

Uranium Study: Final Report

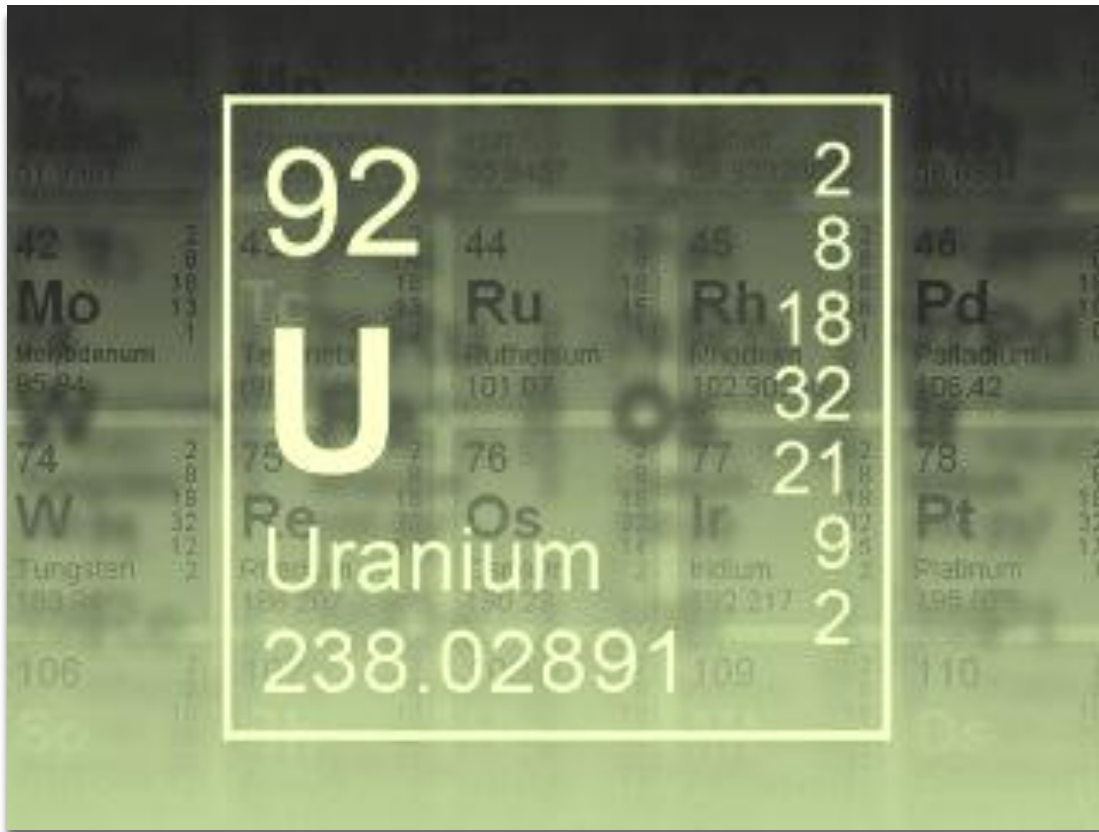
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Department of Environmental Quality

Department of Mines, Minerals and Energy

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Exhibit K VDH Uranium Study: Interim Report #1
Exhibit L VDH Uranium Study: Interim Report #2
Exhibit M Facilitator’s Report (Final Report of Public Meetings Regarding Impacts to Private Water Wells, Public Water Supplies and Recreational Waters by Uranium Mining and Milling)

LIST OF ACRONYMS

ALARA	As Low As is Reasonably Achievable
AQD	Air Quality Division
ATSDR	Agency for Toxic Substance Disease Registry
BLM	Bureau of Land Management
BMP	Best Management Practice
BRFSS	Behavioral Risk Factor Surveillance System
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
DEE	Division of Environmental Epidemiology
DEQ	Department of Environmental Quality
DMM	Division of Mineral Mining
DMME	Department of Mines, Minerals and Energy
DOE	Department of Energy
DOGM	Department of Oil Gas and Minerals
DRH	Division of Radiological Health
DSI	Division of Surveillance and Investigation
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EPA	U.S. Environmental Protection Agency
FTE	Full Time Employees
IAEA	International Atomic Energy Agency
ICRP	International Council on Radiation Protection
ISR	In Situ Recovery
MSHA	Mine Safety and Health Administration
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act
NCRP	National Council on Radiation Protection
NESHAPS	National Emissions Standards for Hazardous Air Pollutants
NIOSH	National Institute for Occupation Safety and Health
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NUREG	Nuclear Regulatory Guide

ODW	Office of Drinking Water
OEpi	Office of Epidemiology
OEHS	Office of Environmental Health Services
OFHS	Office of Family Health Services
OMHHE	Office of Minority Health and Health Equity
OSHA	Occupational Safety and Health Administration
PFC	Points for Consideration
PMP	Probably Maximum Precipitation
PSD	Prevention of Serious Deterioration
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RFP	Request for Proposal
SMCRA	Surface Mining Control and Reclamation Act
UMTRCA	Uranium Mill Tailings Radiation Control Act
UNSCEAR	United National Scientific Committee on the Effects of Atomic Radiation
U.S.	United States
UWG	Uranium Working Group
VDH	Virginia Department of Health
VHI	Virginia Health Information
VPDES	Virginia Pollution Discharge Elimination System
WDEQ	Wyoming Department Environmental Quality
WES	Wright Environmental Services, Inc.
WNA	World Nuclear Association
WL	Working Level
WLM	Working Level months
yr	Year

1.0 INTRODUCTION

In response to renewed interest in uranium mining and milling and concerns regarding the ability to do so while protecting public health and the environment, the Commonwealth of Virginia (Virginia) has undertaken studies assessing the range of possible regulatory frameworks that might be adopted should the existing moratorium on uranium mining be lifted. On January 19, 2012, the Governor directed members of his cabinet to form a Uranium Working Group (UWG) with staff from the Department of Mines, Minerals and Energy (DMME), the Department of Environmental Quality (DEQ), and the Department of Health (VDH). The Governor's letter is included as Exhibit A to this report. This Uranium Working Group was established:

“ ... to provide a scientific policy analysis to help the General Assembly assess whether the moratorium on uranium mining in the Commonwealth should be lifted, and if so, how best to do so.”

A study by the National Academy of Sciences titled *“Uranium Mining in Virginia: Scientific, Technical, Environmental, Human Health and Safety, and Regulatory Aspects of Uranium Mining and Processing in Virginia”* (National Academy of Science [NAS], 2011) and other recent studies on uranium mining and milling in Virginia have identified important issues related to the protection of public and occupational health, safety and the environment, and potential socioeconomic impacts related to uranium mining and milling. Consequently, the UWG has been directed to develop a conceptual regulatory framework that would address these issues as well as other issues identified by the UWG, the public and other stakeholders.

In order to respond to this directive, the UWG issued two requests for proposal (RFP) to solicit expert advice. Due to the different areas of focus and responsibility of the staff within the UWG, two procurements were developed; one to address issues related to the DEQ and DMME areas of responsibility, and one to address the areas of responsibility related to VDH. Both procurements were awarded to Wright Environmental Services (WES).

The DEQ/DMME and VDH studies must ultimately be integrated into a cohesive single analysis for consideration by Virginia's Governor and General Assembly. Therefore, this Final Report has been developed to respond to both the DEQ/DMME Uranium Study procurement and the VDH Uranium Study procurement. These procurements are briefly described below.

The focus of this report is not intended as an endorsement for rescinding the existing moratorium on uranium mining in Virginia. Rather this report supports informed decision making by enumerating key technical items for consideration should new or expanded regulatory programs be authorized.

1.1 Procurement Summary

1.1.1 DEQ/DMME Uranium Study Procurement

On March 2, 2012, the DEQ issued RFP # 12-06-PJ (Uranium Study). The purpose of the procurement was to acquire contractor services to provide information and expert analysis of uranium mining and milling issues in Virginia relevant to the statutory jurisdictions of DEQ and DMME. The Contract identified two major work Tasks (A and B). Work Task A involved the development of an initial report based on 1) a review of studies related to uranium mining and milling in Virginia, 2) a comparison of other existing regulatory programs for uranium mining and milling, and 3) a review of emerging standards from international organizations. The initial report for the DEQ contract was completed on July 30, 2012 by WES.

Work Task B involved provision of ongoing technical advice and assistance to the UWG. The efforts of Work Task B resulted in a series of interim reports analyzing a range of issues identified in the RFP (Task B.2), and this Final Report (Task B.1) that: 1) compares the Points for Consideration (PFC) in the initial report to the statutory jurisdictions of DEQ and DMME; 2) identifies areas where regulatory coverage needs to be created, modified or expanded to ensure protection of public health and the environment with respect to the lifespan of mining and milling projects in Virginia and long-term site monitoring requirements; and 3) recommends structure for possible new statutes.

1.1.2 VDH Uranium Study Procurement

On March 5, 2012, VDH issued RFP # 1200001-999 (Uranium Study). The purpose of the procurement was to acquire contractor services to conduct a study of uranium mining and milling issues in Virginia relevant to the statutory jurisdiction VDH. The Contract identified two major work Tasks (A and B). Work Task A involved the development of an initial report based on 1) a review of Virginia and other relevant studies related to uranium mining and milling in Virginia, 2) a comparison of existing uranium mining and milling regulatory programs including the Nuclear Regulatory Commission (NRC), Agreement State programs, and international programs (such as Canada and France), and provisions from within those regulatory programs that are relevant to the Board of Health's mission, and 3) a review of emerging standards from international organizations. The initial report for the VDH contract was completed on July 27, 2012, by WES.

Work Task B involved ongoing technical advice and assistance to the UWG. The efforts of Work Task B has resulted in a series of interim reports analyzing a range of issues identified in the RFP (Task B.1 and B.2), and support of the VDH public meetings regarding the regulation of private wells as well as this Final Report.

1.2 Overview of Final Report Structure

Section 1.0 of this Final Report summarizes the Uranium Study procurements. Section 2.0 provides an overview of the initial and interim reports developed as part of the Uranium Study. Section 3.0 of this report summarizes the existing statutory jurisdictions of DMME, DEQ and VDH as they relate to uranium mining and milling. Section 4.0 of this report identifies regulatory recommendations based on the WES review of these jurisdictions, and identifies gaps that would exist if Virginia lifts the moratorium on uranium mining. This gap analysis, which incorporates other state or Country best practices, also considers the option of Virginia expanding its existing authority to include Byproduct Material under the Agreement State program with NRC. In addition, Section 4.0 provides programmatic points for consideration (PFC) in any draft statutes and conceptual regulatory framework developed by the UWG. The determination of whether measures recommended in the PFC would make uranium mining and milling sufficiently safe in Virginia is the heart of the issue to be addressed by the General Assembly. Some of the PFC are too detailed to be fully incorporated in a draft statutory and conceptual regulatory framework. Therefore, the PFC presented in this report reflect the major programmatic points that would be relevant and appropriate for explicit treatment in a draft statutory framework. Readers wanting additional detailed PFC that would be more appropriately incorporated into subsequent regulation and technical guidance documents are referred to Exhibit B.

Exhibit B, “Compilation of Points for Consideration (PFC)”, provides all the PFC developed by WES, organized by the mining or milling project life-cycle phase for which the PFC are relevant, and identifies the primary agencies that would be engaged with the PFC. Most of these PFC are relevant to understanding what actions and requirements Virginia might implement to provide a uranium mining and milling regulatory program that ensures protection of the environment, public health and safety, and occupational health and safety.

Section 5.0 provides a summary and a conceptual regulatory framework.

1.3 Purpose and Objective

The purpose of this Report is to respond to the Work Task B.1 requirement in the DEQ Contract EP881027 and Work Task B.2 requirement in the VDH Contract 1200001-999, as described above. The objective of this report is to assess the departments’ statutory jurisdiction, compare these jurisdictions to the PFC developed in the initial report and subsequent interim reports, and provide recommendations for development of a draft statutory and conceptual regulatory framework for regulation of uranium mining and milling in Virginia.

As directed by the UWG in a meeting on September 25, 2012, the final reports identified in Work Task B.1 of the DEQ/DMME Uranium Study Contract and in Work Task B.2 of the VDH

Uranium Study Contract have been combined into this single Final Report to provide a more cohesive and uniform treatment of the issues.

1.4 Technical Approach

As per the RFP for both Uranium Study Contracts, WES's approach to developing the Final Report included three components:

- comparing agency jurisdictions to PFC developed during these studies;
- identifying gaps in the current regulatory framework that would need to be addressed should the moratorium on uranium mining be lifted; and
- developing PFC in modifying, expanding or developing new authorities and requirements for regulation of uranium mining and milling in Virginia.

Though the existing moratorium addresses uranium mining, the issue of whether or not Virginia should expand its regulatory authority to include Byproduct Material (the wastes associated with uranium recovery as defined in Section 11e.(2) of the Atomic Energy Act) is also a factor that must be considered.

1.4.1 Subtask A – Comparison of Jurisdictions to PFC

First, WES reviewed the respective statutory jurisdictions of DEQ and DMME for mining to provide: 1) a general discussion of the basic jurisdictional structure and responsibilities of the departments related to mining, and 2) a description of the detailed statutory authorities of the departments organized by the regulatory areas for mining developed in the Initial Report. A table was then created to segregate the PFC developed in the initial report into mining regulatory areas and to show where the departments' jurisdictional responsibilities reside. This tabulation will provide information for developing Subparts B and C of this task. Although the initial report addressed only mining, the regulatory aspects of uranium mining and milling are distinctly interconnected. Therefore, the response to this subtask included a discussion of the current situation in Virginia related to uranium milling and a tie to other reports prepared under the VDH RFP.

1.4.2 Subtask B – Regulatory Gap Analysis

Second, WES assessed Virginia's existing regulatory framework and identified areas where additional authorities, regulations and guidance may be warranted, should the moratorium on uranium mining be lifted.

1.4.3 Subtask C –Recommendations for Statutory Modifications

As identified in the Governor’s directive of January 19, 2012, UWG was tasked to:

“Establish a draft statutory and conceptual regulatory framework that could be used to govern all aspects of mining and milling uranium in Virginia...”

As the third component in developing the Final Report, WES developed programmatic PFC based on all the assessments performed as part of the Uranium Study Contracts. The programmatic PFC address key modification and additions to existing regulatory and statutory framework. The PFC are included within the individual reports developed for the Uranium Studies, and are attached as Exhibits to this Final Report. In addition, these PFC have been compiled into Tables for more easy reference and are included in Exhibit B.

The PFC cover points directly applicable to a draft statutory and conceptual regulatory framework as well as detailed points that are more appropriate for treatment in specific regulations and guidance. The primary points for consideration that are identified in Sections 3.0 and 4.0 of this report represent those PFC most material to the draft statutory framework identified by the Governor’s directive of January 19, 2012. The conceptual regulatory framework, describing functional relationships, processes and lines of communication, is discussed in Section 5.0 of this report.

2.0 URANIUM STUDY REPORTS

The following section provides an overview of the various initial and interim reports developed for the DEQ/DMME Uranium Study Contract and for the VDH Uranium Study Contract. These reports are included as Exhibits to this Final Report. These reports provide substantial detail regarding specific technical issues identified in the RFPs and from the Uranium Study investigation.

2.1 DEQ/DMME Uranium Study Reports

2.1.1 DEQ/DMME Uranium Study: Initial Report

The Initial Report for the DEQ/DMME Uranium Study was developed in response to the requirements of Work Task A, identified in the DEQ contract No. EP881027 (the contract), and is included as Exhibit C of this report. Based on a review of existing studies, existing regulatory programs, and emerging international standards, the report presents an initial analysis and recommendations concerning issues and provisions that a potential future regulatory framework for uranium mining and milling in Virginia might be expected to encompass. The report was the first report developed under the DEQ/DMME Uranium Study and includes the following items:

- a review of nine (9) literature items identified by the UWG and WES;
- a comparison of existing regulatory programs including the U.S. Environmental Protection Agency (EPA), the NRC as well as State Programs of Colorado, Utah and Wyoming and the Canadian regulatory program.;
- a discussion of Emerging International Standards; and
- a PFC regarding lifting the existing moratorium on uranium mining development in Virginia.

The PFC range from general regulatory items to points developed from review of international programs. In addition, the PFC address specific issues related to aspects of mining and milling projects life-cycle including permitting, baseline studies, as well as considerations relating to mine and mill operations, reclamation and post-reclamation program components. Some of the issues identified in the literature review, regulatory program comparison and PFC are addressed by further study in the subsequent reports in the DEQ/DMME Uranium Study. These reports are summarized below and are also included as exhibits of this Final Report.

2.1.2 DEQ/DMME Uranium Study: Surface Water and Groundwater Monitoring Plans and Standards Adequacy Assessment

The Surface Water and Groundwater Monitoring Plans and Standards Adequacy Assessment Report for the DEQ/DMME Uranium Study was developed in response to the requirements of

Work Task B.2.a, b, and d, identified in the contract, and is included as Exhibit D of this report. The report includes the following discussions:

- potential water quality parameters and standards (mining and milling) for surface water and groundwater;
- compliance inspections and enforcement by regulatory agencies;
- appropriate hydrologic siting criteria for mining and milling: regulatory considerations;
- pre-operational baseline characterization for surface water (mining and milling);
- operations (mining and milling plan): environmental protection plans for surface water;
- closure/reclamation planning (mining and milling) for surface water;
- pre-operational baseline characterization for groundwater (mining and milling);
- operations (mining and milling plan): groundwater protection plans and procedures;
- closure and reclamation for groundwater protection (mining and milling);
- well construction and abandonment standards; and
- water quality constituents, sampling, and testing protocols.

