7 Ariz. J. Envtl. L. & Pol'y 27

Arizona Journal of Environmental Law & Policy
2017

Article
William Jenney

*27 HAVING YOUR YELLOW CAKE AND EATING IT TOO: THE ENVIRONMENTAL AND HEALTH IMPACTS OF URANIUM MINING ON THE COLORADO PLATEAU

Introduction

On May 6th, 2011, the Ninth Circuit upheld the Arizona District Court's ruling in *Ctr. for Biological Diversity v. Salazar*.[1] The court determined that pursuant to current Environmental Protection Agency (EPA) regulations, the Bureau of Land Management (BLM) was not required to review and approve a new plan of operations to allow mining activities at a uranium mine on the Colorado Plateau that had been dormant for almost twenty years.[2] The court held that reopening the mine and acquiring the necessary permits did not constitute a major action, therefore not requiring a new plan of operations to be submitted to the BLM for review and approval pursuant to the National Environmental Policy Act (NEPA).[3] This article agrees with the Ninth Circuit that, under NEPA regulations, no new environmental impact statement was needed. However, this article contends that NEPA regulations requiring certain safety precautions and environmental assessments be undertaken by uranium mines prior to the commencement of mining activities must be rewritten to further protect the environment as well as the health of the people that call the Colorado Plateau home.

A Brief History of Uranium Mining and Exploration in the United States

The immense mineral riches of the New World have been sought out since Columbus and the first European explorers set foot in the Caribbean in 1492. Although the treasures Columbus described were mostly gold and spices, a much more volatile mineral lay buried in an area of the ***28** Northern Arizona desert that, until recently, went mostly unappreciated by all but the Navajo Indians that inhabited the land. To European and American explorers, the Colorado Plateau held little-to-no value. The land was dry, hot, and not suitable for European agriculture as there were not enough grasslands to support the type of cattle grazing that Midwestern cattlemen had become accustomed to.[4] During a visit in 1934, federal biologist Waldo Lee McAtee went so far as to call the area "not a normal case ... largely devoid of terrestrial wildlife."[5] William Tecumseh Sherman, the famed Civil War general, even stated that the land was "utterly unfit for white civilization" after his visit to the region in 1868.[6] The only reason American explorers originally visited the plateau was to find a suitable railroad route to the west coast, which ultimately resulted in a war with the Navajo Indians that inhabited northern Arizona and southern Utah.[7]

This lack of appreciation and general disdain for the entire Colorado Plateau largely continued until the discovery of radioactive minerals in the area at the turn of the 20th century.[8] Initially however, the uranium produced was considered to be a waste product of radium and vanadium, both of which were used for industrial and medical purposes.[9] It was not until the exploration and development of nuclear weapons in the early 1940s that uranium's true potential became known and its value became apparent to the United States government.[10] During the Cold War, the United States greatly increased the production

of uranium on the Colorado Plateau in order to develop the nuclear warheads necessary to keep up with the Soviet Union.[11] Uranium ***29** was also mined to fuel nuclear reactors that the United States planned to build in an effort to meet the energy needs of a post-war economy. In 1955, the U.S government was effectively operating roughly 800 uranium mines on the Colorado Plateau that were producing high grade, tradable ore.[12]

However, by the 1970s, the United States had amassed ample supplies of uranium. This stockpile was sufficient to allow the Atomic Energy Commission (AEC) to effectively stop buying uranium.[13] This, combined with the fact that many of the anticipated nuclear power reactors were never built and an increasing fear of nuclear energy caused by the Three Mile Island and Chernobyl accidents, led to a precipitous drop in uranium prices and a near cessation of uranium mining in the 1980s.[14] Uranium prices fell from an all-time high of almost $45 a pound in the late 1970s to $7.30 a pound by 1991.[15] A myriad of factors, spearheaded by plummeting prices, led to a reduction of United States uranium production from 44 million pounds a year in 1980 to barely 1 million pounds a year by 1992.[16] However, in recent years the uranium industry has seen a resurgence, with mines in the United States producing a total of 4.9 million pounds of triuranium octoxide (a compound of uranium) in 2014--a 7% increase from 2013.[17] This increase in uranium production is mostly due to increased interest in expanding renewable or semi-renewable energies to combat the precipitous rise of the greenhouse gasses ***30** that contribute to climate change.[18] Increased uranium production also provides a domestic fuel source to compete with foreign oil.

On the Colorado Plateau, uranium mining followed the trend of the rest of the country. After uranium was found on the Navajo Nation in the 1940s and 1950s, uranium mining took off in order to supply the needs of the United States' weapons program.[19] However, in the 1970s uranium mining effectively ceased on Navajo land and many mines were either improperly sealed or simply left open to the surrounding environment.[20] The environmental damage that resulted from the improper cleanup of shuttered uranium mines has since caused the the Navajo Nation to ban any further uranium mining on their lands.[21] Current uranium mining and exploration is confined to an area north of the Grand Canyon commonly referred to as the Arizona Strip.[22]

Presently, there are no operating uranium mines in the Arizona Strip. The last two mines, the Arizona 1 and the Pine Nut, temporarily ceased operations in 2014 because falling uranium prices made production non-viable.[23] These mines (along with the Kanab North mine which was shut down in 1991) have been placed on standby status until mineral prices increase to the point at which mining will again be economically feasible.[24] A twenty-year government ban on new ***31** uranium mining claims in the Grand Canyon region makes these standby mines essential to future mining in the area.[25]

When mines are placed on standby status, regular maintenance is performed. With uranium prices beginning to inch upwards, economic viability is becoming more likely. To further encourage the uranium industry to resume mining on the Colorado Plateau in Northern Arizona, the Uranium Producers of America has recently published findings showing that there are approximately 13 million pounds of uranium contained in Northern Arizona's collapsed breccia pipes, the majority of which contain high grade ore.[26] In fact, the Arizona Strip contains the highest grade or uranium deposits identified in the United States, making the area attractive to producers.

