APPENDIX D: ENVIRONMENTAL BASELINE SECTION FROM OSMRE'S 2020 FINAL BIOLOGICAL ASSESSMENT

ENVIRONMENTAL BASELINE

The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early § 7 consultation, and the impact of State or private actions, which are contemporaneous with the consultation in process. 50 C.F.R. § 402.02. The key purpose of the environmental baseline is to describe the condition of the listed species and designated critical habitat that exist in the action area in the absence of the action subject to consultation. Thus, for this programmatic consultation on SMCRA mining regulations, the environmental baseline will include consideration of the major stressors influencing the current status of the species and critical habitat designations (see list of species and critical habitat analyzed within guild categories in this BA) in the absence of the SMCRA Title V regulatory programs governing federal and state surface coal mining and surface effects of underground coal mining, as well as reclamation activities.

Given the programmatic nature of this consultation on a nationwide regulatory program, this consultation relies on a generalized discussion of past and present activities that have influenced the status of species within the action area which are grouped as guilds for the purpose of this BA. As previously mentioned, more detailed, site-specific information contributing to the environmental baseline will be assessed for subsequent, individual permit decisions made by states via the technical assistance process (i.e., the exchange of information with the Service as required under SMCRA implementing regulations and described in the description of the action), or for subsequent, individual permit decisions made by OSMRE that are subject to ESA § 7(a)(2) requirements. 30 U.S.C. § 1536(a)(2).

With respect to the guilds considered in this BA, the major factors associated with effects on species in the action area are associated with habitat modification and destruction, pollution, harvesting, other anthropogenic activities, and the effects of surface coal mining and the surface effects of underground coal mining. Additionally, the effects of climate change are generally considered.

Consideration of Climate Change

Since climate change is a long-term process primarily driven by a combination of past emissions of greenhouse gases (GHGs), the effects of climate change are appropriately part of the environmental baseline. The local effects from forecasted levels of global climatic change are likely to impact, to some degree, all of the species discussed in this BA.

"Climate" is the weather condition that occurs over long periods—typically decades (USGCRP 2018). Scientists use observations of climate indicators such as frequency of heat waves, annual precipitation, annual start of spring, and annual average surface temperature to construct present trends. Experts use climate models to forecast future conditions, typically at periods greater than a decade, based on assumptions about future atmospheric concentrations of GHGs and anticipated climate response to increasing concentrations of GHGs. Emission models are a key input to climate models. Emission models extrapolate from assumptions about prospective human behavior on a global scale—e.g., future worldwide trends in public policy, population and economic growth, and land use—to provide future GHG emission scenarios and modeled atmospheric concentrations of GHGs at given points in the future.

The Coupled Model Intercomparison Project (CMIP) is an international effort begun in the 1990's by multiple research organizations engaged in climate model development to produce, study, and compare climate simulations. Representative Concentration Pathways (RCPs) are the climate change scenarios used in CMIP5. The RCPs are not fully integrated scenarios of future socioeconomic conditions and resulting future emissions. Instead, as implied by the name, the focus of the RCPs is on the total amount of GHGs in the atmosphere and the resulting change in energy balance of the Earth measured at the top of the atmosphere. The four most frequently used RCPs are numbered according to the change in radiative forcing projected to occur by 2100 relative to the preindustrial period (IPCC, 2013). Thus, RCP 2.6 represents scenarios in which global mitigation of GHG emissions is achieved, and based on modeling experiments, is still believed to be technically achievable. RCPs with higher numbers correspond to higher emissions and resulting larger global temperature change. Therefore, RCP 8.5 represents a future that could be consistent with limited or no climate change mitigation policies. The two middle scenarios were chosen to be roughly equally spaced between the higher and lower scenarios. These RCPs, known collectively as "AR5," forecast widely diverging (through generally increasingly) levels of radiative forcing in the atmosphere beginning around 2050. Therefore, the anticipated level of climate change become significantly less certain over longer timeframes, while the presence of some level of change becomes more certain. For this reason, beyond a certain level, the magnitude and effects of climate change may not be "reasonably certain to occur" beyond mid-century. At that point, the atmospheric concentration levels forecast by AR5 begin to diverge dramatically. After this point, potential consequences from climate change may not be reasonably certain to occur because they are both remote in time and the result of a highly attenuated chain of events.