The primary focus of the report is to address surface water and groundwater monitoring requirements and to assess current Virginia water quality standards. The report sections present a compilation of information, summarized from other state programs (Colorado, Wyoming, Oregon) and federal agencies (i.e., NRC and EPA), with respect to protection of water quantity and water quality for uranium mining and milling. States with both high and low levels of precipitation were included in the compilation. The report includes a review of statutes, rules and regulations, as well as a summary of relevant guidance for the UWG to require of an applicant who intends to prepare a uranium mine permit or mill license application within Virginia.

2.1.3 DEQ/DMME Uranium Study: Air Quality Monitoring Plan

The Air Quality Monitoring Report for the DEQ/DMME Uranium Study was developed in response to the requirements of Work Task B.2.c, identified in the contract, and is included as Exhibit E of this report. The report includes the following discussions:

- a review of current air quality monitoring programs (NRC, EPA National Emissions Standards for Hazardous Air Pollutants [NESHAPs]);

- technical requirements of air quality monitoring systems;
- the release of particulate matter from stationary and fugitive sources;
- the adequacy of the EPA NESHAPs standards;
- emissions from uranium extraction residues; and
- radon release potential from evaporation ponds, dewatering activities and tailings impoundments (VDH/NRC responsibility).

The primary focus of the report is the monitoring radioparticulates and radon from uranium mining and milling projects, as these are programs that Virginia does not have in place. The report emphasizes published material that provides a basis for consideration of uranium mining and milling air quality monitoring systems, methods, techniques and equipment, should Virginia need to develop a regulatory structure for regulation of these activities. The report only briefly summarizes the EPA programs under the Clean Air Act, which are already successfully implemented by DEQ/Air Quality Division (AQD).

2.1.4 DEQ/DMME Uranium Study: Safe Disposal of Mine and Mill Wastes

The Safe Disposal of Mine and Mill Wastes report for the DEQ/DMME Uranium Study was developed in response to the requirements of Work Task B.2.e, identified in the contract, and is included as Exhibit F of this report. Based on a review of existing studies, existing regulatory programs, and the current standards of practice by design professionals the report presents an initial review of the disposal practices for mine and mill wastes. This report includes the following discussions:

- the potential for environmental problems resulting from acid rock drainage (ARD) and other leachates;
- segregation and safe disposal of sub-ore waste rock;
- minimizing ecological risk from the release of radionuclides and contaminants from mining and milling;
- mitigation of mine and mill contaminants from existing sources to both groundwater and surface water; and
- on-site workers health and safety related to mine and mill waste.

The primary focus of the report is to present a review of various federal and state regulations and guidelines pertaining to disposal of uranium mining and milling wastes. These references are not intended to be an exhaustive list of all pertinent or applicable regulations and guidelines. Rather, they are cited as representative examples which are included to aid DEQ and DMME in decision making. This report emphasizes published material that provides a basis for consideration of

practices for safe disposal of uranium mining and milling waste, should Virginia need to develop a regulatory structure for regulation of these activities.

2.1.5 DEQ/DMME Uranium Study: Engineering Design Best Management Practices

The Engineering Design Best Management Practices Report for the DEQ/DMME Uranium Study was developed in response to the requirements of Work Tasks B.2.f and B.2.i, identified in the contract, and is included as Exhibit G of this report. The report includes the following discussions:

- review of methods for addressing risks of catastrophic events;
- best management practices for minimizing the environmental effects of the failure of a waste containment facility;
- review of methods and practices for minimizing the risk of extreme flooding events;
- assessment of risks from landslides, debris flows, and slope failures;
- assessment of risks from seismic events;
- assessment of risks from the failure of on-site storage facilities;
- vulnerability analysis for security events; and
- review of criteria to develop an effective hydrogeological model for use at potential sites.

The report outlines the engineering design best management practices that can be used for addressing risk in mining and milling. The report discusses guidelines from a variety of federal and state regulatory agencies and presents a series of tables that summarize the best management practices for the design, operation and closure of uranium mine and mill facilities. The report also presents a table that provides an extensive summary of selected case histories and technical articles related to a variety of aspects of uranium mining and milling.

2.1.6 DEQ/DMME Uranium Study: Full Components of Environmental Impact Analyses

The Full Components of an Environmental Impact Assessment (EIA) report synthesizes the results of DEQ/DMME Uranium Study work task B.2.g with the results of the VDH work task B.2.e, and is included as Exhibit H of this report. The report includes the following discussions:

- the regulatory framework for EIA and National Environmental Policy Act (NEPA);
- the required components of an EIA or EIS, as typically addressed within NEPA;

- the timing of environmental studies, impact assessment and submittals; and
- the timing of environmental impact assessment.

The primary focus of the report is to present a review of the regulatory framework for existing NEPA and State EIA processes, review the required components of EIA and NEPA decision documents as well as the timing of these components within the permitting and licensing process. The report emphasizes the NEPA process as implemented by NRC, as different federal agencies implement NEPA according to their specific regulations and in line with their individual missions. This report is intended to assist the UWG in assessing potential changes to the existing EIA process as it may be implemented for uranium mining.

2.1.7 DEQ/DMME Uranium Study: Assessment of Financial Assurance Mechanisms

The Assessment of Financial Assurance Mechanisms report for the VDH and DEQ/DMME Uranium Studies was developed as a single document in response to the requirements of Work Task B.2.j, identified in the DEQ contract and Work Task B.2.g in the VDH contract, and is included as Exhibit I of this report. This report identifies and describes different financial assurance mechanisms commonly used in mining and milling regulatory programs.

The report includes a discussion of the critical components which form the basis of a strong financial assurance mechanism and how the amount of the mechanism is developed. The report also describes the procedures and processes used to keep the financial assurance mechanism up to date, the release of the mechanism, and the need for public involvement. Lastly, the report discusses financial assurance mechanisms for other considerations including long-term mining impact mitigation, long-term stewardship of mills and mitigation of impacts from catastrophic events.

2.2 VDH Uranium Study Reports

Contract No. 120001-999 required an Initial Report and two Interim Reports. VDH staff commented on each report and the comments were addressed by WES staff. In each case a second review was conducted by VDH staff and additional responses made by WES. Summaries of each report are given below. The Initial Report and Interim Report #1 were finalized after addressing the final set of comments. At the time of this writing Interim Report #2 is still undergoing revision.

2.2.1 VDH Uranium Study: Initial Report

The Initial report for the VDH Uranium Study was developed in response to the requirements of Task A, Initial Literature Analysis and Recommendations, identified in VDH contract No. 120001-999 (VDH contract). This report is provided in Exhibit J of this Final Report.

The Initial Report presents an initial analysis and recommendations concerning issues and provisions that potential future regulation of uranium milling in Virginia might incorporate. The considerations are based on a review of existing studies, existing regulatory programs, and emerging international standards. Sections of the Initial Report to VDH are summarized below, with their relevant.

2.2.1.1 Initial Literature Analysis (Section 2)

The initial report contains a review of existing studies that had been conducted regarding the potential impacts of uranium mining and milling in Virginia. These include the National Academy of Sciences (NAS) Report (NAS, 2011), the Baker report commissioned by the City Council of Virginia Beach (Baker, 2010), a socioeconomic study by Chmura Economics and Analytics commissioned by the Virginia Coal and Energy Commission (Chmura, 2011), and a socioeconomic study by RTI International commissioned by the Danville Regional Foundation (RTI, 2011). Each of these studies is reviewed and sections pertinent to VDH are commented on separately.

2.2.1.2 Summary of Epidemiologic Studies (Section 3)

Epidemiologic studies are summarized for lung cancer in miners, health effects other than lung cancer, effects of exposures to toxins other than radon progeny, potential health effects related to uranium mill workers, and potential health effects to populations in the vicinity of uranium recovery facilities, including mines and mills.

Epidemiologic studies conclusively demonstrate that uranium miners have an increased risk of lung cancer due to inhalation of the short-lived radon progeny. The risk is greater with increased exposure and increases with the miner's smoking history. Smoking is a major confounding factor making interpretation of some of the epidemiologic studies of miners difficult. Individual epidemiologic studies have reported increased risk of other adverse health effects, such as leukemia and non-malignant respiratory disease, but lung cancer is the only effect consistently demonstrated in all studies. Epidemiologic studies do not demonstrate increased risk of cancer in mill workers with no mining experience. However, a potential increased risk of non-malignant respiratory disease and renal toxicity was observed in one study. No significant human health impacts due to uranium recovery operations were demonstrated in the most recent epidemiologic studies of surrounding communities.

The epidemiologic studies involving populations surrounding uranium recovery facilities are, by necessity, ecologic studies, which means that there are no specific individual exposure data. Inferences with regard to exposure are based on location and time sequence. Since members of the public are not generally individually monitored, exposure must be presumed based on other factors. The National Academy of Sciences, National Research Council recently published Phase 1 of its Analysis of Cancer Risks in Populations near Nuclear Facilities (NAS, 2012). The

NAS document includes several recommendations for this study that might be considered by VDH including an ecologic study of multiple cancer types in populations living near the facilities and a case-control study of cancers in children born near such facilities.

2.2.1.3 Existing Regulatory Programs (Section 4)

Milling

NRC has authority over milling of mined materials, in situ processes used to recover uranium, and mill tailings waste. The NRC regulates conventional uranium mills: including heap leach processes, and in situ recovery (ISR) facilities under the auspices of 10 Code of Federal Regulations (CFR) Part 40: Domestic Licensing of Source Material. Colorado, Texas, Utah, and Washington currently have effective Amended Agreements with NRC to regulate uranium recovery facilities in their states. This means that regulations in those states are equivalent to and compatible with 10 CFR Part 40. Periodic reviews of an Agreement State's regulations are conducted to ensure that statutory or regulatory changes have not made the state rules incompatible with 10 CFR 40 and changes that have been made to 10 CFR Part 40 since the state's regulations were initially accepted by NRC.

If the moratorium on uranium mining were lifted, an important question to be addressed by Virginia would be whether to apply for Agreement State status for uranium processing. Virginia would need to amend its existing regulations in a manner compatible with NRC regulations. Compatibility levels with 10 CFR 40 are detailed in Tables 12 and 13 of the report.

Section 4 of the VDH Initial Report also describes briefly the process to license an ISR facility and a conventional mill. Components and various elements required to produce an environmental impact analysis are also presented (Table 4-4 of the report).

Mining

The NRC has no authority over uranium mining. The Commonwealth of Virginia, as well as other states, has a wide variety of regulations that deal with permitting, operations, reclamation and closure and financial assurance of mines of various types in the state. These regulations are under the purview of DMME and DEQ, and not VDH.

2.2.1.4 International Considerations (Section 5)

Best practices and lessons learned regarding uranium milling are summarized from information published by the International Atomic Energy Agency (IAEA), the International Council on Radiation Protection (ICRP), the World Nuclear Association (WNA). A series of recommendations to be considered by VDH are listed in the context of the international community.

2.2.1.5 Recommendations to Virginia Department of Health (Section 6)

A series of recommendations for consideration by VDH are provided under the following headings listed below.

- Licensing and Agreement State Issues
- Human Health
 - Workers
 - General Public
- Environmental
 - Drinking Water – Including Private Water Wells
 - Recreational Water
 - Gamma Exposure Rate
 - Animal Health and Food Production
 - Environmental Impact Analysis

2.2.2 VDH Uranium Study: Interim Report #1

Interim Report #1 for the VDH Uranium Study was developed in response to the requirements of Task B-1 and is included in this report at Exhibit K. Sections of Interim Report #1 are summarized below.

2.2.2.1 Mining and Milling of Uranium (Section 2)

Processes are described for mining and milling of uranium, including ISR, open pit, underground mining, and conventional milling of uranium.

2.2.2.2 Potential Releases and Pathways to the Public (Section 3)

Conceptual site models are presented showing potential exposure pathways from an underground mine, an open pit mine and a uranium mill. Specific constituents of concern are summarized along with the potential route of exposure, pathway of transport and affected organ. An appendix to the report details reported health effects associated with potential constituents of concern.

2.2.2.3 Comparison of Recommendations to Existing Regulations (Section 4)

This section examines Radiation Protection Regulations under scenarios of the uranium milling regulated by NRC (if Virginia is not an Agreement State for uranium milling) and regulation by Virginia as an Agreement State. In both cases, specific recommendations are made regarding changes to Virginia Radiation Protection Regulations. Additional considerations are suggested for definition of the licensed area, environmental laboratories, environmental monitoring of

water sources and commercial food sources by the licensee, and characteristics of a meteorological station.

Section 4 also suggests considerations of water works regulations, disease reporting and control regulations, and regulation of private water well and recreational use of water.

2.2.2.4 Determine and Characterize Available Health Data (Section 5)

This section compares Virginia disease reporting requirements and laboratory testing capabilities to other states and national requirements. Based on that analysis, it appears that Virginia's disease reporting requirements reflect the national standard, even in states that have uranium mining and processing operations and potential exposures. Regarding laboratory analysis, Virginia appears to have the most specific instructions, among the states examined for reporting of laboratory testing of biosamples in cases of suspected chemical/toxin exposure or illnesses attributed to these types of exposures.

This section also discusses Virginia databases for baseline rates of lung cancers, silicosis and radon-associated health problems, and other available data to establish baseline rates for conditions of concern. VDH maintains state-wide registries for both cancer and birth defects that should provide appropriate baseline data for evaluating incidence rates in Pittsylvania County and identifying long-term trends and/or occurrences of disease clusters, rare cancers or unusual congenital malformations.

2.2.2.5 Develop and Test Case Report Investigation Materials (Section 6)

Based on information described in this section, the existing Virginia system appears to be adequate for any potential health outcomes that might result from uranium mining and milling in Virginia. Several changes to improve data completeness, accuracy and information flow are suggested using examples from Texas and New Mexico, both states with uranium mining and milling experience.

If it is desired to conduct broad, large population epidemiological studies of potential uranium recovery-related health outcomes, then a new set of report investigation worksheets might be needed. However, given that no mining or milling is on-going, no such study is forthcoming.

2.2.2.6 Develop Locus of Responsibility (Section 7)

Current responsibility for long-term monitoring of health effects within Virginia is assigned by Disease Reporting and Control regulations. Additional monitoring as described in Texas and New Mexico might be added to increase completeness and accuracy of reporting.

Tracking of health effects in workers is not currently performed by NRC. Radiation exposure of workers is monitored as required by license condition at licensed facilities, and reported to workers using NRC Form 5. The regulator may examine those records, but they are not

routinely reported to the regulator. For non-licensed facilities, the Virginia Department of Labor and Industry is responsible in Virginia for administering and enforcing occupational safety and health activities as required by the federal Occupational Safety and Health Act.

This section concludes that the existing Virginia regulatory structure is adequate to track potential health effects from exposures received at either a uranium mine or mill. However, there is no uranium processing state that does such tracking. Difficulties with conducting such monitoring are described in this section.

2.2.2.7 Monitor Work Spaces (Section 8)

This section focuses on worker protection in uranium recovery facilities, specifically addressing monitoring and record-keeping. Regulatory requirements are summarized for underground or open pit mines and uranium mills. Worker training, designed to prevent unnecessary exposures and keep both radiation exposures and other hazards as low as reasonably achievable (ALARA), is described.

The U.S. and international standards for exposure to radon and radon daughters are compared. The comparison considers IAEA, Australian and Canadian radiation protection standards. The National Institute for Occupation Safety and Health (NIOSH) recommendations for radon decay product exposure are also presented.

The section concludes with a series of recommendations for monitoring and evaluation of work spaces in mines and mills to augment current regulatory requirements in Virginia.

2.2.2.8 Monitoring of Long-term Health Effects (Section 9)

Monitoring of potential precursors to long-term health effects are described in Interim Report #2, described below.

2.2.2.9 Impacts on Cisterns and Onsite Sewage Systems (Section 10)

Potential pathways are described for materials from a potential uranium mill to cisterns or onsite sewage systems. Potential impacts via cisterns or onsite sewage systems to humans from routine uranium processing facility release are likely to be less or much less significant than impacts via other pathways including more direct exposures via air and water.

2.2.3 VDH Uranium Study: Interim Report #2

Interim Report #2 for the VDH Uranium Study was developed in response to the requirements of Task B-2 and is included in this report at Exhibit L. The contents of the Interim Report #2 Sections are summarized below.

2.2.3.1 Water Quality and Human Health Impacts (Section 2)

Potential effects on surface water are summarized for both normal operating conditions and accidents involving catastrophic event. Under normal operating conditions, liquid releases to surface waters from a uranium mine and/or mill should cause no detriment to water quality of the receiving surface water and should have no detrimental effect on human health or the environment. For catastrophic events, hazardous chemicals in the tailings present the greatest concern for receiving surface waters and impact on human health. A review of the literature of uranium tailings dam failures in the U.S. found no deaths that could attributed to the dam failures among persons present on-site or off-site. The failure of the Church Rock tailings dam is described in detail.

Potential effects on groundwater from uranium mining and milling are discussed. With regard to mining, estimates of potential negative impacts is highly site specific and cannot be adequately assessed without site-specific parameters including hydrologic conditions and ore characteristics. With regard to milling and management of mill tailings, under current regulations and regulatory inspection and enforcement practices, it is unlikely that the management of a uranium mill tailings structure will result in the contamination of off-site groundwater. Without degradation of the off-site groundwater, there would be no negative impact on human health of the public via the groundwater pathway as a result of uranium mill tailings.

