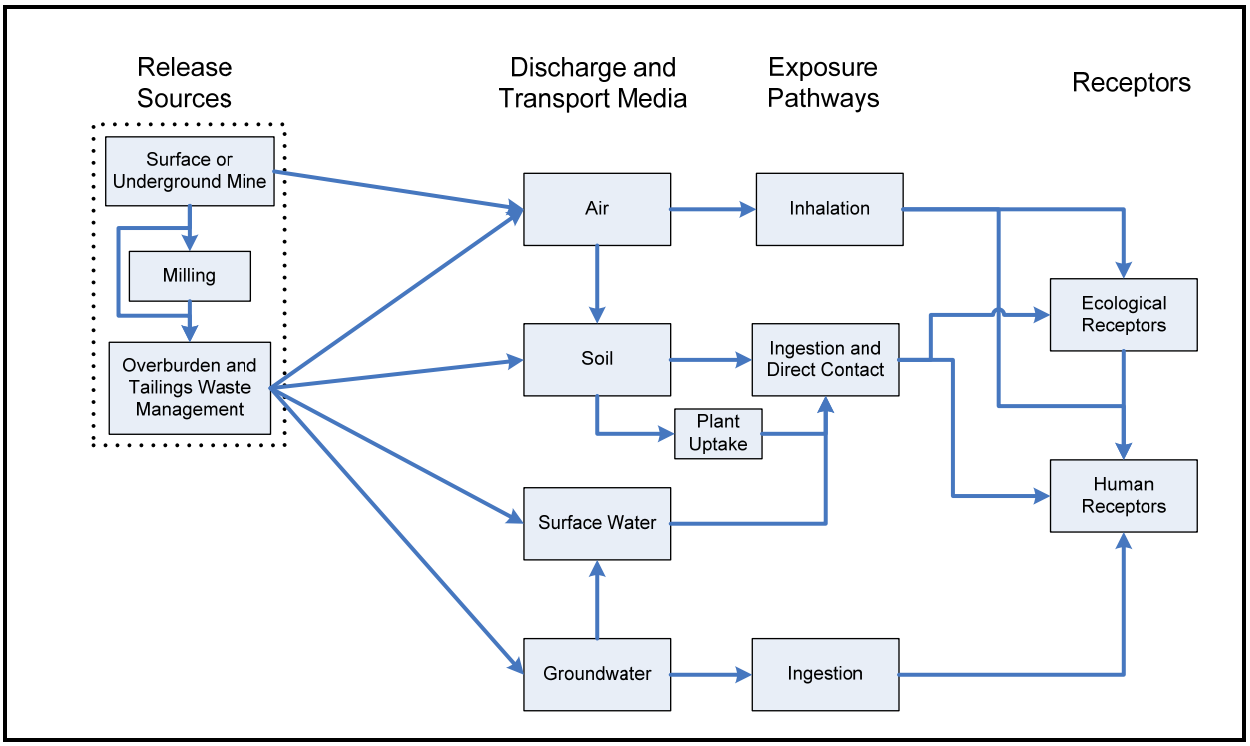
on uranium mining, the state of Virginia does not have any regulations associated with these activities. The Atomic Energy Act (AEA), Uranium Mill Tailings Radiation Control Act (UMTRCA), Clean Air Act (CAA), Clean Water Act (CWA), and Safe Drinking Water Act (SDWA) are the statutes in place to regulate emissions, wastes, and water from uranium mining and milling.

Postmining activities include dismantling of the infrastructure associated with the mine and mill and long-term monitoring to ensure that environmental standards are not compromised.

ES.5 Human and Ecological Health

Using information about the possible environmental releases from the proposed mine and mill, together with a characterization of the region's environment, we evaluated potential implications of the proposed Coles Hill uranium mine and mill for human and ecological health. The general environmental setting was discussed along with its importance in controlling contaminant mobility from the mine and mill and possible resulting environmental impacts. Chemicals of potential concern were evaluated such as radiological elements and heavy metals that may be released as a result of mine/mill activities. In addition, this section considered the potential transport of these chemicals away from the facility in the various environmental media, including air, soil, surface water, and groundwater. Lastly, possible impacts to human health and ecosystems that might result from such contaminant releases and transport were discussed. Figure ES-3, below, presents a conceptual illustration of the impacts analyzed.

Figure ES-3. Generalized Exposure Diagram Illustrating Possible Routes of Transport and Exposure



Several of the key issues evaluated in this section are summarized below.