Additionally, most sources acknowledge that current climate models are not able to predict with sufficient precision the fine-scale climate impacts associated with a given level of global climate change, particularly at the local scale of habitats for threatened and endangered species. Compounding this difficulty, negative impacts to a portion of a species' habitat do not guarantee net-negative impacts to critical habitat as a whole. Thus, assessing the likelihood of adverse modification on a holistic basis may be difficult due to the lack of fine-scale precision in current climate models. Nonetheless, climate change is a currently existing threat to listed species, and any loss or shifting, or loss and shifting of habitat from climate change may increase the number of species classified as threatened or endangered as well as the potential for extinction of species already proposed or listed as threatened or endangered. As environmental conditions shift within a region, certain species within that area may be unable to adapt to the changing environment or be mobile enough to relocate to acceptable areas.

The Mining Process

This section contains a general description of the mining process. This section provides the reader with a basic understanding of the steps involved in coal removal and reclamation. This understanding is necessary to evaluate the effects mining may have on threatened and endangered species and critical habitats.

Both surface and underground (deep) mining occur in the area considered by this BA. The most common methods of surface mining are contour mining and area mining. The two most common underground mining methods are room-and-pillar and longwall mining. These methods are described in more detail below. In general, many of the activities and facilities associated with underground mining, such as excavations for portals and ventilation shafts, coal-cleaning facilities and coal stockpiles, buildings, equipment yards, and roads produce land disturbance (clearing and grubbing vegetation) similar to that found at surface mines, albeit often at a smaller scale. Other effects of underground mining can have a more dramatic influence on the surface, such as subsidence. Subsidence can impair surface and groundwater systems (Iannacchione, 2011). Ground movement under streams can be predicted and the location and size of protective coal barriers can be determined (Agioutantis, Karmis, & Kirby, 2013). From their study of undermined Appalachian streams, Karmis & Agioutantis (2015) found that the effects of longwall mining can be successfully controlled and mitigated.

Surface Mining

Contour Mining

Contour mining takes place in mountainous terrain or in areas with rolling topography. Excavation progresses along the outcrop of a coal seam, moving inward towards the mountaintop or ridge core. Mine cuts wrap around mountaintops or ridge lines in a pattern that parallels topographic contours. Contour cuts may be conducted on multiple seams on a given mountain or ridge line. Near the tip of a ridge line on a contour mining operation, "point removal" may occur where the coal seam is mined from the outcrop on one side of the narrow point, through the center of the ridge, and to the outcrop on the opposite side of the point. This occurs where the overburden is shallow.

To begin a contour mine, an initial box (or first) cut is opened at the coal outcrop and excavated to the highwall limit, forming a mine pit. Spoil material from this first cut may be temporarily stockpiled on site for use in later backfilling, or it may be hauled to an excess spoil disposal area.

Spoil from successive cuts is hauled and placed along the trailing edge of the advancing mine pit. Contour mining may also be employed to recover lower-elevation coal seams on steep slopes, or used to access coal seams at areas where excess spoil might later be deposited.

Secondary coal extraction at surface mines that have reached the final limit of the highwall may use augers, highwall miners, and similar equipment that operates along the base of the highwall. Surface mines can use any combination of these methods to maximize coal recovery from a given parcel of land.

Area Mining

Area mining offers the advantages of a high coal recovery rate and high production rate potential. It also allows overburden placement that should easily restore a site to the approximate original contour (AOC). However, area mining requires a large capital investment and a large reserve base to be practical because of the large amount of spoil material that must be moved during the life of the mine. In steep slope areas, area mining may require disposal of large volumes of excess spoil, depending on how the mine operation is planned. Operators have the option of requesting a variance from AOC if that would be compatible with the postmining land use. In areas that have been previously mined, excess spoil may be used to reclaim unreclaimed areas, such as previously mined benches.