2.2.3.2 Standards for Mine Waste Disposal Related to Human Health (Section 3)

This section summarizes Mine Safety and Health Administration (MSHA), Virginia and NRC regulations and their relation to uranium mining. Radiological and toxicological characteristics of mine and milling wastes are also discussed, along with methods to minimize human health risks from release of radionuclides and contaminants. Mining BMPs for ore and waste rock handling include encapsulation and isolation, liners on ore and waste storage pads, back stowage of waste, and dust minimization, among others. The BMPs for milling to reduce human exposure include effluent control and monitoring, characterization of ore and tailings, and control of dust. Tailings are controlled by placement in an engineered impoundment. Long-term disposal and closure usually occurs in an engineered repository.

2.2.3.3 Evaluate Methods to Incorporate “As Low As Reasonably Achievable” Standards in Commonwealth Regulations (Section 4)

The practice of minimizing radiation exposure in accordance with the ALARA principle is described this section, including ICRP and NRC considerations and recommendations. Methods of incorporating ALARA into Agreement State regulations are discussed as well.

Although ALARA is specifically applied to radioactive material licensees, there are, in some cases, similar concepts in other fields, such as industrial hygiene. Several recommendations to

keep exposures ALARA are presented including implementation of dose constraints, radon decay product exposure limits, dose limits for members of the public and chemical exposures.

2.2.3.4 Develop Recommendations for Environmental Monitoring (Section 5)

The NRC requirements from Regulatory Guide (Reg. Guide) 4.14 are described for pre-operational and operational phases of a uranium mill. Specific recommendations over and above Reg. Guide 4.14 are presented.

2.2.3.5 Media Specific Environmental Monitoring Recommendations (Section 6)

Sampling of specific environmental media are described including air particulate and radon monitoring; ground and surface water; vegetation, food and fish; soil and sediment; direct gamma exposure; and, meteorological data collection. Recommendations are presented for specific sampling of each media type.

2.2.3.6 Evaluate NRC Regulations for Milling and Tailings Management Given State-Specific Climate and Hydrologic Considerations (Section 7)

This section provides Virginia-specific comments that are pertinent to the NRC Regulations in 10 CFR Part 40, Appendix A. Technical criteria in Appendix A are listed. Virginia-specific comments include the need to adequately consider potential extreme rainfall events, use full below-grade disposal of tailings, state discretion with regard to location of compliance points for groundwater, potential exclusion of certain contaminants from sampling, a requirement of license conditions for ore and tailings storage.

2.2.4 Facilitator's Report

A series of public meetings and discussion group were held at three locations in Virginia to hear and discuss public concerns regarding potential impacts from uranium mining and milling to private water wells, public water supplies and recreational water supplies. Meeting agendas included: comments and questions received by VDH regarding private wells and recreational water issues related to uranium mining and milling; groundwater, surface water and air quality issues related to uranium mining and milling; and Opportunity for public comments. The Facilitator's report is included in this report at Exhibit M.

3.0 DISCUSSION OF STATUTORY JURISDICTIONS

The primary agencies to regulate potential future uranium mining and milling activities in Virginia and address protection of public health safety and the environment are the three UWG agencies, VDH, DEQ, and DMME. These three agencies have differing statutory jurisdictions identified within the Virginia Code fitting to their individual missions. The following report sections briefly discuss the statutory jurisdictions of these agencies.

3.1 Mining and Milling Statutory Jurisdictions

3.1.1 Current Status of Uranium Mining in Virginia

Though certain types of mining in Virginia are currently authorized under Title 45.1 of the Code of Virginia (the Code), uranium mining is specifically restricted. Title 45.1 Section 283 of the Code states:

“§ 45.1-283. Notwithstanding any other provision of law, 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. For the purpose of construing § 45.1-180 (a), uranium mining shall be deemed to have a significant effect on the surface. “

This provision not only prohibits DMME from accepting or approving any uranium mining permit applications but also requires that a specific program for regulating uranium mining be established by a new statute. Therefore, though the DMME has extensive experience with successfully regulating all aspects of mineral mines, it does not currently have the authority to regulate uranium mining. Should the General Assembly elect to authorize regulation of uranium mining, selected provisions of Virginia’s existing mining and environmental statutes, regulations and guidance could be incorporated in to a new regulatory framework.

If regulation of uranium mining is authorized in Virginia, each department DMME, DEQ, and VDH would need additional statutory and regulatory authority to include radionuclides and other issues specific to uranium mining. Each department has already developed and refined regulations that govern mining and activities associated with almost every anthropogenic compound and naturally occurring element into all media (air, surface water, groundwater, vapor phase) except uranium and its radiological cousins. Therefore, while each regulatory section will need modification to incorporate the relevant radionuclides into their existing programs, the basic regulatory building blocks are present.

3.1.1.1 General jurisdiction of DMME (Mines and Mining)

DMME’s mission is to enhance the development and conservation of energy and mineral resources in Virginia in a safe and environmentally sound manner. In meeting its mission,

DMME works to: 1) provide for worker safety and health at coal and mineral mines, and gas and oil extraction sites; 2) eliminate off-site environmental impacts and ensure the proper restoration of lands used for coal and mineral mining, and gas and oil operations; 3) examine and provide information about Virginia's geology and mineral resources; and 4) promote economic development in Virginia's natural resource and energy sectors.

DMME's Division of Mineral Mining (DMM) regulates Virginia's non-coal minerals to ensure that they are produced in a manner that is safe and protective of the environment. DMM administers both health and safety and surface mining reclamation regulatory programs for all non-coal mineral mining operations and is presumed to be the lead agency for oversight of uranium mining in Virginia.

3.1.1.2 General jurisdiction of DEQ (Environment)

The DEQ has a mission to protect and enhance Virginia's environment, and promote the health and well-being of its citizens. The DEQ's mandate is to regulate discharges to the environment so that Virginians will have clean water available for all uses, improved air quality that supports communities and ecosystems, and productive re-use of contaminated land.

On behalf of the State Air Pollution Control Board, DEQ's Air Division is responsible for carrying out the mandates of the Virginia Air Pollution Control Law, as well as meeting Virginia's federal obligations under the Clean Air Act. The Air Division's programs protect and enhance public health and the environment by controlling present and future sources of air pollution. The division ensures the safety and quality of the air in Virginia by monitoring and analyzing air quality data, regulating sources of air pollution, and working with local, state and federal agencies to plan and implement strategies to protect Virginia's air quality.

On behalf of the State Water Control Board, DEQ's Water Division is responsible for carrying out the mandates of the Virginia Water Pollution Control Law, and for meeting Virginia's federal obligations under the Clean Water Act. The DEQ administers state laws and regulations to improve and protect Virginia's streams, rivers, bays, wetlands and groundwater for aquatic life, human health and other beneficial water uses. Permits are issued to businesses, industries, local governments and individuals that address physical, chemical and biological standards for water quality. Sustainability and availability of Virginia's water resources are addressed through regulations on water use, water withdrawals, and water conservation.

On behalf of the Virginia Waste Management Board, the DEQ Division of Land Protection and Revitalization is responsible for carrying out the mandates of the Virginia Waste Management Act, and for meeting Virginia's federal obligations under the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response Compensation Liability Act (CERCLA). The division is tasked with the protection of Virginia's land and groundwater resources through the regulation of solid, hazardous and regulated wastes. The division also

addresses legacy sites and historic contamination through voluntary cleanup of contaminated soil and groundwater.

The DEQ Office of Environmental Impact Review coordinates Virginia's response to environmental documents for proposed state and federal projects. The environmental impact review staff distributes documents to appropriate state agencies, planning districts and localities for their review and comment. Upon consideration of all comments, the staff prepares a single state response.

3.1.1.3 General jurisdiction of the Virginia Department of Health (VDH)

The mission of the VDH is to promote and protect the health of all Virginians. As the designated public health agency for the Commonwealth of Virginia, VDH has statutory responsibilities and authorities to conduct regulatory and health promotion activities to:

- ensure clean, safe drinking water and protect the public from waterborne disease and water pollution;
- prevent or minimize exposures to toxic substances and ionizing radiation;
- strengthen the culture of emergency preparedness and respond in a timely and effective manner to any emergency potentially affecting public health; and
- promote systems, policies, and practices that facilitate improved health for all Virginians.

If the moratorium on the mining of uranium in Virginia were to be lifted, VDH could see an increase in services for communities and areas where uranium mining and milling activities occur. Five offices and one division within VDH have been identified as organizational units that would be impacted by increased workloads and citizen expectations if uranium mining were to be conducted in Virginia. Those organizational units are:

- Division of Radiological Health (DRH);
- Office of Drinking Water (ODW);
- Office of Epidemiology (OEpi);
- Office of Environmental Health Services (OEHS);
- Office of Family Health Services (OFHS); and
- Office of Minority Health and Health Equity (OMHHE).

Division of Radiological Health: Administratively DRH is the organization within VDH that conducts Virginia's radiation control program. It has the authority and responsibility for the licensing/registration of all users of radioactive materials and other sources of ionizing radiation

such as x-ray units and accelerators and for the inspection of these facilities and the enforcement of radiation safety and security regulations. The regulatory program for radioactive materials is conducted as an Agreement State under an Agreement between Virginia and NRC.

Authority under the Agreement does not extend to users at federal facilities or to nuclear fuel cycle facilities such as nuclear power plants, fuel fabrication facilities, enrichment facilities, or uranium mills. The Agreement could be amended to grant Virginia authority to regulate uranium mills.

The DRH also currently provides information on radon testing and mitigation resources to members of the public. Previously DRH conducted a more active program in public education and out-reach regarding indoor radon testing and mitigation. If the prohibition on uranium mining is lifted, the indoor radon program within DRH should be reactivated and statutory changes sought to give VDH authority to license and regulate private sector radon testing and mitigation service companies.

Office of Drinking Water: ODW conducts Virginia's regulatory program for public water systems under the Safe Drinking Water Act and the Virginia Waterworks Regulations. This program regulates water supply systems that provide piped water for drinking or domestic use to multiple users.

ODW regulates the design and construction of public water supply systems, the staffing and operations of these facilities, and the sampling, monitoring, and reporting of water quality of the water distributed. Water quality standards include biological, chemical, and radiological components.

ODW does not regulate private water wells used as sources of drinking water or for sources of water for agricultural or industrial use.

Office of Epidemiology: OEpi is the administrative unit within VDH that houses the Division of Radiological Health, the Division of Surveillance and Investigation (DSI), and the Division of Environmental Epidemiology (DEE), all of which would need to be involved in public health monitoring and environmental surveillance, if uranium mining takes place in Virginia. The DSI, through the statutory authority given to the VDH by the Code of Virginia and the Board of Health, is required to collect, analyze and report incidence data on an extensive list of infectious diseases, documented exposures to toxic chemicals (including workplace exposures), cancers, and congenital anomalies. Through a contractual arrangement with Virginia Health Information (VHI), the DSI has access to hospitalization data and information from a network of physicians and other healthcare facilities. In addition, chronic disease trends are monitored through the use of Behavioral Risk Factor Surveillance Surveys. The Public Health Toxicology program of the DEE conducts surveillance of toxic substances exposures and maintains a database of medical

information documenting those exposures. The DEE has a Cooperative Agreement with the Agency for Toxic Substance Disease Registry (ATSDR) that provides a structure for conducting health assessments.

Office of Environmental Health Services: OEHS regulates private water wells under the provisions of 12VAC5-630-10 *et seq.* These regulations address construction standards, horizontal setbacks from potential sources of pollution, and bacteriological quality of the water at the time of initial construction or rework of a private well. Regulations addressing the chemical or radiological quality of the water from private water wells or mandating periodic on-going testing of the water from private wells should be considered.

Office of Family Health Services: The OFHS is charged with “providing timely, reliable and accurate data concerning the health status of families in Virginia”. This office coordinates the Behavior Risk Factor Surveillance System Survey (BRFSS), analyses hospital discharge data and conducts surveys, the results of which are used to understand and promote healthy behaviors and lifestyles in Virginia. The OFHS has primary responsibility for conducting public education regarding disease prevention and control.

Office of Minority Health and Health Equity: The OMHHE has programmatic responsibility for research and analysis that defines disease distribution and social determinants of health. This office has primary responsibility for identifying health equity concerns related to public health outcomes.

4.0 REGULATORY ANALYSIS (GAPS AND CONSIDERATIONS)

This section builds on the information in Section 3.0 by identifying regulatory gaps that would exist if Virginia lifts the moratorium on uranium mining and expands its existing authority to include Byproduct Material under the Agreement State program with the NRC. In addition, this section provides programmatic points for consideration in the draft statutory and conceptual regulatory framework to be developed by the UWG. All three departments (DEQ, DMME, and VDH) are included in this analysis as there is overlap in jurisdictions and responsibilities in regard to the affected media and populations. A coherent regulatory program for uranium mining and milling must recognize the standards and actions of the three departments; and provide for effective interaction and coordination of regulatory activities. Some gaps may be addressed by modification of existing regulations. Other gaps may require new statutory authorization.

4.1 DMME Analysis

4.1.1 Programmatic Considerations

4.1.1.1 Statutory Authority for a Uranium Mining Program

Title 45.1 Section 283 of the Code prohibits the DMME from accepting applications for uranium mining until a uranium mining program is established by statute. Consequently, the existing programs within DMME do not address uranium mining and a gap analysis results in an entire new program being required. This new program would need to be established by amending Title 45.1 of the Code. The enabling statute for a uranium mining program could be general in nature directing the department to develop regulations to address all components and impacts of uranium mining. Alternatively, it could be very explicit in listing all the different components of a program, standards or goals to be achieved, and how the department operates the program. Most existing uranium mining regulatory programs are a blend of the two where the enabling statute has enough detail to give direction to the department but still allows the department latitude to adapt and modify regulations in response to changing conditions or information. Existing uranium mining regulatory programs also have guidance documents that provide additional level of information and detail that applicants may use to comply with statutes and regulations.

A summary of a uranium mining regulatory program can be found in Table 3-1 of the WES Uranium Study: Initial Report Commonwealth of Virginia, July 30, 2012 (WES, 2012b) (Exhibit C). Exhibit A of this report is a tabulation of jurisdictional areas and their related PFC combined from all the WES reports. The following discussion concentrates on the major programmatic components identified in the WES Initial and Interim Reports and does not address minor technical details of a regulatory program.

4.1.1.2 Environmental Impact Assessment (EIA) Process

Both the NAS report and the WES interim report *Full Components of Environmental Impact Analyses* (WES, 2012g) recognize the value of a comprehensive environmental impact assessment process for any proposed uranium mining or milling operation. In addition, the NAS report and direct public comment received in public meetings throughout the UWG Uranium Studies identified that greater accessibility by the public to proposed project data and documents and the ability to have adequate opportunities meaningful input is important. Currently, Virginia statutes only require a review of potential environmental impacts related to major Commonwealth projects and do not address private projects on private lands (Virginia Code § 10.1-1188).

If a uranium mining program is authorized, Virginia should strongly consider developing an Environmental Impacts Assessment (EIA) process for uranium mining more closely resembling the federal NEPA process, as discussed in the WES EIA report (WES, 2012g). This process provides Virginia with detailed analysis of multiple environmental and social factors on which to base permitting and licensing decisions. In addition, this process also provides ample public input and comment on agency scoping for assessment of the proposed action and provides the public opportunities to review and comment on draft and final decision documents. The requirement for an EIA process should be within the DMME as that department would have primary jurisdiction over uranium mining.

If Virginia requests NRC to grant regulatory authority to cover uranium milling and the associate byproduct material through the NRC Agreement State Program, the VDH would have to adopt the full federal NEPA process as promulgated in 10 CFR 51. If Virginia does not elect to seek this authority, NRC would implement the NEPA process for all uranium milling applications in Virginia, though the NEPA process may not address uranium mining if the mining is not a “connected Action” to the proposed milling project.

Therefore, it would be beneficial to Virginia to develop a compatible and comparable EIA program, including authorization to adopt any appropriate NRC NEPA decision documents (e.g., Environmental Impact Statements) as satisfying Virginia’s EIA obligations, provided that the analyses and documents met Virginia’s program requirements. The existing EIA process, as it could apply to uranium mining projects, warrants revision and expansion as discussed in the related WES interim report (WES, 2012g). This includes:

- solicitation of public input on the department’s scoping for the analysis of the proposed action;
- full assessment of the relevant and appropriate environmental, socioeconomic and public safety issues related to a proposed action;
- solicitation of public comment on draft EIA decision documents;

- solicitation of public comment on final EIA decision documents; and
- public appeals process for decision under the EIA process.

This NEPA process, required for licensing of a uranium mill, mandates assessment of all “connected actions,” including any mining projects that are dependent on a proposed uranium mill licensing action.

In this case, Virginia could participate in the federal NEPA process as a Cooperating Agency and, should it find the analysis appropriate and acceptable, could adopt the analyses, assessments and related federal NEPA decision documents (e.g., Environmental Impacts Statement, or Environmental Assessment) that related to a connected mining action, as having fulfilled Virginia’s requirements.

4.1.2 Permitting/Licensing

The DMME statutes for mining regulation are found in Title 45.1 of the Code of Virginia (Mines and Mining). It is this title that would be amended to address a new regulatory program for Uranium mining should Virginia elect to lift the existing moratorium. By reference to or amendment of Title 45.1 and 4VAC25, DMME should provide uranium mining specific statutes, regulations, and/or standards that ensure uranium mining operations can be conducted and regulated in a manner protective of public health, safety and the environment.

The DMME should consider amending Title 45.1 to address the following components that will assist in assuring the requisite protections.