Surface Water

- The proposed mine and mill are in a climatic region with relatively greater rainfall than many uranium facilities, particularly in the southwestern United States. This characteristic raises concerns about the potential for flooding and accidental releases and possible challenges in containing wastes and other contaminants on the site. A maximum daily precipitation of 7.9 inches is predicted to occur once every 100 years. The flood plain associated with this predicted 100 year event has been delineated as shown in Figure 5-12 of the project report. Any mine and mill facilities handling potential contaminants would clearly need to be located at elevations well above the area of potential flooding. Furthermore, stormwater management facilities would need to be designed to minimize runoff and erosion across the facility, particularly in areas where ore, ore byproducts, and wastes are handled.

- The ore body is located within watersheds for Mill Creek and Whitethorn Creek, streams located less than 1 mile to the south and north of the ore body, respectively. These waterbodies would be most subject to potential releases from the facility, including discharges from treatment and surface water management facilities and any uncontrolled surface runoff from the property.

Groundwater

- Mine dewatering would be necessary to lower groundwater levels from current depths of approximately 33 ft below the surface to the depth of the ore body (approximately 980 ft). Recovered groundwater would be used to support the industrial processes. Any excess groundwater recovered beyond the facility demand would need to be managed (e.g., stored and treated if contaminant levels exceed regulatory thresholds). The groundwater system is complex and includes bedrock fractures with variable and unknown density and interconnectivity. Groundwater flow in fractured bedrock systems can be difficult to predict, so estimates of potential groundwater pumping necessary to dewater the mine are highly uncertain. Preliminary estimates developed by RTI and reflecting this uncertainty suggest that the required groundwater pumping could range from 150 to 1,500 gallons per minute. These rates also could vary significantly over time. Additional hydrogeologic testing is needed to refine estimates of groundwater recovery necessary to dewater the mine and the potential extent of groundwater lowering.

- Groundwater levels in the area around the mine would lower as a result of the dewatering, which could impact nearby wells, springs, and surface water bodies. Wells and springs in the affected area could decrease in capacity or go dry. Groundwater flow to surface water could decrease, or surface water could flow back into the groundwater system in areas of lowered groundwater elevations, thus decreasing the surface water flows.

Constituents of Concern

- Possible constituents of concern that may be encountered at the mine include (1) uranium and its radioactive daughter products (e.g., thorium, radium, radon gas); (2) heavy metals present in the ore or overburden; (3) acidic or alkaline leachate; (4) particulates, including the potential for chemicals to be bound to the particulates; and (5) other mine process chemicals (e.g., blasting chemicals, leaching chemicals).

- Preliminary information suggests that concentrations of heavy metals at the site may be limited, which would mitigate concerns about some potential contaminants from ore and overburden sources. However, this determination should be verified through more comprehensive sampling and analysis of rock and leachate samples from the site.

Tailings Management

- Water in contact with uranium tailings (the primary waste material from the milling process) contains elevated radioactivity and concentrations of several metals well above regulatory thresholds (e.g., arsenic, cadmium, chromium). This information underscores the requirement for proper management and long-term isolation of tailings materials because of the associated metals concentrations in addition to the elevated radiation levels.

Testing for Acid Mine Drainage

- Based on communications with VUI, the ore appears to have significant buffering capacity, which partially accounts for the current plan to adopt an alkaline rather than an acid leach process. If the buffering capacity is sufficient, it may mitigate acid (or alkaline) mine drainage concerns. Nevertheless, specific leachate testing of the ore and other potentially stockpiled materials (overburden, subore) would be necessary to confirm whether acid (or alkaline) mine drainage would be an issue at this site.

Need for Baseline Characterization

- Many of the chemicals of potential concern are present naturally in the environment. It can be challenging to distinguish between natural and anthropogenic concentrations of these chemicals. Therefore, characterization of baseline conditions prior to facility construction would be important to understand future environmental concentrations and potential impacts due to operations. The report summarizes available baseline concentration data from various sources for air, surface water, groundwater, and soils. Additional, more comprehensive baseline characterization is needed. Several studies by VUI are ongoing with results anticipated in 2012.

Airborne Particulate Emissions and Deposition

- RTI estimates of airborne particulate emissions and subsequent transport generally show limited migration at levels of concern for potential inhalation hazards such as asthma and cardiovascular issues.

- RTI estimated the deposition rates of airborne particulates and the associated transfer of uranium mass. The deposition rates beyond one mile from the facility were less than 0.01 gm $U_3O_8/m^2/yr$. Estimation of associated human health risks was outside the scope of the current analysis. A comprehensive human health risk assessment would be needed to provide quantitative estimates of the potential risks associated with these emissions.