Uranium Geology of the Colorado Plateau and Extraction Methods

Uranium is most commonly found in two types of deposits: roll front and breccia pipe. For the purposes of this article, only breccia pipes will be discussed in depth. This is due to the fact that a majority of the uranium deposits found on the Colorado Plateau are found in breccia pipes and thus are most closely linked to the purpose of this article. Roughly 1,300 breccia pipes have been discovered in the Grand Canyon region of the Colorado Plateau alone.[27]

Breccia pipes are vertical or nearly vertical cylindrical collections of broken rock found almost exclusively in Northern Arizona.[28] These deposits range from 30 to 175 meters in ***32** diameter and may extend up to 1,000 meters below the surface.[29] Due to the fact that many pipes are made of rocks from stratigraphically higher formations, it is generally accepted that the pipes were formed when the underlying Redwall Limestone dissolved and created caves.[30] With the aid of modern geologic dating techniques, geologists have determined that the dissolution of the Redwall Limestone occurred during the late Mississippian period, roughly 330 million years ago.[31] Some of the remaining caves can be seen within the walls of the Grand Canyon. When these caves collapsed, the overlying sandstone and limestone formations subsided into the resulting sinkhole and created an amalgamation of rock that has since been cemented together by a naturally occurring carbonate solution.[32] From the surface, these collapsed pipes leave a cone-like depression in the land that can be up to a mile in

diameter.[33] The reason for this enlargement is the dissolution of the Permian gypsum and limestone beds both within and immediately adjacent to the breccia pipes themselves.[34] These depressions can commonly be seen from the air and are often used as a guide for prospectors when exploring a region for possible mineral deposits.

The uranium that is found within the breccia pipe formation usually lies further down in the geological strata.[35] The main uranium mineralization events occurred some time after the Triassic Chinle deposit formed, roughly 200 million years ago.[36] On the Colorado Plateau, much of the uranium found has been located at the level of the Hermit Shale and Esplanade Sandstone ***33** rock formations.[37] Typically, most of the uranium that is economically valuable is mineralized as uraninite.[38] On the surface, mineralization of the underlying breccia pipe is indicated by modestly raised levels of gamma radiation and the presence of copper minerals, barite, calcite, and goethite.[39]

Extraction Methods

The extraction of uranium ore often occurs by one of two methods: open pit mining or traditional underground mining.[40] Open pit mining occurs when the surface rock is stripped away, revealing the uranium ore located beneath the surface.[41] However, due to the depth of the uranium ore commonly found in Colorado Plateau breccia pipes, this process is rarely used unless the uranium deposit is less than 400 feet from the surface.[42] Additionally, ore grades mined by open pit methods are often less than 0.5%.[43] A more commonly used method is traditional underground mining. Underground mining uses shafts and other openings to access and extract the uranium ore at lower geological elevations. Many existing uranium mines on the Colorado Plateau use this method of extraction.[44]

After extraction, the ore is separated based on the amount of uranium found within the rock. Overburden, or ore that contains low levels of uranium not economically feasible to mill, is often sent to large waste piles that contain elevated concentrations of radioisotopes.[45] This waste rock is rarely further processed. The ore that does contain sufficient levels of uranium to make ***34** further refinement profitable is sent to a mill where it is processed to create "yellow cake."[46] When the raw ore reaches the mill, it is crushed, ground, and often treated with sulfuric acid to dissolve the uranium present in the crushed rock.[47] The dissolved uranium is then recovered from the solution.[48] Even though the uranium contains impurities, it is packaged and shipped as yellow cake.[49] Yellow cake uranium is typically used as fuel to be consumed in nuclear reactors.[50] The remaining waste by-product is then stored in specially designed waste containers due to the radioactive nature of the ore.[51]

While the milling process removes 90 to 95% of the uranium from the ore, only 0.1% of the initial grade ore is processed. The remaining 99.9% of raw materials are discarded as sludge.[52] The refining process is specifically designed to remove only triuranium octoxide, leaving behind other minerals with long half-lives in the sludge. The remaining sludge can contain up to 85% of the initial radioactivity of the ore due to the presence of the other radioactive minerals not targeted by the refinement process.[53] During the enhancement process, harmful minerals found within the ore are freed from relatively safe confinement in the natural rock into a potentially much more environmentally harmful fine sand.[54] The toxic chemical, radon-222 (radon gas), is produced as a by-product of the milling process.[55] Radon gas can be easily spread by the wind, but because its half-life is a mere 3.8 days, the gas does not present a ***35** significant risk unless it is continuously produced.[56] However, radon gas is constantly produced by the decay of radium-226 which has a half-life of 1,600 years.[57] The containment of uranium milling by-products is a lengthy process and requires continual maintenance because of the long half-lives of radon gas producing radium 226 and another radioactive by-product, thorium-230.[58]

Another process used to extract uranium is in-situ recovery mining or in-situ leaching. In this process, water is pumped from the rock formation and an oxidant, often gaseous oxygen and sodium bicarbonate, is pumped into the resulting void.[59] By adding the solution of gaseous oxygen and carbonate into the uranium-rich, porous sandstone, the uranium is dissolved and absorbed into the solution.[60] In this method, injection wells are placed at a specific distance and in a particular pattern in order to maximize the rock that is exposed to the solution.[61] Extraction wells are also placed at a prescribed distance from the injection points to extract the newly uranium-enriched solution from the rock.[62] These pumps also serve to mitigate the amount of uranium-enriched solution that travels outside of the mining area by pumping more water into the ground than is extracted.[63] This creates a depression cone that uses gravity to draw the solution down to the middle of the field, rather than allowing it to leach and expand into the surrounding countryside.[64]

After the water solution is extracted from the ground, the water is filtered to remove the uranium that was dissolved into the solution during the leaching process.[65] When all of the uranium has been removed from the solution, the water is refreshed

with the original mixture of ***36** oxygen and a sodium bicarbonate and is then pumped back into the ground to begin the process again.[66] The extracted uranium is then processed into yellow cake much in the same way crushed ore from open pit and traditional mining processes is treated for marketability.[67]

The in-situ leaching process for uranium extraction is preferable to other methods such as open pit and traditional underground mining because it exposes workers to lower levels of radiation and creates less waste rock.[68] The surface area needed for in-situ leaching operations is small compared to open pit and underground mining operations, thus allowing for other surface uses.[69] Although in-situ leaching provides many benefits for miners and the surrounding environment, the possibility of radiation laden waters leaching into surrounding aquifers has kept environmentalists on edge.[70] To help alleviate some of the possible environmental issues surrounding in-situ leaching, the United States government has promulgated regulations governing the cleanup of leaching areas.[71] The regulations require that the aquifer from which the uranium was extracted be restored to pre-leaching conditions.[72] Despite these regulations, recent studies have shown that total restoration is almost impossible.[73]

Regardless of which method is used to extract uranium, United States mining law regulates how it can be done, by whom, where, and how it is to be cleaned up. The major piece of legislation that regulates uranium mining practices in the United States is NEPA.