1. Developing minimum requirements for characterization of site hydrogeologic, hydrology, and water quality, and geochemical characteristics.
2. Guidance for sampling and quantitative characterization of geologic and hydrologic conditions, mine waste characteristics (see Exhibits A, F and G for additional details).
 - a. Consider characterization requirements and guidance to address:
 - i. identification of which aquifers may be impacted, estimates of the degree of potential future impact (both physical and chemical), and the duration of potential impacts;
 - ii. modeling groundwater and surface water systems to support assessment of potential impacts including water consumption, aquifer drawdown and radius of influence, and modification of surface water systems; and
 - iii. documentation of efforts to identify locations of, acquire access to and survey private wells and septic systems, and collect data on private wells

from public data sources and through detailed inventories of local wells and septic systems.

3. Groundwater withdrawal requirements analogous to the surface water withdrawal requirements identified § 62.1-44.15:22. This requirement could include estimates of groundwater draw down and provisions for minimization and/or compensation for decreased access or availability.
4. Requirements for the development of rigorous surface water control systems and monitoring requirements for applicants to ensure appropriate management of surface water and sediments and control of mining and milling related hazards.
5. Establish requirements that applicants and operators provide quantitative basis for demonstrating control and isolation of surface wastes from exposure and surface transport (air and surface water) during operations and for the applicable reclamation design period established.
6. Requirements for development of sound quantitative water balances for all life-cycle phases of each mine waste management facility. As part of the water balance the following requirements for characterizations of the following should be considered:
 - a. characterization of water quality for all mine waste liquid effluents resulting from pumping, infiltration, seepage and/or inundation (deep disposal of mine waste below the water table);
 - b. quantitative assessment of changes to water resource systems (quality and quantity) from transport of water balance components into the environment;
 - c. quantitative basis for the location (vertical and lateral spacing) and sampling frequency of environmental sampling locations (air, groundwater and surface water).;
 - d. comprehensive characterization for constituent concentrations of solid, liquid and gaseous effluents; and
 - e. a minimum of one year of environmental baseline data for air and groundwater and a minimum of two years baseline for surface waters potentially receiving effluent discharges. Baseline assessment would include all appropriate constituents.
7. Establish requirements for baseline radiological characterization of site conditions, including surveys for surface gamma radiation and baseline soils radium and uranium concentrations. Pre-operational baseline radiological surveys for mine areas should consider NRC guidance identified in NRC regulatory Guide 4.14 (NRC, 1980).

The DMME also should consider incorporating a citizens environmental monitoring program analogous to that found in § 62.1-44.19:11 (DEQ's Citizen Water Quality Monitoring Program) to support citizen engagement in monitoring of surface water, groundwater, and air quality systems associated with uranium operations.

The DMME, in coordination with the DEQ, should ensure that the mine design and operations are sufficient to achieve the requirements identified in 40 CFR 440, Subpart C (EPA Ore Mining and Dressing Point Source Category; Uranium, Radium and Vanadium Ores Subcategory), which has specific surface water effluent discharge requirements.

4.1.2.1 Pre-application Data Collection and Analysis

A detailed description of site conditions is crucial to the proper design and operation of any mine. The new uranium mining regulatory program should specify the minimum standards and acceptable methods to be used to collect information concerning the pre-mining conditions of all media that has the potential to be impacted by the operation. To this end, the DMME should consider establishing detailed guidance identifying acceptable methods and criteria for data collection, analysis, and quality assurance while allowing for alternatives to be proposed by applicants. Alternatives should be required to demonstrate they are appropriate and sufficient to provide comparable or better completeness and accuracy as those components identified in guidance.

The regulatory program also needs to specify how the data should be analyzed based on a scientifically valid study design. The standards and methods should be coordinated with the DEQ since they will also require pre-application data for the media they regulate.

4.1.2.2 Standards for Design, Construction, Operation, and Reclamation

The majority of challenges for the management of uranium mine waste are similar to those for managing non-radioactive mine wastes (e.g., dust mitigation, control of mine waste seepage, long-term stabilization). Uranium mine waste has a few additional issues not typical of other mineral development (e.g., control of radon emissions, control of low levels of radiation). Therefore, uranium mine wastes may warrant a more conservative approach to managing uranium mine wastes than for other types of mine waste. In addition, should DMME be authorized to develop a regulatory program for uranium mining, DMME should consider establishing specific regulations regarding management of mine wastes incorporating appropriate engineering and best management practices, including consideration of those identified in the WES interim reports (WES 1012e, 2012f)

Thorough statute and/or regulation, guidance, necessary standards for mine design, construction, operation and reclamation must be established for uranium mining operations. As explained in the WES interim report *Engineering Design Best Management Practices* (WES, 2012e) the risk

of unintentional release of contaminants to the public and the environment may be substantially reduced by requiring strong standards for the different stages of the operation. Some portions of the operation such as waste rock management should require the design and construction to be under the supervision of a licensed and qualified professional engineer. The permitting process should include a risk assessment of the potential impacts to all media as well as human and ecological receptors to allow designs to be tailored to mitigate specific risks. The risks considered should include both natural (e.g., earthquakes, storms) and man-made events, both accidental (e.g., unintentional operational failures) and intentional (e.g., acts of vandalism). The regulatory program should require the mining operation to develop an emergency response plan that is periodically reviewed and updated. Additional detail and listing of best management practices can be found in the WES interim report (WES, 2012e).

4.1.2.3 Harmonization of Radiological Occupational Protection Standards

On site miner health and safety regulations pertaining specifically to radon daughter exposure monitoring are found in the MSHA mine worker safety regulations 30 CFR 57.5037. The MSHA regulations are federal and are applicable to all mining activities in the United States, whether or not the mining is for uranium or mining other metals and non-metals. NRC does not regulate radiological exposure for uranium mine workers, though it does regulate and enforce protective standards for occupational exposures for uranium mill workers via the requirements in 10 CFR 20. However, there are inconsistencies between how occupational radiation exposure is regulated between MSHA and NRC. In order to provide for uniform regulation of occupational exposures to radon, its decay products and other radionuclides, DMME should adopt uniform and appropriate standards for occupational exposure to radon and other forms of ionizing radiation without distinction of their sources or the activities by which the worker is exposed. A statutory point for consideration is a recommendation that DMME adopt by reference to the existing VDH standards, which already incorporate the 10 CFR 20 standards that are applicable to uranium milling.

4.1.2.4 Environmental Protection Standards

Uranium mining in Virginia, if authorized, will require promulgation of new standards for protection of public health, safety and the environment addressing both radiological and non-radiological constituents. Most emissions from uranium mines would be addressed under permits issued by the DEQ for air quality (Clean Air Act; NESHAPs if delegated by the EPA) and surface water Virginia Pollution Discharge Elimination Systems permits (Clean Water Act-VPDES). A statutory point for consideration is that the requirement to obtain, maintain and comply with these permits should be referenced in any future uranium mine permit. In addition, the DMME should consider specific requirements for groundwater protection; both quantity and quality, in the design, construction, operation and reclamation of all uranium mine facilities including management of mine wastes and mine dewatering. As the mine disturbance is reclaimed, standards are necessary to ensure that post mining radiation levels are either at

acceptable levels or background (see Section 3.1.1.8 of WES, 2012j). There should also be a regulatory recognition of the existing standards of DEQ by their incorporation into the mining permit. Given that an entirely new authority for permitting uranium mining is required under VAC § 45.1-283, all aspects of this program must be developed.

4.1.2.5 Financial Assurance Requirements and Mechanisms

Like the existing DMME coal program and mineral program, a future uranium mining program would also require statutes and regulations concerning financial assurance mechanisms. Fundamentally, the mechanisms for uranium mine reclamation surety are not and need not be substantially different than those for other mining operations. Similarly, the scope of what a uranium mine reclamation surety must address is not substantially different from that addressed for coal mining or other commodities. Issues related to potential liability for hypothetical catastrophic failures are not the subject of reclamation surety but rather of liability insurance.

The WES interim report Assessment of Financial Assurance Mechanisms (WES, 2012h) outlines the critical components of a strong financial assurance program. The components include:

- defining the process for approval and release of financial assurance mechanisms including public input;
- requiring that the amount be based on a third party contractor;
- specifying what should be included in the amount of the financial assurance;
- listing the acceptable financial assurance mechanisms;
- providing for periodic updates of the amount of the mechanism;
- requiring an initial closure plan and a process to keep it current;
- requiring contemporaneous reclamation/restoration;
- providing well defined standards for release of the mechanism; and
- establishing provisions for other types of mechanisms to cover perpetual treatment and mitigation for impacts caused by catastrophic events (i.e., insurance).

4.1.3 Operations

4.1.3.1 Environmental Monitoring and Compliance Coordination with the Department of Health and Department of Environmental Quality

Many of the environmental standards are regulated by the DEQ. The interrelationships between mining and the environment, the imperative to appropriately manage mining to protect the environment and public health requires that Virginia agencies responsible for protection of

public health, safety and the environment coordinate their standards and oversight of the uranium industry. Public health and environmental protection are intimately connected to the design, construction and operation of uranium mining facilities as well as the environmental monitoring of mining emissions. For example, reclamation design for mine wastes relate to long-term protection of surface water, groundwater, air quality and public health. Consequently, implementation of new uranium mining and reclamation standards by either the DMME or DEQ should be coordinated among all stakeholder agencies. However, though the agencies have experience working together in a coordinated fashion, the current regulatory mechanisms for such coordination are not explicit and could be strengthened. A statutory point for consideration is a requirement that the agencies enter into a formal agreement coordinating standards, monitoring, compliance, and enforcement activities.

4.1.3.2 Operational and Institutional Controls

Uranium mining may produce wastes that require special handling and deposition. Uranium mine waste disposal areas may require long-term monitoring and/or maintenance to ensure unacceptable environmental impacts do not occur. These areas may also need long-term protection to ensure appropriate long-term land use compatible with the mine waste disposal and to prevent unintentional disturbance that could cause releases. Unlike uranium mill wastes, which receive perpetual custodial ownership and oversight, mine wastes on private lands remain private property and are no longer under the DMME regulatory authority after achieving the approved post mining land use.

A statutory point for the DMME consideration is a requirement for perpetual covenants and deed restrictions that would require mandatory disclosure of mine waste disposal, continued appropriate levels of monitoring and maintenance and restrictive covenants restricting in appropriate land uses. The covenants and deed restrictions would alert future landowners to the special protective measures and prevent activities that could cause release or exposure of contaminants.

4.1.4 Closure/Post-Closure

4.1.4.1 Durability and Performance of Reclamation/Post-reclamation Stabilization

The release of financial assurance mechanisms for mining operations (reclamation surety bonds) are typically tied to the mine operator achieving the approved post-mining land use, which in turn is typically based on the demonstration that the reclaimed land forms are stable. Stability is generally demonstrated by the establishment of vegetation cover on the reclaimed mine facilities with a given level of plant production, a specified level of plant species diversity and the absence of observed erosion. This established, productive and diverse vegetative cover reflects the goal to provide a durable, long-term, productive reclaimed surface that will support the approved post-mining land use. A uranium mining regulatory program should include closure

requirements as discussed in WES, 2012b and in WES, 2012e WES 2012f. These include requiring an updated closure plan as discussed in WES, 2012f.

Uranium mining has waste characteristics that will require consideration of additional criteria for evaluation of successful reclamation (e.g., limiting radon flux). Permanent storage of that portion of mine waste rock with the potential for adverse environmental impacts will often require encapsulation or deep isolation from the environment to protect air quality, surface water, groundwater and the public. The durability and performance of these controls must last for long periods of time. Consequently, criteria will need to be developed to assess the success of constructed isolation features to ensure long-term stability and isolation from inadvertent release. Specifically, criteria for the period over which mine waste isolation must endure need to be established as well as criteria for ensuring that any emissions (i.e., radon emission, infiltration and seepage, etc.) remain protective of public health safety and the environment. Consideration should be given to developing environmental standards to ensure that post-mining radiation exposure levels are either at acceptable levels or background. There should also be a DMME mandate for all DMME uranium mine permits to recognize and require compliance with existing or new emission standards promulgated by the DEQ and any and all the DEQ permits (e.g., Clean Air Act Permits or VPDES Permits).

4.2 DEQ Analysis

4.2.1 Programmatic Considerations

Three regulatory boards – the Air Pollution Control Board, the State Water Control Board and the Waste Management Board, composed of Virginia citizens appointed by the Governor, are responsible for adopting many of Virginia's environmental regulations that would be applicable to any uranium mining proposal. The DEQ administers the regulations for water, air and certain waste through a permitting process.

The DEQ should issue appropriate permits for uranium mining in coordination with the DMME and VDH. The DEQ should ensure compliance with those permits in consultation with the DMME and VDH for related review and inspection as necessary.

For its permits issued for uranium mining operations, the DEQ should consider establishing requirements comparable to § 62.1-44.15:4 (notification of local governments and property owners) either by new language or by reference.

The DEQ should establish that the regulatory process includes review and approval of required renewals and proposed amendments to its permits issued to uranium mining operators.

The DEQ should consider regulations that ensure regular and unscheduled inspections, compliance requirements, and enforcement to ensure operations are following the permits. Develop strong enforcement and penalty authorities.

4.2.2 Permitting/Licensing

4.2.2.1 Groundwater and Surface Water

The DEQ statutes for water protection are found at Title 62.1 Waters of the State, Ports, and Harbors; Chapter 3.1, State Water Control Law. Corresponding regulations and standards are provided at the Virginia Administrative Code, Agency 25 State Water Control Board. Chapter 280 (9 VAC 25-280) specifically addresses groundwater standards. The DEQ should consider the potential impacts of a uranium mining operation on groundwater and surface water as have been described by WES (WES, 2012c). By reference to or amendment of Title 62.1 and 9VAC25, the DEQ should provide uranium mining specific statutes, regulations, and/or standards that ensure operations can be conducted and regulated in a manner protective of the groundwater and surface water environment.

The DEQ should consider amending Title 62.1 (Waters of the State, Ports and Harbors) to consider assisting the DMME in developing the requirements and guidance suggested in Section 3.2.1 of this report.

The DEQ also should consider incorporating and possibly expanding § 62.1-44.19:11 (Citizen Water Quality Monitoring Program) by reference to support citizen engagement in monitoring of surface water and groundwater systems associated with uranium operations.

4.2.2.2 Discharges (VPDES)

Section 402 of the Clean Water Act established the National Pollutant Discharge Elimination System to limit pollutant discharges into streams, rivers, and bays. The DEQ administers the program as the Virginia Pollutant Discharge Elimination System (VPDES). Although the DEQ requires the VPDES permits for all point source discharges to surface waters, the EPA maintains authority to review applications and permits for "major" dischargers, a distinction based on discharge quantity and content.

The DEQ should establish requirements equal to or more stringent than the EPA's regulations at 40 CFR Part 440 for discharges from uranium mines and mills, including a requirement for zero discharge of process water except as allowed by 40 CFR 440.34(b)(2), 440.131(b), (c).

The standards in §440.34(a) are maximum standards and should be assessed on a case-by-case basis for adequacy given site water quality, transport and use water conditions, and potential for impacts surface waters.

The DEQ should consider if the exemptions under 440.34(b) are sufficient and appropriate in Virginia or whether more stringent exception conditions are required (e.g., more than a 10 yr/24 hour storm event must be contained).

4.2.2.3 Air Quality

The DEQ statutes for air quality protection are found at Title 10.1 Conservation, Chapter 13 Air Pollution Control Board. Corresponding regulations and standards are provided at the Virginia Administrative Code, Agency 5 State Air Pollution Control Board. The DEQ should consider the potential impacts of a uranium mining operation on air quality as have been described by WES (WES, 2012d). By reference to or amendment of Title 10.1, and Agency 5, DEQ should consider providing uranium mining specific statutes, regulations, and/or standards that ensure operations can be conducted and regulated by the DMME in a manner protective of the air quality. Points for consideration for a draft statutory and conceptual regulatory framework are offered as means to ensuring adequate data exist to assess and demonstrate continued protection of public health safety and the environment.

The DEQ should consider requesting delegation of 40 CFR Part 61 requirements (NESHAPs) from EPA Region 3.

The DEQ should consider establishing requirements for best management practices for air quality monitoring and modeling.

The DEQ should consider expanding the State list of Toxic Pollutants to include the uranium decay chain radionuclides commensurate with those identified in NRC Regulatory Guide 4.14, Section 1.2, Section 2.2, and Tables 1 and 2.

The DEQ should consider establishing requirements for all uranium mines and mills to perform Prevention of Serious Deterioration (PSD) monitoring regardless of minor/major source status.

4.2.3 Operations

4.2.3.1 Groundwater and Surface Water

The DEQ should consider amending Title 62.1 (Waters of the State, Ports and Harbors) to establish requirements and a process comparable to the Virginia process for implementing a Water Protection Permit (62.1-44.15:20) for groundwater protection.

The DEQ should consider incorporating operational water withdrawal requirements analogous to § 62.1-44.15:22.

The DEQ should consider requiring comprehensive monitoring of groundwater and surface water media during operations to assure contaminants are not migrating.

The DEQ should consider including in its regulations guidance on adequate sampling and analytical methods for radionuclides and their isotopes, and guidance on quality assurance/quality control standards. The DEQ also should consider including acceptable risk values for contaminants that have the possibility to migrate through any potentially impacted media.

The DEQ should consider including regulations for periodically applying site compliance water monitoring data to models used in permitting to verify the original modeling assumptions and conclusions.

The DEQ should consider incorporating and possibly expanding § 62.1-44.19:11 (Citizen Water Quality Monitoring Program) by reference to support citizen engagement in monitoring of surface water and groundwater systems associated with Uranium operations. This could include establishing independent advisory review panels of qualified individuals. These panels could be empowered to periodically review mine monitoring plans.

4.2.3.2 Discharges (VPDES)

The DEQ should establish the operational process to ensure requirements equal to or more stringent than 40 CFR Part 440 for uranium mines and mills are met.