Potential for Sediment Erosion to Contaminate Streams

- RTI estimated the rates of sediment erosion from the proposed mine/mill watersheds under current conditions as ranging from 0.002 to 0.129 tons/acre/year. The local watersheds therefore, have the potential to transfer significant sediment loads to local streams. If the mine/mill facility is built, the overland runoff and erosion conditions will be fundamentally altered. Estimates of erosion rates and associated mass transfer to local waterbodies under as-

built conditions would be needed to quantify potential contaminant loads that may be transferred via sediment erosion.

Substantial Dilution of Surface Water Contaminants

- RTI estimated the downstream travel time of surface water from nearby Mill Creek under annual average conditions. The resulting 6-day travel distance was approximately 160 miles from the proposed mine site. RTI also estimated the downstream dilution in surface water due to confluence with other surface waters and the inflow of groundwater. A high-impact scenario showed dilution to 50% of source pollutant concentrations adjacent to the site and dilution to 2% of source concentration entering Banister Lake. A low-impact scenario showed dilution to 1.8 % of source pollutant concentration adjacent to the site and to less than 0.05% of source concentrations entering Banister Lake. Importantly, these simplistic estimates do not consider any possible chemical transformations such as radiological decay and adsorption. Therefore, the predictions overestimate the potential transport of dissolved chemicals that might be discharged by the facility.

Paste Tailings Backfill Has Both Advantages and Risks

- One tailings waste management option under consideration by VUI would involve mine backfill with low-permeability paste tailings. This option may offer advantages in terms of environmental impacts: a smaller volume of tailings would require management in surface impoundments; filling in open mine cavities would help mitigate possible undesirable changes in subsurface flow regimes; having the mine space filled with lower permeability material may help prevent significant groundwater flow through the former mine. However, subsurface paste tailings could be a source for groundwater contamination, particularly if placed below the water table. To prevent groundwater contamination, isolation of subsurface paste tailings from groundwater flow would be necessary.

Proper Tailings Management Is Critical

- The most significant potential impacts to groundwater associated with uranium mining and milling are generally associated with the management of tailings. Historical tailings waste management practices have led to groundwater impacts at many sites; however, most of these facilities were operational prior to the implementation of regulations requiring isolation of tailings wastes. In particular, current requirements include bottom liners and leakage detection systems for synthetic liner systems. In addition, groundwater monitoring requirements around tailings management facilities have increased. Site experience with uranium tailing management under current impoundment design requirements is limited. More extensive experience with double-lined systems with leakage detection is available for municipal landfills. Researchers have found that double liner systems with leak detection are generally effective; however, they do emphasize the importance of proper engineering and construction and operational maintenance.

Exposure Pathways

- Human receptors that could be exposed to constituents of concern (COCs) within the site and surrounding area include on-site or nearby workers, residents, farmers, and recreational users. Ecological receptors that could be exposed to COCs within the site and surrounding area include native plant and tree species, soil biota, terrestrial wildlife, pets, farm animals and aquatic biota. Potential exposure pathways include inhalation, dermal absorption and ingestion.

Key Mitigating Factors

In closing this section, RTI would like to emphasize key factors that can mitigate potential impacts to human and ecological health if the Coles Hill mine and mill were constructed, including the following:

- comprehensive baseline characterization of environmental media and ecosystems before the mine is built;
- comprehensive and ongoing monitoring during operations of emissions and concentrations in media at the mine and in the mine vicinity, including, air, water, soil, agricultural products, flora, and fauna;
- use of effective technologies to reduce emissions;
- sustained focus on pollution prevention and reduction;
- collaboration and transparency between the mining company, regulators and citizens throughout the planning, operation and closure stages; and
- expedient and effective reclamation activities.

Many older uranium and non-uranium hard rock mines lacked effective treatment technologies and deployed irresponsible waste management practices, leading to long-term environmental degradation and risks to human and ecological receptors in surrounding areas. Wastes from many older mines were not isolated and were left without any reclamation. Many of these mines operated before the establishment of key U.S. laws and regulations, including the Clean Water Act (CWA) and the Uranium Mill Tailings Radiation Control Act (UMTRCA), laws which have placed restrictions on emissions, waste management practices, and reclamation.