Area mines may begin by excavating an initial cut across the entire width of a flat or gently sloping area, mountaintop, or ridge line. Where acid-forming or other toxic-forming overburden is encountered, operators would be required to treat or develop special handling protocols to prevent the formation of acid or toxic mine drainage. In some areas of the country,operators segregate and bury acid-or toxic-forming materials to isolate the materials from oxygen and water or place them well below the groundwater table to prevent acid-or toxic-forming materials from coming into contact with oxygen, thus preventing the formation of acid or toxic mine drainage. In other geographic areas of the country, the potentially acid-or-toxic-forming material is promptly encapsulated to minimize weathering and leaching. Encapsulation occurs in an area of the mining operation that is high and dry, away from watercourses, and under no circumstances shall any of this material be put in a valley fill. Additionally, the material is put on a free draining pad of at least ten feet of coarse non-toxic material. It is covered with at least four feet of the most impervious material on the mine site. In areas of steeper slope, this initial cut may start as a contour cut on the lowest coal seam and progress inward until a final highwall height is established. Smaller equipment such as excavators, loaders, and dozers make these initial cuts and operate ahead of the advancing highwall to remove upper coal and create a flat working bench. In steep slope areas, such as the Appalachian Basin region, excess spoil from area mines is often placed in excess spoil disposal areas or transported to nearby unreclaimed pre-SMCRA open pits to facilitate reclamation.

Mountaintop Removal

Mountaintop removal mining is a subset of area mining that involves recovering an entire coal seam or seams from the outcrop on one side of a mountain or hill through to the outcrop on the other side. By removing substantially all overburden above the coal seam, the postmining topography will be a level plateau or gently rolling ground with no highwalls. Mountaintop removal mining represents a small percentage of the type of mining conducted and is generally restricted to the geography of Appalachia. Currently, only 59 of these operations exist comprising 29 permits in West Virginia, 26 in Kentucky, and four in Virginia. Many of these permits are not producing coal. For example, of the 29 mountaintop removal mining operations in West Virginia, only one permit has produced coal in 2019.

Under SMCRA, a permit for mountaintop removal mining may only be issued if the mining operation is granted a variance from the requirement to return mined ground to AOC, provided that the postmining land use satisfies SMCRA requirements. 30 U.S.C. § 1265(c), 30 C.F.R.

Parts 785, 816 and 824. Approved postmining land uses include industrial, commercial, residential, agricultural, or public facilities (including recreational facilities). A portion of the overburden generated from this mining practice is transported for permanent placement in excess spoil disposal areas. Mountaintop removal mining operations can require disposal of substantial amounts of spoil in excess spoil fills.

Surface Effects of Underground Mining

The two most common underground mining methods are room-and-pillar and longwall. Each method leaves some coal in place to maintain the roof stability of the mine during extraction. Coal pillars support the roof of the underground workings.

Surface disturbance and excavation are required to establish a mine's operational facilities, gain access to the coal seam by way of sloped, horizontal, or vertical entryways, and to construct ventilation shafts or degasification wells. During coal extraction, a portion of the strata above and below the coal seam may be removed with the coal. These waste earth materials, variously referred to as coal refuse or gob, are separated from the coal during processing. Coal processing waste is permanently stored most often at the surface in slurry impoundments or refuse piles.

Room-and-Pillar

Room-and-pillar mining involves the removal of blocks of coal (rooms) while leaving adjacent blocks of coal (pillars) arranged uniformly and large enough to support the mine's roof. Mine voids are inherently unstable within the earth's gravitational field and will eventually collapse. However, that event may not occur for many decades or centuries. Subsidence from modern room-and-pillar mining operations is not common, and surface expression of subsidence is isolated when it does occur. Subsidence from room-and-pillar mining occurs more quickly when retreat mining is conducted. Retreat mining occurs when pillars left for roof support are removed or reduced in volume as an operation leaves a mined area. Subsidence from retreat mining is considered to be "planned." Impacts of retreat mining are very similar to those from longwall mining.

Longwall

Longwall mining operations use specialized methods and equipment to safely remove large blocks of coal commonly referred to as panels. A typical longwall panel is 600-1500 feet (183-457 m) wide and 1-3 miles (1.6-4.8 km) long. The removal of coal by longwall methods can lead to surface subsidence and cause changes to surface topography and hydrology (Iannacchione 2011). The severity of surface expression depends on the seam thickness, depth-to-coal, and overlying geology. Very deep longwall mines may result in little to no surface expression.

Longwall panels are typically mined out parallel to each other and separated by lengths of narrower underground "chain pillars." Chain pillars are mined using room-and-pillar methods which, as stated above, do not commonly subside.

While mining methods can vary between individual mines, all share common exploration, permitting, and site development activities. The following section describes these common activities. Except for the exploration activity, citations to the regulations are generally avoided for simplicity's sake.