The DEQ should consider expanding Virginia Code § 62.1-44.15:4.1 (listing and notice of confirmed oil releases and discharges) to address releases from uranium operations or incorporate a comparable requirement in the new statute.

The DEQ should establish a requirement for robust monitoring of all discharges from uranium mining, and if applicable, uranium milling projects.

4.2.3.3 Air Quality

The DEQ should consider amendment of Title 10.1, Chapter 13 (Air Pollution Control Board) and 9 VAC 5 Regulations for Control and Abatement of Air Pollution to ensure implementation of the NESHAPs requirements through monitoring and inspection.

The DEQ should consider requiring comprehensive air quality monitoring during operations to assure contaminants are not exceeding limits.

The DEQ should consider including in its regulations guidance on adequate sampling and analytical methods for radionuclides. The DEQ also should consider including acceptable risk values for airborne contaminants.

The DEQ should consider including regulations for periodically applying site compliance air monitoring data to models used in permitting to verify the original modeling assumptions and conclusions.

4.2.4 Closure/Post Closure

4.2.4.1 Groundwater and Surface Water

In its amendment of Title 62.1, the DEQ should consider requirements for prompt remediation of impacts to groundwater and surface water that could lead to off-site exposure.

The DEQ should consider establishing requirements for well and borehole abandonment methods and requirements for adequacy by comparing those methods with other state, federal and international best practices.

The DEQ should require a specified period of monitoring to determine that the site is stable and no contaminants are moving to unauthorized areas.

The DEQ should establish a closure process that includes public involvement in water monitoring activities.

4.2.4.2 Discharges (VPDES)

No closure recommendations.

4.2.4.3 Air Quality

In its amendment of Title 10.1, Chapter 13 and 9VAC5, the DEQ should require a specified period of air monitoring to determine that the site is stable and no contaminants are moving to unauthorized areas.

The DEQ should establish a closure process that includes public involvement in air monitoring activities.

4.3 Virginia Department of Health

4.3.1 Programmatic

If the moratorium on uranium mining is lifted, an overarching consideration for legislation is the funding of increased environmental monitoring and other public health services that the VDH will provide. Virginia will have to decide whether to fund these additional activities from general revenue sources, or to enact legislation that would give the VDH the statutory authority to charge fees to cover these increased costs. If Virginia is to become an Agreement State for uranium, additional statutory authorities would have to be given to VDH in areas discussed below.

In cooperation with the VDH, DMME should harmonize the worker safety standards for mining with the NRC mill regulations, by requiring summation of doses for radon progeny, direct radiation, and inhalation of radionuclides in airborne particulate matter, and by limiting the total effective dose equivalent to 5 rem per year.

Also in cooperation with the VDH, DMME should develop regulations that would limit radon decay product exposure to underground miners to 1 working level month (WLM) per year in accordance with NIOSH recommendations (NIOSH, 1987) that conclude that this limit is reasonably achievable under current mining conditions.

The DRH is presently organized, staffed, and equipped to administer the radiation control activities for Virginia for users of many types of radioactive materials and radiation sources. However, if the moratorium is lifted and uranium mining and milling is conducted, the DRH workload will increase even if uranium mill licensing is handled by the NRC.

If Virginia were to extend its Agreement State status to cover uranium extraction, a major increase in DRH staffing/funding would be necessary to handle uranium mill licensing and inspection. Legislation would be required to develop new regulations, additional staff would need to be hired and trained, and additional equipment would have to be acquired to satisfy the NRC requirements for an Amended Agreement giving Virginia authority to regulate uranium mills. We estimate that three years would be necessary to complete these processes and receive NRC approval for the Amended Agreement.

A regulatory program for uranium mills must include professional expertise not commonly found in radiation control programs. Utah is the most recent state to receive NRC approval in this regard. Table 4-1 shows the staffing and professional expertise of NRC and Utah associated with their uranium mill regulatory programs. Data for NRC staffing is taken from their presentation dated March 22, 2012. Utah staffing levels were extracted from the organization chart of the Utah Department of Environmental Quality Division of Radiation Control (<http://www.radiationcontrol.utah.gov/orgchart.htm>). It is important to note that Utah regulates not only the White Mesa Uranium mill, but also the Energy Solutions low level radioactive waste disposal site, with the staff listed. Staff responsibilities are split between the state's permitting and compliance groups. That distinction is identified in the comments column. WES expects that the NRC would require similar staffing levels and professional expertise to be available in an amended Virginia program.

The DRH has estimated that an additional 2.5 full-time employees (FTE) and \$155,000 annually would be necessary if the mining moratorium were lifted. If Virginia were to become an Agreement State for uranium, an estimated 8 FTEs and additional annual budget of \$1,000,000 would be required.

Further, if Virginia were to apply to modify its Agreement State status, the VDH should consider elevating the DRH to office status under the Chief Deputy for Public Health. This reorganization would give DRH increased visibility within VDH in keeping with its increased responsibilities.

Similarly, other programs within the VDH would experience a need for additional staffing and funding if the mining moratorium were to be lifted. This increase is expected whether or not Virginia were to become an Agreement State for uranium, and would include the following.

- VDH ODW has estimated it would need an additional 0.5 FTE and \$40,000 of additional annual funding.
- VDH OEpi has estimated it would need an additional 4 FTEs and \$ 405,000 annual funding for epidemiologists, health educators and data managers.
- VDH OEHS has estimated it would need an additional 6 FTEs, and approximately \$1.9M annual funding for additional annual sampling and analyses of private water wells, assuming that VDH would bear the costs of sampling and analyses.

4.3.2 Permitting/Licensing

If Virginia becomes an Agreement State for uranium extraction, major changes in DRH regulations, including changes in its radioactive materials application review and evaluation process would be necessary to handle uranium mill license applications. Recommended and necessary changes to current regulations were presented in Interim Report #1 and are provided in this report as Table 4-2.

The first Interim Report under the VDH contact (WES, 2012i) suggests that changes to the regulations of the ODW for public water supplies or those of OEHS for private water wells would be necessitated by the lifting of the moratorium on uranium mining. Interim Report #1 suggests changes that might enhance the regulatory programs of both of these programs. These recommendations include requirements related to sampling frequencies and constituents for which analyses should be made.

If NRC maintains authority to regulate uranium mills in Virginia, no additional statutory authority would be necessary for DRH to continue its present regulatory program for users of radioactive materials and other sources of ionizing radiation.

However, if Virginia determines that it will become an Agreement State, additional statutory authority for DRH would need to be enacted to meet NRC criteria in the areas of:

- land ownership;
- financial surety; and
- environmental assessment reviews.

In its assessment of the adequacy of the statutes of Utah to address these requirements, NRC used the criteria shown in Table 4-3. It can be anticipated that the same or similar criteria would be used in assessing the adequacy of Virginia's statutes.

Consideration should be given to providing increased statutory authority in regard testing and periodic retesting of private water wells for chemical and radiological analytes. Consideration should be given to allow OEHS to regulate water quality in private wells.

4.3.3 Operations

4.3.3.1 Environmental Monitoring

If uranium mining and milling were to occur in Virginia without a change in Agreement State status, DRH would be expected to provide environmental monitoring around uranium mines/mills similar to what it now conducts around other operating NRC licensed nuclear fuel cycle facilities in Virginia. The DRH is not presently staffed and equipped to take on this additional responsibility.

The VDH DRH should consider instituting a radon program to assess indoor and outdoor radon levels near a uranium mine/mill.

If Virginia were to become an Agreement State for uranium there would be an additional increase in the amount of environmental monitoring required of DRH to fulfill its regulatory responsibilities. The DRH would need to conduct confirmatory environmental monitoring of media and analytes that the applicant/licensee for the uranium mill was required to sample and analyze by conditions of its radioactive materials license. In addition, DRH would have to review and evaluate the results of the applicant's/licensee's required environmental monitoring program.

If the uranium mining moratorium is lifted, OEHS should expect new monitoring responsibilities and workloads associated with new regulatory programs for private well owners.

If the moratorium on uranium mining is lifted consideration should be given at the same time to enacting statutes that would fund the additional environmental monitoring and other increased public health services that VDH will be expected to provide. Decisions will need to be made regarding whether increases in staffing and funding will be paid from general state revenues or by fees from the owners/operators of uranium mines and mills.

4.3.3.2 Population-Based Human Health Surveillance and Monitoring

If baseline rates for the conditions described below have not been determined, it would be useful to attempt to establish these data for the potentially affected region. These baselines may later help to determine whether human health conditions reported after the start-up of uranium

extraction operations exceed baseline rates if VDH should decide to perform population-based monitoring and surveillance in the affected region. The VDH already has surveillance systems in place that allow for the collection and analysis of health data related to the conditions of interest, although a different focus of analysis might be necessary to detect trends specifically related to uranium-related exposures and to attribute causal relationships. However, this will be difficult or impossible for small populations, rare events and long-term outcomes. Conditions potentially related to uranium mining and milling operations that could be monitored are shown in Table 4-4.

The VDH must evaluate its statutory authority to determine if changes are needed to conduct population-based surveillance and monitoring. However, in the opinion of WES staff, No additional statutory authority is needed to conduct health-related surveillance for uranium mining/milling associated exposures. Wright Environmental Services, Inc. would recommend “oversampling” of populations living in counties where uranium operations exist to increase sample size and provide statistically valid county-level data for existing surveillance programs.

4.3.4 Closure/Post-closure

4.3.4.1 Environmental Monitoring

Environmental monitoring following closure of a mill, or a co-located mine and mill, would involve considerably less effort than that required during the operational phase. Monitoring would focus on intermediate- to long-term water sampling, principally of nearby and other potentially affected wells. The purpose of this sampling would be to remain vigilant for changes associated with slow-moving, relatively high concentrations of toxicants potentially released during operations. The monitoring would also provide data to determine the effectiveness of closure systems, including engineered caps on tailings, protore and waste rock piles, mine pit environmental protection systems, significant contamination events during operations, groundwater depth changes after termination of mine dewatering, and any effects associated with residual rock/ore oxidation on toxicant solubility, which might be expressed as long-term increases in groundwater contamination offsite. Some surface water monitoring would also be likely to continue for an extended period, to determine whether impoundment/cover leakage, or movement of any residual surface contamination, occurs post-closure. Regular long term fish tissue monitoring in the downstream watershed would also indicate transport of residual contamination from groundwater and surface water vectors.

Air particulate sampling would terminate relatively soon following closure, after perhaps a year of stable, background data have been obtained to demonstrate that tailings, protore and waste rock caps, and final mine pit environmental protection systems, are functioning properly. (Annual cap and pit inspections would then become the primary method to determine whether these engineered systems remain functional.) A final, detailed gamma radiation survey of the site and its potentially affected region would be performed, allowing comparison with the pre-

operational detailed gamma survey. One or more final samplings/analyses of potentially affected vegetable gardens, farm crops and food animals might be performed, if increased concentrations in the human food chain had been found during operations. A final sampling of edible portions of game animals might be performed post-closure, as well.

Environmental radon monitoring at a number of stations, including any that demonstrated increased radon levels during operations, would continue for one or more years post-closure. This monitoring would establish either a return to background concentrations, or a stabilization at new environmental values associated with mine pit exposure of low-concentration uranium-bearing materials.

Depending on policies of the final site custodian (DOE or Virginia), VDH may or may not decide to conduct independent environmental sampling similar to the above, or to split samples with the final custodian. A local citizens' group, trained and funded prior to operations and closely involved in environmental monitoring throughout operations and closure, could be a valuable aid to Virginia during post-closure, assuming some responsibilities for continued monitoring, under Virginia supervision.

4.3.4.2 Population-based Surveillance and Monitoring

If population-based surveillance programs are established prior to and during operations, they should be continued for a sufficient period of time post-closure to provide adequate information on potential mining and milling health impacts. The purpose of such population-based surveillance would be to monitor for changes in key health indicators potentially associated with any significant releases of toxicants from the facility during operations or post-closure. However, environmental monitoring that assures compliance with Virginia or federal standards is the key to evaluating potential health effects.

5.0 SUMMARY AND CONCEPTUAL REGULATORY FRAMEWORK

As mentioned in the Introduction, the two uranium studies undertaken by the departments of the UWG were designed to respond to the Governor's directive of January 19, 2012 (Exhibit A). The information provided in this Final Report and the associated exhibits, developed with and for the UWG, are intended to support the Departments' efforts to.

“ provide a scientific policy analysis to help assess whether the moratorium on uranium mining in the Commonwealth should be lifted, and if so, how best to do so.”

This Final Report integrates the material of the two uranium studies in order to aid the UWG in establishing the scientific policy analysis, draft statutory and conceptual regulatory framework, and also in developing future regulation and guidance, if needed.

The material within this report indicates that Virginia departments have extensive expertise and experience with most of the issues related to uranium mining, milling and the monitoring and protection of public health safety and the environment. However, these materials also indicate where additional regulatory elements may be of value to Virginia in addressing some of the specific issues that are unique to uranium mining.

5.1 Past versus Current Practices

The NAS study focused on legacy issues of uranium mining and milling (NAS, 2011). However, the NAS report gave less attention to how current regulation, technical requirements, guidance, and regulatory oversight practices have evolved significantly since these legacy facilities were permitted. Modern regulation, technical requirements, guidance, and oversight practices greatly affected the potential impacts from uranium mining and milling. Abundant requirements for conservatism and defense-in-depth in design and operation of modern uranium mills exist within current national and international regulatory programs, which significantly reduce the risks that were realized in the legacy sites. Although human error can never be eliminated, modern practices significantly reduce the risk of release from human or mechanical failures.

Table 5-1 presents a brief summary of the major risks of failure of uranium mining and milling effluent and waste management systems. In addition, this table identifies modern practices that mitigate, in part or in whole, most but not all of these risks.

A primary concern regarding waste management and public exposure is control of uranium mill tailings. The two primary failure modes for the release of tailings and contaminants is leakage of tailings liquids through the bottom of the disposal cell into water resources and massive loss of tailings containment through overtopping, tailings discharge line failure or embankment failure. Many of the legacy uranium mill tailing sites with groundwater impacts were built before modern standards were in place - many without any impoundment liners or other forms of

secondary containment. In fact, seepage of tailings solution into the subsurface was a design element for liquids management before there was regulation of uranium mill tailings (i.e., Split Rock Site, Cotter Mill Site, and Highland Mill Site). The numerous legacy uranium mill tailings sites with groundwater contamination are to be expected given the regulations, operational methods and engineering controls in place at the time of their construction and operation.

Similar concerns exist in regard to contamination from the disposal of mine waste. Uranium mine waste will often contain constituents that have the potential to erode and be carried off site, or leak into the subsurface and contaminate groundwater. While historically there were requirements for the wastes to be contoured and reclaimed, the chemical and radiological nature of the material often resulted in reclamation failure and allowed the potential for contamination.

5.1.1 Impoundment Liners

Current containment practices dramatically reduce the risk of significant impoundment cell leakage. Current practices include secondary containment and double synthetic liner systems with limits on operating heads (how much saturation is allowed above the primary liner), drainage systems on top of the primary liner, leak detection systems between the primary and secondary synthetic liners, even lower limits on operating heads on secondary liners, requirements for low permeability under liners systems (3 feet of low-permeability compacted clay or a geocomposite clay liner) beneath the double liner system and documentation of appropriate construction through construction QA programs. Most of the sites addressed in the NAS study did not have the benefit of these modern materials and practices. Figure 5-1 illustrates the modern tailings and pond liner methods that mitigate the risk of significant leakage.

5.1.2 Impoundment Embankments

Overtopping or large scale failure of tailings impoundments is a second mode of containment failure. This mode has occurred at some legacy uranium mill sites in the U.S. (i.e., Church Rock, Split Rock). It should be noted that such failures were not related to seismic events but rather due to embankment construction practices that would not be permissible today. Many older legacy sites (i.e., Cotter, Split Rock, and Church Rock) used a tailings embankment construction method called “upstream construction” whereby the tailings were discharged to unlined ponds and the tailings themselves were used to create an embankment as they were spigotted (pumped) to the disposal cell. Figure 5-2 illustrates how tailings were pumped to a starter dike and the coarse tailings that accumulate near the point of tailing discharge (the spigot) were used to build the dam progressively higher, this is called “Upstream Construction”. Those tailing cell construction methods are no longer permissible and the risk of those failures has been almost entirely mitigated by modern impoundment design and operational requirements. Figure 5-1, which identifies modern tailings liner methods, also illustrates current embankment construction approaches.

Modern uranium milling facilities are designed to contain and manage massive precipitation events, a requirement not incorporated into historical facility designs. Figure 5-3 illustrates calculated and measured precipitation for several precipitation events. These events include the calculated precipitation for Virginia for the “middle” Virginia region as opposed to the “lower” Virginia (coastal plain), or the “upper” Virginia region (piedmont). The probable maximum precipitation (PMP) events, described in more detail in Exhibit D to this report, represent the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage area. Consequently, the 6 hour PMP is smaller than the 24 hour PMP. Uranium mill sites are required to design to contain the 6 hour PMP during operational conditions while long-term reclamation requires erosional stability under the 24 hour PMP. This Figure indicates that both the 6 hour PMP and 24 hour PMP are significantly larger (on the order 3 to 4 times larger) than the highest precipitation experienced by Virginia during Hurricane Irene in 2011.

This conservatism in modern uranium mill design requirements substantially decreases the risk of release of contaminants during extreme weather events.

5.1.3 Tailings Disposal in Mine Workings

The NRC regulations focus on the conventional method of disposing of uranium mill tailings in double lined impoundments as described above. However, it is important to recognize that NRC regulation specifically contemplated that alternatives may be proposed. The Introduction to 10 CFR 40 Appendix A states the following on this issue.