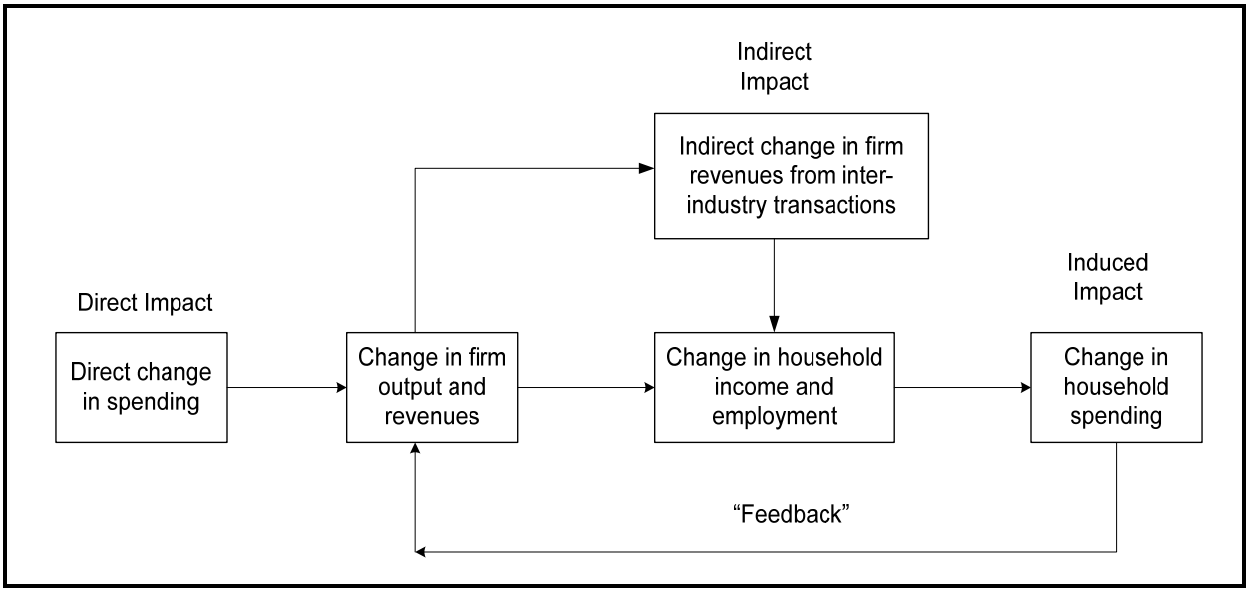
Pollution control technologies are widely available today to minimize mining and milling effluent discharges in water, air, and soil. Such technologies would increase the likelihood that the proposed mining and milling operations in Virginia would comply with current regulations. Furthermore, the mine could develop practices to exceed regulatory standards in an effort to reduce the extent of potential liabilities and to further allay public concerns over the mine. A thorough and ongoing monitoring program coordinated with the public also could mitigate concerns if it demonstrated limited impacts to the surrounding environment (i.e., measuring concentrations in potentially impacted media).

Even if the mine and mill meet or even exceed regulatory standards, detectable concentrations of uranium and other COCs would be released from the facility into the surrounding area. Pollution control technologies and compliance with regulations do not eliminate uranium mining and milling discharges. Predicted risks to human health and the environment would be quite low if the facility meets regulatory requirements, and the associated impacts may not be easily detectable. Nevertheless, finite risks would exist and should be considered in evaluating the possible construction of the Coles Hill mine and mill.

ES.6 Potential Economic and Community Impacts

RTI used both quantitative and qualitative approaches to assess potential economic and community impacts that might be associated with the proposed Coles Hill uranium mine and mill. To identify potential economic and community impacts that should be examined, we combined insights derived from economic theory with insights gained through interviews and focus groups with regional residents and insights from case studies of other mining regions. As indicated by data characterizing existing conditions in the region, and interviews and focus groups conducted with residents within the 50-mile radius surrounding the proposed site, there is a need for economic development and additional employment opportunities within the region, which has been hurt by the decline of traditional manufacturing industries such as furniture and textiles. Although residents and others expressed hope that the employment and spending that would be associated with construction, and especially operation of the mine and mill might result in increased prosperity and opportunity, they also expressed anxiety that the stigmas associated with mining and uranium, not to mention potential genuine health and ecological risks, would outweigh any benefits resulting from the proposed project. We explored these possible outcomes using a quantitative input-output simulation model that estimated the total changes in employment, output, and other economic variables under a variety of scenarios. The input-output framework is illustrated in Figure ES-4, below. The total impact under each scenario includes both VUI's direct spending and employment but also spending and employment by other suppliers within the region and by households within the region experiencing higher incomes.