Exploration

Applicants may conduct exploration drilling or excavation to determine the location and quality of mineable coal. If the operation plans to remove 250 tons of coal or less, the operation is required to provide a notice of intent to explore (NOI). 30 C.F.R. § 772.11(a). This NOI must identify the proposed exploration area and include a description of the method of exploration to be used and the practices that will be followed to protect the environment in accordance with the coal exploration performance standards. 30 C.F.R. § 772.11(b)(3) and (5). If more than 250 tons of coal are planned to be removed, an exploration permit must be obtained. 30 C.F.R. § 772.12(a). The exploration permit must include "[a] description of any endangered or threatened species listed pursuant to the [ESA] identified within the proposed exploration area, 30 C.F.R. § 772.12(b)(9), and a map showing "the location of critical habitats of any endangered or threatened species listed pursuant to the [ESA]," *Id.* § 772.12(b)(12). SMCRA regulations require that before an exploration permit may be approved, the RA must find that the exploration and reclamation activities will not jeopardize the continued existence of an endangered or threatened species listed under the ESA or result in the destruction or adverse modification of critical habitat. *Id*. § 772.12(d)(2)(ii).

In addition, exploration operations that substantially disturb the natural land surface must comply with the performance standards at 30 C.F.R. § 772.13 and Part 815. These regulations prohibit the disturbance of habitats of unique or unusually high value for fish, wildlife, and other related environmental values and critical habitats of threatened or endangered species during coal exploration. 30 C.F.R. § 815.15(a). Furthermore, for federally owned coal, 43 C.F.R. § 3410.2-2(a)(2) specifies that threatened and endangered species should be protected on Federal lands: "No exploration license shall be issued if the exploration would . . . [j]eopardize the continued existence of a threatened or endangered species of fauna or flora or destroy or cause adverse modification to its critical habitat."

Disturbance from exploration operations usually involves building of temporary roads and drill pads. Exploration roads are required to be constructed, maintained, and reclaimed to the same standards as roads used for other purposes and must not seriously alter the normal flow of water in streambeds or drainage channels. Some excavation may also be conducted. All disturbed areas are required to be revegetated and drill holes are required to be sealed.

Permitting

The physical activity associated with permitting involves the collection of baseline information in accordance with the requirements of the regulations. Information is collected about hydrology, geology, vegetation, soils, water quality, existing land uses, proposed, threatened, and endangered species and designated critical habitat occurrences, and habitat suitability using a variety of field methods some of which may involve sampling. This information is used to develop a description of how the applicant plans to protect and enhance fish and wildlife resources. Issued permits continue to be monitored by the regulatory authority during the permit period, including a required mid-term permit review that considers, among other things, the current status of fish, wildlife, and related environmental values.

Erosion and Sedimentation Controls

Erosion and sedimentation control structures are constructed before any other surface disturbance. These structures include sedimentation ponds designed to prevent pollution of receiving streams and diversion ditches built to convey runoff from disturbed areas to the sedimentation ponds. Diversion ditches are also constructed around areas affected by mining to divert runoff from upslope areas to natural drainages. In some instances, alternative sediment control measures (ASCM) such as silt fences, rock check dams, sediment traps, or mulch may be employed. Examples of when ASCM may be appropriate include isolated disturbances away from the primary disturbed area, material stockpiles, and disturbance in advance of the pit until drainage flows to the pit.

Permanent or temporary stream relocations may be used to reroute streams around the mine. These activities may change the hydrology of a site. Construction techniques for temporary diversion channels focus on stability; minimal to no effort is expended to provide ecological functions. Permanent diversions are required to restore or approximate the premining characteristics of the original stream channel including the natural riparian vegetation to promote the recovery and the enhancement of the aquatic habitat.

Maintenance of sedimentation ponds may require removal of nuisance species (e.g., rodents, noxious weeds, trees) to maintain their structural integrity, and dredging of accumulated sediments to maintain storage capacity. Dredged materials are usually buried within the permit boundary. Ponds are either removed or left as permanent structures if approved as part of the postmining land use. Sedimentation ponds are typically removed by breaching the pond's dam in a controlled manner to prevent impacts to downstream waters. Permanently retained ponds are not monitored after final bond release; they are retained as habitat features for fish and wildlife, or to provide water for livestock. The landowner or permittee must assume the responsibility for maintenance of the pond before the regulatory authority may approve its retention as a permanent structure.