***37 The Legal Side of Things**

NEPA was passed in 1970 with the goal of creating a broad, national framework for protecting the environment and the natural resources of the United States.[74] The basic policy of NEPA is to ensure that government agencies give due consideration to the environment before undertaking any major federal action that would substantially affect the environment.[75] Examples of such major federal actions include the building of airports, highways, defense actions, and mining.[76] After the EPA has determined that a major federal action is to be undertaken, various assessments and evaluations are done to determine if the action is worth the possible degradation to the environment and, if possible, what measures can be taken to mitigate the environmental impact of the action.[77] Although it is not one of the more prominent regulatory schemes in the American psyche, NEPA plays a vital role in the day-to-day functions of the American economy.

NEPA went into effect on January 1, 1970, signaling a new era of environmental protectionism within the United States government.[78] Initially, NEPA was a small concise document creating the Council on Environmental Quality (CEQ), and required agencies to prepare and review environmental impact statements whenever a major federal action had the potential to have a significant effect on the environment.[79] During the 1970s, the CEQ made major advancements in environmental policy and created an extensive network of environmental programs, which included amendments to the Toxic Substances Control Act, the Federal Water ***38** Pollution Control Act, and the Safe Drinking Water Act.[80] Due to a refusal on the part of the United States Department of Transportation to release agency comments on the environmental impact statement (EIS) of a new project, the CEQ amended the Clean Air Act to require that the EPA comment on all EISs and that the EPA's comments be made public.[81] This laid the groundwork for allowing the EPA to have a large voice in what constituted substantial federal action triggering NEPA requirements.

The law's effect was drastic and immediately apparent. The AEC's nuclear licensing process was halted for more than a year after a court found that the commission was not in compliance with the regulations contained in the new law.[82] Drilling for oil off the coast, and a multitude of other actions or proposed actions, were either denied or delayed until proper EISs were prepared and reviewed.[83] However, while the new law had achieved its goal of providing for increased environmental protection, it also resulted in unintended consequences. Issues arose when courts interpreted NEPA to cover not only those actions that directly affect the environment but those that have an indirect impact as well.[84] Housing projects were challenged not because of their possible effect on the environment, but because of neighborhood concerns; building permits were challenged because of the unwelcomed change in aesthetics.[85] The law essentially allowed people and organizations to challenge any federal action that they opposed by stating they had an interest in the possible effects the actions would have on the environment.[86] The opposition's goal was to delay or prevent projects that easily would have been approved ***39** prior to NEPA's enactment.[87] Despite all the problems and delays caused by NEPA, the increased environmental safeguards have been a testament to its success. Today, few projects are rejected due to prior planning by government agencies to implement increased precautions that would not exist if not for NEPA.[88]

The most important and intriguing aspect of NEPA is the requirement that all federal agencies proposing a major federal action must prepare an EIS before the action can go forward. The requirement in and of itself is fairly straightforward. However, finding a definition for what constitutes a major federal action is not. Because NEPA regulates everything from offshore drilling to the building of a new field office on federal land, what constitutes a major federal action may be considerably varied. *Center of Biological Diversity v. Salazar*, centers precisely on this question.[89]

Legal Problems on the Plateau

In *Salazar*, the Center for Biological Diversity, along with the Grand Canyon Trust, the Sierra Club, the Kaibab Band of Paiute Indians, and the Havasupai Native American tribe, challenged the BLM's ruling that Denison Corporation, a mining company, did not need to submit a new plan of operations.[90] Denison was seeking to resume uranium mining on the Colorado Plateau after a 17-year hiatus.[91] The plaintiffs argued that resuming uranium mining at a previously dormant mining site constituted a "major federal action" necessary to trigger the need for a new environmental analysis under NEPA.[92] However, the Ninth Circuit sided with the BLM, and found that the previous environmental assessment was still valid based on the ***40** maintenance efforts undertaken by the mining company during the time the mine was on standby status.[93] This ruling exposed a potentially dangerous loophole in NEPA regulations that would allow operators like Denison to resume operations that could be harmful to the environment simply because the BLM approved an EIS they submitted many years prior.

In 1988, Energy Fuels Nuclear submitted a plan of operation to the BLM in the hopes of securing approval and commencing uranium mining from the Arizona 1 claim.[94] After reviewing the plan of operations, the BLM prepared an environmental assessment and approved Energy Fuels Nuclears application, stating that the proposed plan would not cause "undue or unnecessary degradation of public lands" or "significantly affect the quality of the environment."[95] Denison operated at the Arizona 1 mine until, in 1992, a drastic drop in uranium prices made it uneconomical to continue producing at the site. Instead of completely closing the mine, the site was placed on standby management status in accordance with the original plan of operations approved by the BLM in 1988.[96] During this interim period, financial shortcomings forced Denison to relinquish control of the mine to International Uranium Corporation.[97] The two companies later merged in 2007.[98]

In 2007, the price of uranium began to rise precipitously and the economic viability of Arizona 1 increased exponentially.[99] In anticipation of the reopening of the mine, Denison applied for Aquifer and Air Quality Control permits from the state of Arizona.[100] In late 2009, Denison began applying the finishing touches in anticipation of the imminent reopening of the ***41** Arizona 1 mine.[101] Before the mine was able to commence operations, the plaintiffs filed a complaint in the United States District Court for the District of Arizona alleging that, due to the extended period of inactivity, the original plan of operations filed by Denison in 1988 was ineffective.[102] Even though litigation was pending, the Arizona 1 mine began operations by the end of 2009. In an attempt to halt operations at the site, the plaintiffs moved for a preliminary injunction.[103]

However, the District Court denied the preliminary injunction and issued an order of summary judgment in favor of the defendants.[104] The court found that the BLM had fulfilled its obligations when it reviewed and approved the initial 1998 plan of operations.[105] The plaintiffs still had standing to challenge the opening of the mine under NEPA, but the BLM's decision to allow the reopening of Arizona 1 was not arbitrary and capricious-- the necessary standard to overturn the decision.[106] The court also held that a new EIS was not necessary because the monitoring by the BLM during the time the mine was on standby and the increase in the reclamation bond amount did not constitute a major federal action necessary to trigger the need for a new EIS.[107] The plaintiffs filed an appeal with the Ninth Circuit claiming that the BLM was required to approve a new EIS due to the length of time the mine was on standby.[108] In addition, the plaintiffs argued that the issuance of a gravel permit, air quality control permit, and the updated reclamation bond all constituted the major federal action necessary to trigger the need for a new EIS.[109] The plaintiffs also argued that the granting of a free gravel permit by the BLM ***42** gave the operators of the Arizona 1 mine a free gravel source that would be used for a commercial purpose.[110] The plaintiffs alleged this was a violation of the BLM's authority.[111] The court ruled that although Denison may benefit commercially from the issuance of the permit, the public would also benefit from the use of the public road to be built and maintained with the gravel accessed by the permit.[112] The road would not only be used to access the mine but would also provide access to the area's cultural and recreational locations.[113] The Ninth Circuit affirmed the lower court's ruling on all challenges, effectively ending the appellant's chances of halting mining operations at the Arizona 1 site.