Figure ES-4. Feedback Process That Generates a Program's Total Economic Impact Within the Region



Using the IMPLAN input-output modeling system (MIG, 2011), we simulated the overall impacts of the proposed project on the region's employment and output under three scenarios reflecting more- or less-optimistic assumptions about the project. Construction and capital expenditures were evaluated based

on assigning the initial capital and construction spending to a single year (in fact, construction is likely to take 2 to 3 years). Then, we illustrate possible annual impacts from ongoing operations based on estimated costs and employment associated for years 2 through 21 of the proposed mine and mill's operation. Reflecting uncertainty (about VUI's purchasing and hiring decisions, future uranium market conditions, and whether stigma associated with uranium mining and milling would affect demand for other commodities and services produced in the region, for example), we examine three scenarios as described below. It is important to note that, although these simulations result in quantitative impact estimates, they are not meant to be precise predictions of spending on employment that might result under the proposed project. Instead, they should be regarded as illustrations of the range of potential impacts.

For the assessment of the impact of **potential construction and capital equipment** spending during the first 3 years after project initiation, the scenarios reflect assumptions about what share of spending occurs within the study region.

- Under the "**reasonable**" case, construction employment is assumed to be 300, and 70% of the nonlabor inputs are assumed to be purchased from regional suppliers.
- Under the "**best reasonable**" case, construction employment is assumed to be 350, and 98% of nonlabor inputs are assumed to be purchased from regional sources.
- Under the "**worst reasonable**" case, construction employment is assumed to be 250, and 44% of nonlabor inputs are assumed to be purchased from regional sources.

To analyze the impacts of **potential annual operations**, we used varying "regional share" assumptions, but also varied some other aspects of the proposed project:

- Under the **"reasonable"** case, we assume that 76% of nonlabor inputs (84% of all input spending) occurs within the study region. We assume that the future market price of yellow cake would be $60 per pound, and we assume that the quantity of uranium mined is, as assumed in VUI's Scoping Study and Cost Estimate (Lyntek, 2010a), 3,000 tons per day.
- Under the **best reasonable** case, all but the most specialized inputs are assumed to be purchased locally (99% of all input spending), and the market price of uranium is assumed to be $75 per pound.
- Finally, the **worst reasonable** case assumes the price of uranium falls to $45 per pound, resulting in a 25% reduction in output and employment, and assumes a smaller share of share of VUI's inputs are purchased within the region (overall nonlabor input spending falls to 35% of reasonable case, due to the combination of lower production and lower regional share).

The employment and cost estimate data in VUI's studies is based on an assumed production rate of 3,000 tons per day of ore, and associated production of yellow cake. The basic "reasonable," "best reasonable," and "worst reasonable" cases are all based on this level of production.

The market for uranium has historically been quite volatile. Current expectations are that the price of uranium will likely increase, as supply derived from decommissioned weapons is exhausted and societies seek alternatives to carbon-based energy sources. Evidence for this is that new contracts have a price that exceeds the spot price for uranium. Table 7 of the U.S. Energy Information Agency's Uranium Marketing Report (EIA, 2011b) shows that in 2010, spot prices were approximately $45 per pound, while

long-term contracts (for delivery at least a year out) averaged approximately $50 per pound. Economic theory would indicate that if the price of uranium were higher than anticipated, more of the ore would be considered economical to mine and mill, and production would increase. However, increasing the production *rate* (tons of ore per day) would be difficult under the plans VUI currently has, so the increased production is assumed to result in extending the life of the mine rather than increasing production; thus, the "best reasonable" case does not adjust employment and output upward for the "typical year" represented in the model.

However, the price of uranium has historically been volatile, and interviews with stakeholders near an existing uranium mine and mill in the western United States mentioned fluctuating employment and economic and community impacts as a result of price fluctuations. Thus, it is possible that some future event could result in a decline in the demand for and the price of uranium. If that happened, it could be that uranium production at the proposed mine and mill might decline, or be suspended entirely, until the price increases sufficiently to make mining and milling profitable. This potential is reflected in our worst reasonable case.

In addition to this worst reasonable case analysis, we perform sensitivity analysis reflecting alternative assumptions. First, we examine the possibility that price and output of uranium remain at $60 per pound and 3,000 tons per day (as in the reasonable case), but that the local share of VUI's spending may be lower than assumed in the "reasonable" case analysis. Then, in response to concerns expressed about impacts on other regional industries, we also examine a situation where there is a reduction in demand for some of the other goods and services currently produced in the region due to perceived risks associated with uranium. Reflecting our expectation that any "stigma" impacts such as this would be relatively local to the mine and mill, we compute the reduction in output of affected sectors based on the sectors' baseline output within Pittsylvania County.