<u>Clearing and Grubbing</u>

This activity involves the removal of trees, stumps, shrubs, and other vegetation from the permitted area for the purpose of mining and reclamation activities. Vegetation is cleared away so topsoil can be more efficiently picked up for later use in reclamation. Topsoil is segregated in a process that typically removes the recoverable soil from mining areas to temporary stockpiles, which are seeded with fast-growing grass species that persist until the topsoil is needed for reclamation. Excess spoil disposal areas are cleared and grubbed to prepare the foundation to ensure stability before placement of fill.

<u>Blasting</u>

After the topsoil and subsoil layers are removed, blasting may be necessary to loosen the rock above the coal seam. To uncover coal reserves, the rocks overlying the coal are broken with explosives to aid excavation with various types of large earth-moving equipment. Mine operators drill holes to be loaded with explosives. The mine operator must develop a detailed blasting plan that demonstrates how the blasting operation will comply with regulations to prevent damage. A certified blaster must either conduct or directly supervise the loading and detonation of all surface coal mine blasts. 30 C.F.R. § 816.61(c). (Specific, to state regulatory authorities, *see, e.g.*, Indiana Div. Natural Res.).

Excavation of Overburden

Strata above the coal (layers of overburden) are fractured by blasting or by ripping with bulldozers. After fracturing, draglines, trucks, shovels, or other heavy equipment are used to remove the rocky overburden to expose the coal seam. The hole left after excavation is referred to as a mine pit. Overburden that is removed is known as spoil. As a result of the excavation process, this spoil material increases in volume because of the fracturing of competent rock strata, which results in the creation of many more voids. This increase in volume is commonly referred to as swell. In steep-slope areas, the spoil that exceeds the amount required to restore the approximate original contour must often be permanently placed in excess spoil fills constructed in the narrow valleys typical of steep-slope topography. Where potentially acid-forming or other toxic-forming overburden is encountered, SMCRA requires special handling of the material. Special handling methods ensure that potentially acid-forming or other toxic-forming overburden is placed in a manner to prevent formation of acid or toxic mine drainage. Stream channels are sometimes excavated or diverted to access underlying coal. Streams may be buried by excess spoil.

Coal Haulage

Haul roads are constructed to accommodate the widths of vehicles used at a specific mine. Roads can be 50 feet or more wide. The overall grade of a haul road normally does not exceed ten percent for ease of haulage and to minimize brake wear and failure.

Lengths of haul roads vary according to the distances necessary to access development, mining, and fill disposal areas. In steep slope areas, ditches are constructed on the uphill sides of haul roads to collect runoff, and culverts are placed at intervals to convey runoff under the road to the downhill side. In flatter terrain, ditches are constructed on both sides of each road, and the road is crowned to allow for drainage to both sides. Temporary haul roads to working areas are usually surfaced with crushed overburden materials; primary haul roads connecting to public roads are generally surfaced with gravel.

Coal may be transported from the mine site to a processing or power plant by rail, truck, or conveyor. Effects may occur from conveyor infrastructure installation, or road and rail construction and operation. Traffic on haul roads produces fugitive dust. Under SMCRA, operators are required to ensure that fugitive dust as a result of operations on permitted roads stays within the permit area. Operators typically use water drawn from on- or off-site sources to control dust. Operators are not required under SMCRA to abate dust generated by their vehicles while traveling on public roads.

Coal Processing

In many instances, coal must be processed before it is suitable for burning in a power plant or in an industrial or residential furnace. This may be done in a coal preparation plant at the mine site or at a coal preparation plant located elsewhere. Processing involves washing, crushing, and sorting coal to remove rock and other impurities from the coal. The waste produced, called refuse, can be a semi-liquid form known as slurry, or a drier form known as coarse refuse, or some combination of both. Slurry is typically pumped into impoundments for dewatering. Coarse refuse may be returned to the mine excavation or placed in constructed refuse piles.

Backfilling, Grading, Excess Spoil, and Coal Mine Waste

After coal removal, the mine operator places spoil in the mined-out area for reclamation. Under SMCRA, unless they receive a variance, the operator must grade the spoil to closely resemble the general premining surface topography. This is referred to as returning the reclaimed mine to the approximate original contour. In general, mine pits are backfilled with spoil to remove highwalls, spoil piles, and depressions; drainage is recreated to blend into surrounding drainage patterns, and the site is restored to its approximate original contour. Backfilling, also known as "backstacking" in steep slope areas, may be accomplished by a variety of methods, including casting by draglines or shovels, cast blasting, dozer pushes, and truck haulage and dumping. Sites that generate excess spoil must haul that spoil to excess spoil fills or other disposal fill types adjacent to the immediate mining area.