According to the Federal Land Policy and Management Act (FLPMA), the BLM must review all mining operations that occur on federal lands, regardless of the mineral being extracted.[114] FLPMA also gives the Secretary of the Interior the ability

to determine whether the mining operations will cause undue or unnecessary degradation of federal lands and establishes liability should the Secretary fail to protect the environmental integrity of the land.[115]

Also included in the FLPMA is the requirement that every plan of operation submitted to the BLM contain a plan for the management and maintenance of the mine during times of temporary closure, commonly referred to as an interim management plan.[116] After five years of inactivity, the BLM must review the mine's operation under the interim management plan and determine if the reclamation process should proceed or if the mine should be allowed to continue on its established course.[117] The FLPMA regulations do not require a plan of operations be ***43** terminated after five years, only that the plan be reviewed and possibly amended. If operations are revoked or suspended, the entire process must start anew, meaning a new EIS must be submitted and a new plan of operations must be approved by the BLM. A proposed amendment to the FLPMA would have only allowed a mine to stay on standby status for a period of 10 years before the plan of operations was terminated.[118] However, this proposal was ultimately rejected and there are currently no set time limits governing the length of time a mining operation can remain on standby, although a plan of operations "cannot be allowed to remain inactive and unreclaimed indefinitely."[119]

In *Salazar*, the Ninth Circuit ruled that the BLM and the Secretary of the Interior fully complied with the requirements laid out in both the FLPMA and NEPA when they found that neither a new plan of operations nor a new environmental assessment was needed when Denison sought to resume operations at the Arizona 1 mine after a 17-year hiatus.[120] The court reasoned that, because the mine had been operating according to the interim plan that was approved in 1988 and the approved plan carried a financial value, the plan was still valid and the transferability of the approved plan should be protected.[121] When International Uranium Corporation bought the mine in 1997 it undoubtedly relied on the fact that a valid interim plan was in place and thus, the costs of undergoing an additional environmental assessment and submitting a new plan of operations was presumably not included in the final cost calculations associated with resuming operations at the mine.

The court also held that an additional EIS was not required under NEPA because obtaining a gravel permit, air quality control permit, and an updated reclamation bond did not ***44** constitute a major federal action necessary to trigger the need for a new EIS.[122] The Court was not swayed by the appellants' contention that the procurement of the new permits was sufficient to trigger the requirement for a new EIS.[123] The court reasoned that, because the overarching plan of operations had been approved in 1988, no major federal actions remained.[124] By ruling against the appellants, the Ninth Circuit effectively stated that attaining additional permits after an original plan of operations had been approved did not qualify as a major federal action.[125] This rationale may set a dangerous precedent.

Although the Ninth Circuit's holding in *Salazar* may have exposed many dangerous loopholes, the holding was legally correct. The court held that the BLM and the Secretary of the Interior had complied with the procedures and regulations prescribed in both the FLPMA and NEPA for the regulation of mining operations on federal land.[126] The court also correctly gave deference to the BLM under the Administrative Procedure Act (APA).[127] The Ninth Circuit has previously held that deference is to be given to an agency's decision under the APA when the agency has considered the proper factors and no clear error of judgment has occurred.[128] In *Alaska Ctr. For Env't v. U.S. Forest Serv.,* the court stated that "[a]n agency cannot avoid its statutory responsibilities under NEPA merely by asserting that an activity it wishes to pursue will have an insignificant effect on the environment."[129] Here, the court properly found that the BLM and the Secretary of the Interior adequately supported their decision to not request a new EIS or ***45** plan of operations with the necessary facts by relying on the earlier approved plan of operations.[130]

Notwithstanding the legal validity of the BLM's conclusion that a new plan of operations was not necessary to resume the operation of the Arizona 1 mine, the ruling exposes a dangerous loophole in the FLPMA regulations governing the reopening of temporarily closed mining operations. By allowing a previously shuttered mine to reopen without requiring that a new environmental assessment and plan of operations be approved, the BLM's position seems to be that the technology used, and the common methods for mine maintenance at the time the original plan of operations was approved are still acceptable. While this may be true for mines that have been inactive for only a few years, the same cannot be said for a site that has not been in operation for 17 years. The BLM should consider changing the current regulations to include a time provision for stand-by status to address the problem that allowing a shuttered mine to reopen may pose.

At one point the BLM considered adding language to the FLPMA allowing the BLM to begin the reclamation process at a mine site after a period of 10 years of inactivity.[131] If this language were to be adopted, the BLM could also add a notification process to the reclamation procedure.[132] The agency would notify the mine owner that the bureau would begin the reclamation

process shortly and allow the owner to file for an extension, stating valid reasons to delay the permanent closure.[133] Under the current regulations, the BLM only reviews the operations of mines placed on standby after five years of inactivity.[134] Unfortunately, in many instances, the BLM inspectors are only able to conduct an interior inspection of the site and thus, ***46** are not obtaining a full picture of the operations and maintenance procedures that are underway at the site.[135] This allows mine operators to maintain inactive mines with minimal upkeep. In the FLPMA, Congress stated that "it is the policy of the United States that ... regulations and plans for the protection of public land areas of critical environmental concern be promptly developed."[136] Unfortunately, by failing to address the problem of indefinitely shuttered mines, Congress failed to achieve what they set out to do. By amending the current regulations to account for mines that may be on standby for decades, the BLM could accomplish the goals set out in FLPMA and ensure that the uranium mining industry is taking all necessary precautions to protect not only the environment, but workers and civilians living near mine sites.