Model results under each scenario are shown in Table ES-1, below. Construction and capital purchases are estimated to add between 559 and 1,008 jobs (over a short 2- or 3-year period) and between $70 and $138 million in output to the region's economy. Operations is estimated to add between 385 and 889 jobs and between $81 million and $220 million in output each year for over 20 years, under the worst reasonable and best reasonable operating scenarios. Sensitivity analysis around the worst reasonable scenario shows that, if the demand for other regional sectors falls due to stigma or reputational effects, the resulting reduction in output and employment in those sectors could counteract the benefits of the proposed project, and employment could actually decline. The quantitative simulation also shows that state and local tax revenues could increase by $11 million annually during the operating period, but our investigation also reveals that both state and local governments would incur the costs of meeting new responsibilities as a result of the proposed project.

Table ES-1. Estimated Regional Economic Impacts: Estimated Impacts of Construction and Operation of Proposed Mine and Mill by Scenario

Impact Summary Impact Type	Employment (jobs)	Output (million $2011)	Labor Income (million $2011)[a]
Baseline values			
Total at baseline	531,241	68,069.4	19,843.0[a]
Estimated one-time Impacts due to Construction and Capital Equipment Purchases			
Reasonable Case Capital	822	111.7	37.6
Best Reasonable Case Capital	1,008	137.7	46.2
Worst Reasonable Case Capital	559	70.5	24.6
Estimated Annual Impacts due to Operations of Proposed Mine and Mill			
Reasonable Case Operating	724	162.4	32.7
Best Reasonable Case Operating	889	219.9	45.3
Worst Reasonable Case Operating	385	81.3	14.6
Sensitivity Analyses Around Worst Reasonable Case			
Lower Regional Share Operating	569	142.6	25.4
Lower Regional Share and Lower Demand for other Sectors, Operating	−152	90.5	8.6

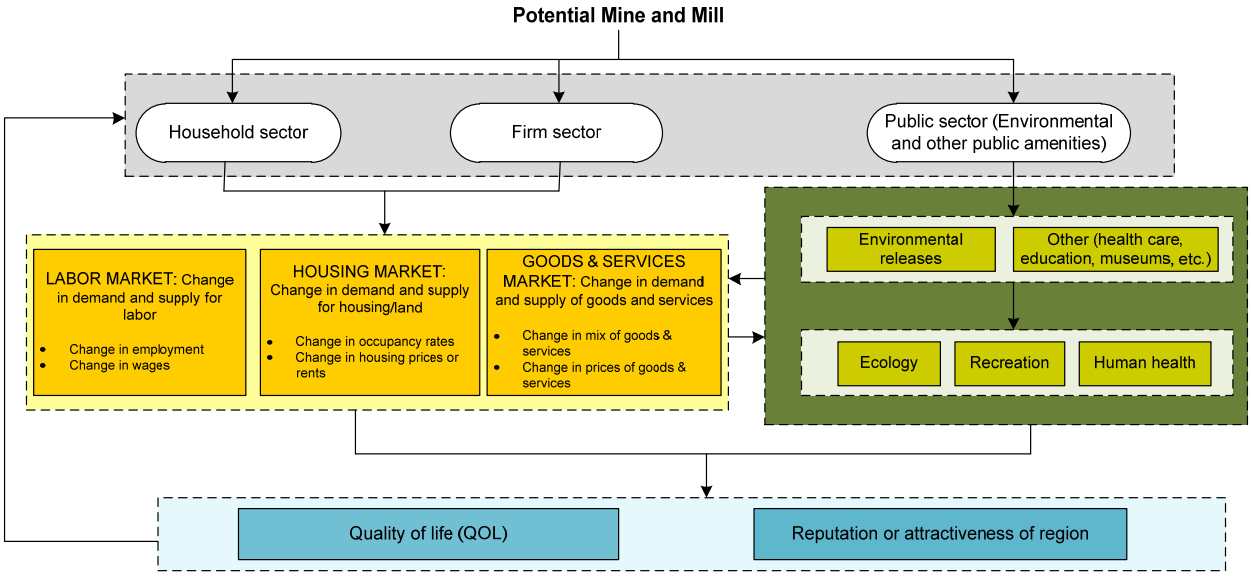
[a] Baseline value is employee compensation, which includes labor income, benefits, and employer-paid taxes. Impact estimates show labor income only.