During these activities, spoil and waste is returned to the mined-out area (or placed in adjacent valleys), graded, and compacted to achieve site stability during replacement. During this activity spoil areas are shaped to final reclamation contours. Soil compaction of the growth medium on surface mines hinders survival and growth of planted trees and low compaction grading techniques enhance reforestation success (Sweigard et al., 2007a; Sweigard et al., 2007b). After spoil casting or haulage and dumping, spoil areas usually have a very irregular surface that may require grading to achieve a surface configuration that better resembles the natural land surface prior to mining, and that will support the postmining land use. Regrading of spoil is primarily accomplished by bulldozers, with the final site topography determined by the site reclamation plan and the approved postmining land use. Except for mountaintop removal mining operations, sites with steep-slope variances, sites with thin or thick overburden, and a few other limited situations, the permittee must restore the approximate original contour. The postmining land use in the southern Colorado Plateau region is typically rangeland and wildlife habitat whereby geomorphic reclamation is conducted in arid to semi-arid watersheds. Geomorphic reclamation aims to create a stable landform by reproducing the natural landform's evolution to the mature stage, resulting in stable slopes and channels, in balance with local environmental conditions (Vasquez and Sheley, 2018).

Areas in and around the riparian zone may be regraded to re-establish or approximate the original drainage patterns. In crop producing areas typical of the Illinois coal basin, land is regraded to meet farming needs. This generally produces uniform slopes and stream corridors, resulting in a similar but slightly more uniform landscape than before mining.

There are situations, particularly in steep terrain, where the volume of spoil is more than sufficient to return the reclaimed land to approximate original contour, or where stability concerns prevent the return of all spoil to the mined-out area when reclaiming the site. Surplus spoil material disposed of in locations other than the mined-out area, except for material used to blend spoil with surrounding terrain in achieving AOC in non-steep slope areas, is referred to as "excess spoil." In steep slope terrain, the permittee may place the excess spoil either in adjacent valleys or on previously mined sites.

Soils and Revegetation

Once the area is regraded, the topsoil that was removed and stored before mining is collected from its storage area and redistributed. However, if the topsoil is of insufficient quantity or of poor quality for sustaining vegetation, selected overburden layers may be substituted for or used as a supplement to topsoil if it can be shown they are as good as or better than the existing topsoil. When forest ecosystem restoration is the reclamation goal and native topsoil cannot be salvaged for mine soil construction, weathered rock spoils are generally superior to unweathered rock spoils as a topsoil substitute (Skousen et al., 2011; Zipper et al., 2012). Any topsoil substitute must be approved in the initial permit application.

Following spreading or preparation, the topsoil or topsoil substitute is planted and seeded with species mixes reflecting the intended postmining land use. Revegetation should be diverse, effective, and permanent; comprised of native species; be compatible with plant and animal species of the area; and meet the requirements of applicable State and Federal seed, poisonous, and noxious plant, and introduced species laws.

The Forestry Reclamation Approach (FRA) is a method for reclaiming coal-mined land to forest under SMCRA. The FRA approach is most commonly used in the Eastern part of the United States, but has also shown to be effective in Mid-Continent regions. The FRA is based on knowledge gained from both scientific research and experience (Angel et. al., 2005). The FRA can achieve cost effective regulatory compliance for coal operators while creating productive forests that generate value for their owners and provide watershed protection, wildlife habitat, and other environmental services (Burger et al., 2005).

The FRA can be summarized in five steps (Burger et. al., 2005): (1) Create a suitable rooting medium for good tree growth that is no less than four feet deep and comprised of topsoil, weathered sandstone and/or the best available material (Skousen et. al., 2011; Zipper et al., 2012); (2) loosely grade the topsoil or topsoil substitute established in step one to create a non-compacted growth medium (Sweigard et al., 2007a); (3) use ground covers that are compatible with growing trees (Buckley et al., 2008; Burger et al., 2009; Horn et al., 2017); (4) plant two types of trees—early successional species for wildlife and soil stability, and commercially valuable crop trees (Burger et al., 2009; Davis et al., 2012; French et al., 2015; Rathfon et al., 2015); and (5) use proper tree planting techniques (Davis et al., 2010). Implementation of the FRA has resulted in the planting of more high-value hardwood trees and has increased the survival rates and growth rates of those trees on reclaimed coal mined lands under SMCRA. The FRA expedites the establishment of forest habitat through natural succession (Groninger et al., 2007) and restores the ecological services of the pre-mining forest.