The Current Battle

In August 2015, a petition concerning the regulation of so-called "zombie mines" was submitted to the United States Forest Service and the BLM by the Grand Canyon Trust, Native American tribes (predominantly led by the Havasupai tribe), and local governments.[137] The petition called for limits on how long mines can remain on standby status as well as requiring new environmental assessments when mine operators plan to reopen a site after a lengthy period of inactivity.[138] Not only did the petition call for regular inspection of inactive mines, but firm deadlines and long-term water monitoring in the area surrounding a mine and its waste product were also proposed.[139] The petition came in response to the increased demand for sources of ***47** alternative energy that led to the recent reopening of two mines in the Grand Canyon area and the proposed reopening of yet another by Energy Fuel Resources.[140]

The petition cited the accidental release of millions of gallons of toxic wastewater into a river in Southwestern Colorado in early August 2015.[141] Kevin Dahl, Arizona Senior Program Manager for the National Parks Conservation Association, voiced his concerns over the current regulations and their possible shortcomings, stating, "[f]ive million people visit the Grand Canyon every year. What if the water had arsenic or uranium in it? We would have to close up the park. Can you imagine closing one of our national landmarks due to toxic waste?"[142] Dahl is not alone in his concern over the seemingly lax regulations. In early August 2015, near Durango, Colorado, 3 million gallons of wastewater containing toxic minerals including zinc and iron spilled into the Animas River from the Gold King Mine.[143] At the time of the spill, the Gold King Mine was undergoing EPA inspections.[144] Environmentalist's concerns were further aggravated by the fact that the Animas River flows into a tributary of the Colorado River at Lake Powell.[145] While the shortcomings of the FLPMA have long been acknowledged, the spill at the Gold King Mine thrust the dangers of mining in the American Southwest into the national spotlight.[146]

***48** The Colorado River supplies water to almost 27 million Americans living in the Southwest and provides irrigation water for 15% of the nation's crops.[147] However, due to previous pollution and years of extended drought, some experts and academics have titled the river "the nation's most endangered waterway."[148] Researchers at the Scripps Institution of Oceanography have estimated that the river could effectively run dry in as little as 14 years.[149] With the river already in a precarious state, one would logically assume that substantial measures have been undertaken to protect the river from future pollution and destruction. However, that is simply not the case. In the last 10 years alone, uranium claims in the Colorado Rivers watershed have increased substantially and many existing mines on standby status have begun to shake off the cobwebs.[150] The location of many uranium mines on the Colorado Plateau, especially in the Grand Canyon region of the Colorado River, is particularly worrisome. The Arizona 1 mine, the target of the *Salazar* complaint, lies only six and a half miles from the Grand Canyon.[151] The proximity of many mines to one of the most important sources of fresh water in the country, along with the subpar history of uranium mining safety on the Colorado Plateau, has many in the area uneasy.[152] With the history of large scale mine spills in the area, the possibility for history to repeat itself has many with interests in the area erring on the side of caution.[153]

In the early morning hours of July 16, 1979, at a uranium mill on the Colorado Plateau in northwestern New Mexico, a dam holding back millions of gallons of radioactive wastewater ***49** broke, releasing toxic substances into a nearby river.[154] In what still stands as the largest release of radioactive material in American history, the Church Rock Mill spill released 1,100 tons of milling waste and 94 million gallons of radioactive wastewater into the nearby arroyo, contaminating 80 miles of streambed.[155] While the Gold King Mine did not reach this magnitude, it nonetheless was a rude awakening that mine spills are still possible. If a spill like this were to occur at one of the mines located in the vicinity of the Grand Canyon and the

Colorado River, the primary water source for Los Angeles, Phoenix, and Tucson could be compromised. Increasing the scrutiny of approval protocol for mines attempting to reopen after years of inactivity could potentially prevent similar disasters in the future.

Even absent a massive spill like the ones at Church Rock and Gold King, seepage of toxic chemicals resulting from uranium mining into the surrounding aquifers poses a significant cause for concern. On the Navajo reservation, it is estimated that roughly 30% of the population get their household water from unregulated sources because their homes are not serviced by Navajo Tribal Utility Authority (NTUA) public water systems.[156] Since 2006, the EPA and the Centers for Disease Control (CDC) have sampled 240 unregulated water sources on the Navajo Nation, finding that twenty nine exceeded drinking water standards for nucleotides, including uranium.[157] While a majority of these sources were exclusively used for livestock, some were also used for human consumption and domestic purposes.[158] To discourage the use of these water sources, signs have been posted warning potential consumers of the water that it is unsafe to ***50** drink.[159] Government agencies have undertaken extensive public outreach programs to warn that continuing to consume the water could pose health risks.[160] These programs not only included the publishing of announcements in local newspapers and the distribution of educational materials at fairs and other gatherings, but also workshops to teach citizens how to properly transport and store clean water and to educate local health providers on the early detection and treatment of uranium-related illnesses.[161]

As part of the effort to help provide safe drinking water to the inhabitants of Northern Arizona that currently rely on uranium-contaminated water, the Navajo Nation Department of Water Resources (NNDWR) and the NTUA are working with federal agencies to extend public water systems to more rural areas without piped water.[162] Since 2008, various government agencies have contributed $26 million to fourteen projects that will provide piped water to 788 homes and will benefit another 1,800 homes that previously relied on contaminated water sources for domestic use.[163] The NTUA and the Indian Health Service have also added seven new regulated hauling points, upgraded three existing stations and are planning to install five more to further increase public access to clean water.[164]

However, despite public outreach programs and other efforts to provide safe water to people living on the Navajo reservation, some citizens have no choice but to continue using the contaminated water.[165] "There's no other water source we have, there's no other well that they ***51** could tap into," said Wayne Lynch, a resident of Sanders, Arizona, a town of 630 residents sitting on the Navajo reservation at the Arizona-New Mexico border.[166] Lynch then cited the numerous instances of cancer in his family to drive home his message that more needs to be done to provide clean water to rural areas.[167] Prolonged consumption of uranium has been linked to kidney disease and radiation-induced cancer.[168] A recent test of wells near Sanders showed uranium levels of forty-seven parts per billion, greatly exceeding the legal limit of thirty parts per billion.[169] At the wells the Sanders Unified School District draws from, uranium levels were measured at thirty-seven parts per billion, still above the legal limit.[170] Because of the low quality of the surrounding well water, the school district has had to rely on bottled water for offices, schools, and teacher housing.[171] To rectify the issue, the water supplier for Sanders has had its certification pulled, leaving the door open for other suppliers to provide safe drinking water to the town.[172]

In an effort to further alleviate the lack of adequate drinking water where none is available, the NNDWR has implemented a pilot water hauling program with a $2.6 million grant from the EPA.[173] This program is designed to bring safe drinking water to homes that are a substantial distance away from the regulated hauling points, or where no hauling points currently exist.[174] By the time the program is fully functioning, roughly 3,000 homes are expected to be ***52** regularly serviced.[175] Although extensive efforts have been undertaken to clean up contaminated sources and provide areas with clean drinking water, another source of uranium is endangering the citizens of mine country.