Possible impacts on the market for housing in the region are mixed. Increased incomes within the region may increase demand for housing. Because of vacancy rates in the region, we do not anticipate that availability of housing will generally be an issue or that prices will be bid up very much because of this increased demand; instead, we expect that residents may use their increased incomes to purchase larger or better quality existing homes, or improve their own homes. On the other hand, properties located close to the proposed mine and mill may experience reduced demand and prices. A survey of economics literature dealing with the impact on property values of proximity to an undesirable site shows that the stigma associated with such sites may reduce demand for them. Properties within a few kilometers of the undesirable location generally do experience reduced property values due to the stigma associated with the site. The reduction in value varies significantly among the studies examined. More contaminated sites or more publicized sites generally reduce housing values more. The impact may fade over time, and if actual contamination occurs, rapid and comprehensive cleanup can restore most of the lost property value.

Combining the information developed to illustrate possible economic impacts with information about potential pollutant releases and environmental impacts, we attempt to assess the overall impact the proposed mine and mill might have on the region's quality of life. Economists use analytical frameworks provided by simulation models to study potential impacts of changes in an economy. Broadly speaking, conditions in an economy can be represented by the characteristics of the set of households and firms in that region. The other major components characterizing an economy consist of environmental amenities

and other public amenities such as education, healthcare, safety, and transportation. In the event that a mine or mill is established at Coles Hill, these are the different sectors or entities in the local or regional economy that may be impacted. Changes in the condition of the region result from numerous interactions and feedback mechanisms among these different entities. This is illustrated in Figure ES-5. Entries inside boxes with dotted lines typically interact with each other. Thus, for example, if the mine and mill opens, there may be changes in the demand and supply of labor and interactions among the household and firm sector may result in changes in wages and employment levels. Similarly effects may be seen in the housing and other goods and services market. This is reflected in the yellow dotted box. This may result in changes in the tax base and thus this might alter public spending on amenities such as hospitals and schools. Thus, there may be interactions among the "market" sector (i.e., firms and households) and the "non-market" or public sector. Similarly, if a mine opens, there may be changes in environmental releases and, consequently, changes in the ecology, human health, and recreation in the region. This is depicted in the green dotted box. All of these different effects contribute to both the quality of life and the attractiveness of the region (to both households and firms considering migrating to the area and tourists visiting the area). This is represented by the blue dotted box at the bottom. Thus, in the long run, there may be feedback effects on the households, firms, and the public sector.

Figure ES-5. Framework for Assessing Overall Socioeconomic Impacts



Economists create quality of life (QOL) indices for various locations based on the idea that cities with more desirable amenities are more attractive to households; this generally results in lower wages and higher cost of living. To determine the most relevant contributors to QOL in the study region, we considered amenities identified by stakeholders as important, and also amenities shown in the literature to be important. Studies comparing the QOL among cities use data on the cities' environmental, community, economic, and population characteristics, and use statistical methods to attach a value to each of the amenities; these can then be used to create an index of quality of life for each location. Because of the uncertainties associated with the possible impacts of the proposed project (both environmental and

economic), we did not attempt to quantify QOL impacts. Instead, we characterize the overall impact on QOL in the region qualitatively, based on the result of our analyses. Minimal adverse impacts on environmental quality and ecological assets are anticipated under normal conditions; public safety, school quality, health care, and infrastructure are unlikely to be affected. Overall, demand for housing may increase, but in the immediate vicinity of the mine and mill, property values might decline. There is a possibility that this stigma effect could diminish after over time, and especially after closure, if efficient and thorough closure and cleanup procedures are used. Opportunities for outdoor recreation would generally be unaffected, although some resources may be perceived as less valuable due to stigma. Indoor recreation, employment opportunities, incomes could be improved, at least during the operating period.

ES.7 Summary

RTI examined the potential impacts of establishing a uranium mine and mill using a broad socioeconomic framework that considers not only impacts on employment, output, and income in the region, but also possible environmental impacts and impacts on government revenues and responsibilities. Key findings include the following:

- Overall, the proposed mine and mill present both potential risks and potential rewards to the study region. Rewards include an estimated addition of 724 jobs and $162 million to the region's economy each year, for more than 20 years. Risks include both actual environmental risks and perceived risks that could hurt the region's reputation. Risks could be significantly reduced if appropriate investments are made in design, pollution control technologies, and regulatory development and implementation, and ongoing commitments are made to frequent monitoring and transparent communication. The costs of making these investments and keeping these commitments, and how they compare to the estimated returns from uranium mining and milling, are uncertain. If these investments are made, with diligent and transparent mechanisms for communication, there could be minimal adverse impact to the 50-mile radius study region. If investments such as there are not made across the board, the region has much to lose.