“In many cases, flexibility is provided in the criteria to allow achieving an optimum tailings disposal program on a site-specific basis. However, in such cases the objectives, technical alternatives and concerns which must be taken into account in developing a tailings program are identified. As provided by the provisions of § 40.31(h) applications for licenses must clearly demonstrate how the criteria have been addressed.”

“All site specific licensing decisions based on the criteria in this Appendix or alternatives proposed by licensees or applicants will take into account the risk to the public health and safety and the environment with due consideration to the economic costs involved and any other factors the Commission determines to be appropriate.”

Further, Criterion 3 of Appendix A states:

*“The “prime option” for disposal of tailings is placement below grade, either in **mines** [emphasis added] or specially excavated pits (that is, where the need for any specially constructed retention structure is eliminated). The evaluation of alternative sites and disposal methods performed by mill operators in support of their proposed tailings disposal program (provided in applicants’ environmental reports) must reflect serious consideration of this disposal*

mode.....Where full below grade burial is not practical, the size of retention structures, and size and steepness of slopes associated exposed embankments must be minimized by excavation to the maximum extent reasonably achievable or appropriate given the geologic and hydrologic conditions at a site. In these cases, it must be demonstrated that an above grade disposal program will provide reasonably equivalent isolation of the tailings from natural erosional forces.

Though disposal of uranium mill tailings in mine facilities (pits or underground workings) is an infrequent practice (i.e., Title I Riverton tailings disposed of in Umetco A9 Pit) such a disposal approach must still “...clearly demonstrate how the criteria have been addressed “(10 CFR 40, Appendix A, Introduction). As such, the burden of demonstration is on the applicant to convince NRC or the Agreement State that equal protection for all criteria is achieved. Therefore, back stowing uranium mill tailings in mine workings, either in their native state or with solidification agents and admixtures (e.g., cement, fly ash, bentonite, etc.), which may or may not become saturated with groundwater after reclamation, must be demonstrated through methods accepted by the NRC or the Agreement State to meet all criteria for stabilization and groundwater protection. Due to the infrequent use of this approach to tailings disposal, the methods by which an applicant may make such a demonstration will likely be developed on a case-by-case basis using sound laboratory, analytical and numerical methods.

5.1.4 Tailings Delivery Line Failures

Another potential failure mode of concern is the failure of tailings delivery lines or solution lines to and from the mill. Historical tailings or pipeline releases (e.g., Homestake, Highland/Smith Ranch ISR) resulted from mechanical failures of the pipelines. Though the potential for mechanical failures cannot be completely mitigated, modern tailings and solution distribution line designs are now required to have secondary containment (double lined pipes, pipe alignments underlain with HDPE synthetic liners) providing redundancy in containment measures. In addition, modern mill systems have in-line pressure sensors that notify operators promptly of potential failures, allowing prompt cessation of pumping, containment, and any necessary clean up (see Table 5-1).

5.1.5 Air Emissions/Radon and Particulates

The wind transport of particulates from ore stockpiles, tailings impoundments or heap leach pads and mill yellow cake driers are the primary sources of airborne radioparticulates. Historical practices controlling these emissions were not as protective as current equipment and methods allowing much greater emission of radon and particulates. For example, current practices include use of zero emission yellowcake dryers in contrast to historic dryers that were vented through pollution control devices. Emissions from tailings were typically limited by maintaining tailings liquid pools over much of the impoundment surface, leaving only the coarse tailings fraction exposed, which were less susceptible to wind transport, or using snow fences to decrease

wind velocities across tailings surfaces. Control of dust from ore piles was limited to occasional application of water. Early yellow cake driers relied on wet scrubbers for control of particulates; these scrubbers were significantly less than 100% efficient in removing yellowcake particles from the exhaust stack. Under current NRC and EPA requirements, uncovered tailings impoundments are limited in size, reducing the total amount of radon and particulate released from the site. When possible, such impoundments are constructed below grade reducing the windblown particulate emissions as well as the potential for release due to impoundment failure. Further, tailings management systems include, sequential covering and/or reclamation of tailings and heap leach piles to reduce the area and the amount of time tailing and radiological materials are exposed.

Modern dust control practices and monitoring provide increased control of airborne particulates and verification that potential exposures remain ALARA. Improved operational dust control practices such as more frequent use of water application, application of crusting agents and surfactants (i.e., magnesium chloride, WEN-DON) and air quality monitoring have decreased airborne particulates from ore stockpiles and other site surfaces.

5.1.6 Transportation Releases and Spills

Transportation of ore and yellowcake was largely unregulated prior to the 1990s. Ore trucks travelled uncovered on public roads and yellow cake shipments were not placarded, did not require licensed or certified carriers, did not have established security control and emergency response plans and did not assess potential radiological content or emissions from the transport of these materials.

Transportation of hazardous materials is now regulated by the U.S. Department of Transportation and the Virginia State Police. All transport of hazardous materials including chemicals and radioactive materials that may be transported to and from the uranium facility are regulated under 49 CFR Subchapter C. The regulations require shipping papers which include emergency response instructions and owner contact information. As with other state-licensed radioactive material transport, the certified or licensed carriers and the VDH DRH must maintain emergency response capabilities for potential mine and mill transportation accidents or inadvertent releases.

5.1.7 Closure Practices

Uranium mill tailings were among the first uranium production legacy wastes to be created. The production of uranium mill tailings goes back to the 1940s, to the places where uranium was first mined and milled in the U.S. The first several decades of uranium mining and milling were conducted with little or no effort to control radioactive or non-radioactive emissions from uranium mill tailings. Prior to the passage of UMTRCA in 1978, many tailings sites had been left as abandoned industrial sites with little concern for the potential for wind-borne or water-borne releases from the sites.

The UMTRCA established clean up requirements for all U.S. uranium mill tailings sites. The EPA and NRC adopted regulations to implement the authorities provided in UMTRCA. In general, these standards require: 1) assessment of the environmental setting for the wastes including surface, geologic and hydrogeologic evaluations to determine site conditions and the extent of existing problems; 2) development of remedial measures to minimize or eliminate surface and subsurface contamination, including groundwater contamination, to specific numerical criteria; and 3) demonstration that remedial measures will isolate wastes for up to 1,000 years, by measures designed to insure geotechnical stability, erosion resistance and containment of airborne and waterborne radionuclides and non-radioactive contaminants. The EPA standards and NRC regulations have resulted in stabilized tailings cells with thick soil and rock covers, stable exterior slopes, and robust erosion protection designs.

In addition to requiring protection and cleanup of groundwater, control of radon emissions, cleanup of contaminated soils, and control and stabilization of tailings, UMTRCA required creation of a long-term care program. In response to this, closed tailings cells are turned over to the DOE for management under an NRC general license. The long-term care includes inspection, monitoring, and any necessary repair or corrective action.

5.1.8 Mine Wastes and Acid Rock Drainage

Mine waste consists of non-mineralized and mineralized rock which is not of sufficient ore grade to warrant processing in the mill. Historically, these materials were placed in piles on site with little or no reclamation or stabilization efforts. The non-mineralized rock may or may not have been separated from the low-grade mineralized material. Both types of material can produce ARD when appropriate sulfide mineralization was present, and which may become known after reclamation efforts failed.

Current practices in the various states now require pre-disturbance characterization of mine wastes as part of the permit review process. Mine permit requirements now include designs that address the handling and segregation of waste rock as well as required assessment of the potential for ARD (e.g., BLM, 43 CFR 3809).

5.1.9 Pit Highwalls

Historically, hard rock mines, including open uranium pit mines, typically did not backfill the mine pit (i.e., fill in the mine pit with mine waste rock after mining), due to the cost of doing so. The resulting reclamation often left pit highwalls which could constitute a public safety hazard especially in high population or high use areas. Many state mine regulatory programs now require the elimination of safety hazards including highwalls. While these requirements are not as absolute as the prohibition of highwalls in the coal program (SMCRA), the criteria that must be met to allow a highwall to be left after reclamation is more stringent than it used to be. BLM regulations at 43 CFR 3809 are similar to the states in that there is not an outright prohibition on

highwalls remaining but additional justification is required. The BLM regulations require regarding and reshaping to conform to adjacent landforms, facilitate revegetation, control drainage, and minimize erosion. They also require information on the feasibility of pit backfilling that details economic, environmental, and safety factors.

5.1.10 Erosion and Sediment Deposition Off-Site

Erosion of disturbed areas during both the mining and reclamation phases of the operation has the potential of contaminants being transported off the mining area. Many early mine regulatory programs had minimal requirements for controlling erosion and sediment loss. With the implementation of the EPA Storm Water Program under the National Pollution Discharge Elimination (NPDES) Program, which has been delegated to Virginia by EPA and is now referred to as the VPDES Program, additional protection has been instituted to prevent off-site impacts from sediment erosion and loss. These measures effectively contain sediment and associated contaminants to the mine site. Discharge of storm water and other mine waters is regulated under the VPDES Program. For the post-reclamation timeframe, restrictions on land use implemented either by the governing State or federal land management agencies or restrictions in private land titles reduce the risk of inappropriate future land use where mine and mill wastes are stored. Similarly, mine and mill waste stabilization and erosion protection requirements have been advanced since the 1950s, 1960s and 1970s when most of the historical uranium mining and milling took place in the United States. However, there is no long-term custodial care of the mine waste in current regulatory frameworks. Returning the mine waste to the mine workings does increase the likelihood of long-term physical stabilization but does not always address long-term chemical stabilization of contaminants in the mine wastes.

5.1.11 Groundwater Impacts from Mining Operations

There are various ways that a mining operation may affect both quantity and quality of groundwater. These include spills, lowering of the water table to allow mining and resaturation of backfilled spoil material and of underground mine workings. State mine regulatory programs are normally in a separate department than the state agency responsible for groundwater protection. This separation has led to a disconnect between minimal requirements in the mining program and the groundwater protection standards in the environmental program. Many state environmental programs have either a no degradation of groundwater quality or a requirement not to impact the pre-mine class of use. The environmental program is normally delegated to the state from the EPA as provided by the Clean Water Act. As programs have matured, there is more awareness and cooperation across agency jurisdictions, which ensures actions approved by one agency will not result in violation of another agency's requirements.

5.1.12 Conclusions: Past versus Current Practices

Development of any natural resource invariably results in some impact to the environment. This includes the development of solar and wind power, the extraction of sand and gravel, water, oil

and gas, coal, as well as uranium. The goal of sound regulation is to ensure that the potential impacts, or risks of impacts, are within acceptable limits, given the resulting benefits to the community. At the same time, regulation and regulators must recognize that some actions cannot be performed while providing the requisite protection of public health, safety and the environment, even with all reasonable mitigations. The decision of what limits and risks are acceptable should integrate scientific data with public policy considerations. Science alone cannot answer what is “protective” for a community.

The vast majority of legacy impacts from uranium mining and milling that were addressed by the NAS study (NAS, 2011) and which are frequently identified in the press and public forums resulted from practices established before modern regulatory and engineering practices were developed. Modern practices have substantially eliminated or reduced the risk for recurrence of such impacts and the magnitude of those impacts.

5.2 Conceptual Regulatory Framework

Review of existing domestic Agreement State, Non-Agreement State and international programs for regulation of uranium mining and milling has identified a range of regulatory frameworks. For example, Wyoming, a Non-Agreement State, has included the Land Quality Division, which is responsible for regulation of all mining, within the Wyoming Department of Environmental Quality (WDEQ). Utah, which is an Agreement State, has regulation of mining within the Department of Oil Gas and Minerals (DOGM) while regulation of uranium milling is within the Utah DEQ, Division of Radiation Control. Canada has split regulation of mining and milling between the provincial and federal governments with overlapping authorities. As such, there is not clear that there is a single regulatory framework by which to model regulation of uranium mining and milling.

An essential component of any regulatory framework for uranium mining and/or milling in Virginia will be improvement of the EIA process. By establishing an EIA process modeled, at least in part, after the federal NEPA process, Virginia will improve its assessment and understanding of the full range of potential impacts and mitigations, risks, costs and benefits. In addition, this process will provide a sound basis for meaningful public involvement, comment, and access to information for all uranium milling and mining applications, should they be allowed by Virginia law.

The focus of this report and of this entire study is not intended as an endorsement of rescinding the existing moratorium on uranium mining in Virginia but rather attempts to support informed decision making by enumerating key technical items for consideration should a new or expanded regulatory programs be authorized.

5.2.1 Framework and Authorities

The goal of having unified regulation of uranium mining and milling, as suggested by the NAS (NAS, 2011), may be achieved by more than one approach, allowing Virginia some flexibility in developing such a regulatory framework, should the agencies be so directed. It is our opinion that, should Virginia elect to develop a new statutory framework for regulating uranium mining, it is worth considering a simple framework that does not require significant reorganization of Virginia agency authorities and does not require agencies to develop expertise with which they have limited experience. Uniform regulation can be accomplished without disruptive and costly reorganization or governmental agency authorities, responsibilities and expertise. Uniform regulation may be developed through coordination and consistency in enforcing “harmonized” (consistent) standards between agencies. This concept will be developed further, below.

5.2.1.1 Role of DMME

Under this simple regulatory framework model, DMME would remain the lead agency for mining and would implement the new uranium mining statutory requirements. As this mining program would be an entirely new and separate from the existing mineral and coal mining statutes, DMME has the opportunity to apply its extensive experience in mining regulation and safety with new BMPs, and requirements that are appropriate for the conventional and unique characteristics of uranium mining. Some elements of such a new statutory and regulatory framework could include, harmonizing uranium miner radon exposure limits to those of NRC, which are more stringent than MSHA, establish an EIA process, possibly modeled in part on the federal NEPA process as implemented by NRC (10 CFR 51), establishing baseline environmental monitoring and site characterization requirements for all media, and establishing specific requirements for demonstrating protection of water resources from mine operations and mine wastes. The materials and references provided in the exhibits to this report provide a sound basis for developing a statutory and regulatory framework, should it be authorized.

5.2.1.2 Role of DEQ

As regulation of mining related activities interrelates with groundwater and surface water protection, the DEQ and DMME would need to continue to work closely together for effective regulation of uranium mining. Under this simple regulatory framework model, the DEQ would continue to administrate the VPDES and air quality programs delegated to Virginia by the EPA. The considerations for the VPDES program we have suggested include considering the exemptions in 40 CFR 440, establishing discharge standards on case-by-case basis that are protective of both surface water and groundwater resources and considering modifying or adding a few additional surface water standards (i.e., Ra-226 in addition to the existing combined standard for Ra-226+228)).

Under this type of model, the DMME regulation of mine waste management would benefit from coordination and consultation with the DEQ as it relates to groundwater and surface water

protection. The DEQ could establish a groundwater permit process, such as Utah and Arizona. Though this approach may provide a balance between mining regulation and environmental protection, this can also create duplicative regulation between the DMME and DEQ and potential conflict between agencies. For example, this could result in the DEQ potentially having dual authority with the DMME over approval of mine waste management facilities and reclamation design. Another approach would be to enhance the specific groundwater protection requirements within a new DMME uranium mining statute and coordinate development of the implementing DMME regulation and guidance with the DEQ. This approach would eliminate the potential conflict in administering uranium mining permits but would ensure appropriate protective requirements were implemented and enforced.

5.2.1.3 Role of VDH

Similarly, under the model discussed in Section 5.2.1.2, the VDH would maintain its mission promote and protect the health of all Virginians, including monitoring of public water supplies and recreational waters, as they currently do with the four major nuclear facilities within the State. Expansion of the VDH's existing authorities may be required for regulation related to public health associated with private wells as well as authority for administration of recreational water use. The VDH's role is discussed in more detail below, as its role and function will depend largely on the issue of whether or not Virginia modifies its NRC Agreement or not.

5.2.2 Agreement State Status

If uranium mining and milling is to be allowed in Virginia, the VDH will either maintain its existing agreement with the NRC or apply to amend the agreement to allow the VDH to regulate uranium milling. Depending on that decision, the VDH will have differing levels of responsibility and should consider a variety of actions as detailed in the paragraphs below.

5.2.2.1 Current Agreement State Status

Two factors argue against Virginia becoming an Agreement State. First, the process to amend the Agreement is relatively long and costly, especially considering that a single mill is likely all that would be regulated at the outset. Second, having amended the Agreement the VDH would need to significantly augment staff resources and expertise. The Governor and the General Assembly must ultimately determine whether or not the cost and staff time are in Virginia's best interest.

If Virginia does not choose to amend its Agreement with the NRC, its regulatory authority over a potential licensee would be limited. However, even without amending the Agreement, there are a number of practices that the VDH could adopt as described below.

As currently regulated by MSHA, activities associated with mining are under state control, so harmonizing mine worker dose limits with the NRC dose limits is not only possible but highly

recommended. The VDH could also take steps to limit in state regulations miner radon decay product exposure to 1 WLM per year. Both of these actions are in keeping with the spirit of the NAS report recommending a single regulatory authority over a co-located mine and mill complex (NAS, 2012).

To promote transparency regarding public concerns about public health and environmental degradation, the VDH could begin baseline environmental monitoring of potentially affected media. This should commence as soon as possible after a specific uranium mining or milling action is proposed. These data should be made available to the public for review.

Once the NRC licenses a site, the VDH can and should set up co-located monitoring stations with the operator and make the data easily accessible to the public. While the VDH would not have the authority to cite the operator if the effluents exceeded the NRC limits, VDH could work with the NRC to encourage action as needed. The co-located monitoring stations would give the public added assurance that the facility is in compliance with regulations and that its operations are being routinely reviewed by the VDH or a local oversight committee.