Dust in the Wind

After mining operations ceased on the Colorado Plateau, many mines were abandoned and left open to the surrounding environment. The EPA estimates that there are currently over 500 abandoned uranium mines on the Colorado Plateau.[176] When many of these uranium mines closed their doors for the final time, they left their tailing piles exposed to the elements, allowing the wind to carry the toxic dust and radon gas across the landscape. A 1984 study found of the thirty-two Navajo men that participated in the study and had developed lung cancer, 72% had worked in uranium mines, suggesting a strong correlation between prolonged exposure to airborne radioactive particles and lung cancer.[177] Even long after many of the mining operations on the Plateau had ceased and the direct exposure had ended, the risk for respiratory problems and cancers was almost four times higher amongst former Navajo uranium miners than non-miners.[178] Of the 150 Navajo miners that

worked at the Shiprock, New Mexico uranium mine until 1970, 133 had died of lung cancer or various forms of fibrosis by 1980.[179] The link between uranium inhalation and forms of lung cancer has been strongly established.

Currently, over 1,000 open tunnels, unsealed pits, and uncovered radioactive waste piles lay dormant on the Navajo Reservation, with many families and communities living close by and ***53** oftentimes downwind.[180] A large cause for the current concern is the radioactive dust that is blown off of the uncovered mill tailings. For every 100 pounds of uranium ore processed, ninety pounds of radioactive tailings are produced.[181] These tailings cause much more damage to the surrounding community compared to standard mining activities, due to the increased exposure. Miners are not the only people exposed to the radiation from these dangerous millings piles. The entire community surrounding a tailing pile is effected whenever a gust of wind blows the unprotected dust over the surrounding landscape, forcing the toxic sand into homes, cars, and water sources. Recently, at the Pinenut Mine, levels of radioactive dust spiked in early January 2016, raising the fears of widespread contamination.[182]

While the federal government has taken steps to clean up and reclaim contaminated water sources, little has been done to try to contain the toxic milling sands that blow across the Navajo Nation. Although the EPA has identified over 500 abandoned uranium mines on the Navajo Nation, only a few have seen any sort of reclamation action in recent years.[183] Although the uranium industry can erect special fences around the perimeter of the mine to stop the spread of radioactive dust, tests conducted outside of the fences have shown that the fences are not particularly effective.[184] Reclamation of uranium mines on the Colorado Plateau will undoubtedly continue to be a lengthy process.

One possible solution to the airborne toxin problem is to implement a "best available technology economically achievable" (BATEA) standard for air pollutants on currently operating mines or mines planning to reopen. A BATEA standard for air pollutants from uranium mines ***54** would ensure that mine operators are using the best available technology to scrub the air surrounding the mine of harmful toxins produced by the uranium mining process. However, each mine operator would only be held to this standard to the extent of which it is economically feasible for them to do so. While BATEA standards are currently in place for effluent from uranium mining operations, no such standard currently exists for air pollution.[185] Implementing a BATEA standard for air pollutants would ensure that people living downwind, and the environment surrounding uranium mines, get the same protection from air pollutants as they do from effluent.

Conclusion

There is a distinct cycle of uranium miners abandoning their claims when they are no longer economically viable and then returning, possibly decades later, when the market rebounds. These naturally occurring fluctuations in the uranium industry are likely to continue as long as there is a market for newly mined uranium. With the current NEPA regulations, miners may continue to return to claims shuttered in the 1980s, decades into the future without having to submit a new plan of operations or environmental assessment. With added regulations that proscribe an exact timeframe that will trigger the need for a new plan of operations to be submitted, the BLM will be fully able to exercise the power it was given under NEPA to prevent the unnecessary or undue degradation of the land. Lawmakers must not forget that the original intentions of NEPA and the FLPMA were to protect the environment, not the economic interests of the mining industry. Adding time limits for interim management periods would also help protect the safety of future miners and the surrounding communities. This is a priority that has to ***55** be at the top of the list. The environmental degradation and harm to communities that has occurred as a result of uranium mining over the last 70 years cannot continue for the financial benefit of the mining industry. However, a complete ban on uranium mining is not the solution either. Maybe it is possible to have our yellow cake, and eat it too.

Footnotes

1 Ctr. for Biological Diversity v. Salazar, 706 F.3d 1085 (9th Cir. 2013).

2 *Id.* at 1092.

3 *Id.* at 1095.

[4] TRACI BRYNNE VOYLES, WASTELANDING: LEGACIES OF URANIUM MINING IN NAVAJO COUNTRY viii, 25 (2015).

[5] *Id.* at 27.

[6] *Id.* at viii.

[7] *Id.*

[8] *Uranium Mining and Activities, Past and Present: Update for the Arizona Game and Fish Department Commission*, GRAND CANYON TRUST, 2 (May 2007), http://www.grandcanyontrust.org/sites/default/files/gc_agfUraniumUpdate.pdf [hereafter GRAND CANYON TRUST].

[9] *Id.*; *Radium vs Vanadium*, COMPARISON OF METALS, http://www.comparisonofmetals.com/en/radium-vs-vanadium/comparison-27-39-0 (last visited March 11, 2016).

[10] GRAND CANYON TRUST, *supra* note 8, at 2.

[11] *Id.*

[12] *Id.*

[13] *Id.*

[14] Jon Sarche, *Company Bets That the Moribund Uranium Industry Will Heat Up*, L. A. TIMES, Dec. 14, 1997, http://articles.latimes.com/1997/dec/14/local/me-63841.

[15] *Id.*

[16] *Id.*

[17] U.S. ENERGY INFO. ADMIN., 2014 DOMESTIC URANIUM PRODUCTION REPORT, 8 (Apr. 2015), http://www.eia.gov/uranium/production/annual/pdf/dupr.pdf.

[18] STEPHANIE A. MALIN, THE PRICE OF NUCLEAR POWER: URANIUM COMMUNITIES AND ENVIRONMENTAL JUSTICE, 2 (2015).

[19] GRAND CANYON TRUST, *supra* note 8, at 2.

[20] *Id.*

[21] *Id.*

[22] H. Dean Garrett, *The Arizona Strip*, UTAH HISTORY ENCYCLOPEDIA, (Allen Kent Powell ed., 1994).

[23] Felicia Fonseca, *Company stops uranium mining in northern Arizona*, ARIZ. DAILY SUN (Nov 20, 2013), http://azdailysun.com/news/local/company-stops-uranium-mining-in-northern-arizona/article_2458c06e-51fa-11e3-84f8-001a4bcf887a.html.

[24] GRAND CANYON TRUST, *supra* note 8, at 3-4.

[25] *Keep the Canyon Grand*, GRAND CANYON TRUST, http://www.grandcanyontrust.org/keep-the-canyon-grand (last visited April 4, 2016).