- The study region, a 50-mile radius around the Coles Hill, Virginia, location of the proposed mine and mill, is an area with relatively low population density, a mild, wet climate, and an abundance of natural resources which have supported both a productive agriculture sector and ample outdoor recreation opportunities. Residents value these attributes, but also recognize the region's high unemployment rate and low educational attainment, relative to the rest of Virginia. They hope for new job opportunities that would make the region more prosperous and encourage population stability or growth. With regard to the proposed mine and mill, they are concerned about safety, find the promised jobs attractive, and feel they need more information about the project and its possible consequences.

- VUI hopes to mine the uranium deposits at a rate of 3,000 tons per day of ore, producing approximately 1.76 million pounds of yellowcake (U_3O_8) annually during years 1–21 of its operation, and producing less during pillar extraction in years 22–35. Although many of the details of the design and operation of the mine, mill, and waste management methods are still undetermined, VUI has stated that it expects to use underground mining (although surface mining has not been ruled out) and an alkaline leaching beneficiation process. Based on these plans, it would employ 324 workers, and hopes to hire up to 90% of its workforce locally.

- Even if the mine and mill meet or exceed regulatory standards, detectable concentrations of uranium and other constituents would be released from the facility into the surrounding environment. The releases would result in finite increases in risk to human and ecological health; the risks would be expected to be quite low if the facility adheres to regulations, and may not even be detectable.

- Mine dewatering would be necessary; the rate at which groundwater would need to be pumped out to dewater the mine is uncertain, but groundwater pumping would reduce groundwater levels in the area around the mine, and could affect nearby wells, springs, and surface water bodies.

- The proposed mine and mill are in a climatic region with relatively high rainfall and exposure to hurricanes. Any facilities should be located well above the 100-year floodplain. Stormwater management facilities should be designed to minimize runoff and scaled to accommodate extreme weather events.

- RTI estimates that pollutant concentrations in surface water would decline rapidly with distance from the mine and mill due to dilution.

- Similarly, estimated airborne particulate emissions generally do not migrate far from the mine and mill; deposition of particulates and associated uranium mass is estimated to be less than 0.01 gm $U_3O_8/m^2/yr$ beyond 1 mile from the facility.

- Proper management and long-term isolation of tailings materials is critical, because water in contact with tailings will be contaminated with heavy metals and radiation, and the tailings will remain radioactive for thousands of years. Regulations require bottom liners and leakage detection systems for synthetic liner systems; experience with these systems at landfills indicates that they are generally effective in avoiding groundwater contamination, but they must be properly engineered, constructed, and maintained.

- If the proposed mine and mill become a reality, potential impacts to human and ecological health can be reduced by:

  - comprehensive and ongoing monitoring during operations of emissions and concentrations in media at the mine and nearby;

  - use of effective technologies to reduce emissions;

  - sustained focus on pollution prevention and reduction;

  - collaboration and transparency between the mining company, regulators, and citizens throughout the planning, operation, and closure stages; and

  - effective reclamation of the site.

- RTI's economic analysis estimates that construction and capital equipment purchase could briefly add from 559 to 1,008 jobs to the region, and increase regional output by $70.5 million to $137.7 million. Operation of the mine and mill could add from 385 to 889 jobs and increase regional output by from $81.3 million to $219.9 million annually during years 1–21 of the proposed project. Concerns about perceptions of risk or reduced quality of local products should be taken seriously; a simulation showed that a relatively small decline in

demand for local sectors' goods and services could counteract the positive impact of the mine and mill.

- The proposed mine and mill would increase state and local tax revenues by an estimated $11.2 million during operation, under the "reasonable" case scenario. These increased revenues would be accompanied by new responsibilities, including developing and effectively implementing a regulatory structure for the industry, upgrading some local infrastructure, and implementing state and local emergency response systems to respond to accidents and incidents at the mine.

ES.8 References

Lyntek Inc. and BRS Engineering. (2010a, August). *Coles Hill uranium project, Pittsylvania County Virginia: Scoping study and cost estimate*.

Lyntek, Inc. and BRS Engineering. (2010b, December), *NI 43 – 101 preliminary economic assessment, Coles Hill uranium property, Pittsylvania County, Virginia, USA.*

Minnesota IMPLAN Group (MIG). (2011). Retrieved from http://implan.com/V4/Index.php

U.S. Energy Information Agency.(2011a, April). *Annual Energy Outlook 2011*. Retrieved from http://www.eia.gov/forecasts/aeo/index.cfm

U.S. Energy Information Agency. (2011b, May). *Uranium Marketing Annual Report*. Retrieved from http://www.eia.gov/uranium/marketing/