Along the same lines and based on expressed public concerns regarding water supplies, the VDH should require enhanced sampling of public water supplies potentially affected by a uranium mine and mill complex for radionuclides specifically associated with uranium mining and milling. The VDH should also seriously consider the ramifications of establishing enhanced regulations including baseline and operational monitoring for private water wells with regard to radionuclide content.

Finally, in keeping with its mission of protecting public health, the VDH should summarize existing baseline health statistics for health conditions potentially related to uranium mining and milling. Lung cancer is the outcome of most interest, although related data are highly influenced by individual smoking habits. Other potential diseases with a potential, although unlikely link to uranium processing include diabetes, kidney disease and asthma. Baseline rates of these conditions should be summarized and publicized prior to operation of a uranium mine or mill, with consideration given to rate tracking during operations as well.

5.2.2.2 Amended Agreement State Status

Opportunities afforded by expanding the NRC agreement to include regulation of uranium milling and byproduct material include Commonwealth control of the milling regulatory program. If Virginia becomes an Agreement State, the VDH will be in the position of regulating all activities of the licensee. All of the above activities should be considered in this context and others as well.

As the licensing agency, the VDH may develop certain specific license conditions that are more stringent than those that might be required by the NRC. Examples include the possibility of

including such items as worker dose constraint limits that are more stringent than the NRC regulations, requirements that workers in a uranium mine and mill complex be monitored using a single unified system, and monitoring for effluents not required by the NRC.

As mentioned above in 4.3.1, the major change that will be required by expanding Virginia's Agreement State status is an increase in staffing, hiring and developing the expertise to review license design proposals and to enforce the conditions of a license. Experienced personnel are in short supply, and the full range of required expertise may not currently exist among the DRH staff.

Finally, given the increased responsibility that would come with an amended Agreement State status, the DRH should be elevated to an office on par with other offices in the organization of the Chief Deputy of Public Health.

5.2.3 Communication

If Virginia elects to lift the moratorium on uranium mining, it should consider developing a formal and structured approach for inter-agency communication in addition to the existing and functional informal communications the agencies currently employ. This approach may be established independently or as part of a new EIA process within DMME or within another Commonwealth agency with regulatory obligations associated with uranium mining, and milling if Virginia expands its Agreement with the NRC. Under a NEPA-like EIA process, interagency communication could be modeled after the cooperating agency role that other federal agencies play with respect to the federal lead agency (i.e., NRC), providing input during EIA scoping, development of alternatives and mitigations and assessment of potential impacts.

6.0 REFERENCES

- Baker, 2011. Baker and Associates. A Preliminary Assessment of Potential Impacts of Uranium Mining in Virginia on Drinking Water Sources. Prepared for City of Virginia Beach.
- Chmura, 2011. The Socioeconomic Impact of Uranium Mining and Milling in the Chatham Labor Shed. Economics and Analytics. Virginia.
- NAS, 2011. National Academy of Science. Uranium Mining in Virginia: Scientific, Technical, Environmental, Human Health and Safety, and Regulatory Aspects of Uranium Mining and Processing in Virginia. December.
- NAS, 2012. National Academy of Science. Analysis of Cancer Risks in Populations Near Nuclear Facilities: Phase I. Committee on the Analysis of Cancer Risks in Populations near Nuclear Facilities-Phase I; Nuclear and Radiation Studies Board; Division on Earth and Life Studies; National Research Council. ISBN 978-0-309-25571-4.
- NIOSH, 1987. National Institute for Occupational Safety and Health. Radon Progeny in Underground Mines. Division of Standards Development and Technology Transfer. Publication No. 88-101.
- NRC, 1980. U.S. Nuclear Regulatory Commission. Radiological Effluents and Environmental Monitoring at Uranium Mills, Regulatory Guide 4.14 Revision 1, April 1980, Washington, D.C.
- RTI, 2011. Proposed Uranium Mine and Mill, Coles Hill Virginia: An Assessment of Possible Socioeconomic Impacts. Prepared for Danville Regional Foundation. December.
- WES, 2012a. Wright Environmental Services; Uranium Study: Initial Report, prepared for the Commonwealth of Virginia, Department of Health. July 27, 2012. Fort Collins, Colorado.
- WES, 2012b. Wright Environmental Services; Uranium Study Initial Report, prepared for the Commonwealth of Virginia, Department of Environmental Quality (DEQ) and Department of Mines, Minerals and Energy, (DMME). July 30, 2012. Fort Collins, Colorado.
- WES. 2012c. Wright Environmental Services; Uranium Study: Surface Water and Groundwater Monitoring Plans and Standards Adequacy Assessment, prepared for the Commonwealth of Virginia, Department of Environmental Quality (DEQ) and Department of Mines, Minerals and Energy, (DMME). August, 2012. Fort Collins, Colorado.

- WES, 2012d. Wright Environmental Services; Uranium Study: Air Quality Monitoring Report, prepared for the Commonwealth of Virginia, Department of Environmental Quality (DEQ) and Department of Mines, Minerals and Energy, (DMME). August, 2012. Fort Collins, Colorado.
- WES, 2012e. Wright Environmental Services; Uranium Study: Engineering Design and Best Management Practices, prepared for the Commonwealth of Virginia, Department of Environmental Quality (DEQ) and Department of Mines, Minerals and Energy, (DMME). September, 2012. Fort Collins, Colorado.
- WES, 2012f. Wright Environmental Services; Uranium Study: Safe Disposal of Mine and Mill Wastes, prepared for the Commonwealth of Virginia, Department of Environmental Quality (DEQ) and Department of Mines, Minerals and Energy, (DMME). September, 2012. Fort Collins, Colorado.
- WES, 2012g. Wright Environmental Services; Uranium Study: Full Components of an Environmental Impact Analyses, prepared for the Commonwealth of Virginia, Department of Environmental Quality (DEQ) and Department of Mines, Minerals and Energy, (DMME). October, 2012. Fort Collins, Colorado.
- WES, 2012g. Wright Environmental Services; Uranium Study: Full Components of an Environmental Impact Analyses, prepared for the Commonwealth of Virginia, Department of Environmental Quality (DEQ) and Department of Mines, Minerals and Energy, (DMME). October, 2012. Fort Collins, Colorado.
- WES, 2012h. Wright Environmental Services; Uranium Study: Assessment of Financial Assurance Mechanisms, prepared for the Commonwealth of Virginia, Department of Environmental Quality (DEQ) and Department of Mines, Minerals and Energy, (DMME). October, 2012. Fort Collins, Colorado.
- WES, 2012i. Wright Environmental Services; Uranium Study: Interim Report #1, prepared for the Commonwealth of Virginia, Department of Health (VDH). October, 2012. Fort Collins, Colorado.
- WES, 2012j. Wright Environmental Services; Uranium Study: Interim Report #2, prepared for the Commonwealth of Virginia, Department of Health (VDH). October, 2012. Fort Collins, Colorado.
- WES, 2012k. Wright Environmental Services; Uranium Study: Final Facilitator's Report. Prepared for the Commonwealth of Virginia, Department of Health (VDH). October, 2012. Fort Collins, Colorado.

FIGURES

Figure 5-1 Modern Tailings and Pond Liner Methods

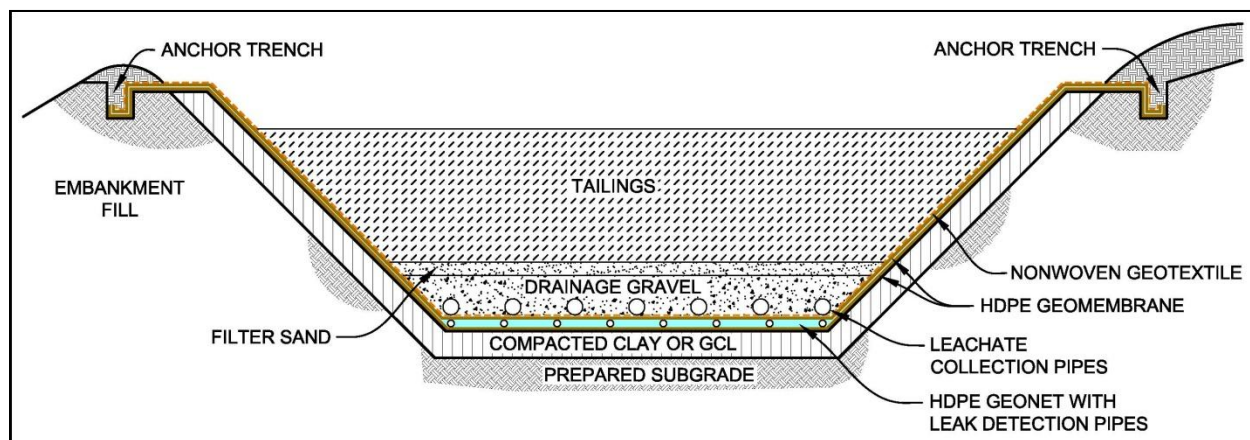
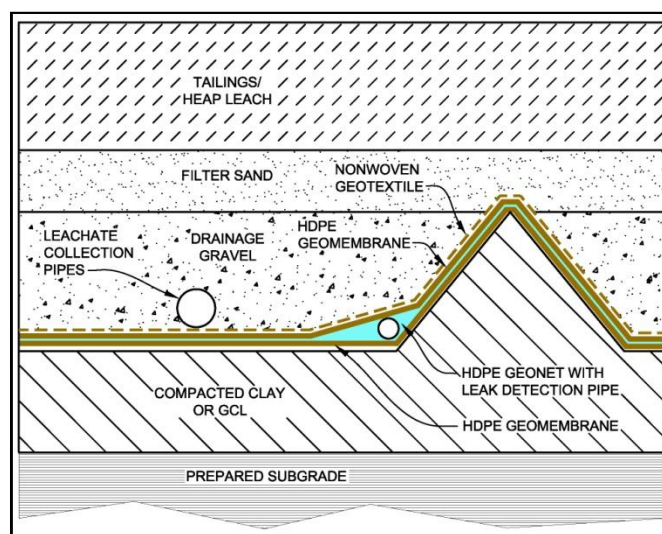


Figure 5-2 Historical “Upstream Construction” of Tailings Embankments

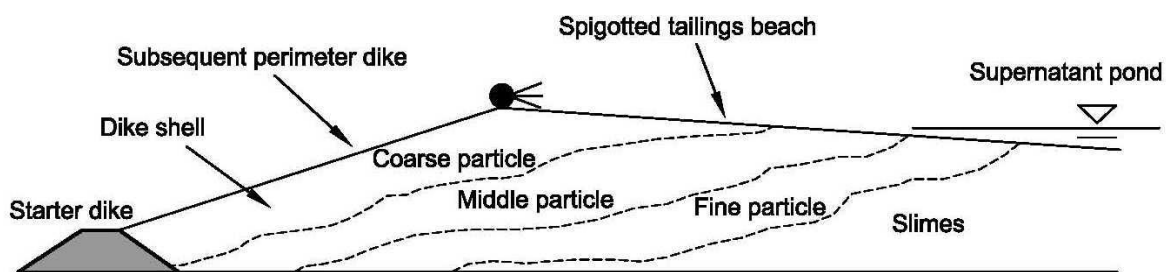
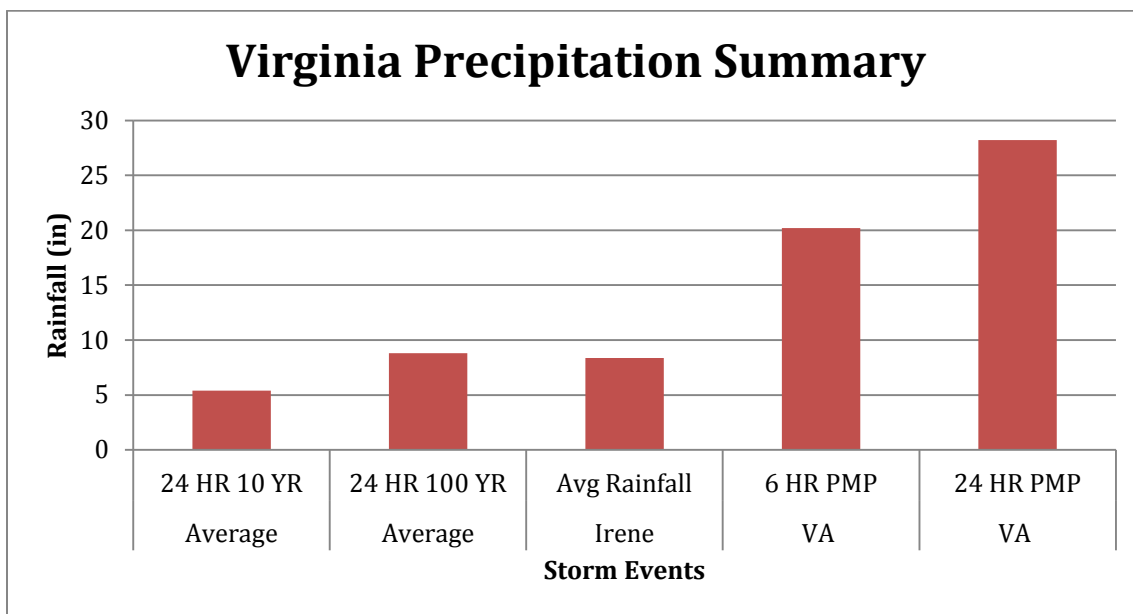
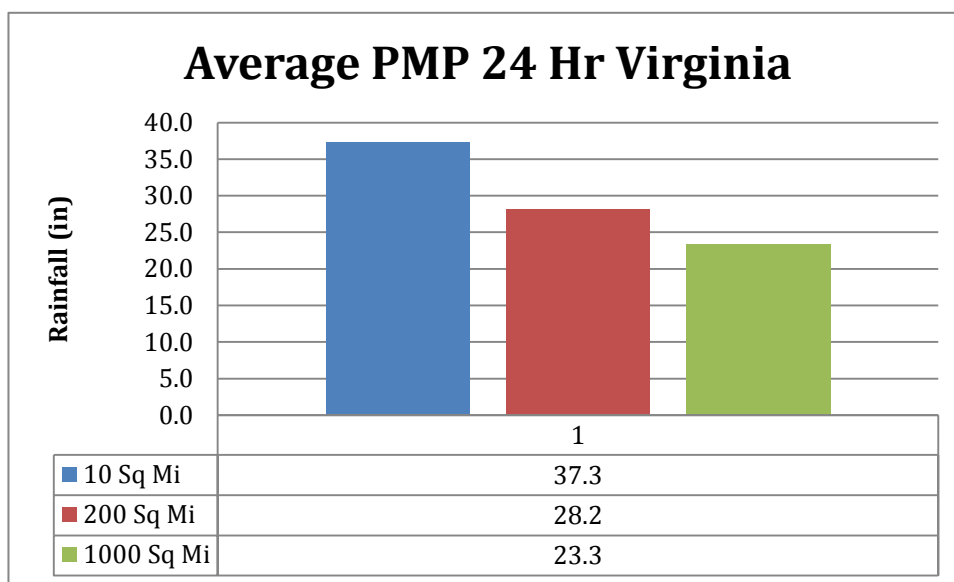


Figure 5-3 Virginia Precipitation Summary



Note: 6 hour PMP and 24 hr PMP shown are in inches of rainfall and are calculated for a 200 mi² area for the “middle” Virginia area. “Upper” Virginia (piedmont) precipitation calculation resulted in a slightly lower precipitation (19 inches) while “lower” Virginia (coastal plain) calculations resulted in slightly higher precipitation (21.5 inches). Differences in calculated precipitation account for physiographic and meteorological differences between the regions. Precipitation events were calculated as per http://www.nws.noaa.gov/oh/hdsc/PMP_documents/HMR51.pdf.



Note: PMP rainfalls are in inches of precipitation. PMP rainfall decrease when averaged over progressively larger areas.

TABLES

Table 4-1 Staffing levels of USNRC and State of Utah for Regulating Uranium Processing

PROFESSIONS	USNRC	Current Utah Staffing	Utah Comments
Hydrologist	5	3	1 Permits, 2 Compliance
Health Physicists	4	4	2 Permits, 2 Compliance
Geotechnical Engineer	1		
Licensing Assistant	3		
Geologist/ Geological Sciences	3		
Cultural Sciences	1		
Chemical Engineer	2		
Ecologist	1		
Environmental Scientist	1	1	Permits
Chemistry	1		
Physics/Nuclear Engineer	1		
Biology	1		
Lawyer	1		
Engineer		2	1 Permits, 1 Compliance
Environmental Engineer		2	1 Permits, 1 Compliance
Transportation Specialist		1	Compliance
Radon Program Coordinator		1	Permits
Total	25	14	

Table 4-2 Recommended Changes to Regulations in 12 VAC5

	Rationale	Suggested Language/Discussion
	Authority to Regulate Mining Waste	
1	In order for VDH to have the authority in its regulations to regulate the releases of radioactive materials to air and water from ores and mining wastes, and require personnel dosimetry for workers in uranium mines, the following regulation should adopted:	“Any person is exempt from 12 VAC5-481-380 if that person receives, possesses, uses, or transfers unrefined and unprocessed ore containing source material; provided that, except as authorized in a specific license, such person shall not refine or process such ore. This exemption does not apply to the mining of ore containing source material.”
	Mining as a Generally Licensed Activity	
2	The establishment of uranium mining as a generally licensed activity should be added to the VDH regulations at 12 VAC5-481-420.D by adding the following or similar wording:	“Uranium Mining - A general license is issued to mine, transport, and transfer ores containing source material without regard to quantity. Persons who mine, transport, and transfer ores containing source material shall comply with the provisions of Part IV Standards for Protection Against Radiation.”
	Addition of NRC Regulations to VDH Regulations	
3	The following paragraphs discuss the provisions of NRC regulations that would need to be added to VDH regulations.	10 CFR Part 40.2a Coverage of Inactive Tailings Sites – Although the requirements in this section are assigned a Level of Compatibility “A” by the NRC for states seeking an Amended Agreement for uranium milling, it does not appear that these provisions of the NRC regulations apply to the Commonwealth since there are no existing uranium mill tailings sites located within Virginia. Therefore it does not appear that VDH regulations would need to be amended to include these provisions.
		10 CFR Part 40.3 License Requirements – The regulations of VDH will need to add this section to its regulations (12 VAC5-481-380) in order to have regulatory authority for uranium milling operations and associated tailings disposal.
		10 CFR Part 40. 4 Definitions – The following definitions would be needed to be modified or added for VDH regulations (12 VAC5-481-10) to be compatible: Commencement of Construction – modify to agree with 10 CFR Part 40.4. Uranium Milling – definition needed.
		10 CFR Part 40.13 Unimportant Quantities of Source Materials – These provisions are adopted by reference in 12VAC5-390; however, it is recommended that the wording mentioned above as an addition to 12 VAC5-390 be added at 12 VAC5-390.B.
		10 CFR Part 40.22 Small Quantities of Source Material - These provisions are adopted by reference in 12 VAC5-420.A; however, it is recommended that the wording mentioned above as an addition to 12 VAC5-420 be added at 12VAC5-420.D.