[26] *Uranium Mining in America*, URANIUM PRODUCERS OF AMERICA, http://www.theupa.org/uranium_in_america/.

[27] Jon E. Spencer & Karen Wenrich, *Breccia-Pipe Uranium Mining in the Grand Canyon Region and Implications for Uranium Levels in Colorado River Water*, Ariz. GEOLOGICAL SURVEY, (Apr. 2011), http://azmemory.azlibrary.gov/cdm/singleitem/collection/statepubs/id/29325/rec/19.

[28] *Breccia Pipe Anatomy*, THE NAU PROJECT - URANIUM EXPLORATION IN NORTHERN ARIZONA, http://northern-arizona-uranium-project.com/breccia_pipe_anatomy [hereinafter NAU].

[29] Warren I. Finch, *Descriptive Model of Solution Collapse, Breccia Pipe Uranium Deposits*, U.S. GEOLOGICAL SURVEY, http://pubs.usgs.gov/bul/b2004/model32e.pdf.

[30] NAU, *supra* note 28.

[31] Karen J. Wenrich & Hoyt B. Sutphin, *Recognition of Breccia Pipes in Northern Arizona*, Vol. 18, No.1, Ariz. Bureau of Geology and Mineral Technologies: Fieldnotes (1988) http://azgs.az.gov/Mineral%20Scans/Breccia%20Pipes.pdf.

[32] NAU, *supra* note 28.

[33] *Id.*

[34] *Id.*

[35] *Id.*

[36] Wenrich & Stutphin, *supra* note 31, at 2.

[37] *Id.* at 3.

[38] NAU, *supra* note 28.

[39] *Id.*

[40] U.S. NUCLEAR REGULATORY COMM'N, URANIUM RECOVERY (EXTRACTION) METHODS, (May 4, 2015),

http://www.nrc.gov/materials/uranium-recovery/extraction-methods.html.

41 GRAND CANYON TRUST, *supra* note 8, at 6.

42 Dana S. Ulmer-Scholle, *Uranium- How is it Mined?,* NEW MEXICO BUREAU OF GEOLOGY AND MINERAL RES. (Jan 7, 2016), https://geoinfo.nmt.edu/resources/uranium/mining.html.

43 GRAND CANYON TRUST, *supra* note 8, at 7.

44 *Id.* at 6.

45 *Id.*

46 *Id.* at 7.

47 *Id.*

48 *Id.*

49 *Id.*

50 U. S. NUCLEAR REGULATORY COMM'N, YELLOWCAKE, (June 21, 2016), http://www.nrc.gov/reading-rm/basic-ref/glossary/yellowcake.html.

51 *Id.*

52 U. S. NUCLEAR REGULATORY COMM'N, CONVENTIONAL URANIUM MILLS (May 26, 2015), http://www.nrc.gov/materials/uranium-recovery/extraction-methods/conventional-mills.html; GRAND CANYON TRUST, *supra* note 8, at 7.

53 GRAND CANYON TRUST, *supra* note 8, at 7.

54 *Id.*

55 *See Id.*

56 *Id.*

57 *Id.*

58 *Id.*

59 Ulmer-Scholle, *supra* note 42.

[60] *Id.*

[61] *Id.*

[62] *Id.*

[63] *Id.*

[64] *Id.*

[65] *Id.*

[66] *Id.*

[67] *Id.*

[68] *Id.*

[69] *Id.*

[70] Geoffrey H. Fettus Matthew G. McKinzie, *Nuclear Fuel's Dirty Beginnings: Environmental Damage and Public Health Risks from Uranium Mining in the American West*, NATURAL RESOURCES DEFENSE COUNCIL, 40 (Mar. 2012), https://www.nrdc.org/sites/default/files/uranium-mining-report.pdf.

[71] Ulmer-Scholle, *supra* note 42.

[72] GRAND CANYON TRUST, *supra* note 8, at 10.

[73] *Id.*

[74] *See* U. S. ENVTL. PROT. AGENCY, SUMMARY OF THE NAT'L ENVTL. POLICY ACT, (last updated Aug. 2, 2016), https://www.epa.gov/laws-regulations/summary-national-environmental-policy-act.

[75] *Id.*

[76] *Id.*

[77] *See* U. S. ENVTL. PROT. AGENCY, WHAT IS THE NAT'L ENVTL. POLICY ACT?, (last updated Aug. 31, 2016), https://www.epa.gov/nepa/what-national-environmental-policy-act.

[78] *Id.*

[79] Alvin L. Alm, *1988 Article on NEPA*: *Past, Present, and Future*, U. S. ENVTL. PROT. AGENCY (Jan.-Feb. 1988), https://www.epa.gov/aboutepa/1988-article-nepa-past-present-and-future.

[80] *Id.*

[81] *Id.*

[82] *Id.*

[83] *Id.*

[84] *Id.*

[85] *Id.*

[86] *Id.*

[87] *Id.*

[88] *Id.*

[89] Ctr. for Biological Diversity v. Salazar, 706 F.3d 1085 (9th Cir. 2013).

[90] *Id.*

[91] *Id.* at 1088-89.

[92] *Id.* at 1095.

[93] *Id.* at 1088.

[94] David Iannella, *Arizona's "Zombie" Uranium Mines: Lax Regulations Threaten Los Angeles Tap Water*, 41 B.C. ENVTL. AFF. L. REV. 54, 56 (2014).

[95] *Id.*

[96] *Id.* at 56.

[97] *Id.* at 57.

[98] *Id.*

[99] *Id.* at 55.

[100] *Id.* at 57.

[101] *Id.* at 58.

[102] *Id.*

[103] Ctr. for Biological Diversity v. Salazar, 706 F.3d 1085, 1089 (9th Cir. 2013).

[104] *Id.*

[105] Iannella, *supra* note 94, at 58.

[106] *Id.*

[107] *Id.*

[108] *Id.* at 59.

[109] *Id.*

[110] *Id.* at 64.

[111] *Id.*

[112] *Id.*

[113] *Id.* at 64.

[114] *Id.* at 60.

[115] *Id.*

[116] Federal Land Policy and Management Act of 1976, Pub. L. 94-579, 90 Stat. 2782.

[117] Iannella, *supra* note 94, at 61.

[118] *Id.* at 62.

[119] *Id.* at 63. (quoting Mining Claims Under the General Mining Laws; Surface Management, 65 Fed. Reg. at 70,054).

[120] Ctr. for Biological Diversity v. Salazar, 706 F.3d 1085, 1094 (9th Cir. 2013).