The FRA is supplanting grassland reclamation where forests are the logical postmining land use. Restoring forestland capability, native species, and watershed protection are positive outcomes. However, more intensive stream protection, water quality, biodiversity, carbon sequestration, native wildlife habitat, and human protection may require a more comprehensive ecosystem reclamation approach. (Burger 2011). The components of such an approach already have a good basis in science and could be applied through a process of adaptive management (Burger 2011).

Surface coal mining in Appalachia has caused extensive replacement of forest with non-forested land cover, much of which is unmanaged and unproductive (Zipper et al., 2011a; Zipper et al., 2011b). The quantity of Eastern U.S. mined lands that could be available for reforestation is on the order of 300,000 ha (Zipper et al., 2007). A modified version of the FRA is available to mitigate the impediments to restoring healthy, productive forests on mine sites initially reclaimed without the benefit of proper reforestation (Sweigard et al., 2007a; Burger et al., 2010; Burger et al., 2013).

Ecologically based invasive plant management should be directed toward preventing the introduction of invasive species, provide for their control, and minimize their economic, ecological and human health impacts (Boyce, 2002). Timely restoring canopy cover is essential to limiting invasive exotic plant species (IES). Applying the FRA is one method to successfully reforest active mine sites in the face of infestations of IES. Rapid establishment of a native-tree canopy sufficient to provide ground shading is a cost-effective means of IES management. Knowing which plants to avoid or not plant is also critical. Once plants of native species become established and begin growth, IES are less of a threat to reforestation success (Zipper et al., 2019).

More than two million acres have been surface mined in the Appalachians (Zipper et al. 2011a; OSMRE). Today, many mining firms are attempting to establish functional forests as a postmining land use. However, many of the lands that were surfacemined for coal and reclaimed to meet legal standards in the past do not support thriving forest ecosystems. These lands, referred to as “legacy” surface mines (Burger et al., 2013), are often dominated by IES which can interfere with successful reforestation (Zipper et al., 2011b). Guidance on methods to combat and control the spread of IES to ensure successful reforestation of legacy mines have been developed by research scientists and are being used on a routine and widespread basis (Adams et al., 2019).

A variety of small tree and shrub species can be planted along with crop trees during reforestation. Small tree and shrub species should be chosen for reforestation plantings based on their tolerance of site conditions, including geographic location, slope and soil type, pH, compaction, and herbaceous competition. The understory woody species should make up between 20 to 30 percent of the planted species. These species should be distributed over the planting area and should be planted in locations where they will have the best chance for survival. Understory woody species are important as wildlife food and cover and contribute to ecosystem development and multiple uses of the forest (Skousen et al., 2019; Brenner, 2000). Revegetation planting and seeding mixes are approved as part of the mine permitting process. If vegetation types or postmining land uses are proposed that differ from the premining land use of a site, then the change must be approved by the regulatory authority.

Clean Water Act and Stream Mitigation

Mining-related activities that impact streams may require mitigation under the Federal Water Pollution Control Act of 1972, 33 U.S.C. §§ 1251 *et seq.*, commonly referred to as the Clean

Water Act (CWA). Where these impacts are reasonably certain to occur, an approved CWA permit and mitigation plan may be coordinated between the U.S. Army Corps of Engineers, the Service, and the appropriate state water quality agency. SMCRA requires that operators comply with conditions of all related permits, including CWA § 404 permits, which may include a mitigation plan. 30 U.S.C. § 1344.

Bond Release

Before permit issuance, the applicant must file a performance bond with the regulatory authority. 30 U.S.C. § 1259. The bond is designed to guarantee that sufficient funds will be available to complete the approved reclamation plan in the event the permittee is unable to complete the required reclamation. The bond amount required for each bonded area must be determined by the regulatory authority and depends on the requirements of the approved permit and reclamation plan.

Bonds are typically released in three phases, with certain exceptions. Phase I bond releases are granted after satisfactory backfilling, regrading, and drainage control have been completed on the disturbed area. Phase II releases are granted after revegetation has been established. Phase III releases are granted after the revegetation responsibility period (which is either two, five, or ten years after the last year of augmented seeding, fertilization, or irrigation) has expired and all reclamation requirements of the permit and regulatory program are met. SMCRA jurisdiction terminates upon Phase III bond release.