Table 4-2 Recommended Changes to Regulations in 12 VAC5

	Rationale	Suggested Language/Discussion
		10 CFR Part 40.26 General License for Possession and Storage of Byproduct Material as Defined in This Part - Although the requirements in this section are assigned a Level of Compatibility “C” by the NRC for states seeking an Amended Agreement for uranium milling, it does not appear that these provisions of the NRC regulations apply to the Commonwealth since there are no existing uranium mill tailings sites located within Virginia. Therefore it does not appear that VDH regulations would need to be amended to include these provisions.
		10 CFR Part 40.31 Application for Specific Licenses – VDH will need to add provisions to its regulations to incorporate the provisions of 10 CFR Part 40.31(f) through (m).
		10 CFR Part 40.65 Effluent Monitoring Reporting Requirements - VDH will need to add provisions to its regulations to incorporate the provisions of 10 CFR Part 40.65.
	Addition of 10 CFR 40 Appendix A Criteria Relating to the Operation of Uranium Mills and the Deposition of Tailings or Waste Produced	
4	This Appendix to 10 CFR Part 40 contains specific requirements related to the design, construction, operations, and closure of a uranium mill. VDH will have to add these or more stringent requirements to its regulations. The NRC Criteria are essentially performance-based rather than prescriptive. In its review of these Criteria VDH may want to consider the advisability of modifying some of these Criteria to be more prescriptive or adding additional prescriptive based criteria.	References to NRC regulations and reporting to the NRC should be replaced with references to specific citations in VDH regulations and VDH reporting requirements, references to the “Commission” should be replaced with references to VDH, and references to pre-existing byproduct material, milling, and tailings sites should be deleted since these do not exist in Virginia.
		10 CFR Part 40, Appendix A, Introduction - Since there are no presently existing uranium milling or tailings disposal sites in Virginia, the definition for “Existing portion” need not be included in VDH regulations.
	Consideration should be given to modifying the definition of “Uppermost aquifer” to read (added language is shown in <i>italics</i>):	“Uppermost aquifer means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property <i>or within five (5) miles of its boundary.</i> ”
	Criterion 3 – It is recommended that the first sentence in this Criterion be replaced with the following to de-emphasize the option of depositing of tailings in the mine:	“The ‘prime option’ for disposal of tailings is placement below grade such that the need for any specially constructed retention structure is minimized. However, if placement of the tailings in the mine is proposed, the applicant should demonstrate to the written satisfaction of VDH that this practice will not result in degradation of groundwater quality.”

Table 4-2 Recommended Changes to Regulations in 12 VAC5

	Rationale	Suggested Language/Discussion
	Criterion 4 – Considering the environmental conditions, including rainfall, in Virginia, the following changes to this Criterion are recommended:	Subparagraph (a) – Modify to read (added language is shown in italics): “Upstream rainfall catchment areas must be minimized to decrease erosion potential and the size of the floods which could erode or wash out sections of the tailings disposal area. <i>Storm water diversion systems shall be designed, constructed, maintained, and operated around the mine and mill sites to safely accommodate the PMP event in the upstream rainfall catchment areas.</i> ”
		Subparagraph (c) – Modify to read (added language is shown in italics): “Embankment and cover slopes must be relatively flat <i>during operations and</i> after final stabilization to minimize erosion potential and to provide conservative factors of safety assuring long-term stability. The broad objective should be to contour final slopes to grades which are as close as possible to those which would be provided if tailings were disposed of below grade; for example, slopes of 10 horizontal to 1 vertical (10h:1v) or less steep. Where steeper slopes are proposed, reasons why a slope less steep than 10h:1v would be impracticable should be provided, and compensating factors and conditions which make such slopes acceptable should be identified.”
		Subparagraph (d) - Modify to read: “A full self-sustaining vegetative cover must be established <i>and maintained during operations and following closure</i> to reduce wind and water erosion to negligible levels. “Furthermore, all impoundment surfaces must be contoured to avoid areas of concentrated surface runoff or abrupt or sharp changes in slope gradient. In addition to <i>vegetative</i> cover on slopes, areas toward which surface runoff might be directed must be well protected with substantial rock cover (rip rap). In addition to providing for stability of the impoundment system itself, overall stability, erosion potential, and geomorphology of surrounding terrain must be evaluated to assure that there are not ongoing or potential processes, such as gully erosion, which would lead to impoundment instability.”
	Additional Criteria for Consideration by VDH	
5	The following additional criteria are provided for consideration by VDH. The term “licensed area” as used in these criteria includes the surface area around both the mine and the mill, if the mill were to be located at the mouth of the mine. In reality, all activities involving the ore that are conducted once the ore leaves the mine are part of the processing of the ore and therefore should be licensed activities.	“The license area shall be contoured and provided with detainment structures or areas to ensure that no runoff from the licensed area is released off-site until the liquids have been sampled, analyzed, and determined to meet as a minimum the stream standards of the receiving stream or drainage basin. The capacity of such holding features shall be designed, constructed, and operated to have a capacity of holding the runoff from the entire licensed area for the PMP event over the licensed area. In the design of such features no credit for evaporation shall be assumed to occur.”

Table 4-2 Recommended Changes to Regulations in 12 VAC5

	Rationale	Suggested Language/Discussion
		<ul style="list-style-type: none"> “The Applicant/license shall have an analytical environmental laboratory either on site or readily available capable of detecting and measuring environmental levels of radionuclides and chemicals associated with uranium mining and processing. The laboratory shall be capable of making these determinations in all media including air, water (and other liquids including milk), and solids (including soil, vegetation, and animal tissue). The laboratory shall be capable of completing analyses within 24 hours of the time a sample is taken.”
		<ul style="list-style-type: none"> “All Analyses shall be performed based on written procedures for sampling, sample processing, and analysis. The analysis shall be conducted under a QA/QC program approved by VDH which ensures the accuracy of the results.”
		<ul style="list-style-type: none"> “The laboratory shall be licensed/certified by organizations and agencies acceptable to and/or approved by VDH.”
		<ul style="list-style-type: none"> “All Liquid wastes from the laboratory shall be handled in a separate, controlled disposal system which is not interconnected with domestic waste or other waste handling systems. All solid wastes from the laboratory shall be controlled and assumed to be radioactively contaminated until surveyed/analyzed and determined to not be contaminated above release limits set by VDH.”
		<ul style="list-style-type: none"> “The Applicant/licensee shall sample and analyze on a monthly basis all surface waters including streams, ponds, and springs within 2 miles of the site boundaries during the two-year baseline sampling period used for the environment report which will accompany the license application. All sampling and analyses shall be conducted according to procedures and methods approved by VDH prior to commencement of sampling. The applicant/licensee shall continue the same sampling and analyses on a quarterly basis from the end of the two-year baseline sampling program until the radioactive materials license for the mill is either granted or denied by VDH. As used in this criterion, “quarterly” means at intervals not to exceed 3 months, and evenly spaced throughout the year. If the license is issued by VDH, the applicant/licensee shall continue the sampling of all surface waters as required by VDH per the applicable license. The applicant/licensee shall file a report of its findings twice each year not later than 45 days following the end of the second quarter of each sampling period.”

Table 4-2 Recommended Changes to Regulations in 12 VAC5

	Rationale	Suggested Language/Discussion
		<ul style="list-style-type: none"> “The applicant/licensee shall sample and analyze on a monthly basis all private water wells within 2 miles of the site boundaries during the one-year baseline sampling period used for the environment report which will accompany the license application. All sampling and analyses shall be conducted according to procedures and methods approved by VDH prior to commencement of sampling. The applicant/licensee shall continue the same sampling and analyses on a quarterly basis from the end of the one-year baseline sampling program until the radioactive materials license for the mill is either granted or denied by VDH. As used in this criterion, “quarterly” means at intervals not to exceed 3 months and evenly spaced throughout the year. If the license is issued by VDH, the applicant/licensee shall continue the sampling of private water wells as required by VDH per the license. The applicant/licensee shall file a report of its findings twice each year not later than 45 days following the end of the second quarter of each sampling period.”
		<ul style="list-style-type: none"> “The applicant/licensee shall sample and analyze on a monthly basis all public water supplies within 5 miles of the site boundaries during the one-year baseline sampling period used for the environment report which will accompany the license application. All sampling and analyses shall be conducted according to procedures and methods approved by VDH prior to commencement of sampling. The applicant/licensee shall continue the same sampling and analyses on a quarterly basis from the end of the one-year baseline sampling program until the radioactive materials license for the mill is either granted or denied by VDH. As used in this criterion, “quarterly” means at intervals not to exceed 3 months and evenly spaced throughout the year. If the license is issued by VDH, the applicant/licensee shall continue the sampling of public water supplies as required by VDH as terms of the license. The applicant/licensee shall file a report of its findings twice each year not later than 45 days following the end of the second quarter of each sampling period.”

Table 4-2 Recommended Changes to Regulations in 12 VAC5

	Rationale	Suggested Language/Discussion
		<ul style="list-style-type: none"> “The applicant/licensee shall conduct representative sampling and associated analyses of crops being commercially grown for human and/or livestock foodstuff (including pasture land grasses and tobacco) within 2 miles of the site boundaries during the one-year baseline sampling period used for the environment report which will accompany the license application. All sampling and analyses shall be conducted according to procedures and methods approved by VDH/VDACS prior to commencement of sampling. The applicant/licensee shall continue the same sampling and analyses from the end of the one-year baseline sampling program until the radioactive materials license for the mill is either granted or denied by VDH. If the license is issued by VDH, the applicant/licensee shall continue the sampling and analyses as required by VDH per the license. The applicant/licensee shall file a report of its findings annually by March 31 of the year following the sampling period.”
		<ul style="list-style-type: none"> “The applicant/licensee shall have an on-site meteorological station capable of continuously measuring and recording meteorological conditions including temperature, wind speed and direction, precipitation, evaporation, and barometric pressure. This station shall be available and operating throughout the baseline period until the radioactive materials license for the mill is either granted or denied by VDH. If the license is issued by VDH, the applicant/licensee shall continue the operation of the meteorological station as required by VDH per the license.”

Table 4-3 NRC Criteria for Evaluation the Adequacy of Utah Statutes

(Extracted from Assessment of the Proposed Utah Program for the Regulation of 11e.(2) Byproduct Materials, NRC 2004)

State statutes or duly promulgated regulations should be enacted, if not already in place, to make clear State authority to carry out the requirements or Public Law 95-604, Uranium Mill Tailings Radiation Control Act (UMTRCA) as follows:
<ul style="list-style-type: none">a. Authority to regulate the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.b. That an adequate surety (under terms established by regulation) will be provided by the licensee to assure the completion of all requirements established by the (cite appropriate State agency) for the decontamination, decommissioning, and reclamation of sites, structures, and equipment used in conjunction with the generation or disposal of such byproduct material.c. If in the States' licensing and regulation of byproduct material or of any activity which produces byproduct material, the State collects funds from the licensee or its surety for long-term surveillance and maintenance of such material, the total amount of the funds collected by the State shall be transferred to the U.S. if custody of the byproduct material and its disposal site is transferred to the federal Government upon termination of the State license. (See 10 CFR 150.32.) If no default has occurred and the reclamation or other bonded activity has been performed, funds for the purpose are not to be transferred to the federal Government. The funds collected by the State shall be sufficient to ensure compliance with the regulations the Commission establishes pursuant to Section 161X of the Atomic Energy Act.d. In the issuances of licenses, an opportunity for written comments, public hearing (with transcript) and cross examination is required.e. In the issuances of licenses, a written determination of the action to be taken based upon evidence presented during the public comment period and which is subject to judicial review is required.f. A ban on major construction prior to completion of the written environmental analysis stipulated in Criterion 31.g. An opportunity shall be provided for public participation through written comments, public hearings, and judicial review of rules.
In the enactment of any supporting legislation, the State should take into account the reservations of authority to the U.S. in UMTRCA as stated in 10 CFR 150.15a and summarized by the following:
<ul style="list-style-type: none">a. The establishment of minimum standards governing reclamation, long-term surveillance or maintenance, and ownership of the byproduct material.b. The determination that prior to the termination of a license, the licensee has complied with decontamination, decommissioning and reclamation standards, and ownership requirements for sites at which byproduct material is present.c. The requirement that prior to termination of any license for byproduct material, as defined in Section 11e.(2), of the Atomic Energy Act or for any activity that results in the production of such material, title to such byproduct material and the disposal site be transferred to the federal Government or State at the option of the State, provided such option is exercised prior to termination of the license.d. The authority to require such monitoring, maintenance, and emergency measures after the license is terminated as necessary to protect the public health and safety for those materials and property for which the State has assumed custody pursuant to Pub. L. 95-604.e. The authority to permit use of the surface or subsurface estate, or both of the land transferred to the United States or State pursuant under provision of the Uranium Mill Radiation Tailings Control Act.e. The authority to exempt land ownership transfer requirements of Section 83(b)(1)(A).

Table 4-3 NRC Criteria for Evaluation the Adequacy of Utah Statutes

(Extracted from Assessment of the Proposed Utah Program for the Regulation of 11e.(2) Byproduct Materials, NRC 2004)

<p>It is preferable that State statutes contain the provisions of Section 6 of the Model Act. But the following may be accomplished by adoption of either procedures by regulation or technical criteria. In any case, authority for their implementation should be adequately supported by statute, regulation or case law as determined by the State Attorney General.</p> <p>In the licensing and regulation of ores processed primarily for their source material content and for the disposal of byproduct material, procedures shall be established which provide a written analysis of the impact on the environment of the licensing activity. This analysis shall be available to the public before commencement of hearings and shall include:</p>	
<ul style="list-style-type: none">a. An assessment of the radiological and nonradiological public health impacts;b. An assessment of the radiological and nonradiological public health impacts;c. Consideration of alternatives to the licensed activities; andd. Consideration of long-term impacts of licensed activities (see Item 36b. (1).	

Table 4-4 Diseases/Conditions Potentially Related to Uranium Mine/Mill Operations

Exposure	Disease/Condition	Acute/Long-Term	Baseline Data*
Heavy metals (lead, cadmium, arsenic, etc.)	Kidney disease (nephrotoxicity)	Acute and long-term	Diabetes, pre-existing kidney disease
Dust (PM ₁₀ , PM _{2.5} , diesel exhaust)	Asthma, pneumoconiosis, silicosis	Acute (asthma), Long-term (pneumoconiosis, silicosis)	Asthma** Chronic Obstructive Pulmonary Disease (COPD)** Smoking rates
Radon	Lung cancer	Long-term	Baseline radon Smoking rates
Other radionuclides	Cancer Birth defects	Long-term Mid-Long-term	Cancer & congenital defects data

* For establishing base rates of disease in community or “confounders” for new disease related to exposures

** Underlying disease may be exacerbated by dust exposure

Table 5-1 Summary of Past and Present Mill Waste Management Practices

RISK	OLD METHODS	NEW METHODS (MITIGATION)	REG. REQUIREMENT
Leakage from Tailings Impoundments or Ponds	Unlined, or single earthen liner	Double synthetic liner	10 CFR Part 40, Appendix A 40 CR 192
		Leachate Collection/ hydraulic head limits on primary liners	“ “ “
		Leak Detection/Monitoring/hydraulic head limits on secondary liners	“ “ “
		Low Permeability underliner	“ “ “
	Point of Compliance groundwater monitoring	Point of Compliance groundwater monitoring, quantitative basis	
Tailings Embankment Failure	Design allowed “upstream construction” using tailings, no liners	Improved embankment design standards, liners	10 CFR Part 40, Appendix A 40 CR 192
		Improved Construction QA requirements	“ “ “
		Inspections / Monitoring	“ “ “
		Capacity requirements including 6 hr PMP storm events	“ “ “
Tailings Line Failures	Pipes, no secondary containment	Pipes with secondary containment	
		Instrumentation of line pressures and discharge monitoring	
Air Emissions/Radon & Particulates	Exhaust stack Scrubbing and Monitoring	Vacuum Driers	10 CFR Part 40, Appendix A 40 CR 192
		Exhaust stack scrubbing and Monitoring	“ “ “
Transportation Releases & Spills	Open trucks, no coverings, minimal regulation of ore haulage & yellowcake shipping	Covered ore haul trucks on public roads, DOT regulation of Class 7 radioactive materials (yellowcake)	49 CFR 172, 173