[121] Iannella, *supra* note 94, at 63.

[122] Salazar, 706 F.3d at 1095.

[123] *Id.*

[124] *Id.* at 1095-96.

[125] *Id.*

[126] Iannella, *supra* note 94, at 64-65.

[127] *Id.* at 64.

[128] Alaska Ctr. For Env't v. U.S. Forest Serv., 189 F.3d 851, 859 (9th Cir. 1999) (citing Marsh v. Or. Nat. Res. Council, 490 U.S. 360, 378 (1989)).

[129] *Id.* at 859 (citing Jones v. Gordon, 792 F.2d 821, 827 (9th Cir. 1986) (quoting Steamboaters v. FERC, 759 F.2d 1382 (9th Cir. 1985))).

[130] Salazar, 706 F.3d at 1098.

[131] Iannella, *supra* note 94, at 62.

[132] *Id.* at 66.

[133] *Id.*

[134] Salazar, 706 F.3d at 1092.

[135] *Id.*

[136] 43 U.S.C. § 1701(a)(11).

[137] Melissa Sevigny, *N. Arizona 'Zombie Mine' Petition Calls For Reform On Public Lands*, KJZZ (Aug. 25, 2015, 5 AM), http://www2.kjzz.org/content/182512/n-arizona-zombie-mine-petition-calls-reform-public-lands.

[138] *Id.*

[139] *Id.*

[140] *Id.*

[141] Tyler Scholes, *Groups Ask Feds to Tighten Mining Rules in Light of Spill*, ARIZONA DAILY STAR (Aug. 29, 2015), http://tucson.com/business/local/groups-asks-feds-to-tighten-mining-rules-in-light-of/article_8af8bdc9-7762-544d-9590-8bdc245652fa.html.

[142] *Id.*

[143] *Id.*

[144] *Id.*

[145] *Id.*

[146] Alan Neuhauser, *EPA to Blame for 'Preventable' Gold King Mine Spill*, U.S. NEWS AND WORLD REPORT (Oct. 15, 2015, 5:55 PM), http://www.usnews.com/news/articles/2015/10/22/epa-to-blame-for-preventable-gold-king-mine-spill-interior-dept-finds.

[147] Abraham Lustgarten & David Hasemeyer, *Colorado River May Face Fight of it's Life*, THE SAN DIEGO UNION TRIBUNE (Dec. 21, 2008, 12:02 AM), https://perma.cc/TK5U-WTV5.

[148] *Id.*

[149] *Id.*

[150] *Id.*

[151] Iannella, *supra* note 94, at 55.

[152] Lustagrten, *supra* note 147.

[153] *Id.*

[154] Marley Shebala, *Poison in the Earth: 1979 Church Rock Spill a Symbol for Uranium Dangers*, NAVAJO TIMES (Jul. 23, 2009), http://navajotimes.com/news/2009/0709/072309uranium.php.

[155] *Id.*

[156] U.S. ENVTL. PROT. AGENCY, NAVAJO NATION: CLEANING UP ABANDONED URANIUM MINES - PROVIDING SAFE DRINKING WATER IN AREAS WITH ABANDONED URANIUM MINES, epa.gov, https://www.epa.gov/navajo-nation-uranium-cleanup/providing-safe-drinking-water-areas-abandoned-uranium-mines [hereinafter PROVIDING SAFE DRINKING WATER IN AREAS WITH ABANDONED URANIUM MINES].

[157] *Id.*

[158] *Id.*

[159] *Id.*

[160] U.S. ENVTL. PROT. AGENCY, NAVAJO NATION: CLEANING UP ABANDONED URANIUM MINES - WORKING WITH COMMUNITIES ON CLEANING UP ABANDONED URANIUM MINES, epa.gov, https://www.epa.gov/navajo-nation-uranium-cleanup/working-communities-cleaning-abandoned-uranium-mines.

[161] *Id.*

[162] PROVIDING SAFE DRINKING WATER IN AREAS WITH ABANDONED URANIUM MINES, *supra* note 156.

[163] *Id.*

[164] *Id.*

[165] Jessica Swarner, *Rez Uranium Mine Cleanup Pressed*, ARIZONA DAILY SUN (Feb. 2, 2016), http://azdailysun.com/news/local/rez-uranium-mine-cleanup-pressed/article_02c1c6c3-5caf-5d11-95d3-8fb4c38c59b7.html.

[166] *Id.*

[167] *Id.*

[168] Joe Dana & Nancy Harrison, *Research Into Arizona Town's Uranium-Contaminated Water Supply Sparks Change*, 12 NEWS (Apr. 10, 2016), http://www.12news.com/news/local/arizona/research-into-arizona-towns-uranium-contaminated-water-supply-sparks-change/124812713.

[169] Swarner, *supra* note 165.

[170] *Id.*

[171] *Id.*

[172] *Id.*

[173] U.S. ENVTL. PROT. AGENCY, FEDERAL ACTIONS TO ADDRESS IMPACTS OF URANIUM CONTAMINATION IN THE NAVAJO NATION, 6, https://www.epa.gov/sites/production/files/2016-06/documents/nn-five-year-plan-2014.pdf.

[174] *Id.* at 6.

[175] *Id.*

[176] U.S. ENVTL. PROT. AGENCY, NAVAJO NATION: CLEANING UP ABANDONED URANIUM MINES, https://www.epa.gov/navajo-nation-uranium-cleanup/cleaning-abandoned-uranium-mines [hereinafter CLEANUP]

[177] Carrie Arnold, *Once Upon A Mine: The Legacy of Uranium on the Navajo Nation*, ENVTL. HEALTH PERSPECTIVES, 122:A4, at A47, http://ehp.niehs.nih.gov/122-a44/.

[178] *Id.*

[179] Erin Klauk, *Human Health Impacts on the Navajo Nation from Uranium Mining*, INTEGRATING RES. & EDUC., http://serc.carleton.edu/research_education/nativelands/navajo/humanhealth.html (last visited Nov. 13, 2016).

[180] *Id.*

[181] Jovana J. Brown & Lori Lambert, Blowing in the Wind: The Navajo Nation and Uranium 5 (2010) (unpublished case study).

[182] Miriam Wasser, *Radioactive Dust Surges Near Mine Close to Grand Canyon*, PHOENIX NEW TIMES (Jan 4, 2016) http://www.phoenixnewtimes.com/news/radioactive-dust-surges-near-mine-close-to-grand-canyon-7942879.

[183] CLEANUP, *supra* note 176.

[184] Wasser, *supra* note 182.

[185] 40 C.F.R. § 421.323.